The Contribution of Economic, Social and Environmental Factors to Life and Tourist Satisfaction

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Diane Jarvis

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College of Business, Law and Governance

James Cook University

Cairns Queensland 4870

Australia

Primary Supervisor: Professor Natalie Stoeckl

Co-supervisor: Dr Hong-Bo Liu

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Thesis committee

Professor Natalie Stoeckl, Tropical Leader, College of Business, James Cook University

Dr Hong-Bo Liu, College of Business, James Cook University

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Abstract

The world faces many different challenges such as climate change, refugee flows, terrorism, and the ongoing consequences of the global financial crisis. In response, many governments aim to foster economic growth, regarding GDP as an indicator for overall progress and a proxy for overall well-being.

However, research has shown that increasing GDP does not necessarily increase the levels of well-being or life satisfaction (LS) experienced by individuals, particularly within the developed world. Many different factors influence an individual's wellbeing; these factors are interrelated together forming a highly complex, dynamic system of which economic activity is just one part. A focus on GDP means that other factors that may contribute equally, or even more, to overall well-being than GDP may be ignored.

Economics is traditionally the science of choice and provides many tools and methods to consider trade-offs and choices; these methods work particularly well when considering trade-offs between priced goods or services, but it is more difficult to assess trade-offs between non-priced items. Difficult, but not impossible. Economics focuses on utility (historically assumed only measureable in ordinal terms), and revealed and stated preference valuation methods (such as contingent valuation and choice modelling) were developed to monetise the values of non-market goods.

That said, these traditional valuation methods restrict the researcher to investigating just a small part of the picture (perhaps looking at choice between option 1 rather than option 2) rather than taking a more holistic approach (whereby many different options are considered within the analysis). More recently it has emerged that LS can be used as a (cardinal) proxy for 'utility' which negates the need to rely on valuation methods that assume utility is only measurably ordinally and which allows researchers to take a more holistic view of 'value'. LS researchers seek to understand more about factors affecting people's overall LS – often regressing LS against a wide range of explanatory variables to determine which factors contribute most/least to LS.

The LS literature focuses on explaining variations in satisfaction with life to inform social policy, but the insights gained from this research approach need not be restricted to social policy. The LS approach is likely to be a useful tool for industry to evaluate customer satisfaction in commercial enterprises. Analogously, marketing studies sometimes rely, like

non-market valuation studies, on techniques such as choice modelling, to identify key factors contributing to customer satisfaction. Despite similarities (in both the underlying concepts and the methodologies adopted) between the study of what makes individuals satisfied with their lives (and thus what trade-offs they must face), and what makes customer satisfied with their purchases/choices in the commercial world (and thus what trade-offs they must face), as far as I am aware, no-one has investigated both using a conceptually parallel approach to see what lessons can be learnt from the comparison.

The overall aim of my thesis is thus to improve our understanding of the trade-offs that arise within complex interlinked social-economic-environmental systems. I focus on both trade-offs for social policy and trade-offs for industry. The region of Queensland, Australia, including urban and rural areas, adjacent to the Great Barrier Reef (GBR) is used as a study area primarily because of its natural beauty and abundance of resources which presents numerous trade-offs for assessment. The local economy, for example, is focused around three industries, mining, agriculture and tourism, all of which are based on using the environment, in sometimes competitive ways.

The thesis addresses four specific research objectives to fill a number of identified research gaps. Objectives one and two focus on the commercial sector, using tourism as the case study industry, investigating tourist trip satisfaction. Objectives three and four focus on the public sector, investigating residents LS.

Objective one is addressed in Chapter 3. First, I investigate the determinants of tourist trip satisfaction (TS). The insights I concentrate on here are those relating to the potential impact of climate change on tourism. Using (secondary) survey data collected from tourists visiting the GBR catchment region, I find that economic, social and environmental factors all influence TS, along with factors specific to the visit. I found that the relationship between maximum temperatures and TS is non-linear; it has an inverted U shape, with the average maximum daily temperature that optimises TS found to be just above 29 degrees centigrade. This finding could have significant implications for the tourism industry, across the world. Global warming could result in a redistribution of tourists between regions, with hotter regions suffering due to the negative relationship between temperatures and trip satisfaction above 29 degrees, whilst currently cooler regions benefit from the positive relationship between maximum temperatures and tourist satisfaction at lower temperatures.

Objective two is addressed within Chapter 4, using the same dataset as Chapter 3. To determine how changes to factors impacting TS may subsequently affect the likelihood of tourists returning, a two stage ordinal regression with instrumental variables is applied to estimate the TS model. Ordinal regression is then used to estimate the model explaining variations in the likelihood of the tourist returning with TS as one of the explanatory variables. A significant positive relationship is found between TS and the likelihood of repeat visits, whilst TS is found to be influenced by environmental, social and economic factors, in addition to income, whether the tourist visited the Reef and whether they had just arrived in the region. These relationships were then used to estimate a financial value for the impact (in terms of lost revenues from reduced numbers of returning visitors) that could result from deterioration in any factors that influence TS. A deterioration of 10% in perceptions of crime, or intensity of construction work, or water turbidity (with all other factors held constant) is estimated to reduce the tourism income generated in the regional economy by between $300,000 and $400,000 per annum.

Objective three is addressed in Chapter 5, using (secondary) survey data collected from residents of the Wet Tropics World Heritage Area. Principal component analysis is used to group different factors that may explain variations in LS into separable discrete categories, based on subjective data regarding the importance of, and the satisfaction with, these factors. Geographically weighted regression (GWR) is used to estimate a LS model including the composite variables calculated from the groupings, finding that significant composite variables represent the social, environmental and economic domains, and finding significant spatial variations in the factors contributing to resident LS. Social factors have the strongest impact on LS across the region; but the second strongest influencer is the environment in the northern and central sections of the region, and income for the south of the region. These variations in preferences were found to correspond to the electoral boundaries that existed prior to the fairly recent local government amalgamations. It was apparent that those successful amalgamations comprised combinations of regions with fairly homogenous preferences whilst the unsuccessful amalgamations (that were subsequently reversed) tried to combine residents with very different preferences. Thus improved understanding of spatial variations in preferences gained from the LS approach could provide clear benefits if used to inform discussions regarding the redrawing of electoral boundaries or amalgamating existing electorates.

Objective four is addressed in Chapter 6, using (secondary) survey data collected from residents of the GBR catchment region. Variations in the LS of residents are explained using GWR to specifically identify and evaluate the spatial heterogeneity of values within the region, including a composite variable derived from exploiting principal component analysis to represent the satisfaction of residents with the cultural ecosystem services provided by the GBR. Cultural ecosystem services comprise a wide range of values including existence and bequest constructs that arise from people's beliefs or understandings. Significant spatial variation is found in the residents' values, with those of the north appearing to gain relatively more satisfaction from the cultural ecosystem services (and less satisfaction from income) than residents of the south. The coefficients from this LS model are used to estimate the compensation required to maintain current level of resident LS should there be a decline in their satisfaction with these cultural ecosystem services, finding that the cultural ecosystem services provided by the GBR contribute to resident LS, with an estimated value of around $8.7 billion per annum. This study indicates that the LS valuation approach offers promise as an alternate method for estimating the hard to monetise non-market non-use values.

Overall, the key findings are that factors from all domains of life – social, environmental and economic – are important to trip and life satisfaction. Of these, economic factors are frequently the least important in explaining LS, although significant spatial variations exist in the significance and magnitude of impact that the different explanatory factors have. Distinct spatial variations are found – income is more important to residents in the south of the study region whilst for those in the north, social and/or environmental factors are more important.

The LS approach has been demonstrated as a highly versatile tool, enabling us to better understand what truly makes people satisfied with their lives or purchases; my findings reveal that different things contribute differently to the satisfaction of different people in different places. Thus a national or international focus on increasing GDP is unlikely to meet the preferences of most people; local solutions focused on the local preferences and choices of people in particular areas are much more likely to improve the welfare of the people. Similarly, commercial organisations are likely to find that a better understanding of the preferences of their customers, and the spatial variations within these, will enable them to differentiate their service offering and thus best satisfy the preferences of those people who comprise their potential customer base.

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Publications during PhD

Articles directly associated with PhD

As first author – already published

Jarvis, D., Stoeckl, N., & Liu, H.-B. (2016). The impact of economic, social and environmental factors on trip satisfaction and the likelihood of visitors returning. *Tourism Management*

Jarvis, D. (2015). Could Climate Change Redistribute Global Tourism Activity By Impacting Trip Satisfaction. *Proceedings of the 25th Annual Council of Australasian University Tourism and Hospitality Education Conference*. Paper presented at the CAUTHE 2015 conference, 2-5 February 2015, Southern Cross University, Gold Coast, Queensland, Australia.

As first author – in review

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Farr M., Stoeckl N., Esparon M., Larson S. & Jarvis D. (2016). The importance of water clarity to tourists in the Great Barrier Reef and their willingness to pay to improve it, *Tourism Economics*

Stoeckl N., Farr M., Jarvis D., Larson S., Esparon M., Sakata H., Chaiechi T., Lui H., Brodie J., Lewis S., Mustika P., Adams V., Chacon A., Bos M., Pressey B., Kubiszewski I. & Costanza B. (2014). The Great Barrier Reef World Heritage Area: its 'value' to residents and tourists Project 10-2 Socioeconomic systems and reef resilience. Final Report to the National Environmental Research Program. Reef and Rainforest Research Centre Limited, Cairns.

Stoeckl, N., Chaiechi, T., Farr, M., Esparon, M., Larson, S., Jarvis, D., Chacon, A., Tran, L. T. (2015). Improving the efficiency of biodiversity investment. Darwin: Charles Darwin University.

Tran, L. T., Stoeckl, N., Esparon, M., & Jarvis, D. (2016). If climate change means more intense and more frequent drought, what will that mean for agricultural production? A case study in Northern Australia. Australasian Journal of Environmental Management.

Chapter 1 Introduction

Aim of Chapter 1

This chapter provides a general introduction to the thesis, including setting out the over-arching aim of the research and explaining how this thesis is organised to address this aim. The chapter discusses relevant literature, explaining the theoretical and empirical background to the research. The chapter then explains the overall aim of the thesis, and based on the research gaps identified, specifies the research objectives addressed within it.

1.1 General Introduction

The world is currently facing a number of different crises: climate change, terrorism and refugee flows to name three of the most topical. In response, governments around the world have adopted a range of different policies, aiming to address their responsibilities to their own populations and to the rest of the world regarding these issues, in addition to others such as the after effects of the 2008 global financial crisis, and the ambitious targets of the Millennium Development Goals[1] (United Nations, 2015). But are these policies really going to improve the overall welfare of the people?

Much policy and activity around the world is based on the desire to increase GDP, or at the micro level, to increase individual incomes. However, "national product … is there to serve man and not the other way around. All economic activity aims, or is supposed to aim, directly or indirectly, now or in the future, at providing human satisfaction" (Scitovsky, 1975, p. 45). Yet, (particularly in the developed world), growing GDP doesn't necessarily increase the level of happiness or well-being experienced by individuals. Evidence supports increasing GDP trends around the world, but similar trends are not being seen in the well-being of the people. That is, whilst people are generally getting richer they do not seem to be getting happier (Layard, 1980). Other things, beyond GDP, must also matter – the key issue is to understand what these are and how to address trade-offs between the various factors if

[1] These include eradicating extreme poverty and hunger, achieving universal primary education, promoting gender equality and empowerment of women, reducing child mortality, improving maternal health, combating HIV/AIDs, malaria and other diseases, ensuring environmental sustainability and developing a global partnership for development.

we are to achieve an overarching aim of making the world a better place, rather than merely a richer place in financial terms.

Despite the income paradox, also known as the Easterlin paradox, (whereby a higher income for an individual at one point in time appears to increase that individual's happiness, whilst a general rise in income levels over time within a country does not increase the average happiness levels of that country's population (Easterlin, 1973)), "… GDP in particular and economic growth in general is regularly referred to by leading economists, politicians, top-level decision-makers, and the media *as though* it represents overall progress" (Costanza, Hart, Talberth, & Posner, 2009, p. 7). There is some merit in this, as "…few economies have reached such a high level of abundance that a lower level of GNP would not reduce welfare" (Frey & Stutzer, 2002, p. 37). However, GDP does not measure progress in all aspects of life, it is designed to measure economic market activity and was not designed to measure broader aspects of human welfare; it thus excludes factors such as the degree of equality in the distribution of income, in addition to economic, social and environmental aspects of life that do not pass through markets (Kubiszewski et al., 2013). Additionally, as the measure of GDP excludes changes in the levels of natural, social and human capital it has been noted that focusing on growth of GDP as a goal encourages the depletion of non-renewable capitals, and thus undermines the quality of life that may be available for future generations (Costanza et al., 2009).

Much economic theory is market based, reflecting values in monetary terms of market goods and services. However, it is important to move beyond a purely market based analysis to fully understand the influences on human welfare. This is because "both economic goods and services and ecological services and amenities are produced and both contribute in different ways to satisfying basic human needs and creating both individual and community well-being" (Costanza, Cumberland, Daly, Goodland, & Norgaard, 1997, p. 140).

Much research effort has thus focused on finding ways to 'value' nonmarket goods and services (where the term 'non-market' refers to goods and services that are not traded in markets and so do not have an easily identifiable financial value or price), so that they can be treated on an equal footing to things such as GDP, thus ensuring the development of appropriate environmental (and social) policy (Welsch & Kühling, 2009). Monetising the value of the environment can help inform resource allocation decisions; omitted or under-stated values contribute to the degradation of assets and the over-exploitation of ecosystems

(de Groot et al., 2012). The challenge of valuing natural assets is frequently conceptualised using the total economic value framework (Turner, 1993), a framework which highlights that environmental values comprise both use (direct and indirect) and non-use values. This recognises that if non-use (or passive use) values (highlighted by Weisbrod (1964) and Krutilla (1967)) are omitted from policy assessments, then we may exclude the things people care most about (Carson, Flores, & Meade, 2001).

The total economic framework highlights the importance of considering factors denominated in monetary terms and also those that do not have a simple monetary value if we are to truly understand how these features contribute to human welfare. However, the methods required to obtain these values can be challenging, as will be seen in the discussion below.

Economic theory assumes that individuals generally act rationally, making the choices between their different options that they believe will maximise their own self-interest. If society is to make optimal decisions about trade-offs between different uses of our resources, (for example when developing policy, evaluating planning proposals, analysing alternate land uses (Bertram & Rehdanz, 2015)) it is important to understand the differing preferences of the individuals that make up society. The term 'utility' is used to define the preferences of individuals, where the utility function is formally thought of as a "… function that captures human preferences and thereby explains human choices" (Gill, 2008, p. 227). Neoclassical economic theory has developed the idea that an agent's utility function can be written as: $U = f(x, y, z \ldots n)$, and subject to constraints, assumes that the rational agent will seek to maximise the utility arising from this function (Gill, 2008; Keita, 1999).

Extended further, economic theory posits that the value of any asset relates to the utility that can be obtained from that asset, from whatever source (Carson et al., 2001). Whilst early studies of human well-being, (whether conducted by economists and others), approached the question of asset valuation from the basis that the level of utility, or well-being, was directly measurable, from around 1930s onwards the generally held view amongst economists evolved such that it became the accepted norm that utility could not be directly measured but instead needed to be inferred by observing the choices that people made.

The various concerns regarding direct measurement of the utility of individuals have included issues of subjectivity versus objectivity, and encompassed the interpersonal, international and intertemporal comparability of such information, along with the cardinality of the measurement scale and whether individual utility levels are meaningfully additive

(Kristoffersen, 2010). This utility immeasurability constraint meant that economists were unable to use direct estimates of the utility obtained from non-market goods to estimate their 'value'. Instead other techniques were required.

Accordingly, economists have developed a range of different techniques enabling values to be determined without requiring a measure of utility; these include market based methods and those based on hypothetical markets. Having assumed that utility is cardinally unobservable, these traditional non-market valuation techniques require researchers to work with indirect utility functions; well-being is assumed to be based upon the satisfaction of self-interest informed preferences, and an individual's willingness to pay is assumed to reflect their preference satisfaction, whether this willingness to pay is determined from market behaviour or from studies based on hypothetical scenarios (D. M. Hausman & McPherson, 2009).

Estimating the monetary worth of some values, (specifically 'use values'), associated with natural assets can be relatively easy. Where there is a recognised market for their use (e.g. fish or timber) a valuation can be derived from the revenue generated from the asset. If there is no recognised market, one can also draw inferences about value by observing prices in related (or 'surrogate') markets. For assets where there are connections between the use value and the market (e.g. house prices and ocean views), revealed preference techniques (such as hedonic pricing or travel cost studies) can be used to obtain valuations (Carr & Mendelsohn, 2003; Driml, 2002; Prayaga, Rolfe, & Stoeckl, 2010).

However, non-use values cannot be revealed from observing usage behaviours and choices in other markets, as these values involve no involvement (direct or indirect) with the market (Carson et al., 2003) and are not traceable through well-functioning markets, or indeed through any market at all (Costanza, d'Arge, et al., 1997).

Non-use values are thus much more difficult to monetise; for these, stated preference approaches (including contingent valuations (CV) and choice modelling (CM)), designed to simulate 'hypothetical' markets are used (Harris & Roach, 2013; Turner, Pearce, & Bateman, 1994). Examples of the use of CV include a valuation of the Great Barrier Reef (GBR) (Hundloe, Vanclay, & Carter, 1987), whilst a variant of the CV approach, based on contingent behaviours was used to investigate recreational fishing in a section of the GBR (Prayaga et al., 2010). Examples of discrete CM include estimating values for coral reefs in the Caribbean (Parsons & Thur, 2008), an estuary within the GBR catchment (Windle & Rolfe, 2005) and a river catchment and estuary in Tasmania (Kragt & Bennett, 2011).

These methods, whether based on revealed or stated preferences, are all theoretically underpinned by the utility function referred to above. For further discussion of these theoretical underpinnings, see, for example, (Brown & Mendelsohn, 1984) regarding hedonic travel cost approach, and (Hanemann, 1991) regarding the estimations of willingness to pay and willingness to accept that result from CV and CM studies.

Although widely used, these various revealed and stated preference based techniques are not without problems. These approaches focus on a subset of the interactions within an economy; breaking the economy into small segments, focusing on just a few key variables assuming that (a) all other factors are held constant (ceteris paribus), and that (b) a change in one sector will not impact on other sectors. Thus this methodology lacks the ability to study interrelations between all parts of the economy. This approach is particularly useful if the researchers wishes to understand more about a single good or service, and certainly has its place within research where separability of effects can be reasonably assumed, but is not best suited to the task of understanding linkages in a complex system. If our aim is to understand these complex linkages we may need to adopt more holistic dynamic approaches, considering a location, region or country as a whole, rather than focusing on a particular industry or aspect of the decision. In short: socio-economic systems are complex and feature many complex interactions, requiring a wide view to be taken if we are to be confident of reaching appropriate decisions regarding all the various trade- offs required[2].

Second, these approaches generally only allow the analysis to focus on the trade-off between a limited number of options (although increases in computer power make it easier for CM analysts to assess more 'attributes' simultaneously). This precludes them from being able to take a holistic view of the impact across the full range of relevant interrelationships; including a failure to fully recognise the importance of non-economic domains of life and the impact of spatial influences.

[2] An alternative economic approach that attempts to take the economy as a whole into consideration is that of the general equilibrium approach. This is based on the assumption that different sectors are mutually interdependent, and prices/values can only be determined by considering the whole. However, the non-market values that are used in these models have often been derived from the partial-equilibrium methods described here and do not adequately reflect general equilibrium values (Carbone & Kerry Smith, 2013). Moreover, even general equilibrium analysis struggles to develop models that fully reflect the complex nature of the interactions within the economic and environmental systems. Considered independently, both environmental and economic systems are highly complex systems, taken together "… linked ecological economic systems are devilishly complex" (Costanza, Wainger, Folke, & Mäler, 1993, p. 545). An additional issue with the general equilibrium approach is that this method assumes the system is at equilibrium, which may not be the case in practice. Thus, an alternate approach that can better cope with this complexity appears to be required.

Third, stated preference approaches assume that the individuals being studied have an understanding of the causes and effects of the problem being considered. For example, respondents may be required to have an understanding of exactly how, and in what degree, a pollutant may impact on their health; requiring detailed technical knowledge or understanding of environmental issues (Welsch & Kühling, 2009). Furthermore, the use of hypothetical scenarios which underlie the stated preference methods may result in unreliable or strategic responses (Welsch & Kühling, 2009). Additionally both CV and CM valuation studies can suffer from protest responses (Meyerhoff, Mørkbak, & Olsen, 2014), and require respondents to be able to accurately predict their utility in different scenarios, and to truthfully, and rationally respond to questions about willingness to pay for (or trade-off) those scenarios. Moreover, a growing body of research highlights the problem of attribute non-attendance (Campbell, Hensher, & Scarpa, 2011; Hole & Riise Kolstad, 2013; Scarpa, Gilbride, Campbell, & Hensher, 2009) whereby it seems that the complex survey designs required to simulate hypothetical markets impose such substantive cognitive burden on some respondents that they are either unable or unwilling to fully 'attend to' all issues described in the survey. Finally, CV and CM valuations are only robust when appropriate indicators are selected (Zhao, Johnston, & Schultz, 2013).

1.2 The Life Satisfaction (LS) method

As has been seen, the attitudes to utility adopted by economists and psychologists have historically diverged; economists assumed utility (other than that which informs future choices) was unmeasurable, whilst the psychology profession developed their research following the alternate assumption that utility may in fact be measurable. Theory has developed to describe different types of utility, of which the most important distinction is between experienced utility and decision utility.

Decision utility is inferred from observed choices, and is used to explain these choices; it is seen as the weight given to the utility of outcomes and attributes when making decisions (Kahneman, Wakker, & Sarin, 1997). Economist have believed that this form of utility is measurable, and thus it is decision utility which informs revealed and stated preference economic valuation approaches such as hedonic pricing and contingent valuation methods (Welsch & Ferreira, 2014).

Experienced utility refers back to the definition of utility used by figures such as Bentham, referring to the pleasure and pain (Kahneman et al., 1997), and can be considered the ex post hedonic quality associated with an outcome whilst decision utility is the ex ante expectation of experienced utility (Welsch & Ferreira, 2014). This is the form of utility that economists generally believed to be unmeasurable, but recently, some economists have begun to reconsider the assumption of utility measurability; it has emerged that we may be able to measure life satisfaction (LS), which could then be used as a proxy for experienced utility, a significant change from the established neo-classical welfare economics discussed above (Gowdy, 2005). This thesis seeks to investigate some of the possibilities offered by this recently developed approach.

1.2.1 What does LS research seek to do?

LS researchers seek to understand more about factors affecting people's overall quality of life, happiness, subjective well-being or satisfaction with life. The terms happiness, life satisfaction and subjective well-being are frequently used interchangeably within the literature. Subjective well-being is often associated with short lived pleasant affects (happiness) or unpleasant affects (unhappiness), whereas life satisfaction is the contentment derived from living a meaningful and fulfilling life (living well) (Engelbrecht, 2009). Whilst research has shown that the term 'happiness' is less closely related to life satisfaction than is the term subjective well-being (Engelbrecht, 2009); throughout this thesis I will use the term LS for consistency. Once we accept that LS can be measured, and used as a proxy for experienced utility, this provides a new way of measuring and understanding the complex interrelationships and trade-offs within the various systems described in Figure 1, in a holistic manner. Interestingly, this does not require one to discard the 'neoclassical' utility function. Simplistically, $U = f(x, y, z \ldots n)$, can be represented as $LS = f(a, b, c, d)$, where LS is a proxy for U. The arguments within the function are assumed to be separable, hence the importance of testing for separability as I have done using Principal Component Analysis (further explained in Chapters 5 and 6). Furthermore, the arguments are generally assumed to enter the function additively.

LS studies seek to understand the different factors that influence how satisfied people are with their lives; simplistically, a survey question of the type 'how satisfied are you with your life nowadays?' is posed, and responses are recorded using a Likert scale. Researchers then undertake statistical analyses, generally using regression techniques, to identify and

empirically test factors that are believed to contribute to, or detract from, overall LS. Thus, at the micro level, LS researchers seek to develop models that explain variations in LS (determining the degree of impact of factors individually, and the interactions between these different factors), that are of the form:

> *Overall satisfaction with life = f (personal factors relating to the individual, other factors from various domains of life that affect the individuals satisfaction)*

Over the last 20 years or so, many different studies, at both the microeconomic (Ferreira & Moro, 2010; Helliwell, 2003) and macroeconomic (Engelbrecht, 2009; Vemuri & Costanza, 2006) levels, have followed this approach as they attempted to understand variations in LS, and to determine the factors contributing to differences in LS. Most studies have adopted this hedonic approach to well-being as opposed to the eudaimonic approach, which is more concerned with whether people are achieving their potential and living a good life (Deci & Ryan, 2008).

1.2.2 The use of different personal factors and different factors from different domains of life to explain LS

Much of the research within the LS literature has sought to explain variations in LS by the inclusion of a very wide range of different factors, drawn from many different aspects of life, that are thought to be likely to have an impact. Some are personal to the individual whilst others relate to the city or region where the individual resides, some relate to material goods whilst others relate to non-material, or non-pecuniary, life events such as marriage, divorce, and serious disability (Easterlin, 2003). Most studies, whether based on cross section or panel studies, have found similar explanatory factors, usually including physical health, family status, employment, age and country of origin (Layard, 2010). Some of the most important and most frequently used factors are summarised in Table 1.

Demographic and other factors relating to the individual have frequently been found to have a statistically significant impact on LS; thus it is important to control for these confounding factors if we are to understand the significance of the social, environmental and economic factors on LS. The most commonly included variables include demographic factors such as gender (females generally reporting higher LS (Welsch, 2007b)), age (found to have either positive (MacKerron & Mourato, 2009), negative (Florida, Mellander, & Rentfrow, 2013), or U shaped relationship with LS (Di Tella, MacCulloch, & Oswald, 2003)), and marital status

(married people are generally happier (Diener, Suh, Lucas, & Smith, 1999)). Studies have also found that increasing levels of education generally increases LS (Frey & Stutzer, 2000; Helliwell, 2003), although a more significantly positive impact has been found for city residents as opposed to their rural counterparts (Florida et al., 2013).

The influence of genetic or hereditary factors on the reported level of satisfaction is recognised as an important factor when considering variations in LS, now widely accepted as explaining around 50% of all observed differences (Lyubomirsky, Sheldon, & Schkade, 2005; Zidanšek, 2007). This is based on empirical investigations that estimated the influence of genetic factors by calculating correlations between self-reported happiness levels of identical and non-identical twins and siblings, including those brought up together and those separated at birth, explicitly evaluating the impact of genetics on studies of adults (finding impact of genetics to range from around 39% to 58%) (Diener et al., 1999; Tellegen et al., 1988); and of young children (finding impact of genetics to lie between 35% and 57%) (Braungart, Plomin, DeFries, & Fulker, 1992). Most researchers do not, however, have access to genetic data (particularly when using cross-sectional survey data) for conducting their analysis. Thus, most LS models based on cross sectional data are only able to explain 10% - 30% of variations in LS, with around 50% of the unexplained variations being due to genetic factors.

In addition to these personal socio-demographic factors, a range of studies have found factors from the social, economic and environmental domains to be significant influencers of happiness. The importance of these domains to overall LS has been demonstrated in a range of conceptual frameworks (van Kamp, Leidelmeijer, Marsman, & de Hollander, 2003); incorporating all three domains within the well-being study can enhance understanding of sustainable development and advise how to achieve a sustainable balance between economic, social and environmental factors (Larson, 2009; McAllister, 2005).

These systems are highly complex and composed of non-linear, interdependent components, and the value of the various services they provide are likely to be interdependent and overlapping (Costanza, d'Arge, et al., 1997). Accordingly, we need to ensure that we avoid double counting, resulting from adding up the value of direct and indirect contributions to the same benefits (Haines-Young & Potschin, 2013). Due to the potential overlap between the different factors within these complex systems, it is likely that these factors may not ‘enter’ the LS regression model as separable and additive components, thus several researchers have

suggested that it may be most appropriate to work with a collective measure of value than to work with single measures (Stoeckl, Farr, Larson, et al., 2014; Windle & Rolfe, 2005).

The implication of this is that some preliminary analysis of the relationship between explanatory variables is required, checking for separability between the factors being considered for inclusion as explanatory variables of LS, and grouping similar factors together in some manner to form new discrete overarching variables, rather than simply entering each factor as a separate contributor to LS.

These ideas underpin the approach of estimating regression models to explain LS with a small number of variables representing discrete categories, often referred to as domains, rather than including many possibly overlapping factors. The challenges are to determine the appropriate domains that taken together should define LS, then to define and measure a variable to reflect each domain, and then finally to determine how to combine these domain variables to explain variations in LS. Whilst some research has been conducted within both the LS and quality of life fields into the number and type of domains that may be appropriate, no definitive classification has yet been established.

Some important work on defining the different discrete domains that together explain quality of life was conducted by Cummins (1996). His work, based on appraising 32 previous studies that between them had used 173 different terms to explain the factors affecting LS, demonstrated that satisfaction can be explained by the use of seven domains. These domains were Health, Productivity, Material Well-being, Community, Intimacy, Emotional well-being and Safety. This work formed the basis for later research where the number of domains was extended to eight (Hsieh, 2003, 2012) by splitting the Emotional Well-being domain into two separate domains of Religion and Spare time, splitting Intimacy into the two domains of Family Life and Friendships, and removing the Safety domain. Additionally, some of the other domains were renamed and redefined a little, such as Material Well-being becoming Financial Situation and Productivity being renamed Work.

Other research has used some of these same, or similar, domains, whilst combining or removing others and adding in additional factors. For example, Guardiola, González-Gómez, and Lendechy Grajales (2013) incorporated some very similar domains, being Health, Work, Money, Community, Nurture and Leisure, whilst also including House and Water as additional domains. A refinement to the methodology was adopted by van Praag, Frijters, and Ferrer-i-Carbonell (2003), specifying that to aggregate the underlying domains to

estimate overall LS, the individual's satisfaction with each of the separate domains was required; this study again used the domains of Health, Job, Financial, House and Leisure, and incorporated the additional domain of Environment.

A more aggregated approach was adopted by Larson (2009), whereby the factors explaining well-being were grouped into just three overall domains, being society, economy and ecology. Each of these high level domains were then explained by a number of more detailed factors, some of which have themselves been defined as separate domains in other studies. For example, the social domain, representing family and community issues, included family relations and health, the economic domain represented economic issues and the provision of services and thus included income and health services, whilst the ecological domain represented the natural environment and included water quality.

For the research within this thesis I have followed the lead shown by Larson (2010) and adopted three high level domains of life; however I have substituted the name Environment for the domain representing the natural environment and ecosystem services provided by nature. Two alternate approaches have been used within this research, either using one particular factor to represent a particular domain (e.g. water clarity to represent the environment), or by using a number of factors combined together using statistical techniques (principal components analysis) to determine the appropriate, separable groupings into the different underlying domains represented by the different factors.

The use of these three domains is appealing for a number of reasons, other than being supported by previous research. Firstly, this echoes the important concept of the triple bottom line developed fairly recently within the financial and business fields of study, where businesses and individuals are encouraged to consider the social and environmental domains in addition to the economic domain that has been the primary focus within those bodies of literature. Secondly, this approach is grounded within the environmental economics literature, where activity is based on the use of natural, social and physical capital; each of these capitals representing a separate domain of life. Finally, by focusing on high level factor groupings, rather than many separate individual factors, there is less risk of results being biased or otherwise invalidated by the effects of individual factors that may have inseparable or overlapping impacts on LS[3].

[3] As explained above, the LS function assumes the arguments enter the function in an additively separable manner; if this assumption is violated then the results may be biased. By using principal component analysis to

Table 1 Factors frequently found to influence overall life satisfaction

Domain/factors frequently found in studies	Relationship generally found with LS and related references
Demographic or respondent specific factors	
Age	Either positive (Frey & Stutzer, 2000; Helliwell, 2003; MacKerron & Mourato, 2009), negative (Florida et al., 2013), or U shaped (Di Tella et al., 2003; Ferreira et al., 2013; Ferrer-i-Carbonell & Gowdy, 2007; Murray, Maddison, & Rehdanz, 2013). Potential non-linearity addressed by including age and/or age squared.
Gender	Females have higher LS (Brereton, Clinch, & Ferreira, 2008; Ferreira et al., 2013; Ferrer-i-Carbonell & Gowdy, 2007; Welsch, 2007b).
Genetic factors	Recognised that genetic or hereditary factors crucially affect LS, explaining around 50% of all observed differences (Lyubomirsky et al., 2005), based on empirical investigations explicitly evaluating the impact of genetics on studies of adults (Diener et al., 1999; Tellegen et al., 1988); and of young children (Braungart et al., 1992). Most LS models explain 10% - 30% of variations in LS, with genetic factors responsible for around 50% of the unexplained variations.
Marital status	Marriage increases LS; divorce associated with lower LS (Diener et al., 1999; Ferreira et al., 2013; Ferrer-i-Carbonell & Gowdy, 2007; Frey & Stutzer, 2000).
Living in country of origin (not a foreigner)	Improves LS (Ferreira et al., 2013; Frey & Stutzer, 1999, 2000).
Health	Better health improves LS; stronger relationship from subjective rather than objective health measures (Diener et al., 1999).
Education levels	LS enhanced by increasing levels of education (Frey & Stutzer, 2000; Helliwell, 2003), with a more significantly positive impact for city as opposed to rural residents (Florida et al., 2013). This positive relationship may be mainly due to the indirect effect education has on income levels; when income effects are controlled for, education is frequently found to have an insignificant or negative effect (Diener et al., 1999; Manning, Fleming, & Ambrey, 2015). Education may reduce LS if it raises aspirations to a level that cannot be met (Diener et al., 1999).
Factors from economic, social and environmental domains	
Economic domain	Incomes generally increase LS (Abdallah, Thompson, & Marks, 2008; Di Tella et al., 2003; Diener, Sandvik, Seidlitz, & Diener, 1993; Ferreira et al., 2013; Ferreira & Moro, 2010; Frey & Stutzer, 2000; Murray et al., 2013; Welsch, 2002), but alternate research found a negligible/statistically insignificant relationship (Easterlin, 1995; Oswald, 1997), and recent research has begun to investigate potential endogeneity issues (Ferreira & Moro, 2010). Relative income (both to others and to previous periods) (Easterlin, 1995, 2003), future material aspirations and their relationship to anticipated future income levels (Easterlin, 1995, 2001), and previous income levels (reflecting habituation effect) (Menz & Welsch, 2010) may be important. Employment status important with employed people reporting higher LS than the unemployed (Brereton et al., 2008; Ferreira et al., 2013; Ferreira & Moro, 2010; Helliwell, 2003; Winkelmann & Winkelmann, 1998), and living in high unemployment region, even if not unemployed, reduces LS (Welsch, 2007b).
Social domain	LS enhanced by being able to spend time with family and friends, and know that they are safe and well (Larson, 2009; Myers & Diener, 1995); having local political autonomy (Abdallah et al., 2008; Frey & Stutzer, 2000; Inglehart, Foa, Peterson, & Welzel, 2008); political stability (Abdallah et al., 2008); strong rule of law and control of corruption (Abdallah et al., 2008); low crime rates (Manning et al., 2015) or low perceptions of

group factors into a smaller number of separable groupings, which can be seen as representing the different domains of life, then we are reducing the risk of violating this assumption. Should the assumption be violated, and non-separable preferences be included within the analysis, then the results could biased, possibly by a relatively large amount and in either direction, depending on the nature of the non-separability of preferences. As explained by Carbone & Smith (2013), if the non-separable preferences are of a complementary nature then the importance or value of a feature could be overstated, whilst if the non-separability includes substitution effects then the importance or value of a feature could be understated. Hence the importance of adopting an approach that limits the risk of violating this assumption.

Domain/factors frequently found in studies	Relationship generally found with LS and related references
	crime (Ambrey, Fleming, & Manning, 2014); increased tolerance of different groups in society (Inglehart et al., 2008); increased involvement in voluntary work (Sørensen, 2014); degree of freedom and personal choice (Stanca, 2010); and having trust in others, or trust in society (Engelbrecht, 2009; Helliwell, 2003).
Environmental domain	Extreme climates are often associated with lower LS (Frijters & Praag, 1998; Maddison & Rehdanz, 2011), as is pollution, including air pollution (Ferreira et al., 2013; Ferreira & Moro, 2013; MacKerron & Mourato, 2009; Rehdanz & Maddison, 2008; Welsch, 2007a) and noise levels (Rehdanz & Maddison, 2008; van Praag & Baarsma, 2005). Environmental disasters, such as draught (Carroll, Frijters, & Shields, 2009), forest fires (Kountouris & Remoundou, 2011) and flooding (Luechinger & Raschky, 2009) reduce LS, as does proximity to landfill sites (Brereton et al., 2008). LS is enhanced by high quality environmental amenities, such as living near the coast or having good views (Ambrey & Fleming, 2011; Brereton et al., 2008), ecosystem diversity (Ambrey & Fleming, 2014d), the quality of ecosystem services (Abdallah et al., 2008; Vemuri & Costanza, 2006), and environmental sustainability (Zidanšek, 2007).

1.2.2.1 Economic domain

The factor that the layman may consider to be the most obvious influencer of LS is that of income. However, despite decades of research, the response to the question posed by Easterlin (1973) 'does money buy happiness?' is still unclear. The income paradox (also known as the Easterlin paradox) (Easterlin, 1973) indicates that whilst a higher income for an individual at one point in time appears to increase that individual's happiness, a general rise in income levels over time within a country does not increase the average happiness levels of that country's population. It appears that the marginal contribution of income to LS is high when people are poor but above subsistence levels of income where basic needs (food, shelter etc.) are met, improvements in non-economic aspects of life, (social and/or environmental aspects), become increasingly important to improving LS (Inglehart, 1997; Inglehart et al., 2008; Mellander, Florida, & Rentfrow, 2012; Sen, 1999). Thus, it may be that, in the developed world at least, an individual's well-being is about a lot more than money. Many believe that improving economic circumstances is sufficient to improve the well-being of the population, and this premise drives much political/social policy (focusing on GDP growth); thus it is important to understand whether this assumption is empirically correct.

The relationship between income and LS has been widely examined in many studies. The most common finding is that higher incomes have a small positive impact on LS, particularly at low levels of income (Arifwidodo & Perera, 2011; Frank, 1997), but this relationship has been found by others to be negligible or not statistically significant (Easterlin, 1995; Oswald, 1997); time series studies considering growth in incomes and changes in LS frequently fail to

find any income/LS link. Attempts have been made to explain this finding; a good discussion of these can be found in Clark, Frijters and Shields (2008).

One theory argues that relative rather than absolute income may be important in explaining variations in LS; this includes income relative to others, which impacts on an individual's status in society, and relative to the individual's income in previous periods, which impacts on habits and the view of what is the norm (Clark et al., 2008, Daly, 1987; Diener et al., 1999; Dixon, 1997; Easterlin, 1995, 2001, 2003; Layard, 2003; Menz & Welsch, 2010; Stutzer & Frey, 2010). Mentzakis and Moro (2009) found that a subjective measure of perceived financial situation used as a proxy for relative income, had a strong positive linear relationship with LS when absolute income was controlled for; however, alternate research into the impact of relative income on LS found no evidence to support the influence of comparisons to the income of others, or of adaptation or habituation effects (Diener et al., 1993). Another explanation for the income paradox is that future material aspirations, and their relationship to anticipated future income, may be significant (Easterlin, 1995, 2001). Research has also investigated the possible endogeneity of income within the LS model, testing methods for controlling for this issue should it be found to exist (Ferreira & Moro, 2010)

However, the majority of empirical studies have found income to be a significant factor explaining variations in LS at the microeconomic level (Arifwidodo & Perera, 2011; Brereton et al., 2008; Diener et al., 1999; Ferreira & Moro, 2010; Ferrer-i-Carbonell & Gowdy, 2007; Ferrer-i-Carbonell & Frijters, 2004; Frey & Stutzer, 1999, 2000; Helliwell, 2003; MacKerron & Mourato, 2009; Michalos & Zumbo, 2000; Rehdanz & Maddison, 2005; Stanca, 2009; van Praag & Baarsma, 2005; Winkelmann & Winkelmann, 1998). Many studies have used the natural log of income, however others have found including income as a linear variable to produce a better performing model (Ferreira & Moro, 2013).

At the macroeconomic level, GDP per capita has been found to have a significant positive impact by many (Abdallah et al., 2008; Di Tella et al., 2003; Engelbrecht, 2009; Inglehart et al., 2008; Welsch, 2002, 2006). The degree of economic growth or development within a region or country has also been found to be important, using growth in GDP rates as a proxy for this factor (Kountouris & Remoundou, 2011; Welsch, 2007b).

Beyond income, the most common economic feature found to influence LS has been employment status; employed people generally report significantly higher LS than those who are unemployed (Helliwell, 2003; Winkelmann & Winkelmann, 1998).

1.2.2.2 Social domain

Human development theory has proposed that the purpose of economic development is to improve people's lives by increasing the freedoms, or choices, that are available to each person, being freedoms of both opportunity and of capability (Inglehart et al., 2008; Sen, 1999; Welzel, Inglehart, & Kligemann, 2003). This theory builds on the ideas discussed above whereby the influence of income on LS appears to be lower in more affluent societies, and emphasises the importance of factors from within the social domain on improving LS once survival can be taken for granted (Inglehart, 1997; Inglehart et al., 2008).

Many empirical LS studies have included a wide range of factors representing different elements of social capital. For example, it is important to be able to spend time with family and friends, and to know that these people are safe and well (Larson, 2009; MacKerron & Mourato, 2009; Myers & Diener, 1995). Some of the other social measures also found to have a positive relationship with LS, include measures of democratic rights (Frey & Stutzer, 1999, 2000), voter turnout/rate (Helliwell, Huang, & Wang, 2014; Moro, Brereton, Ferreira, & Clinch, 2008), local political autonomy (Abdallah et al., 2008; Frey & Stutzer, 2000; Inglehart et al., 2008), political stability (Abdallah et al., 2008), rule of law and control of corruption (Abdallah et al., 2008), perceptions of crime and personal safety (Arifwidodo & Perera, 2011; Michalos & Zumbo, 2000), volunteering rates (Helliwell, 2003; Helliwell et al., 2014; MacKerron & Mourato, 2009), religion (Helliwell, 2003; Inglehart et al., 2008; Stanca, 2010), degree of freedom and personal choice (Stanca, 2009), tolerance towards different groups in society (Inglehart et al., 2008) and trust in others or society (Engelbrecht, 2009; Helliwell, 2003; MacKerron & Mourato, 2009; Stanca, 2009).

Thus it appears to be clear from the research that social factors impact significantly on LS.

1.2.2.3 Environmental domain

Factors from the environmental domain have also been included in a number of studies, with empirical evidence supporting significant relationships existing between both climatic and environmental factors, and LS.

Pollution is possibly the most widely studied environmental factor. Both air pollution (Ferreira et al., 2013; Ferreira & Moro, 2013; Levinson, 2012; MacKerron & Mourato, 2009; Rehdanz & Maddison, 2008; Welsch, 2002, 2006, 2007a), water pollution (Welsch, 2002), and noise levels (MacKerron & Mourato, 2009; Rehdanz & Maddison, 2008; van Praag & Baarsma, 2005) have been found to significantly reduce reported levels of LS.

Living in, or close to, a 'nice' environment also enhances LS, based on various empirical studies. For example, high quality environmental amenities, such as ecosystem diversity, ecosystem services, and environmental sustainability, have been found to enhance LS (Abdallah et al., 2008; Ambrey & Fleming, 2011, 2014d; Brereton et al., 2008; Vemuri & Costanza, 2006; Zidanšek, 2007). More specifically, living near the coast (Ambrey & Fleming, 2011; Brereton et al., 2008; Moro et al., 2008), having good views (Ambrey & Fleming, 2011), or living near areas with natural land cover (Kopmann & Rehdanz, 2013) improve LS, whilst proximity to landfill or waste sites (Brereton et al., 2008; Moro et al., 2008) and environmental disasters such as drought (Carroll et al., 2009), forest fires (Kountouris & Remoundou, 2011) and flooding (Luechinger & Raschky, 2009) have been found to have a negative impact.

Climate variables have been incorporated within a number of studies attempting to explain LS, and have frequently found a significant relationship to exist, indeed, 'climate variables have a highly significant effect on country-wide self-reported levels of happiness' (Rehdanz & Maddison, 2005, p. 111). A variety of different climate based variables have been included within studies; these have included measures of maximum, minimum or average temperatures, hours of sunshine, humidity, rainfall and wind speed (Abdallah et al., 2008; Brereton et al., 2008; Ferreira & Moro, 2013; Moro et al., 2008; Murray et al., 2013; Rehdanz & Maddison, 2005). Whilst extreme climates are often associated with lower LS (Frijters & Praag, 1998; Maddison & Rehdanz, 2011), the direction of impact for some of these other climate factors is unclear; some variables have been found to have a positive impact in some studies and the opposite effect in others. For example, higher temperatures have been found to improve LS (Brereton et al., 2008; Ferreira & Moro, 2010; Frijters & Praag, 1998) and also to reduce LS (Cuñado & de Gracia, 2013; Rehdanz & Maddison, 2005); alternately LS may not have a linear relationship with temperature but instead LS may in fact be maximised at a particular temperature level (Maddison & Rehdanz, 2011). Thus, it has been noted that '… there is abundant scope for more elaborate attempts to estimate the amenity value of climate to households (and firms)…' (Dietz & Maddison, 2009).

Research to date has thus clearly established that LS is significantly related to environmental features and that climate is also important; the magnitude and direction of impact, and the interrelationship between these and other factors/domains are, however, less clear.

1.2.3 The use of LS for non-market valuations

As discussed earlier, economists place a value on an asset based on the utility that can be obtained from that asset, from whatever source (Carson et al., 2001). Historically the valuation techniques used for non-market valuations have been based on the assumption that utility cannot be directly measured; following recognition that life satisfaction may be able to serve as a proxy for utility, researchers have now begun to use the LS approach to estimate the value of environmental goods and services. Here, coefficients from the model describing LS are used to estimate the marginal rate of substitution between income, and an environmental feature. The technique has been used to value a range of different assets or environmental externalities, as shown in Table 2. The majority of these studies have sought to estimate the cost of externalities (such as air pollution); more recently the technique has been extended to identify current use values for the environment (such as benefits from scenic beauty, open space or ecosystem diversity).

Table 2 Using the life satisfaction approach to value environmental assets, externalities or public goods

Environmental asset, service or externality	Studies using the life satisfaction approach to value the asset, service or externality
Costs of pollution	Air pollution studied by Ambrey, Fleming, and Chan (2014); Cuñado and de Gracia (2013); Ferreira and Moro (2010); Levinson (2012); Luechinger (2009); MacKerron and Mourato (2009); Menz and Welsch (2010); Welsch (2006, 2007a), air and water pollution studied by Welsch (2002), and noise pollution van Praag and Baarsma (2005)
Greenhouse gas emission reductions	Studied by Beja Jr (2012)
Scenic amenities	Studied by Ambrey and Fleming (2011)
Public greenspace, protected areas, natural land areas	Studied by Ambrey and Fleming (2012, 2014c); Bertram and Rehdanz (2015); (Kopmann & Rehdanz, 2013)
Ecosystem diversity	Studied by Ambrey and Fleming (2014d)
Cost of environmental disasters	Drought studied by Carroll et al. (2009), forest fires by Kountouris and Remoundou (2011), and flooding by Luechinger and Raschky (2009)
Climate or climate change	Studied by Ferreira and Moro (2010); Frijters and Praag (1998); Maddison and Rehdanz (2011)
Reduction in terrorism	Studied by Frey, Luechinger, and Stutzer (2009)

However, the non-use value attributable to the existence of an asset or service, or the bequest of an asset or service for the future, has not previously been considered within the field of LS research so far as I are aware.

1.2.4 The importance of space on satisfaction

The LS literature demonstrates that location specific factors (such as scenic views, pollution and climate) impact LS (see also Morrison, 2011). But people's subjective satisfaction with those factors and/or the importance that people assign to those factors (as contributors to wellbeing or LS) are likely to vary across both time and space (Costanza et al., 2007), and this has important implications for researchers wishing to estimate LS functions. Thus a key question for this thesis is whether there are indeed spatial variations in the contribution of different factors to resident LS in different locations.

This question was prompted by the theory that the law of one price (whereby arbitrage ensures that goods sell for the same price in all locations (Gans, King, Stonecash, & Mankiw, 2009)) may apply to LS. Within a country, people are generally fairly mobile. Thus, they can be expected to migrate to places that they deem to be more desirable and attractive, until so many people move that these areas become congested and too expensive, leading to a state of equilibrium (Ballas & Tranmer, 2012; Oswald & Wu, 2009); at this point individuals can no longer improve their well-being by relocation elsewhere (Hoehn, Berger, & Blomquist, 1987). As Tiebout (1956) explains, a (rational) individual (with perfect information) will choose to live in (or move to) the community which best satisfies his own personal preferences for public goods and community services. In this context, 'moving or failing to move [replaces] the usual market test of willingness to buy a good' (Tiebout, 1956 p.420). Estimating the implicit prices of all attributes (consumer and producer related) that vary across price is complex, and has been addressed with approaches based on variants of hedonic pricing theory (Rosen, 1974; Roback, 1982).

A region with inherent negative characteristics (such as a harsh climate) may have to offer compensating benefits to persuade people to move to, or stay, in the region (Oswald & Wu, 2010) and evidence has shown that both local taxes and local services affect location decisions and migration patterns (Dowding, John, & Biggs, 1994). This compensating differentials theory has not been proved for all factors however. For example, the negative impact of commuting time on LS has been found not to be fully compensated for by other factors (Stutzer & Frey, 2008).

Within the literature, region specific factors have been found to impact on LS. For example, Florida et al. (2013) noted the importance of considering happiness at a city rather than national level because individuals actively select where they live in light of job opportunities,

public goods and services provided. In addition, a higher unemployment rate in the region of residence has been found to reduce individual LS in people who are not unemployed and improve the LS of those who are unemployed themselves (Clark, 2003; Powdthavee, 2007).

Spatially derived data has previously been used within LS studies; for example geographic information systems (GIS) have been used to develop dummy variables indicating proximity to features such as the coast, landfill sites, airports and major roads (Brereton et al., 2008); to develop local climate indices (rainfall, temperature and wind speed data) (Brereton et al., 2008; Ferreira & Moro, 2010); the proportion of green space within 1km buffer around the respondents home (Bertram & Rehdanz, 2015) and local measures of pollution (Ferreira et al., 2013; Luechinger, 2009; MacKerron & Mourato, 2009). However, including descriptors of location specific factors such as these when assessing LS, and then estimating a single (regression) equation for all, implicitly assumes that all factors contribute similarly to the LS of all individuals (equivalent to assuming that the equations explaining LS of each individual will each have the same functional form and parameters in a universal utility function); that is the regression estimates the impact of a given factor on the LS of the average individual. Some researchers have attempted to account for the relevance of geographic factors and regional differences using, for example, multi-level statistical models (Ballas & Tranmer, 2012) or incorporating regional dummy variables within models (Clark, 2003; Ferreira & Moro, 2010; Morrison, 2011; Oswald & Wu, 2009).

However, so far as I am aware, the only study to have specifically addressed the issue of spatial variation in the relationship between LS and explanatory variables was Stanca (2010), who investigated whether geographic proximity affected the relationships between unemployment, income and LS in different countries, concluding that 'in order to understand the links between economics and happiness, geography matters' (Stanca, 2010, p. 132). Thus investigations into variations in the importance/significance of influencing factors across space have been rare, indeed, the '… spatial dimensions of [LS] also appears somewhat neglected…' (MacKerron, 2012, p. 725).

1.2.5 Future developments of the LS approach

As discussed earlier, much of the focus of government policy around the world is based around growing GDP. Recognising that GDP is not a perfect measure of welfare, a number of extensions have been proposed in an attempt to rectify some of the more important deficiencies. Examples of these include the Index of Sustainable Welfare (Daly & Cobb,

1989), the Human Development Index (as used by the World Bank), the Genuine Progress Indicator (as discussed in Kubiszewski et al., 2013) and a National Well-being Index (Vemuri & Costanza, 2006). However another possible measure of most relevance to this thesis is LS itself: governments could focus on maximising the happiness of individuals as measured by LS, rather than promoting the much narrower measure of welfare that is GDP.

Whilst a policy of maximising some form of happiness index may be better than one of maximising GDP (Frey & Gallus, 2013a), it has been noted that such a policy would also carry risks, and is probably not to be recommended (Ferrer-i-Carbonell, 2013). All research into happiness or LS relies on the assumption that the individuals who are questioned about their level of LS answer in a truthful manner (Frey & Gallus, 2013b). However, if an explicit government goal were to maximise the happiness of the population as measured by an index, then this index could no longer be relied upon as a true measure of happiness; individuals would have incentives to answer the question (regarding their level of happiness or well-being) in a strategic manner rather than answering truthfully, and governments would be incentivised to manipulate the index to its own benefit (Frey & Gallus, 2013a, 2013b). Currently, an advantage of the LS approach over alternates such as CV or CM is that the latter approaches suffer from the problem of strategic bias, whereas LS does not (as discussed in section 1.1 above); should LS become a policy goal then this approach would begin to suffer the same biases which befall stated preferences approaches to valuation.

This is not to say that the study of LS and the factors influencing its levels does not offer important benefits. The results of LS studies better enable us to understand individuals preferences; this should contribute to theoretical developments and policy orientated applications (Ferrer-i-Carbonell, 2013), such as improving public policy by enabling decision makers to better evaluate the benefits provided by public goods (Frey & Stutzer, 2012). Insights can be gained regarding matters of constitutional and political organisation by improved understanding of the impact of institutions on LS (Frey & Stutzer, 2012). Thus, the study of LS and the factors that influence it should provide important inputs to public policy, but LS should not itself be an explicit goal of policy; policy should establish the conditions within which each person is empowered to pursue their own happiness, according to his or her own personal preferences (Frey & Gallus, 2013a, 2013b).

1.3 The study of customer satisfaction, focusing on tourism

There would appear to be similarities (in both the underlying concepts and the methodologies adopted) between the study of LS and the study of the customer satisfaction within commercial sectors. However, as far as I am aware, no one has previously explicitly linked these two fields of study – that is, the study of what determines LS and the study of what determines customer satisfaction within any particular industry. This thesis seeks to address this research gap by testing to see if factors that have been found to influence LS also influence of trip satisfaction (TS).

Within the marketing profession, the primary consideration is to put the customer first: the customer's needs must be identified, enabling the product or service to be designed to meet those needs, thus ensuring that the customer is satisfied (McGhee, 1986). Extensive work has been conducted regarding customer preferences, using approaches such as CM[4], and also regarding customer satisfaction itself: how it can be measured and how to interpret what the measure is telling you.

Industry and commerce make regular use of customer satisfaction surveys aiming to elicit customer feedback on their satisfaction level with the product or service they have received. (For further information on the methodology and techniques, see literature such as Hayes (2008)). Such customer satisfaction surveys generally include a number of questions gathering the customer's views on a range of different facets of the product or service, along with a question regarding the customers overall level of satisfaction; questions regarding their likelihood of purchasing again, and likelihood of recommending the firm to a friend, often also feature. Questions can generally be answered with yes/no responses or by selecting a response from a Likert scale, sometimes more open answers are also possible. The researchers then analyse and use this information in such a manner to encourage customer loyalty and repeat business, to improve the profitability of the firm delivering the product or service. The analysis conducted by the marketing profession can range from the simple, such as descriptive statistics, to the more complex such as correlation analysis or analysis of variances (ANOVA), through to the fairly sophisticated such as using regression to determine which factors or service best explain overall satisfaction. Factor analysis or principal components analysis is often used to combine a number of survey question responses

[4] As discussed earlier, a weakness of techniques such as choice modelling is the requirement to focus on a limited number of options within a partial equilibrium approach, rather than being able to take a more holistic view of the complex interrelationships within factors that influence customer's preferences.

together into a fewer number of categories, where the specific questions reflect different facets of the same or similar underlying concepts.

Whilst all industries to a greater or lesser extent require satisfied customers if they are to continue to trade over the longer term, different types of industries face different customer requirements that need to be satisfied. The composition of the economy of any region depends on many different factors, with the various combinations of natural, man-made and human capitals available contributing to the mix of industries operating in that location. Many countries seek to develop their economies and improve the quality of life of their population by focusing on the exploitation of their natural capital through industries such as mining, agriculture and tourism. Indeed, tourism has been recommended to many less developed tropical regions as a source of future prosperity, although it has also been acknowledged that developing a tourism industry could in fact degrade the natural environment on which the tourism itself is dependent (Commission on Sustainable Development, 1996). In many regions of the world, tourism is a vitally important industry and it forms an important and growing part of the world's economy; indeed there were 1087 million international tourists during 2013, generating 9% of the world's GDP and creating 1 in every 11 of the jobs around the world (The World Tourism Organisation (UNWTO), 2014). Accordingly, tourism is an internationally important industry, and a substantial body of literature has developed investigating the factors that influence the satisfaction of tourists. Hence this important industry was selected for study, to determine whether the use of factors found to impact on LS could enhance understanding of TS.

The tourism literature includes numerous studies using a wide range of different methods that evaluates factors influencing tourist TS. This is acknowledged to be an important area of study as being satisfied with a trip contributes to destination loyalty, encourages repeat visits and also increases recommendations to family and friends (Alegre & Cladera, 2006; Hui, Wan, & Ho, 2007; Kozak & Rimmington, 2000; Yoon & Uysal, 2005). Loyal visitors, who return regularly, can be more valuable than first time visitors, as little or no marketing costs are incurred in attracting these repeat visits and their recommendations to others reduce the marketing costs of attracting additional visitors. Thus satisfied and/or repeat visitors contribute to the financial sustainability of the tourist industry in a number of ways.

Just as personal/demographic factors have been found to influence LS, these types of variables also influence TS. Factors of this type that have been found to contribute to TS

include the tourist's age (Alegre & Cladera, 2006; Alegre & Garau, 2010; Shahrivar, 2012; Torres-Sovero, Gonzalez, Martin-Lopez, & Kirkby, 2012), gender (Coghlan & Prideaux, 2009), nationality or country of origin (Alegre & Cladera, 2006; Coghlan & Prideaux, 2009; Shahrivar, 2012), education level (Alegre & Garau, 2010; Shahrivar, 2012; Torres-Sovero et al., 2012), occupation (Coghlan & Prideaux, 2009) and income level (Alegre & Garau, 2010; Shahrivar, 2012; Torres-Sovero et al., 2012).

Specific trip factors also have an impact on TS; whether measured objectively, such as the type of accommodation (Alegre & Garau, 2010), the length of stay (McElroy & Parry, 2010), and the number of activities undertaken during the trip (Saltzer, 2002a), or subjectively such as satisfaction relating to prices (Alegre & Cladera, 2006; Alegre & Garau, 2011; Lu & Stepchenkova, 2012; Ziegler, Dearden, & Rollins, 2012), to facilities and accommodation (Alegre & Garau, 2011; Torres-Sovero et al., 2012), to hospitality and service (Alegre & Cladera, 2006), and to cleanliness (Alegre & Garau, 2010, 2011).

Thus, many similarities can be seen between factors found to impact on overall tourist TS and on overall LS; in addition to factors mentioned above such as age etc., in both cases satisfaction (with life or trip) appears to be influenced by factors from the social, economic and environmental domains. Within the social domain, significant influencing factors have included satisfaction with safety (Alegre & Garau, 2011) and perceptions of the crime level in the visited area (Demos, 1992); higher perceived safety levels increase TS. Within the economic domain, perceived high levels of development and indications of overdevelopment and congestion have been found to significantly reduce tourist TS, whilst peace, quiet and no perceived overcrowding improve TS (Alegre & Cladera, 2006; Ziegler et al., 2012). From the environmental domain, factors found to impact TS include the number of species observed (greater numbers increase TS) (Torres-Sovero et al., 2012), and satisfaction with factors such as: sunshine and beaches (Alegre & Cladera, 2006); climate (Alegre & Garau, 2011); contact with nature (Alegre & Garau, 2010); coral, fish etc. (Coghlan, 2012; Saltzer, 2002a); and visibility in the water (Coghlan, 2012; Ziegler et al., 2012).

Research has also shown that a wide range of factors influence the likelihood of a tourist returning to a region; somewhat surprisingly these factors do not always have a similar impact on TS. This may be because tourists are likely to report high levels of TS due to the emotional and financial investment they have personally made in that trip, but their reported likelihood of returning is not affected by this personal investment (Alegre & Garau, 2010);

alternately some tourists would not return to a location however high their satisfaction as their main motivation for location choice is novelty seeking (Assaker, Vinzi, & O'Connor, 2011; Jang & Feng, 2007). However, despite this, overall TS has been found to be one of the most important factors influencing return visits (Kozak, 2001; Moscardo, Saltzer, Norris, & McCoy, 2004; Yoon & Uysal, 2005) and visitors are unlikely to return if they are not satisfied with their trip (Alegre & Cladera, 2006).

1.4 Overall aim of thesis

The overall aim of my thesis is to improve understanding of the factors that impact life and tourist trip satisfaction. By meeting this aim I will generate insights that will improve welfare and customer satisfaction.

1.5 Specific research gaps and research objectives identified

Research gap 1

As discussed within section 1.3 above, there are a number of similarities between the concepts and research approaches adopted to enhance understanding of customer satisfaction within the commercial sector and those used within research into LS; however there has been little blending of LS & customer satisfaction ideas in the literature. In particular, so far as I am aware, there has not been any research that uses determinants of LS found from the application of the LS approach to provide insights into customer satisfaction within one specific and globally important commercial sector, tourism.

One of the most significant challenges faced by the world today is that of climate change, including the effects of global warming and the predicted increase in extreme climate events. Both the LS and TS literature have demonstrated that climate has an impact on life/trip satisfaction; however the approaches adopted in the two bodies of literature to understand the impact of climate variables has been quite different. Within the field of LS research objective data has been widely utilised for a range of different variables (such as minimum, maximum and average temperatures, millimetres of rainfall, actual wind speed etc.) as discussed in section 1.2.2.3. However, tourism research has focused on the relationship between tourist perceptions of the climatic conditions experienced on their trip, rather than assessing the impact of objectively measured climate data for the period of the trip, as discussed in section

1.3. Thus there is a gap within the tourism literature, to understand the impact of actual climate conditions on TS. As our climate changes, and temperatures around the world increase due to global warming, understanding the impact this may have on the global tourism industry is likely to become increasingly important.

Research objective 1

To determine if factors that have been found to contribute to LS are also key contributors to customer satisfaction, using tourism as a case study; . Within this context, I aim to improve understanding of the relationship between temperatures, as a key element of climate change, and tourist TS, generating new insights into factors that are important to tourists and, therefore, to a successful tourism industry. Specific questions relevant to this are expanded on within Chapter 3.

Research gap 2

Whilst there have been numerous studies investigating the factors impacting on tourist TS or the factors impacting on the likelihood of tourists returning (section 1.3 above), so far as I am aware, previous studies have not explicitly linked this research. That is, previous research has not attempted to draw inferences about how changes to factors impacting on TS may subsequently affect the likelihood of tourists returning, and then seek to estimate, based on these relationships, the financial impact (in terms of lost revenues from reduced numbers of returning visitors) that could result from changes to those underlying factors impacting TS.

Research objective 2

To address the gap in the literature whereby previous research has not sought to determine how changes to factors impacting TS may subsequently affect the likelihood of tourists returning, and has not attempted to estimate the financial impact (in terms of lost revenues from reduced numbers of returning visitors) that could result from changes to factors impacting satisfaction. Specific questions relevant to this aim are set out within Chapter 4.

Research gap 3

Economic research into the LS field began by investigating the impact of economic factors, particularly income or GDP; this research has since been widely extended, demonstrating that many other factors are also important to LS, including factors of a social or environmental nature.

It is not clear which factors or domains are the most important in explaining variations in LS, or indeed how many different domains are relevant and which factors should be incorporated within each domain. Whilst theorists have posed the hypothesis that within a rich developed country where incomes are above subsistence levels, social and/or environmental factors are likely to be more important influences on LS than economic factors, as far as I am aware there has not yet been clear empirical evidence showing that social and/or environmental domains dominate over the economic domain in explaining variations in LS.

Additionally, it has been noted that the study of spatial variations in the preferences of individuals has been somewhat neglected in the LS literature, as discussed in section 1.2.4 above. Whilst it seems likely that the complex inter-relationships between factors/domains impacting on satisfaction will be affected by the geographic location where the resident chooses to live, and where the tourist chooses to visit, this dimension has been little studied. Whilst some research has attempted to recognise the importance of geography and spatial variations by using methods such as incorporating dummy variables for different regions, I am not aware of research that explicitly recognises the possible spatial heterogeneity within the LS function and addresses this with the use of spatially varying models as opposed to estimating global models.

Research objective 3

To improve understanding of the importance of geography and spatial variations in people's preferences, and determine the relative importance of the different domains to overall LS of people living in different places, thus enhancing local and regional policy development. Specific questions relevant to this aim are expanded on within Chapter 5.

Research gap 4

Economists have developed a range of different methods to estimate the value of various environmental assets and services. The appropriate method to use depends on whether the environmental feature is a public or market good, and whether its value is of a use or non-use nature. Whilst some features are easy to value, relating to a use that has a clear market price (payment of an entrance fee for a park for example), the non-market, non-use values (such as the value of knowing a feature exists and is being preserved for future generations) are far more difficult to estimate. Methods such as CV or CM are traditionally the only valuation options in these circumstances. Whilst the LS approach has also been used to estimate non-

market values for a range of different environmental features, as far as I am aware, the potential usefulness of the LS approach for estimating non-use values has yet to be investigated.

In addition to this important methodological research gap, it has also been noted in the economic/environmental literature that there is a lack of knowledge about the spatial distribution of values within the GBR region, revealing an empirical research gap.

Research objective 4

To extend the existing literature based on environmental valuation using the LS approach to include the hard to monetise non-market non-use values, whilst also addressing the lack of knowledge about the spatial distribution of values within the GBR region noted in the literature. Specific questions relevant to this aim are expanded on within Chapter 6.

1.6 Thesis outline

This thesis is structured into eight chapters, followed by three appendices.

Chapter 1 (this chapter) sets out the key aim of the thesis within the context of the current state of knowledge, and goes on to discuss the LS and tourism TS literature in some detail. The chapter discusses the research gaps identified, and sets out specific research objectives identified, within the context of the overarching aim of the research.

Chapter 2 introduces the study region, explaining why the Great Barrier Reef (GBR) catchment area, Queensland, Australia, was selected. It also explains why the particular data sets used within the research were selected, and how this data was collected. The chapter concludes with a discussion of the methodological approaches adopted for this research.

Chapters 3 to 6 present the details of four separate studies that together comprise the research undertaken to address the various aims identified. These chapters comprise papers prepared for publication within peer reviewed journals or conferences. Chapters 3 and 4 discuss the research relating to tourists visiting the study region, whilst Chapters 5 and 6 relate to studies based on residents of the study region.

Chapter 3 tests to see if factors that influence LS also influence TS, specifically incorporating the temperatures experienced by the tourists on their trip within a TS model. This enabled

the optimal temperature for tourist TS to be estimated and facilitated consideration of the potential impacts of global warming on the tourism industry. Thus this chapter addresses research gaps in the literature by specifically addressing objective 1 above. This paper was accepted for, and presented at, the 25th Annual Council for Australasian University Tourism and Hospitality Education Conference, and was solely authored and presented by myself.

This research focuses particularly on the relationship between temperatures, within the environmental domain, and tourist TS. The research uses ordinal regression to determine the impact of maximum daily temperatures experienced by tourists on their reported TS when controlling for other factors that influence TS; the analysis was repeated using ordinary least squares regression to enable comparison of the findings using different techniques.

Chapter 4 builds on the insights from Chapter 3 regarding the factors that influence tourist TS, and also investigates the likelihood that a tourist will revisit a region, establishing that those reporting higher TS are more likely to return. The paper then evaluates the impact of a hypothesised change in a factor that influences TS on the level of TS, and the subsequent impact that this has on the likelihood of the tourist returning. A financial value is then estimated for the change in tourist revenue generated per annum as a consequence of the hypothesised change in the underlying factor. Thus this chapter addresses research gaps in the literature by specifically addressing objective 2 above. This paper was published by *Tourism Management* in February 2016, and was co-authored with members of my thesis committee, Natalie Stoeckl and Hong-Bo Liu.

The research investigates the relationship between the three domains of life, within specific geographic locations, and tourist TS; then determines the impact the TS has on revisit decisions, and the subsequent impact of those decisions back on the domains of life in the region. The chapter uses ordinal regression and two stage ordinal regression to calculate and value in $ terms the lost tourist revenue resulting from a change in repeat visitor numbers caused by changes in factors influencing the tourist's reported TS.

Chapter 5 investigates the impacts of economic, social and environmental factors on the LS of residents, explicitly recognising spatial variations in the relationships across the region. The paper then considers whether the insights drawn could be used to better inform the process when local government boundaries are being considered for reorganisation or amalgamation, reducing the likelihood that amalgamations will need to be reversed subsequently. Thus this chapter addresses research gaps in the literature by specifically

addressing objective 3 above. This paper is ready for submission to either Urban Studies or Urban Policy and Research (yet to be decided), and was co-authored with members of my thesis committee, Natalie Stoeckl and Hong-Bo Liu.

The research uses geographically weighted regression (GWR) to explain the reported LS of residents, detecting significant spatial variations in the influence of different factors from the economic, social and environmental domain on LS. The variables representing each of the domains within the model were derived using principal components analysis to meaningfully group and combine subjective responses to survey questions regarding satisfaction with a range of different factors, drawn from across the domains. The insights gathered from these findings are then used to consider the relative homogeneity or heterogeneity of resident preferences within current and previous local government electoral boundaries; demonstrating that previous local government amalgamations of regions with relatively homogenous resident preferences were successful, whilst those amalgamations that sought to combine relatively heterogeneous preferences were so unsuccessful that they were subsequently deamalgamated.

Chapter 6 places particular focus on how the environment impacts on LS, focusing particularly on the non-use values provided by cultural ecosystem services within a spatial context; that is the study specifically reflects spatially variations in the relationship between cultural ecosystem services and LS. In addition to investigating this relationship, the paper demonstrates that the LS approach can be used to estimate a non-use value for these cultural services to the residents of the region. Thus this chapter addresses research gaps in the literature by specifically addressing objective 4 above. This paper is currently in review with *Ecosystem Services*, and was co-authored with members of my thesis committee, Natalie Stoeckl and Hong-Bo Liu.

The research investigates the relationship between the three domains of life, focusing particularly on the environmental domain, and resident LS. The research uses GWR to explain the reported LS of residents, detecting significant spatial variations in the influence of different factors, and finding that primarily non-use cultural ecosystem services significantly influence LS across the region. The LS valuation approach is used to estimate the worth of cultural ecosystem services to residents of the region, using the coefficients from the LS model. The variable used to represent cultural ecosystem services values was derived by using principal components analysis to meaningfully group and combine subjective responses

to survey questions regarding satisfaction with a range of different factors, drawn from across the economic, social and environmental domains.

Chapter 7 summarises the key findings from the previous chapters, and draws conclusions from my work, discussing the empirical and policy contributions that are relevant to policy makers and to tourism operators/planners in the GBR region. It discusses the methodological contributions which are more broadly relevant, as these methods could be applied to any region of the world; policy considerations are also discussed. In this chapter I also discuss the limitations of my research, and provide some recommendations for future research.

The thesis then closes with a list of references in Chapter 8, followed by three appendices which include the surveys used to collect the data for this research.

Chapter 2 Overview of the case study region, questionnaire and data collection methods

Abstract of Chapter 2

This chapter will introduce the study area, and explain why this particular region, the Great Barrier Reef catchment area, Queensland, Australia, is an ideal one in which to address the research questions identified. It also discusses the specific datasets adopted for analysis and how the data were collected. Finally, the chapter discusses the methodological approach adopted for this research, and explains how this is based on, and develops, the methodological approaches adopted within the literature.

2.1 Introduction

The overall aim of my thesis is to improve understanding of the trade-offs that arise within complex interlinked social-economic-environmental systems. By meeting this aim I will generate insights that will improve welfare and customer satisfaction.

The region on which I have focused has four attributes which make it an ideal place in which to undertake the research, for four key reasons, briefly outlined here, and discussed in more detail below. First, the region is within a developed wealthy economy rather than a developing, subsistence economy. Second, the region's economy is composed of a number of different industries, one of which, tourism, is an ideal industry on which to test the applicability of the LS approach to improving understanding of customer satisfaction in the private sector. Third, the region has internationally significant environmental value, and a diverse mix of urban and rural inhabitants; these characteristics ensure the study is able to fully explore the environmental and social dimensions of LS in addition to economic factors. Fourth, the region is large enough to encompass a range of different spatial and environmental characteristics, including such diverse features as rainforest, beaches, agriculture and industrial land, and residential communities ranging from isolated country properties to regionally important cities.

2.2 Suitability of study region

As discussed in Chapter 1, previous research has shown that income is generally more important in explaining LS in poor countries, whilst the relationship between income and LS appears to become weaker, and social and/or environmental factors appear to become increasingly more important to LS, as incomes rise. Thus Australia is a highly suitable country in which to site my research since it is likely that multiple factors will contribute to LS. In poorer countries, the contribution of income to LS is more likely to dominate.

The Great Barrier Reef (GBR) catchment region, north eastern Queensland, Australia, is particularly suitable. The region has internationally recognised environmental value, and is also a region with a diverse economic base where the major industries of the region are firmly rooted within the natural environment. Tourism (based around the regions attractiveness to visitors for sun, sea, sand and scenery rather than manmade features such as shopping and the theatre) is important but is by no means the only economic activity in the region. The region is visited by huge numbers of tourists, international and domestic, each year (for example, tourism to the region generated 42.8m visitor nights in 2011/12 (Deloitte Access Economics, 2013), and yet also generates significant non-tourism economic value from other industries, the most important of which are mining and minerals processing, and agriculture, as can be seen in Figure 2. The remainder of this section explains the features of this region in greater detail, and a map of the region can be seen in Figure 4.

The natural environment of north east Queensland is very special; in addition to the natural beauty of the region's beaches and rainforest countryside, the region incorporates two overlapping World Heritage Areas (WHA), each containing special and unique features.

The GBR was proclaimed a WHA in 1981 and the listing provides a brief synthesis of the outstanding universal value of the region, including the following:

> *"As the world's most extensive coral reef ecosystem, the Great Barrier Reef is a globally outstanding and significant entity. Practically the entire ecosystem was inscribed as World Heritage in 1981, covering an area of 348,000 square kilometres ... Collectively these landscapes and seascapes provide some of the most spectacular maritime scenery in the world ... There are over 1,500 species of fish, about 400 species of coral, 4,000 species of mollusk, and some 240 species of birds, plus a great diversity of sponges, anemones, marine worms, crustaceans, and other species. No other World Heritage property*

contains such biodiversity. This diversity, especially the endemic species, means the GBR is of enormous scientific and intrinsic importance, and it also contains a significant number of threatened species. At time of inscription, the IUCN evaluation stated "... if only one coral reef site in the world were to be chosen for the World Heritage List, the Great Barrier Reef is the site to be chosen".”(UNESCO World Heritage Convention, 1981).

However, despite its environmental importance, the future of the GBR is not secure. At least partially because of degradation suffered as a consequence of economic development, the GBR is close to being added to the World Heritage in Danger list (UNESCO World Heritage Centre, 2014a) which currently includes other iconic environments such as the Everglades National Park in the USA and the ancient rainforests of Madagascar (UNESCO World Heritage Centre, 2014b).

The second WHA within the region, the Wet Tropics, was proscribed in 1988; the listing provides a brief synthesis of the outstanding universal value of the region, as follows:

“The Wet Tropics of Queensland, or Wet Tropics, stretches along the northeast coast of Australia for some 450 kilometres. Encompassing some 894,420 hectares of mostly tropical rainforest, this stunningly beautiful area is extremely important for its rich and unique biodiversity. It also presents an unparalleled record of the ecological and evolutionary processes that shaped the flora and fauna of Australia, containing the relicts of the great Gondwanan forest that covered Australia and part of Antarctica 50 to 100 million years ago ... These living relicts of the Gondwanan era and their subsequent diversification provide unique insights to the process of evolution in general ... The property supports tropical rainforests at their latitudinal and climatic limits, and unlike most other seasonal tropical evergreen equatorial forests, is subject to a dry season and to frequent cyclonic events. Many of the distinct features of the Wet Tropics relate to its extremely high but seasonal rainfall, diverse terrain and steep environmental gradients. In addition to its complex array of species and life forms, the Wet Tropics is also recognised as an area possessing outstanding scenic features, natural beauty and magnificent sweeping landscapes.” (UNESCO World Heritage Convention, 1988).

Despite the unique environmental features of the region, this is also a region with huge industrial value, currently and prospectively, to the interrelated mining/minerals processing/ports industries. Using 1999/2000 data) within the GBR catchment area (the

latest period for which both employment and value added data was collected for the region), tourism (attracted to the environmental offering) was the second most important industry based on the gross value of production, and the most important in terms of numbers employed. Mining & mineral processing combined, and agriculture, occupied the remaining top three positions for both production and employment (Productivity Commission, 2003), as shown in Figure 1.

Considering more recent data, employment figures for the region by industry are available from the 2011 census. Using data for the four main statistical areas within the GBR region (Cairns, Townsville, Mackay and Fitzroy) and the industry classifications used by the ABS, as shown in Figure 2, we can see that agriculture appears to have become less important to employment within the region, whilst mining and construction (mainly related to the mining construction boom) have become more important to the employment of the region. Tourism remains important for employment in the region, as in addition to the accommodation and food employment much of the retail trade employment is likely to be tourism related.

Thus the region depends upon three key industries for income and employment, all of which rely upon the natural environment – albeit in different ways.

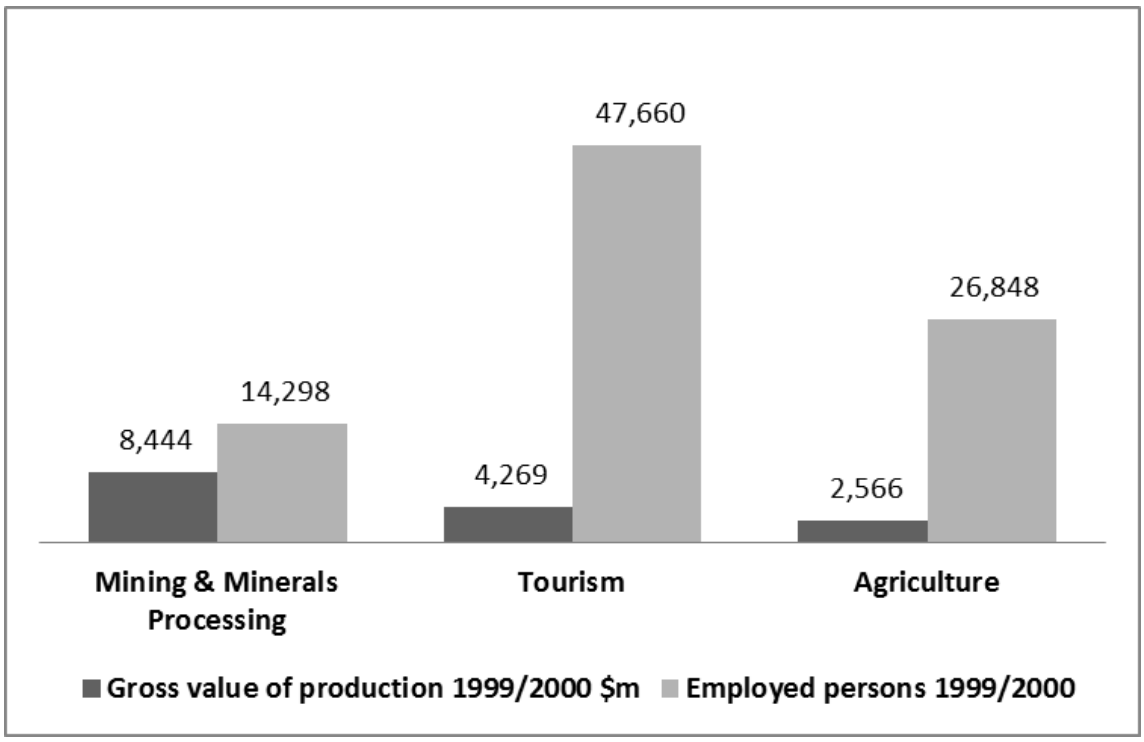


Figure 1 Relative importance of the three major industries within the GBR catchment region (Productivity Commission, 2003)

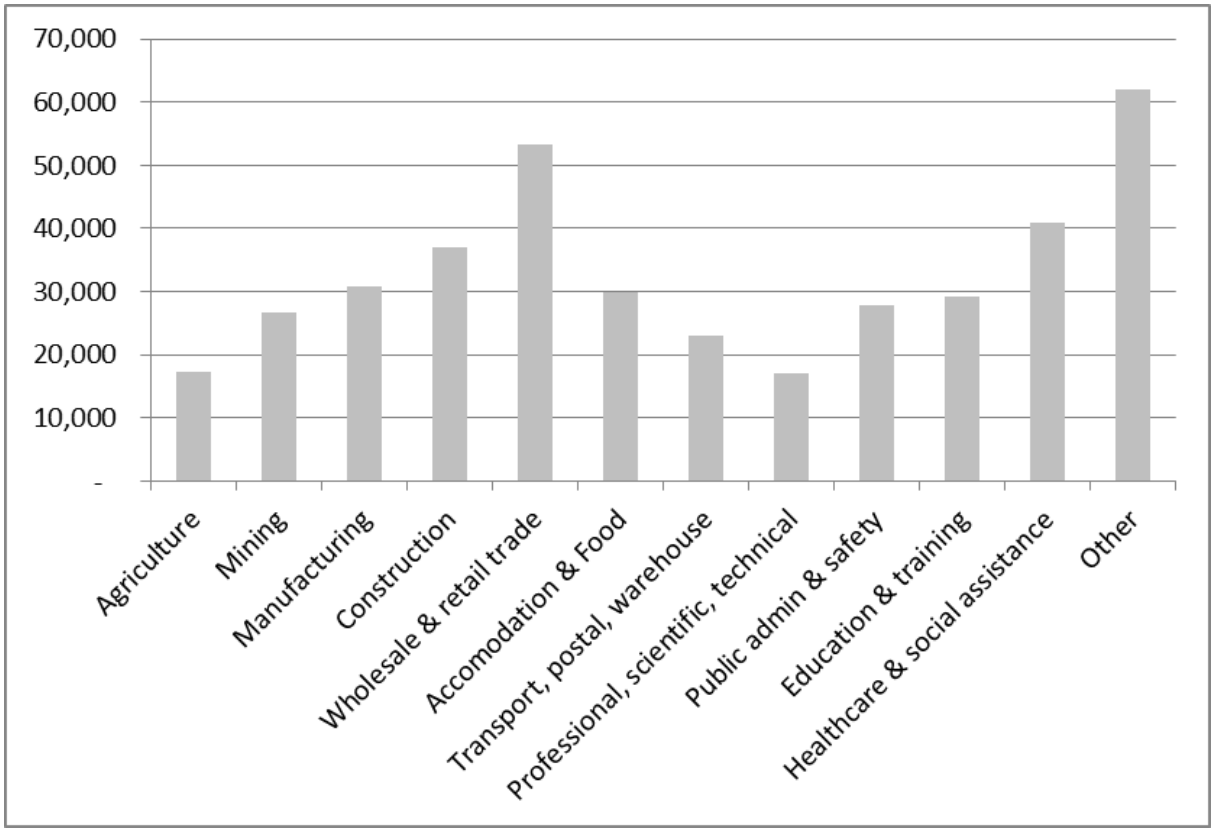


Figure 2 Number employed by industry 2011 within the GBR region (data from ABS website: http://stat.abs.gov.au/itt/r.jsp?databyregion#/)

In addition to the various current mining and minerals processing operations, there are significant plans for new mining and processing operations in the region, along with associated infrastructure developments, such as new rail and expanded port facilities. These include the exploitation of the coal reserves of the Galilee Basin (a large region lying inland from north of Mackay down to south of Gladstone). This region has been described as one of the largest coal basins in the world, covering 247,000 square kilometres, and is expected to provide over 13,000 jobs once the proposed mining projects are fully operational (State Development Queensland, 2014). This scale of mining development also requires significant development of related infrastructure, with rail routes planned to connect the Basin to the coast, where significant expansion of the existing ports has been proposed and is underway.

Recent development within the region has also seen the construction of three liquefied natural gas (LNG) production facilities on Curtis Island, near Gladstone; these plants convert coal seam natural gas piped from the Bowen and Surat Basins in South Western Queensland and represent the world's first coal seam gas LNG export facilities. Production within the first plant commenced late 2014, with further facilities due to come on line later in 2015.

Current major ports within the region include Abbot Point and Hays Point, both north of Airlie Beach, where shipping routes have to pass through the GBR, and Gladstone Port, which is close to the southern tip of the GBR. These are already significant ports, handling in excess of 160 million tonnes of coal, coke, briquettes and non-ferrous metals between them in financial year 2013/14 (comprising Gladstone 98.3m (Gladstone Ports Corporation), Hays Point 40.8m (North Queensland Bulk Ports Corporation Hay Point Port) and Abbot Point 22.9m (North Queensland Bulk Ports Corporation Abbot Point Port)). Significant growth is anticipated from these ports: planned expansion at Abbot Point Port, to meet the needs of the Galilee Basin mining projects, is likely to increase capacity by 70 million tonnes per annum (North Queensland Bulk Ports Corporation Abbot Point Port), whilst throughput from Gladstone will increase significantly in response to the new LNG facilities at Curtis Island. The growing importance of the mining industry (and related construction activities) to the economy of Queensland as a whole can be seen from the graph in Figure 3.

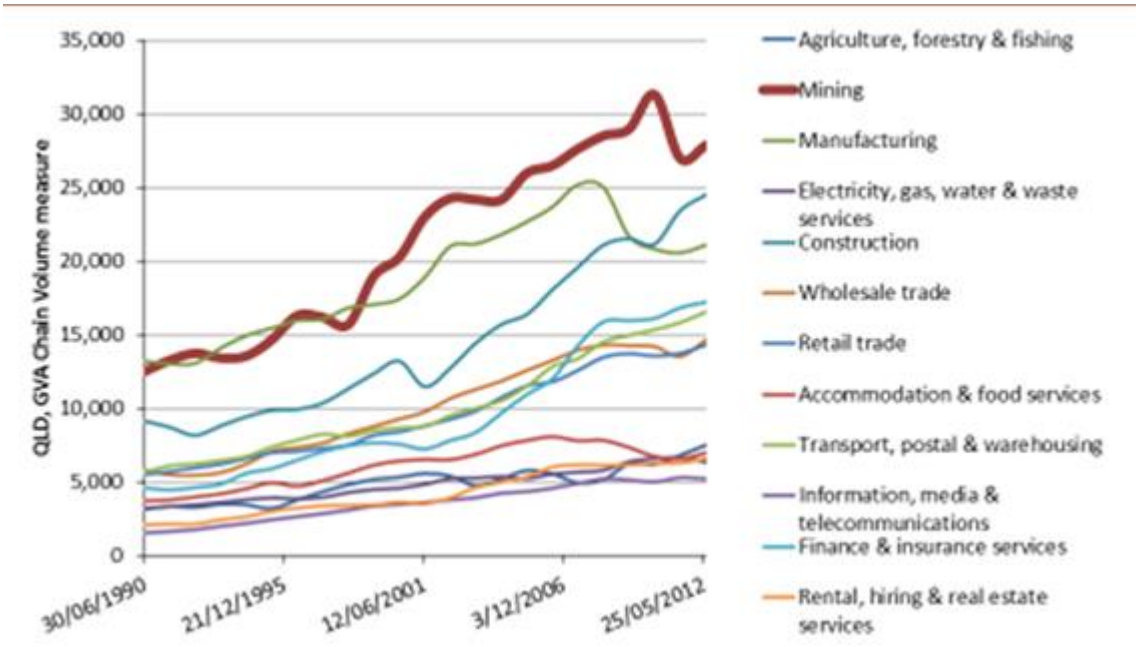


Figure 3 Industry gross value added 1990 to 2012 for Queensland (Data source: dXtime, ABS State Accounts, Table a5220-25 Industry Gross Value Added – QLD Chain Volume Measures

The region has also seen strong population growth over the recent past, partly as result of the industrial development in the region which has required considerable numbers of construction workers in addition to workers engaged within the various operations. Considering the statistical regions defined by the ABS as Cairns, Townsville, MacKay and Fitzroy (working from north to south along the main region adjacent to the GBR), the population of the region has grown by over 22% in the 10 years to June 2014 (Australian

Bureau of Statistics, 2015). Such strong levels of population growth bring their own pressures to the economic, social and environmental features of the region, as the additional population require not only jobs, but also infrastructure such as schools and hospitals, in addition to wanting to be able to enjoy the social and environmental offerings of the region during their non-working hours.

Thus, the economic development of the region, from mining, minerals processing, and related infrastructure, is highly significant, and has brought the supporters of development into conflict with other key stakeholders within the region, particularly the environment based tourism industry, and others who desire the protection of the natural environment. These factors combine to present the GBR region as an ideal case study area for my research. It should be noted, however, that whilst the empirical results of this study are specific to the GBR catchment region, the empirical findings may be transferable to similar regions elsewhere, and the methodology demonstrated is transferable to any region around the world.

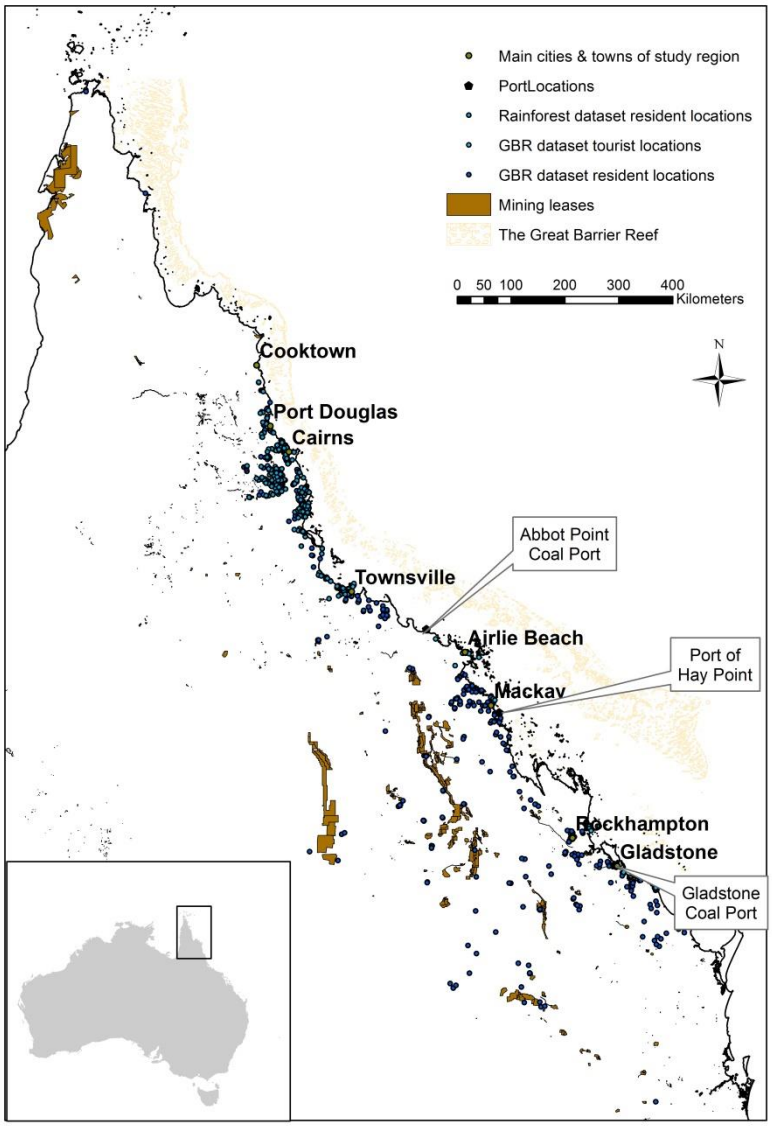


Figure 4 Map of chosen study region, north eastern Queensland

2.3 Data selection

I chose to use secondary data from two sets of cross-sectional surveys (gathered as part of two research projects funded by the Australian Government's National Environmental Research Project (NERP)) for my study. Collecting sufficient primary data across the region would have been beyond the financial, and time, limits placed on this research, and was unnecessary as these data were already available and appropriate for the task at hand.

These two NERP funded projects were "Project 10.2 Socio-economic systems and reef resilience", and "Project 12.3 Relative Social and Economic Values of Residents and Tourists

in the Wet Tropics World Heritage Area". I shall refer to these as the "GBR Project" which provided the "Reef dataset", and the "Wet Tropics project" which generated the "Rainforest Dataset" respectively. The two projects covered overlapping regions of northern Queensland, Australia. The GBR Project sought to improve our understanding of the relationships between socio-economic systems and the biophysical system which makes up the Great Barrier Reef World Heritage Area (GBRWHA), and thus investigated the catchment region of the GBR, focusing on the area from Gladstone (towards the southern end of the Reef) up to Port Douglas. The Wet Tropics Project sought to improve our understanding of the value which residents place upon the ecosystem services of the Wet Tropics World Heritage Area (WTWHA), and focussed on the smaller Wet Tropics region stretching from Townsville to Cooktown. Both projects covered coastal settlements and adjacent inland regions, and the specific areas covered by the studies can be seen in Figure 4. I was a member of the research team for each of these projects, with my role including data collection (as part of a team of researchers who approached tourists to request that they complete surveys), and subsequent data analysis.

These datasets offered a number of advantages making this data highly suitable for the purposes of this research, compared to alternate options.

1) The data were available for a region identified as ideal for my study, as discussed in section 2.2 above.
2) The surveys gathered subjective data relating to the respondents perceptions across all domains of life; survey questions related to economic, social and environmental factors.
3) The datasets included responses from tourists visiting the region and residents, enabling the analysis of the different influences on, and effects of, tourist TS and resident LS.
4) The data could be precisely matched to specific geographic locations; for tourists I had the exact location where the tourist was approached to complete the survey whilst for data collected from residents I had access to their full address details. This enabled survey responses to be matched precisely to secondary data on economic, environmental or social factors available from other sources.

The data provided from these projects was thus able to provide me with subjective information regarding the perceptions of tourists to the region, and the region's residents,

about their overall satisfaction with their trip, or with their life, respectively, in addition to their perceptions regarding many different features of the region. It was important to be able to utilise data on perceptions in addition to objective data to enable full exploration of the drivers of satisfaction with life/trip. This data was also available at fine enough geographic detail to enable the responses to be analysed within the context of specific spatial features within which the economic, social and environmental factors are rooted which was also vital for this study. Moreover, both projects included related but separate studies of tourists and residents; this research utilises the Reef dataset for tourists (chapters 3 and 4), and for residents (chapter 6), and utilises the Rainforest dataset for residents only (chapter 5).

However, whilst the use of the Reef Dataset and the Rainforest Dataset enabled this study to address the research objectives posed in Chapter 1, these datasets are not perfect. Particularly, because they only provide cross-sectional data, the view presented by this study can thus only reflect a snapshot in time. This prevents a full investigation into cause and effect over time of the trade-offs within these complex, interrelated, dynamic systems[5]. Accordingly, alternate sources of data were considered, but none were as well able to meet the requirements of this study.

For example, a potential source of data was the Australian Bureau of Statistics (ABS), which provides a wide range of data types, both across time with historical data and also cross-sectional across space, providing data for different statistical regions. The ABS web-site has in fact been used extensively as a source of objective data within this thesis, but as it could not provide the subjective data required, specifically, being information regarding LS of residents, or the TS of tourists, this could not be the primary data source for this research.

Another potential source for data was the Household, Income and Labour Dynamics in Australia (HILDA) survey, from the University of Melbourne, which is a panel study where data have been collected annually since 2001. This study collects data about economic and subjective well-being, labour market dynamics and family dynamics, and the data have been used in other LS research, such as that by Ambrey and Fleming (2014b). Whilst meeting many of the criteria for this study, this dataset has three key drawbacks when considered against my specific research objectives. Firstly, the survey focuses on economic and social factors; it does not question the respondents about their perceptions regarding any aspects of the natural environment. Secondly, the dataset provides information from the perspective of

[5] As described in the final chapter of this thesis, there is an opportunity for future research to address this matter.

residents only; it would be unable to inform the research regarding influences on, and effects of, tourist TS. Thirdly, the data are not available with the necessary level of granularity at the spatial level to enable survey responses to be precisely matched with objective environmental data available from other sources, or to economic data available from sources such as the ABS. The unconfidentialised release of the HILDA dataset reports respondents by ABS statistical region; however, given the size of these regions, a number of different respondents would be reported as sharing the same geographic location which would not be ideal[6].

Accordingly the secondary cross-sectional datasets gathered as part of the GBR and the Wet Tropics projects were utilised for this study. Detail with regard to the survey and the sample that is relevant to each of my individual research studies is provided within the relevant chapter of this thesis, thus the GBR Tourist survey is discussed within Chapters 3 and 4, WTWHA Resident survey is discussed within Chapter 5 and the GBR Resident survey is discussed within Chapter 6. However, as an introduction, I briefly describe the design process for these survey instruments and explain how the samples were selected and the data actually collected in section 2.4 below. Section 2.5 describes some overall characteristics of the data. Further detailed information regarding these projects is available; for the GBR Project from the Interim Report (Stoeckl, Farr, & Sakata, 2013) and the Final Report (Stoeckl, Farr, Jarvis, et al., 2014), and for the Wet Tropics Project from the Final Report (Esparon, Stoeckl, Larson, Farr, & Schmider, 2014).

2.4 Development of the surveys, sample selection and sampling technique

2.4.1 Development of the surveys

For both the GBR Project and the Wet Tropics Project, draft questionnaires were developed after a process including literature review, focus groups, and workshops with various parties considered to be key stakeholders of the project. The questionnaires were refined and finalised after conducting pilot tests, encompassing pilot mail outs to a subset of residents of the region, and pilot testing of the tourist survey at the departure lounge at Cairns airport.

[6] The unconfidentialised HILDA dataset for the state of Queensland (size approximately 1.8km^2) provides two alternate spatial categories, one of which segregates Queensland into Brisbane and Other, the second segregates Queensland into four, being Major Urban, Other Urban, Bounded locality, and Other rural. The first of these would classify the entire GBR region as lying within one statistical district, whilst the second would classify the GBR region across three districts. Neither of these would have provided sufficient granularity of data for my analysis.

For the final surveys of GBR tourists, GBR residents and WTWHA residents, 24 different versions of each of the surveys were produced. Research has shown that respondents can be highly sensitive to the order in which questions are presented, particularly when asked to consider a long list of items (Cai, Cameron, & Gerdes, 2011; Lasorsa, 2003). Accordingly, different versions of the surveys were produced varying the order of the key "importance of" and "satisfaction with" values questions to reduce the risk of question order bias[7].

For the tourist survey, in addition to the original survey in English, versions were produced in both Japanese and Chinese, thus ensuring that visitors from those regions would be represented within the data collected. Whilst around two thirds of visitor nights within the region are domestic visitors (Tourism Research Australia, 2013), the remainder come from a wide range of different countries from all continents; for international visitors to the GBR catchment region, research found the most frequent countries of orgin were UK, China and Japan (Tourism Research Australia, 2013). Accordingly, the project team estimated that the surveys were understandable to at least 90% of tourists in this region (Stoeckl et al., 2013).

One version of the GBR Tourist survey can be found at Appendix 1, one version of the GBR Resident survey can be found in Appendix 2, and one version of the WTWHA Resident survey can be found in Appendix 3.

2.4.2 Sample selection and sampling technique for the GBR Tourist surveys

The sampling strategy was designed to collect surveys from a sample of tourists that reflected the geographic, temporal and sectoral differences in tourists that visit the GBRWHA, and reflected the mix of origin countries of the region's visitors. Some areas of the region are more heavily visited than others, thus data collection focused on the areas that receive the largest number of tourists[8]. Tourism is a seasonal industry, the region experiences different types of visitors at different times of the year; to reflect this seasonality, surveys were conducted regularly throughout a 12 month period, from early July 2012 to end June 2013; this ensured that the sample reflected seasonal changes in the visitors to the region. Finally, to ensure a range of different types of tourists were sampled, tourists were approached and asked to complete surveys at a number of different location types. These included airport departure lounges (international and domestic terminals), on boats and at boat/ferry terminals,

[7] Whether question order appeared to impact responses was tested for; see 5.5.1 and 6.5.1 for results.
[8] Data from GBRMPA (Great Barrier Reef Marine Park Authority, 2014b) demonstrates that more than 90% of tourists visit either the Cairns/Cooktown or Townsville/Whitsunday reef management areas; thus collection efforts focussed on these regions.

at beaches and sunbathing areas at seafront lagoons, and at caravan and camping sites. Additionally, a number of surveys were collected indirectly, by tourism operators across the region, including boat/ferry operators, tour operators and accommodation providers.

In total, 2,743 completed surveys were collected from 59 different locations within the region (shown in the map Figure 4); 203 (7%) of these were collected by tourism operators on behalf of the project, the remainder (93%) were collected directly. Personally, as part of the research project team I collected surveys from tourists at Cairns airport (domestic and international terminals), Rockhampton and Whitsunday Coast airports (domestic terminals), at the Lagoon in Cairns, on the beach at Port Douglas, from camping/caravan sites in Cairns, Arlie Beach, Rockhampton and Yeppoon, and from ferry terminals in Airlie Beach.

2.4.3 Sample selection and sampling technique for the Reef resident surveys

The sample of residents of the GBR catchment region was selected using a stratified sampling technique from the 48 postcodes that lay wholly or partially within the geographic region of interest. From a purchased database, 100 households were selected from each of the relevant postcodes and each was sent a version of each type of survey, ensuring that each postcode received at least 4 surveys of each of the 24 different versions. Furthermore, only one half of our residents were asked to tell us about both importance and satisfaction, with the remaining half being provided with a shorter questionnaire that excluded the questions relating to the respondents satisfaction with the community benefits (instead, only asking about the importance of these benefits). The study was conducted using the Dilman (2007) methodology; following the original posting out of the surveys, reminders and replacements sent out 4 weeks later, with final reminders and replacements sent out subsequently. Of the 4,800 surveys posted out, 823 were returned due to either incorrect addresses or the recipient having moved away; thus an estimated 3,977 surveys reached their recipient. Of these, 902 completed surveys were returned, giving an overall response rate of 22.7%.

In addition to the surveys received from the mail out activity, researchers also collected a number of resident surveys when out on location collecting tourist surveys, as discussed in section 2.4.1 above. When approaching potential respondents at airports, lagoons etc. the researcher ascertained whether the person was a tourist or resident of the region; residents of the locality were asked to complete a resident survey instead of the tourist survey. Unfortunately none of these additional surveys were suitable for use within my study as the full address of the resident was not obtained, thus preventing the mapping of the response

within the GIS system and preventing the inclusion of the response within the GWR analysis. If these responses are included, a total of 1,592 completed surveys were collected from GBRWHA residents.

2.4.4 Sample selection and sampling technique for Rainforest resident surveys

Similarly to the sample selection for the GBR region, a stratified sampling technique was used to select 2000 households evenly spread across the 33 postcodes that had been identified as being wholly or partially within the WTWHA, and evenly spread across the 24 different versions of the questionnaire. The study was again conducted using the Dilman (2007) methodology. Of the 2,000 surveys posted out, 447 were returned due to either incorrect addresses or the recipient having moved away; thus it is estimated that 1,553 surveys reached their recipient. Of these, 386 completed surveys were returned, giving an overall response rate of 24.8%.

2.5 Descriptive statistics of the data collected

For the purposes of the research within this thesis I started with the full dataset collected by these projects, as discussed above. From this, I selected the respondents that could be used within my studies as they had answered all of the survey questions that I intended to use within my analysis. As only one half of our residents were asked to tell us about both importance and satisfaction, those given the shorter questionnaire need to be excluded as the satisfaction variables were at the core of this study. Additionally, for residents, I selected only those that had full address details providing sufficient spatial resolution to enable the use of GIS techniques. For tourists, I selected a subset of respondents being those that were spending less than 14 days in the region; this enabled me to filter out those travelling along 2000+km coast and experiencing huge variety of social economic and environmental factors[9]. Accordingly, the summary descriptive statistics set out within Table 3 give an overview of the sub-samples used within this thesis.

[9] The selection of 14 days or less was chosen as representing, for most people, the period they spend on their annual holiday, which is likely to be to one destination; longer time periods are more likely to be spent travelling longer distances. However, this suggests an opportunity for future research, to investigate the differences in preferences of those on longer trips and to verify the appropriateness of using 14 days as the cut off point for this study.

Table 3 Descriptive statistics of the survey data used within this thesis

	GBRWHA Tourist survey Chapter 3	GBRWHA Tourist survey Chapter 4	WTWHA Resident survey Chapter 5	GBRWHA Resident survey Chapter 6	Queensland Residents (2011 Census)
Total number of responses received	2743	2743	386	1592	
Less: responses from tourists in region for 14 days or more deliberately excluded from analysis	(1,358)	(1,358)			
Less: responses from residents collected when collecting tourist surveys excluded from analysis due to not collecting their full postal address				(690)	
Less: responses from residents who were only requested to answer the importance questions rather than importance and satisfaction questions				(387)	
Adjusted number of responses received	1,385	1,385	386	515	
Number of responses used within the relevant chapter of the thesis	552	641	292	245	
Gender - % Male	51%	50%	45%	52%	50%
Age – mean in years	39	39	55	57	46
Marital status - % married or living with partner	47%	48%	80%	75%	48%
% with Year 12 education or higher	91%	91%	76%	77%	48%
Mean midpoint income divided by equivalence factor	$57,567	$58,874	$46,651	$51,373	$38,581

The gender mix for each of the samples used within this thesis was fairly equal, representing the gender mix in the wider population of residents of Queensland. For the sample of WT residents, the survey respondents was a little biased towards females; however as gender was not found to be significant for the study this slight overrepresentation of females is unlikely to have caused any significant distortion to the results of the study.

With regard to the samples of residents, the average respondent was aged 55, married and had completed year 12 education level or higher; thus the sample over represents the older, married and more educated person compared to the general population of Queensland. The average survey respondent also had a higher mean income than that of the wider population, which is to be expected given the average age and education characteristics of the respondents. The respondents of the GBRWHA region were found to have higher incomes

than the respondents of the WTWHA; this difference is unsurprising given the greater number of relatively highly paid jobs in the mining and minerals processing industries found in the southern part of the GBRWHA, outside the WTWHA.

For the tourist data gathered within my survey, the socio-demographic characteristics of all tourists to the GBR region is not available, so far as I am aware, as most data sources only track visitor numbers, nights spent in the region and expenditure levels. Thus I am unable to determine whether my sample is representative of the population of tourists visiting the region; however should my sample not be representative then there is a risk of sample selection bias influencing my results.

Thus, as is frequently found with survey based studies within the social sciences, there is a possibility of sample selection bias within my data. As can be seen from table 3, only around half of the survey respondents answered all of the relevant questions used within my research; it is possible that there are differences in preferences between those people who do decide to fully complete the survey and those who chose not to answer all of the questions. The differences between my sample and the wider population should be borne in mind when applying the results found to the wider population and wider region; for example, should the sample be biased to include more people with pro-environment views than are found within the wider population, then my estimates of the importance of the environment, and the value of environmental features could be overstated. The potential implications of such bias, and future research activities that could aim to address this potential sample bias are discussed within Chapter 7, section 7.4.

2.6 Methodology issues

This thesis comprises four separate studies (set out in Chapters 3 to 6); each uses different, innovative, methodological approaches to analyse the specific research questions identified, and thus provides methodological contributions to the field of knowledge in addition to the empirical contributions resulting from the analysis. Whilst the specific methodology adopted to address each specific question is discussed within each chapter in turn, there are some overarching principles adopted within the research which are discussed here.

2.6.1 Model estimation when dependent variables are of a categorical nature

For each of the studies presented in this thesis, the models used have categorical dependent variables, each of which has been measured using an ordinal scale. The data for the dependent variables were obtained by asking survey questions where the respondent was asked to give their response based on a 5 point Likert scale. Thus, the resident or tourist described their life or trip satisfaction as either very satisfied, satisfied, neutral, dissatisfied, or very dissatisfied; the tourist's likelihood of returning was described as will definitely return, may return, neutral, may not return or will definitely not return.

There has been considerable debate in the LS literature as to whether techniques designed for use with continuous data (particularly ordinary least squares (OLS) regression) can also be used with ordinal Likert scale data. Most within the psychology profession seem to have accepted the use of techniques such as OLS regression. Economists have generally preferred ordinal techniques such as ordered Probit regression (Ambrey, Fleming, & Chan, 2014; Ferrer-i-Carbonell & Frijters, 2004; Frey & Stutzer, 1999), although OLS techniques have sometimes been used in micro level studies focusing on individuals responses (Ferreira & Moro, 2010; Helliwell, 2003; Kountouris & Remoundou, 2011) and continuous data methods have been used in macro level research (using cross-section or panel data) where the responses for many individuals in a region or country are aggregated to give average satisfaction levels (Easterlin, 1995; Engelbrecht, 2009; Rehdanz & Maddison, 2005; Vemuri & Costanza, 2006).

The tourism literature, investigating the likelihood of tourists revisiting an attraction or region, and/or investigating tourist satisfaction, have used a range of techniques, some suitable for categorical or ordinal dependent variables (Alegre & Cladera, 2006; Alegre & Garau, 2010; Ledesma, Navarro, & Perez-Rodriguez, 2005) and others more appropriate for continuous data (Hui et al., 2007; Kozak, 2001; Yuksel, 2001).

Research has been conducted into the effect of using techniques designed for continuous rather than ordinal data; from a statistical perspective (in terms of predictive ability), differences are generally small (Kromrey & Rendina-Gobioff, 2002; Newsom, 2012). Furthermore, when coefficients from the equations are used to estimate marginal effects differences in final estimates also small (Bertram & Rehdanz, 2015; Ferreira & Moro, 2013; Ferrer-i-Carbonell & Frijters, 2004; Frey et al., 2009; Frey & Stutzer, 2000; Helliwell, 2003; MacKerron & Mourato, 2009; Moro et al., 2008). The story is similar when using

coefficients in more sophisticated calculations (e.g. as is done within the LS literature, to estimate the monetary 'value' of non-priced goods and services); the choice of estimation technique (OLS or ordered probit) has little or no impact on the resulting valuations (Ambrey & Fleming, 2011; Frey et al., 2009; Frijters & Praag, 1998; Levinson, 2012; Luechinger, 2009; Luechinger & Raschky, 2009). As Levinson (2012) points out, the LS approach is based on a ratio of coefficients, rather than the absolute effect on the ordinal dependent ratio; as such final estimates of 'value' may be relatively insensitive to the choice of ordinal or continuous techniques; this conclusion is confirmed by others (Welsch & Kühling, 2009).

The overwhelming conclusion from such LS studies is thus that the choice of technique is more important in theory than in practice. One attraction for working with OLS rather than ordinal regression techniques is that OLS model coefficients can be far more easily interpreted. With OLS, the coefficient can easily be interpreted as showing the amount the dependent variable would change as a result of a one unit change in the explanatory variable. However, with ordinal regression techniques this is not the case; rather the coefficients can be used to derive the probability that the response to the dependent variable will fall into each of the possible categories available. There are thus advantages in using continuous techniques.

For the tourism studies set out in Chapters 3 and 4, I have used ordinal regression for the analysis but then repeated the model estimation using OLS regression, allowing the results from each method to be compared. This analysis thus contributes to the existing literature on the appropriate use of these techniques. For the studies using resident data, set out in Chapters 5 and 6, a continuous data regression technique was used; I chose to use geographically weighted regression to enable a full exploration of any spatial patterns inherent within the data.

2.6.2 How to measure factors influencing LS: Objective or subjective measures?

Objective indicators focus hard facts that can be measured without having to refer to opinions and personal beliefs, such as annual income (measured in $), whilst subjective indicators explicitly takes account of opinions and personal beliefs regarding the item under study, such as satisfaction with income (Veenhoven, 2002). Subjective measures have been criticised as being unstable, incomparable, unintelligible, invalid and unreliable (Veenhoven, 2002); however, objective measures may not always be as 'objective' as believed; they can suffer from measurement problems and sometimes determining the optimum level of such a

measure requires a subjective value judgement[10] (Diener & Suh, 1997). Moreover, people's perceptions of reality have often been found to be more important determinants of behaviour, or satisfaction with life, than those scientifically measurable ('objective') indicators (Cummins, 2000a; Schneider, 1975). It thus seems that both objective and subjective measures are required to fully understand human quality of life and to make informed policy decisions (Diener & Suh, 1997); their joint use helps in getting the full picture (McAllister, 2005; Veenhoven, 2002).

Whether considering overall LS, the dependent variable within the study is of a subjective nature. Objective independent variables have been found to better explain objectively measured dependent variables, whilst subjective independent variables better explain subjectively measured dependent variables (Cummins, 2000a, 2000b); objective measures of factors relating to the individual's quality of life tend to be highly inter-related (such as higher paid people also tending to be more highly educated and healthier) thus resulting in significant correlations between variables. Thus, considering subjective explanatory variables, in addition to objective variables, is likely to be important in LS studies.

Within the literature there has been some research considering the relative performance of subjective and objective measures in explaining variations in LS. Economic factors such as income have generally been measured objectively, but studies that have included a subjective indicator of perceived financial situation have found this to have a strong and significant positive relation to LS (Johnson & Krueger, 2006; Mentzakis & Moro, 2009).

Subjective indicators have been extensively used to measure social factors, and within the social domain objective indicators have generally been found to be poorly related to overall LS and to subjective measures of similar factors (Schneider, 1975; Wasserman & Chua, 1980). Focussing particularly on one element from the social domain, that of crime and safety, perceived crime levels have been found to be more significant to LS than actual crime levels by a number of different studies (Ambrey, Fleming, & Manning, 2014; Larson, 2010; Manning et al., 2015), whilst the incidence of crime had little relationship to people's perceptions (Veenhoven, 2002).

[10] As an example, an index of deforestation would appear to be an objective measure, but frequently does not fully represent the destruction of old growth timber as loggings are offset with new plantings, judgement is required as to what type of cutting and what type of planting is to be included (Diener & Suh, 1997).

Within the environmental domain, the evidence is mixed as to whether objective and subjective measures are related to each other, and as to whether objective measures correlate with LS. Public perceptions of environmental quality have been found to be inconsistent with scientific analysis; for example, a number of studies have found differences between perceived and actual water quality (Artell, Ahtiainen, & Pouta, 2013; Kataria et al., 2012; Lepesteur, Wegner, Moore, & McComb, 2008; Pendleton, Martin, & Webster, 2001), whilst others have found objective measures and perceptions to be fairly similar (Steinwender, Gundacker, & Wittmann, 2008). Better predictive or explanatory powers have been found from using subjective, rather than objective, indicators in hedonic pricing models (Adamowicz, Swait, Boxall, Louviere, & Williams, 1997; Chasco & Le Gallo, 2013) and contingent benefit studies (Farr, Stoeckl, Esparon, Larson, & Jarvis, 2014).

Evidently, whilst perceptions regarding the environment may be different to the actual condition based on objective measures, human behaviour is based on individual's preferences which are formed from each person's perceptions, hence '… people's perceptions of environmental amenities should therefore provide the most accurate estimates of the values attached to these amenities' (Artell et al., 2013, p. 288). Thus, differences between perceived and objective indicators can result in biased or otherwise invalid results from analysis based only on objective measures (Chasco & Le Gallo, 2013; Kataria et al., 2012).

An emerging body of literature has hypothesized that it is not only the stated perceptions of a feature that has a significant impact (e.g. satisfaction with income or family relationships); stated perceptions of the importance of the feature or need (e.g. reported importance of income or family relationships) may also have an influence. Relatively more important needs will have a bigger impact on overall LS if they are not met compared to less important needs; if a feature is not important to an individual, then the quality of that feature is likely to be irrelevant to that person's behaviour or their overall quality of life (Farr et al., 2014). From this premise it flows that weighting satisfaction levels with different features by their relative importance may better reflect their impact, enabling us to better understand what really explains LS, and the degree to which needs of varying priorities are being met (Costanza et al., 2007; Hsieh, 2003, 2012; Larson, 2010).

Different techniques have been tried to incorporate the effect of perceived importance of a feature in addition to the perceived satisfaction to explain the influence of the feature on whatever dependent variables (Farr et al., 2014; Larson, 2010). However, the evidence

supporting the use of combined measures is inconclusive; weighting by importance may be unnecessary as item satisfaction may already reflect relative importance (S.-K. Chen & Lin, 2014; C.-H. Wu & Yao, 2006).

In summary, the literature suggests that objective attributes of factors within each of the three domains can influence the subjective perceptions of those factors, and these perceptions (possibly along with the relative importance assigned to that factor) determine the impact that the factor has on overall LS. Thus this research uses a mix of subjective and objective measures within the analysis presented in Chapters 3 and 4, and focuses more on subjective measures within Chapters 5 and 6. Subjectively measured importance in addition to satisfaction is incorporated into the analysis within Chapter 5.

2.6.3 Spatial techniques

Regression methods such as OLS provide a global model of the variable or process you are trying to understand or predict; it creates a single regression equation to represent that process, thus assuming that the coefficients are the same across the entire study area. However, regional variations mean that global techniques will not always model the relationship well, and alternate techniques that address spatial relationships may be required to avoid biased or invalid estimation results (Bateman, Jones, Lovett, Lake, & Day, 2002; Stanca, 2010). In the spatial econometrics literature the terms 'global model' and 'local model' are used to differentiate methods that produce one overall equation from methods that produce different equations for different locations.

Spatial data exhibits two properties that can prevent global methods from modelling the relationship well:

- Spatial autocorrelation - Geographic features are frequently spatially autocorrelated: those features near each other tend to be more similar than features further away. Whilst this is evidence of the underlying spatial processes and spatial relationships, it can result in an over counting type of bias[11]; to avoid this it is necessary to identify the full set of explanatory variables that effectively capture the dependent variable's inherent spatial structure. If all the variables are not included within the model, there is likely to be statistically significant spatial autocorrelation in the model residuals and the results of the

[11] One of the problems with spatial autocorrelation is known as pseudo-replication. As observations are not truly independent, they are effectively overcounted when calculating degrees of freedom, this can lead to type 1 errors (Fortin & Dale, 2005).

model will be unreliable. Conducting a statistical test (such as the Global Moran's I spatial autocorrelation test) on the residuals will reveal whether they exhibit statistically significant spatial clustering; if no spatial autocorrelation is found in the residuals then it can be concluded that the model reflects the inherent spatial nature of the data with no important spatial variable having been omitted (thus omitted variable bias is unlikely).

- Spatial nonstationarity - Geography is important; often the processes most important to the model will behave differently in different parts of the study area. This characteristic can be referred to as regional variation or nonstationarity. When processes are consistent across the region then global techniques like OLS model the relationships well. When those relationships behave differently in different parts of the study area then the regression equation is more of an average of this mix of relationships; in the case where the relationships represent two extremes, the relationship will not be well modelled by this global average. Thus, if the explanatory variables exhibit nonstationary relationships (regional variation) global models tend to fall apart unless robust methods are used to calculate regression results. Thus, if you have regional variation you need to either include variables that explain regional variations, or use alternate methods that incorporate regional variations, or redefine/reduce the size of study area so that the processes within it are all stationary. The Koenker BP Statistic tests whether explanatory variables have consistent relationship with dependent variable across geographic space and in data space, thus indicating if spatial nonstationarity is present.

The two potential problems attending spatially differentiated data (spatial autocorrelation and spatial non-stationarity) generate very different potential problems when analyzing data. Should spatial autocorrelation be present, neither global nor local techniques will model the relationship well; additional variables must be identified to develop a bias free model. However, should spatial non-stationarity (also known as regional variation) be present, then a local approach (such as GWR) is able to model the relationship better than a global approach (such as OLS) that calculates an average relationship for the entire region studied. Thus, spatial regression methods have been developed to robustly manage these two characteristics of spatial data and to incorporate these special qualities of spatial data, thus improving their ability to model data relationships. If spatial autocorrelation is present it is necessary to search for further explanatory variables to include in the model; data sets which only suffer from spatial nonstationarity (tested for using the Koenker (BP) test) can be successfully analysed using geographically weighted regression (GWR).

GWR is a form of linear regression used to model spatially varying relationships, and is one of several spatial regression techniques increasingly used in geography and other disciplines. GWR provides a local model of the variable or process you are trying to understand/predict by fitting an equation to every feature in the dataset. GWR evaluates spatial relationships by calculating a separate regression equation for each observation as a function of other observation's values; thus separate variable parameters are calculated for each observation, influenced by the values for the other observations, with the influence exerted by each other observation inversely related to the distance between the observations. When used properly these methods provide powerful and reliable statistics for examining and estimating linear relationships, and the approach also allows parameters to be compared across space. GWR constructs a separate equation for every feature in the dataset incorporating the dependent and explanatory variables of features falling within the bandwidth of each target feature; the shape and extent of the bandwidth is dependent on user input for the kernel type, bandwidth method, distance and number of neighbours parameters. GWR should be applied to datasets with several hundred features for best results; it is not appropriate for small datasets.

GWR can be defined by the equation:

$$Y_i = \beta_0 (u_i,v_i) + \Sigma_k \beta_k (u_i,v_i) X_{ik} + \varepsilon_i$$

Where Y_i is the dependent variable, X_i is the corresponding covariate vector of variables, (u_i,v_i) denotes the coordinates of the ith point in space and $\beta_k (u_i,v_i)$ is a realisation of the continuous function $\beta_k (u_i,v_i)$ at point i; thus the equation recognises that spatial variations in the relationships may exist and allows estimates of the localised parameters to be obtained for any point in space (Fotheringham, Brunsdon, & Charlton, 2002, p. 52). Local standard errors are also calculated (additional to local parameter estimates), based on using the normalised residual sum of squares from the local regression equations (Fotheringham et al., 2002).

Thus, within this research the GWR function within ArcGIS has been used to incorporate regional variation within the analysis when estimating LS models. Various statistical tests within ArcGIS were used to verify the appropriateness of the use of this technique: the presence of spatial non-stationarity between explanatory variables and the dependent variable was tested for with the Koenker BP test and spatial autocorrelation was tested for with the Global Moran's I test. The AIC method within ArcGIS was used to determine the extent of the kernel (that is the optimal distance/number of neighbours to be used) for estimating the

regression for each location, rather than the researcher imposing their view. As will be seen in Chapters 5 and 6, when regional variation is present then the use of GWR results in models that better explain the varying impact of different factors on LS across space (I found that coefficients vary considerably from location to location; and such variation would not have been detected by OLS). To provide just one example of why the use of GWR can provide us with far more information than OLS, within chapter 5 one explanatory variable used within the regression was the satisfaction of residents with their use of the environment. OLS regression estimated a coefficient of 0.107 for the whole region. However, GWR regression revealed that the average influence of the factor across the region estimated by OLS was not representative of the smaller sub-regions; the coefficient varied from 0.013 in the region least influenced to 0.211 in the region most influenced. Thus the use of GWR (when appropriate, as indicated by use of the statistical tests) can provide the researcher with useful information regarding regional variations and the importance of accounting for differences across space.

2.6.4 Endogeneity

It was recognised that endogeneity could be present within the models developed in this research, as this problem has been seen within earlier LS studies (Ambrey & Fleming, 2014a; Ferreira & Moro, 2010; Kountouris & Remoundou, 2011; Luechinger, 2009). Endogeneity can take two forms. Firstly, it is present if a variable has been omitted from the model that both directly affects the dependent variable itself, but also directly affects one or more of the other independent variables, and hence indirectly affects the dependent variable through its impact on the other variable(s). Secondly, it is present if reverse causality is present, that is, if in addition to the independent variables impacting on the dependent, the dependent variable also has an impact on one or more of the 'independent' variables. Endogeneity of either form could be present within LS models, and would result in biased estimates of the coefficients.

If endogeneity is thought to be present, the problem can often be addressed by using one or more instrumental variables (IVs). If the explanatory variables are exogenous, then estimating the model directly (without using IVs) will be more efficient; thus the IV should only be used if truly needed. A suitable IV needs to be highly correlated with the potentially endogenous variable, but not with the dependent variable. Thus bivariate correlation tests can be conducted on a wide range of variables, to enable selection of suitable IVs.

A model can be tested for endogeneity using a number of different tests, of which the most widely known are the Durbin test (Durbin, 1954) and the Wu-Hausman test (J. A. Hausman,

1978; D.-M. Wu, 1973). To conduct these tests potential IVs are identified, and used within a two stage least squares regression process. In both tests, the null hypothesis is that the variables are exogenous; if a significant result is found the null hypothesis is rejected, the implication being that endogeneity is present. Conversely, if the tests reveal insignificant results, there is no evidence that the null hypothesis should be rejected, providing evidence that endogeneity does not appear to be present.

An alternate approach can also be adopted, based on insights from J. A. Hausman (1978). In this paper he formally demonstrated that for large samples the probability limit of the covariance of X and ε approaches zero if X is exogenous; therefore the null hypothesis here is that X is exogenous. Thus, the residuals from the regression are saved and the statistical significance of the correlation between the saved residuals and any potentially endogenous variables tested for. If a significant correlation is found then the null hypothesis of exogeneity must be rejected, whilst if insignificant, then this fails to provide any evidence that null hypothesis should be rejected, providing evidence that endogeneity is not present.

Should endogeneity be found to be present, then this can be controlled for using a two stage regression process using IVs. This process is used where you wish to develop a model as per Equation 1, to explain Y where C_1, C_2 are independent predictor variables but the third predictor variable X appears to be endogenous:

$$Y = \alpha_1 + \beta_1 C_1 + \beta_2 C_2 + \beta_3 X + \varepsilon_1 \qquad \text{Equation 1}$$

This is resolved by following the two step processs. Firstly it is necessary to estimate an equation with X as dependent variable, including predictors of Equation 1 plus instrumental variables, and save predicted values of X demoted PredX. This equation would look like:

$$X = \alpha_2 + \beta_3 C_1 + \beta_4 C_2 + \beta_5 I_1 + \beta_6 I_2 + \varepsilon_2 \qquad \text{Equation 2}$$

Where I_1, I_2 are instrumental variables for predicting X and C_1, C_2 are the same predictor variables from Equation 1. The second step is to estimate an equation with Y as dependent variable including predicted values of X from Equation 2 as follows:

$$Y = \alpha_3 + \beta_4 C_1 + \beta_5 C_2 + \beta_6 \text{PredX} + \varepsilon_3 \qquad \text{Equation 3}$$

Where C_1, C_2 are the same predictor variables from Equation 1 and Equation 2.

Therefore, for this thesis multiple lines of evidence (the formal Durbin test, the Wu-Hausman test, and the correlation between independent variable and the error term) were obtained to indicate whether endogeneity was present. The guidance from these tests enabled us to determine whether the regression models should be estimated using IVs within a two stage process, or whether the models would be more efficient without the use of IVs, thus ensuring that the appropriate techniques were adopted for each of the models estimated. The two stage process with IVs was adopted for the paper forming Chapter 4, but was not found to be required for the research studies set out in Chapters 3, 5 and 6.

2.6.5 Non market valuation method using LS approach

The LS approach uses coefficients from the model describing LS to estimate the marginal rate of substitution (MRS) between income and other non-priced contributors to LS (e.g. an environmental feature or service). This provides an estimate of the 'value' of that good or service – formally its monetary equivalent (in terms of its ability to contribute to LS) – i.e. the (average) amount of additional income that each respondent needs to adequately compensate them (i.e. to keep overall LS constant) should there be an unfavourable change in the environmental feature, service or externality.

The estimated compensation is calculated using an equation of the form shown here, where E refers to the environmental feature, service or externality:

$$\text{Average compensation per person for marginal change in E} = \frac{\frac{\partial LS}{\partial E}}{\frac{\partial LS}{\partial Income}}$$

This calculation is based on estimating a LS function where both E, our environmental feature, and income both enter the LS function linearly (should either or both have entered the function in log form then the calculation for compensation would need to be modified to reflect this).

Having estimated the average compensation per person, this per-capita figure can then be multiplied by the number of people in the region, generating an aggregate estimate of the total compensation required for all residents of the region should this marginal change in the feature, service or externality occur. This provides an estimate of the valuation of the environmental feature or service, or the total cost of the externality, to the population residing

in the region. This approach is adopted within the research set out in Chapter 6 where a valuation of the cultural ecosystem services provided by the GBR is estimated.

2.7 Summary

As has been discussed above, for my thesis I chose to use secondary datasets that comprised survey data, collected as part of Australian government funded projects, the Reef dataset for tourists and for residents, and the Rainforest dataset for residents. The datasets provided me with a range of data regarding the perceptions of residents and visitors to the region regarding a wide range of factors, and included sufficient geographic detail to enable the responses to be matched to objective data regarding the environment, climate, and economic characteristics of the location. The datasets were sourced from within the GBR catchment region, Northern Queensland, Australia which was an ideal location to site my research, having internationally significant environmental value combined with a diverse industry base, and comprising a large enough area that it encompassing rural and urban areas, and a diverse range of features, all located within a rich, developed economy. This data has been utilised within a number of models, adopting the LS approach to improve understanding of factors affecting satisfaction (with the resident's life or the tourist's trip) and to enable the development of innovative valuation techniques.

This location, data and methodology all helped me to meet the aim of this thesis, to improve understanding of the trade-offs that arise within complex interlinked social-economic-environmental systems.

Chapter 3 Could climate change redistribute global tourism activity by impacting trip satisfaction?

In this chapter I address my first research objective. I demonstrate that the many of the factors which LS researchers have found to influence LS are also important determinants of TS. I do thus using a simple TS model based on the tourists income, their perceptions regarding factors within the environmental and social domains, and whether they have just arrived in the region or not. Additional measures relating to temperatures experienced during their trip was included to provide insights into the impact increasing temperatures (a key facet of climate change) may have on the global tourism industry.

This chapter is based on a conference paper that has been presented and published in February 2015; the citation for this paper is:

Jarvis, D. (2015). Could Climate Change Redistribute Global Tourism Activity By Impacting Trip Satisfaction. Proceedings of the 25th Annual Council of Australasian University Tourism and Hospitality Education Conference. Paper presented at the CAUTHE 2015 conference, 2-5 February 2015, Southern Cross University, Gold Coast, Queensland, Australia.

This article has been edited for inclusion within this thesis, to remove duplication of information already discussed elsewhere. Footnotes within the text indicate when notable amendments have been made to the original article. Minor amendments have also been made to ensure consistent use of terminology within this thesis.

Abstract

Understanding the elements influencing tourist trip satisfaction is critical if we are to understand the risk tourism faces from climate change. If it affects satisfaction, and thus repeat visitation and/or recommendations to others, it could affect the sustainability of the tourism industry. This case study of tourists visiting the Great Barrier Reef (GBR) catchment investigates the impact of daily maximum temperatures on trip satisfaction. The relationship is found to have an inverted U shape; increased temperatures improve trip satisfaction until a turning point at around 29 degrees centigrade, beyond this point increased temperatures reduce satisfaction. As current temperatures in the region are very close to this turning point,

a temperature increase would decrease trip satisfaction, adversely impacting the region's tourism industry. However, currently cooler regions would benefit as increasing temperatures improve the satisfaction of tourists visiting those areas; the net effect being a global redistribution of the tourism activity.

3.1 Introduction

A sustainable tourism industry requires both new and repeat visitors. Loyal visitors who return regularly can be more valuable than first time visitors, as little or no marketing costs are incurred in attracting repeat visitors and their recommendations to others reduce the marketing costs of attracting additional visitors. Therefore, retaining repeat visitors is important from a cost-benefit perspective. Many factors influence the likelihood of a tourist returning to a region, but overall trip satisfaction has been found to be one of the most important (Kozak, 2001; Moscardo et al., 2004; Yoon & Uysal, 2005); visitors are unlikely to return if unsatisfied with their trip (Alegre & Cladera, 2006). Thus, tourist satisfaction levels make a vital contribution towards sustainable tourism by building destination loyalty, encouraging repeat visits and encouraging other visitors via the spread of positive word of mouth (Kozak & Rimmington, 2000; Yoon & Uysal, 2005).

Climate change is likely to impact factors believed to be important to tourist satisfaction; this may have long term consequences to the sustainability of the tourism industry in many regions. The term "climate change" encompasses a range of effects including increases in temperatures, increases in the number and severity of extreme events such as heat waves, extreme precipitation, flooding, cyclones, and droughts (IPCC, 2014). There is a broad scientific consensus that temperatures around the world are increasing, a recent report stated "Warming of the climate system is unequivocal" (IPCC, 2013, p. 4).

A number of studies have investigated possible climate change impacts on tourism, some of which are summarised in Stoeckl, Farr, Reside, et al. (2014). These include investigations into the potential impact on tourism from climate change consequences such as coral degradation and bleaching (Ramis & Prideaux, 2013; Zeppel, 2011) and increased risks of extreme events such as cyclones (Prideaux, Coghlan, & Falco-Mannome, 2007; Zeppel, 2011). However, there has been little research specifically investigating the relationship between temperatures and tourist overall trip satisfaction; that is specifically addressing the

direct impact that global warming itself may have on the tourist experience, so far as I am aware. This study aims to address this gap in the literature.

Using the GBR catchment as the study area, the relationship between average maximum daily temperatures and overall trip satisfaction is investigated. A model is developed demonstrating factors influencing overall trip satisfaction, including the impact of the actual average daily maximum temperatures experienced. Consequences for the tourism industry resulting from future rising temperatures are then discussed, considering effects on tourism within the GBR catchment and across the globe.

3.2 Literature Review

There has been extensive research investigating the numerous influencers of trip satisfaction (such as Alegre & Garau, 2010; Coghlan, 2012); considering factors relating to the tourist and their specific trip, and factors relating to the economic, social and environmental domains. Research has incorporated objective and subjective indicators, and considered both actual experiences and prior expectations.

Trip satisfaction has been found to relate to socio-demographic factors such as the tourist's age (Alegre & Garau, 2010; Torres-Sovero et al., 2012), gender (Coghlan & Prideaux, 2009), nationality or country of origin (Alegre & Cladera, 2006; Coghlan & Prideaux, 2009), education level (Alegre & Garau, 2010; Torres-Sovero et al., 2012), occupation (Coghlan & Prideaux, 2009) and income level (Alegre & Garau, 2010; Torres-Sovero et al., 2012).

The tourist's overall satisfaction is also affected by factors relating to the specific trip, including the type of accommodation (Alegre & Garau, 2010) and the length of stay (McElroy & Parry, 2010), and satisfaction relating to prices (Alegre & Cladera, 2006; Alegre & Garau, 2011), to facilities and accommodation (Alegre & Garau, 2011; Torres-Sovero et al., 2012), to hospitality and service (Alegre & Cladera, 2006), and to cleanliness (Alegre & Garau, 2010, 2011).

Tourist satisfaction has been found to be impacted by the economic and social domains. Trip satisfaction is significantly reduced by high levels of development and indications of overdevelopment and congestion, with higher levels of construction activity reducing trip satisfaction (Jarvis, Stoeckl, & Liu, 2016); whilst peace, quiet and no perceived overcrowding is important to satisfaction (Alegre & Cladera, 2006; Ziegler et al., 2012). Trip satisfaction

has been found to increase with perceived safety levels, based on the use of indicators such as satisfaction with safety (Alegre & Garau, 2011; Jarvis et al., 2016) and perceptions of the crime level in the visited area (Demos, 1992).

Satisfaction is also impacted by the environmental domain. Greater satisfaction with an environmental factor such as: sunshine and beaches (Alegre & Cladera, 2006); contact with nature (Alegre & Garau, 2010); coral, fish etc. (Coghlan, 2012; Saltzer, 2002a); and visibility in the water (Coghlan, 2012; Ziegler et al., 2012) has been found to increase trip satisfaction. Additionally, observing a greater number of species has been found to increase trip satisfaction) (Torres-Sovero et al., 2012) whilst higher water turbidity reduces trip satisfaction (Jarvis et al., 2016).

Trip satisfaction has been found to be influences by climatic factors, using a variety of subjective variables to represent climatic factors. For example, satisfaction with climate (Alegre & Garau, 2011) and sunshine and beaches (Alegre & Cladera, 2006) has a positive relationship with overall trip satisfaction. Also, perceived good weather increases trip satisfaction, and vice versa; however in that study the bad weather was seen as contributing to sea sickness and poor water visibility thus related to wind and rainfall rather than temperature effects (Coghlan & Prideaux, 2009). The number of repeat visits or the likelihood of returning has also found to be influenced by perceptions of the weather; satisfaction with climate has a positive relationship with the number of repeat visits (Assaf, Pestana Barros, & Machado, 2013). Studies have also found a positive relationship between indications that the weather exceeded expectations and trip satisfaction (Coghlan, 2012).

Related research, investigating life satisfaction (LS), has also considered the impact of climate; however, in contrast to the tourism research referred to above, studies have generally measured temperature objectively rather than utilising perceptions of climate. Conflicting results have been found, apparently dependent on whether the country studied generally has a cool or hot climate. In studies focusing on Ireland, mean maximum temperatures in the hottest month positively contributed to LS (Brereton et al., 2008; Ferreira & Moro, 2010) and a study focusing on Russia found that increased temperatures increase welfare (Frijters & Praag, 1998). However, higher minimum temperatures in the hottest month are negatively related to well-being in Spain (Cuñado & de Gracia, 2013) and mean maximum temperatures in the hottest month of the year correlate negatively with LS when comparing many different countries (Rehdanz & Maddison, 2005). Maddison and Rehdanz (2011) adopted a different

approach in their cross country study, adopting a base mean temperature of 18.3 degrees centigrade as being the temperature where neither heating nor cooling is required to feel comfortable indoors. A negative relationship with LS was found for both the number of months with average temperatures below this base and for the number of months above, indicating that LS does not have a linear relationship with temperature but is in fact maximised at this temperature; the researchers concluded that increases to temperatures globally as a consequence of climate change would increase LS in cooler countries, such as those of northern Europe, and reduce LS in hotter countries, such as those in Africa (Maddison & Rehdanz, 2011).

3.3 Methods

3.3.1 Data collection and the study region

The GBR, situated off the coast of Queensland, Australia, is the world's largest reef system and a proclaimed World Heritage Area. Within this catchment area, tourism is the third most important industry (after mining and minerals processing), providing in excess of 64,000 full-time equivalent jobs and generating $5.2bn value added in 2011 (Deloitte Access Economics, 2013).

This study utilises surveys developed following a literature review and pre-testing process, whereby surveys were collected over a twelve month period to June 2013 from 59 locations along the Queensland coast[12] (see Figure 5). Only tourists staying in the region for 14 days or less were included within this analysis as those staying longer are likely to have visited a number of different locations making it difficult to determine which temperature (from which location) to include.

Climate data (including temperatures, rainfall, and hours of sunshine) were obtained from the Australian Bureau of Meteorology (BOM) website[13], using the weather stations located closest to where survey responses were obtained (identified on the map at Figure 5)[14].

[12] The original article on which this chapter is based discussed this matter in further detail but this discussion has been edited to prevent unnecessary duplication. For further discussion on the collection of the dataset refer to section 2.4.

[13] BOM website http://www.bom.gov.au/climate/data/index.shtml?bookmark=136&zoom=2&lat=-20.7065&lon=147.78&layers=B00000TFFFFFFFTFFFFFFFFFFFFFFFFFFTTT&dp=IDC10002-d

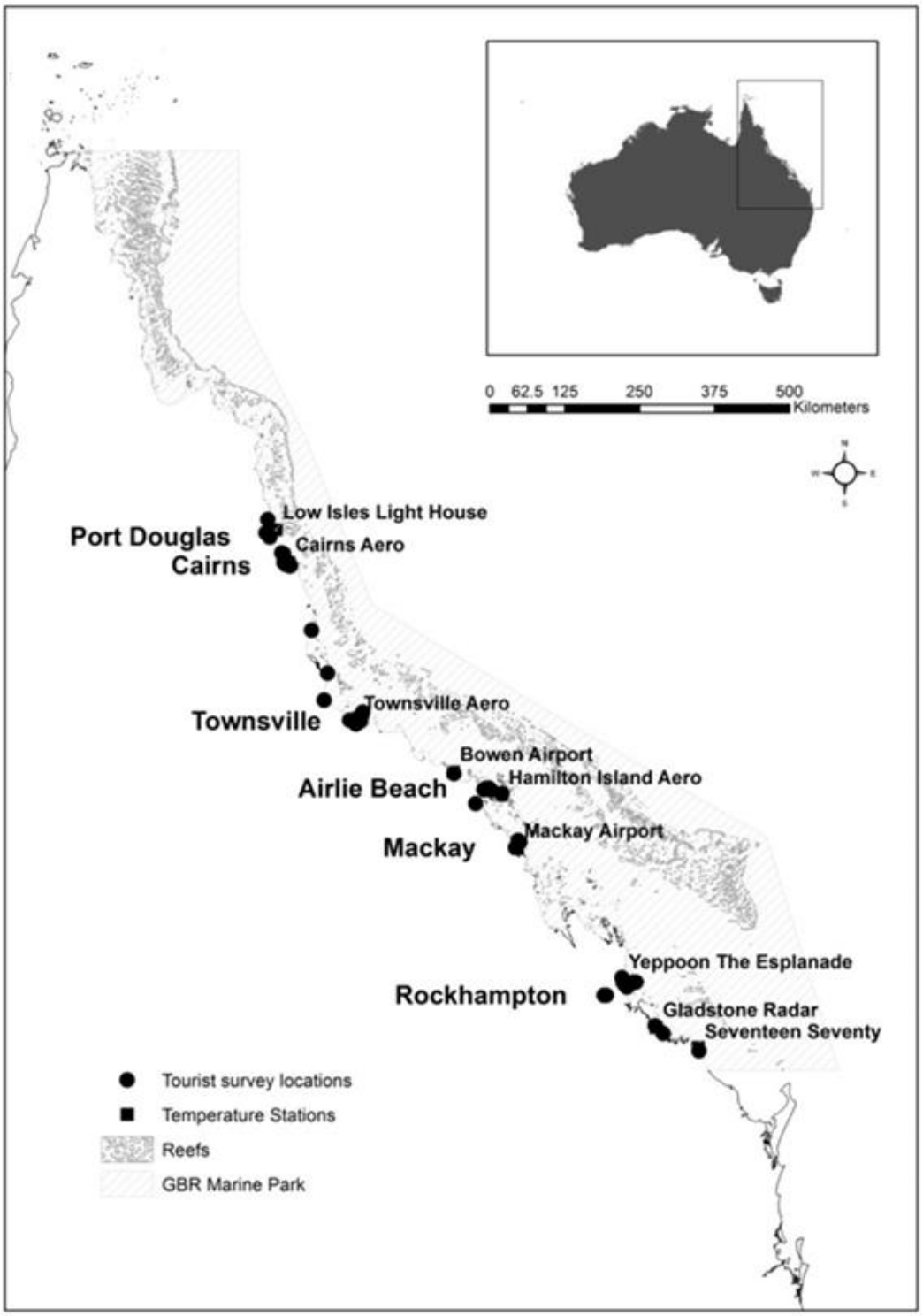


Figure 5 The case study region

[14] Thus, this study follows the practice of using objective climate data generally adopted within LS studies rather than using the more normal practice within tourism studies of using subjective climate data. Unfortunately data limitations prevented a comparison being made between the two approaches.

3.3.2 Variables and methods used

This research sets out to develop a model explaining the tourist's overall trip satisfaction. Following Jarvis et al. (2016), I set out to estimate a model hypothesized to be of the form:

> Overall trip satisfaction = f (specific factors relating to the tourist and their trip, climate, factors relating to the economy, to society and to the environment)

The overall trip satisfaction data, forming the dependent variable, were collected from a survey question where tourists were asked to indicate their level of satisfaction using a 5 point Likert scale. As this is a categorical variable this study uses ordinal regression; a complementary log-log linking function was used because of the skewed distribution, with a higher number of satisfied and very satisfied responses compared to other responses (response frequencies shown in Table 5). However, as research has indicated that results from OLS and ordinal regression are generally very similar (Ferrer-i-Carbonell & Frijters, 2004; MacKerron & Mourato, 2009), the estimation was repeated using OLS regression and results compared.

The independent variables were informed by the literature, and can be broadly classified as factors describing the tourist and their trip plus factors relating to the economy, society and the environment. Therefore the variables reflect socio-demographic factors (such as age, gender, income etc.), factors relating specifically to the trip (such as length and cost of trip, whether they visited the Reef etc.), and social and environmental factors, derived directly from the survey responses. Social factors were represented by the tourist's perceptions of crime and safety, gathered by a question where the tourists were asked whether they agreed or disagreed with the statement "if I lost my wallet/purse somewhere in the town I am now visiting, I would get it back with all the money and cards still in it". Environmental factors were represented by the tourist's satisfaction with water clarity in the GBR lagoon, informed by research indicating the most important factor to visitors to the GBR when choosing their holiday was clear ocean waters (Stoeckl et al., 2013).

For the climate variables, daily data relating to maximum and minimum temperatures in degrees centigrade, rainfall in mm, hours of sunshine and wind speed were obtained from the BOM weather stations closest to the locations where survey responses were obtained. The climate data were matched to the actual dates that each tourist spent within the region, thus providing a precise measure of the actual climate experienced by the tourist for the specific

time and place of their visit. The station locations are shown on the map at Figure 5; details, including temperature data, relating to these stations are shown in Table 6.

Having determined the appropriate variables to include, a model was developed to explain the impact of these factors on trip satisfaction. The final set of variables, shown in Table 4, was obtained after a series of estimations, starting from a wide specification including many different socio-demographic, economic and environmental variables, and gradually dropping insignificant variables from the analysis[15].

Table 4 Summary of variables used to explain trip satisfaction

Variable	Description	Mean or proportion for dummy variables	Std. Dev.
Dependent Variables			
Overall trip satisfaction	The tourist's level of satisfaction with their experience as a whole on this trip, reported using a 5 point Likert scale from "very unsatisfied" (-2) to "very satisfied" (+2)	1.32	.77
Explanatory Variables			
Midpoint income divided by equivalence factor	Tourists were asked "On average, how much pre-tax income does your household (you and everyone you live with) earn each year?" Respondents selected the appropriate category from a list; the midpoint of each category was used for the study. The midpoint household income was converted to individual income using the modified OECD scale adopted by the ABS (Australian Bureau of Statistics, 2010).	57,566.70	37,748.03
Stayed more than 1 night	Dummy variable set to 1 if tourist spent more than 1 night, otherwise 0[16]	.89	.32
Believe would get lost wallet and contents back	The tourist response to the question "To help us gauge how 'safe' you have felt whilst here, please tell us how much you agree or disagree with the following statement: if I lost my wallet/purse somewhere in the town I am now visiting, I would get it back with all the money and cards still in it." were reported using a 5 point Likert scale ranging from strongly agree to strongly disagree. Responses coded as dummy variable set to 1 for those who agreed, otherwise 0	.35	.48
Satisfaction with clear oceans	The tourist response to the question "How satisfied have you been with your experiences and/or ability to see clear oceans (with good underwater visibility)." were reported using a 5 point Likert scale ranging from "very unsatisfied" (-2) to "very satisfied" (+2)	1.11	.94
Average daily maximum	Daily maximum temperature data for a number of different locations obtained from the BOM website, daily maximum air	28.03	3.50

[15] The original specification of the model included the factors set out in table 9 (age, gender etc.), but these variables were then excluded from the final model as not found to be significant here. A significance level of 5% was used as the cut off for excluding variables from the regression analysis.

[16] Consideration was given to the appropriateness of this variable, as there is the possibility of endogeneity, with those who are satisfied choosing to stay longer. However for this region I believe the risk to be low as tourists are being asked about nights within the GBR, a large and remote region, rather than a specific place close to alternate places that could be visited. (For example, this is very different to Europe where if you don't like city A in country A it is easy to move to city B in either country A or country B the next day, using many different types of transport at differing prices.)

Variable	Description	Mean or proportion for dummy variables	Std. Dev.
temperature	temperature described as the highest temperature for the 24 hours leading up to the observation which is recorded as the maximum temperature for the previous day; nominally recorded at 9am local clock time. The average of the maximum daily temperatures for each day of the tourist's visit, obtained from the BOM site nearest to where they were staying, was calculated		
Average daily maximum temperature squared	The square of average daily maximum temperature as above	798.17	188.80

Table 5 Frequencies for categorical variables included within the model

	%
Satisfaction with overall trip	
Very unsatisfied	.5
Unsatisfied	2.0
Neutral	9.2
Satisfied	41.8
Very satisfied	46.4
Satisfaction with clear oceans	
Very unsatisfied	1.6
Unsatisfied	3.4
Neutral	19.6
Satisfied	33.5
Very satisfied	41.8

Table 6 Details of the weather monitoring stations (data from 1 January 2003 to 31 December 2013 being the period where all stations included in the study were fully operational)

BOM station number	BOM station name	Year BOM station opened	Highest maximum temperature Degrees C	Lowest maximum temperature Degrees C	Average of daily maximum temperatures Degrees C
31011	Cairns Aero	1942	38.60	21.00	29.36
31037	Low Isles Light House	1967	37.10	21.10	29.40
32040	Townsville Aero	1940	41.00	13.90	29.26
33045	Mackay Airport	1995	37.20	13.30	27.52
33106	Hamilton Island Aero	2002	35.60	16.80	26.28
33257	Bowen Airport	1987	38.00	16.40	28.59
33294	Yeppoon The Esplanade	1993	39.10	11.50	25.75
39123	Gladstone Radar	1957	42.00	12.50	28.28
39314	Seventeen Seventy	1986	33.30	13.00	25.94
Average			37.13	15.50	27.82

3.4 Results

The ordinal regression model results are presented in Table 7, the results from repeating the estimation process using OLS regression are shown in Table 8. Very similar results, in terms of direction and significance of the explanatory variables and overall explanatory power of

the models are found, according with previous comparisons of the two approaches (Ferrer-i-Carbonell & Frijters, 2004; MacKerron & Mourato, 2009).

Table 7 Results of the trip satisfaction model using ordinal regression

	Coefficients	Standard error	Significance
Dependent variable			
Overall trip satisfaction			
Very unsatisfied	6.60	(2.28)	***
Unsatisfied	8.18	(2.23)	***
Neutral	9.81	(2.22)	***
Satisfied	11.76	(2.22)	***
Very satisfied	Reference group		
Independent variables:			
Midpoint income divided by equivalence factor	4.10E-06	(1.67E-06)	**
Spent 0 or 1 night in GBR - Just arrived	Reference group		
Stayed more than 1 night	.38	(.18)	**
Neutral or don't believe would get lost wallet and contents back	Reference group		
Believe would get lost wallet and contents back	.34	(.13)	**
Satisfaction with clear oceans	.49	(.43)	***
Average daily maximum temperature	.76	(.17)	***
Average daily maximum temperature squared	-.01	(.003)	***

Standard errors in brackets; *significant at 10% level, **significant at 5% level, ***significant at 1% level; sample size: n=552 Pseudo R2 .157 (Cox and Snell), .180 (Nagelkerke) Model $\chi 2$ (6) 94.553 p<.001

Table 8 Results of the trip satisfaction model using OLS regression, dependent variable 'Satisfaction with overall trip'

	Coefficients	Standard error	Significance
Independent variables:			
Midpoint income divided by equivalence factor	2.10E-06	(7.82E-07)	***
Stayed more than 1 night	.19	(.09)	**
Believe would get lost wallet and contents back	.15	(.06)	**
Satisfaction with clear oceans	.30	(.03)	***
Average daily maximum temperature	.32	(.09)	***
Average daily maximum temperature squared	-.01	(.002)	***
Constant	-3.95	(1.17)	***
Adjusted R^2	.189		

Standard errors in brackets; *significant at 10% level, **significant at 5% level, ***significant at 1% level; sample size: n=552

As expected, this research has found a significant positive relationship between each explanatory variable and overall trip satisfaction. Thus, tourists with higher incomes are more satisfied with their trip, as supported by Alegre and Garau (2010) and Torres-Sovero et al. (2012), and tourists who stay in the area for more than one night are more satisfied than those on shorter trips, as found by McElroy and Parry (2010). Tourist's perceptions of safety significantly affect trip satisfaction positively, this finding accords with Demos (1992) and Yuksel (2001). The tourist's perceptions of water clarity also significantly contribute to

overall trip satisfaction; the tourist's demonstrating a preference for clearer waters, in accordance with prior research (Coghlan, 2012; Ziegler et al., 2012).

The relationship between trip satisfaction and maximum daily temperatures was found to be non-linear. As average daily temperatures increase from lower levels then the overall trip satisfaction also increases. However, beyond a certain temperature level, found to be 29.1 or 29.3 degrees centigrade (ordinal and OLS regression models respectively), the relationship reverses; further increases in average daily maximum temperatures reduce the overall level of trip satisfaction. Thus, we have an inverted U shaped relationship between these variables, as shown in the graph in Figure 6.

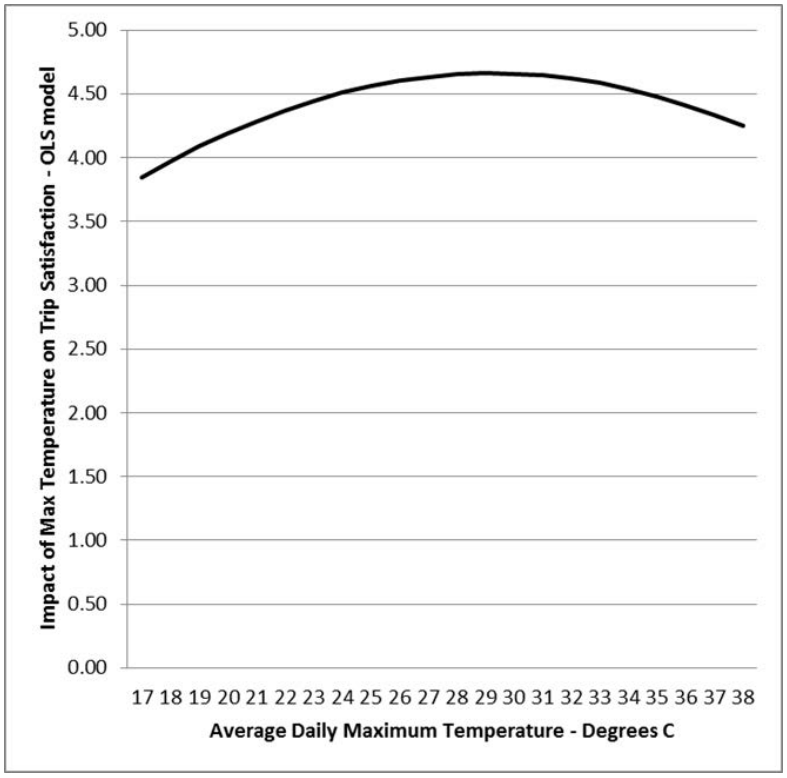


Figure 6 The relationship between overall trip satisfaction and average maximum daily temperatures

3.5 Discussion

The relationship between average daily maximum temperatures and trip satisfaction has an inverted U shape, rather than being of a linear form. Whilst this apparently disagrees with previous research suggesting a linear relationship, this may reflect the range of temperatures actually experienced by the tourists surveyed for this study, ranging from the lowest average maximum daily temperature of 17.9 degrees to the highest average maximum daily temperature of 37.15 degrees, compared with the temperature range experienced within

countries used for previous research. For example, the positive linear relationship found between temperatures and LS in Ireland (Brereton et al., 2008; Ferreira & Moro, 2010) and Russia (Frijters & Praag, 1998) may reflect that the temperature range for those countries fall entirely within the uprising portion of the relationship found in this study. The negative linear relationship found between temperatures and LS in Spain (Cuñado & de Gracia, 2013) may reflect the comparatively higher temperatures in that country, where their data may have fallen mainly within the range making up the downward sloping portion of the relationship found here[17]. An inverted U shaped relationship does accord with the findings of Maddison and Rehdanz (2011), who investigated average temperatures, and found that the number of months averaging both in excess of and below 18.3 degrees reduced LS, demonstrating a similar inverted U shaped relationship.

The turning point found by this study, at around 29 degrees centigrade, could be critical to the future sustainability of tourism within the GBR catchment. As shown in Table 6, for the years 2003 to 2013, (the time period where all the weather stations utilised in the study were fully operational), the weather stations towards the north of the region are already experiencing average daily maximum temperatures in excess of 29 degrees, indeed the two stations within the Wet Tropics (Cairns Aero and Low Isles Light House) already have average daily maximum temperatures in excess of the turning point of 29.3 degrees resulting from the OLS model.

The northern portion of the GBR catchment receives far more tourists, international and domestic, than more southern areas. The Wet Tropics alone received around 40% of the tourist expenditure within the region, amounting to $2.576 million in 2011-12 (Deloitte Access Economics, 2013), whilst the Burdekin, including Townsville and Bowen, is noted in the same study as generating a further 16%, at $1.044 million. Given current temperatures in these locations are at or around the turning point found in the study, around 56% of tourist revenue is at risk should tourist satisfaction decline in response to increased daily maximum temperatures.

Other locations within the GBR catchment may initially benefit from increasing temperatures, as their current levels are below the turning point. However, gains here are unlikely to offset the lost revenues within the Wet Tropics and Burdekin in the long run,

[17] Alternately, the linear relationship found in these studies may reflect that the temperature variable was only entered in the model in a linear form; further investigation within those studies may have revealed evidence that a non-linear relationship was present.

partly due to the significantly smaller portion of tourist revenues currently arising from these locations. More importantly, as the margin between the current maximum temperatures and the turning point is small, with current average daily maximum temperatures ranging from 26.0 to 28.3 degrees centigrade, these other locations could also face declining tourist satisfaction due to high temperatures in the future. Further investigation of the impact of rising temperatures on tourist revenues within individual regions of the GBR catchment and to the GBR catchment region as a whole would be a highly useful and non-trivial[18] future research opportunity.

However, locations elsewhere in the world, currently experiencing average maximum temperatures well below the turning point identified here could benefit significantly from global warming. Based on this finding, regions currently experiencing cool temperatures would see the satisfaction of their tourist's increase as temperatures rise, resulting in increased repeat visitation rates and increased recommendations to others; these factors should give a strong boost to the tourism industries in these regions. However, further research in other regions is required to confirm that the relationship found between trip satisfaction and temperatures is valid elsewhere.

3.6 Conclusion and Implications

This research has found that the relationship between trip satisfaction and maximum daily temperatures experienced by tourists has an inverted U shape, trip satisfaction improves as temperatures increase to around 29 degrees centigrade; trip satisfaction then decreases as temperatures increase further beyond this point. This decreasing satisfaction reduces the likelihood of repeat visits and may discourage new visitors from coming due to negative word of mouth (Kozak, 2001; Yoon & Uysal, 2005), thus reducing the sustainability of the tourism industry in regions with maximum temperatures in excess of 29 degrees.

This finding has important implications for tourism within the GBR catchment. With current average maximum temperatures across the region approximately 28 degrees, and exceeding 29 degrees in the northern part of the region, any increase in temperature from current levels

[18] This would form a non-trivial addition to the analysis presented here. The TS model would need to be linked to a likelihood of returning model, ideally using a two-step methodology, to determine how much changes in temperatures lead to reduced revisitation and reduced $ revenue. The analysis would also need to look at this in stages across the region, as visitors may still revisit GBR, but choose to visit further south where temperatures are lower e.g. choosing to visit Yeppoon rather than Port Douglas.

is likely to result in visitor's overall trip satisfaction decreasing. Thus a direct consequence global warming could be a reduction in trip satisfaction, which could seriously impact the tourism industry in the region. However, for currently cooler locations, this finding could have positive implications as increasing temperatures would increase the satisfaction of tourists which could significantly boost their tourism industry.

The global implications on tourism from increased temperatures experienced as part of climate change could therefore be a redistribution of tourists between regions, with hotter regions suffering due to the negative relationship between temperatures and trip satisfaction above 29 degrees, whilst currently cooler regions benefit from the positive relationship between maximum temperatures and tourist satisfaction at lower temperatures. Whilst the overall impact global tourism is unclear, it appears likely that some regions could experience great benefits whilst in other regions tourism may become unsustainable.

Chapter 4 The impact of economic, social and environmental factors on trip satisfaction and the likelihood of visitors returning

Having demonstrated in the previous chapter that the determinants of LS derived from the use of the LS approach can be used to gain insights into factors that influence TS, this chapter develops a more complex model that incorporates objective measures of the environmental quality experienced by the tourist. A model explaining the likelihood of a tourist returning is developed, demonstrating TS is a significant determinant of whether the tourist will return. The TS and likelihood of returning models are then linked, developing a valuation technique that can be used to make an estimate in financial terms of the revenue that would be lost as a result of deterioration in any of the factors influencing satisfaction reducing the likelihood of revisiting. Thus, this chapter addresses research objective two.

This chapter is based on a journal article that has been accepted for publication in February 2016; the citation for this article is:

Jarvis, D., Stoeckl, N., & Liu, H.-B. (2016). The impact of economic, social and environmental factors on trip satisfaction and the likelihood of visitors returning. *Tourism Management*.

This article has been edited for inclusion within this thesis, to remove duplication of information already discussed elsewhere. Footnotes within the text indicate when notable amendments have been made to the original article. Minor amendments have also been made to ensure consistent use of terminology within this thesis.

Abstract

Tourism is vital to the economy of many regions; however visitor numbers in some are stagnating. Using a novel approach, this case study of the Great Barrier Reef explores and quantifies risks to visitor numbers, utilising tourist survey data supplemented by objective data from secondary sources. Economic, social and environmental factors affecting trip satisfaction are identified, which itself is found to affect the likelihood of a tourist returning; the impact of changes on trip satisfaction and on repeat visits is then estimated. Linkages between tourism and other industries are clearly demonstrated; increased construction work,

decreased water clarity and decreased perceptions of tourist safety are all estimated to significantly reduce likelihood of repeat visits and hence impact tourist revenues, placing the financial viability of the industry at risk. Future development within the region should be evaluated holistically, rather than industries such as tourism, construction, agriculture etc. each being developed in isolation.

4.1 Introduction

Tourism is a vitally important industry to many regions of the world and forms an important and growing part of the world's economy. There were 1087 million international tourists during 2013, generating 9% of the world's GDP and creating 1 in every 11 of the jobs around the world (The World Tourism Organisation (UNWTO), 2014). This research uses tourism within the Great Barrier Reef (GBR) region of Australia as a case study, and the methods used are transferable to any other region of the world.

Tourism is important to Australia, which has enjoyed significant increases in visitor numbers over the last 20 years, with total annual visitors having almost doubled over the period to almost 6.2 million visitors for 2012/13 as shown in Figure 7 (Australian Bureau of Statistics). Within the GBR catchment area, tourism is the third most important industry behind mining and minerals processing (based on the gross value of production; (PDP Australia Pty Ltd, 2003); in 2011 the tourism industry generated $5.2 billion value added and provided more than 64,000 full-time equivalent jobs (Deloitte Access Economics, 2013). Evidently, maintaining a Reef-based tourism industry is important for the region, and for Australia as a whole.

But a similar increase in visitors has not been seen within the GBR. Considering the GBR itself, the number of visitors to the reef can be compared over time based on the Environmental Management Charge data collected by the Great Barrier Reef Marine Park Authority. As demonstrated in Figure 8[19], the number of visitors to the reef peaked in 2004/05 at almost 2 million reef visitor days but has since declined with less than 1.8 million reef visitor days recorded for 2012/13 (Based on full day, part day and exempt visitors (Great Barrier Reef Marine Park Authority, 2014b).

[19] Figure 7 includes data from the entire GBR region. A map is shown in Figure 8 identifying the entire region and the locations where my data was collected. The areas are similar other than that Fig 7 extends further north, encompassing the Torres Strait and Cape York areas; however these areas only account for ~2% of visitor nights in the GBR region (Deloitte Access Economics, 2013).

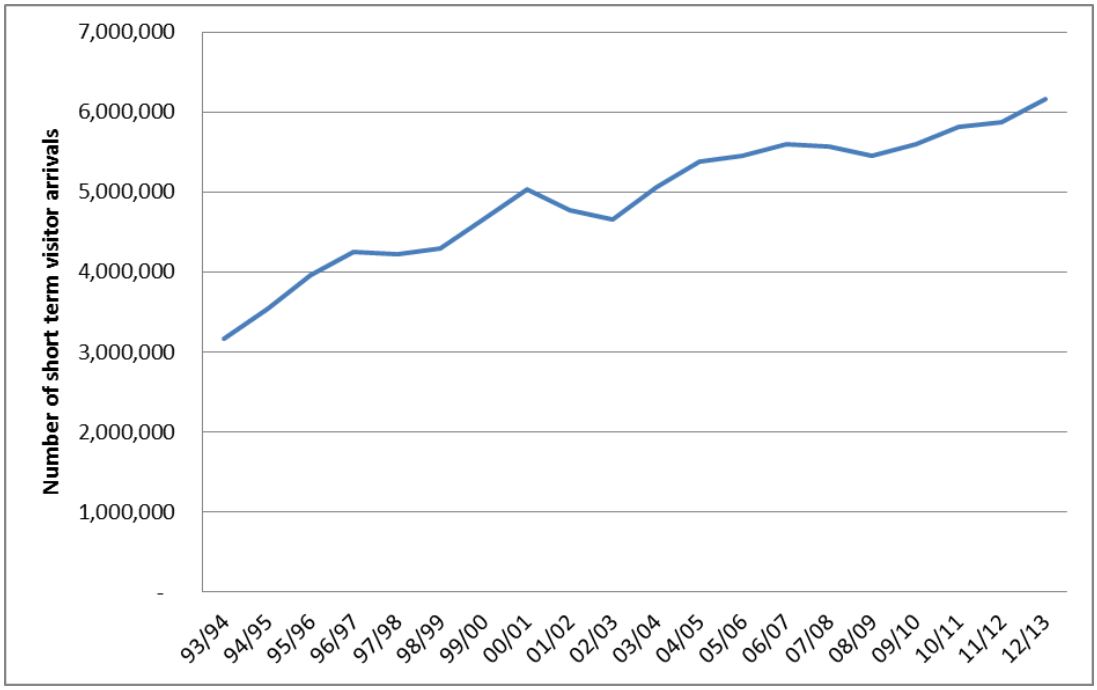


Figure 7 Number of short term (less than 1 year) visitor arrivals to Australia

Reduced numbers of visitors to the reef, despite increased numbers of visitors to the country as a whole, implies that visitors may be choosing to visit other tourist attractions instead of the GBR; a continuation of this trend over time could threaten the long term future of the tourism industry within the region with consequent impacts on future employment and income.

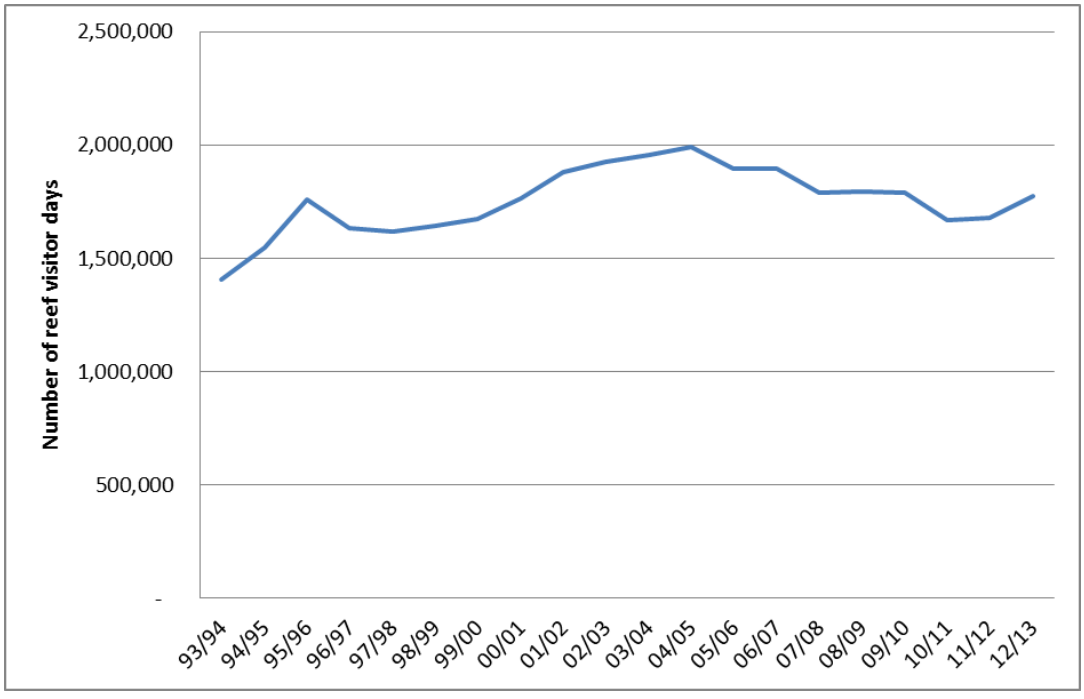


Figure 8 Number of reef visitor days

In addition, a successful tourism industry does not just need to attract new visitors – it also needs to encourage repeat visits. This is because repeat visitors can: reduce marketing costs (benefiting from the spread of positive word of mouth); reduce price sensitivity amongst customers (Assaker & Hallak, 2012; Baker & Crompton, 2000); and increase economic profit (Choo & Petrick, 2014). Importantly, the likelihood of a tourist returning to a particular location has been found to depend on a range of factors (column 2, Table 9) but there is broad consensus that overall trip satisfaction is one of the most important factors influencing repeat visitation (including C.-F. Chen & Tsai, 2007; Kozak, 2001; Yoon & Uysal, 2005). Additionally, while repeat visitors are more likely to return once again than first time visitors, neither are likely to return if their level of satisfaction with their most recent visit is low (Alegre & Cladera, 2006). Specific research on tourists to the GBR region (Moscardo et al., 2004) or to the GBR itself (Saltzer, 2002b) has found that those visitors who report positive experiences are more likely to return. Other important factors found to increase the likelihood of returning to the GBR are if the tourists are younger and from Australia (particularly from Queensland). The particular location visited within GBR also has an impact (Saltzer, 2002b). As such, tourist satisfaction is vital for maintaining/growing visitor numbers: it builds destination loyalty, encourages repeat visits and also increases recommendations to family and friends (Hui et al., 2007; Kozak & Rimmington, 2000; Yoon & Uysal, 2005).

Tourist satisfaction generally depends on a range of features (column 3, Table 9), and in the GBR, has been shown to be particularly sensitive to tourist satisfaction with fish, coral and other marine life (Coghlan, 2012; Saltzer, 2002a), the reasons for choosing the GBR location including the importance of experiencing and learning about nature (Saltzer, 2002a), the number of activities undertaken during the trip (Saltzer, 2002a) and the weather experienced during their visit to the region (Coghlan, 2012; Coghlan & Prideaux, 2009). But factors that impact the probability of repeat visitation do not always have a similar impact on trip satisfaction (compare column 2 and 3, Table 9). Reasons for this may include that tourists are likely to report high levels of trip satisfaction due to the emotional and financial investment they have personally made in that trip, but their reported likelihood of returning is not affected by this personal investment (Alegre & Garau, 2010); alternatively some tourists would not return to a location however high their satisfaction as their main motivation for location choice is novelty seeking (Assaker et al., 2011; Jang & Feng, 2007).

Numerous studies have investigated factors impacting tourist trip satisfaction (including Alegre & Garau, 2010; Torres-Sovero et al., 2012); factors impacting on the number of tourists returning, and the direction of their impact, have also been identified previously (including Assaker et al., 2011; Kozak, 2001), as shown in Table 9. However, so far as I am aware, previous research has not sought to determine how changes to factors impacting trip satisfaction may subsequently affect the likelihood of tourists returning. Neither am I aware of previous research that has estimated the financial impact (in terms of lost revenues from reduced numbers of returning visitors) that could result from changes to factors impacting satisfaction.

Although not always considered in tourism studies, the life satisfaction literature also has useful insights which can be used to enrich studies of tourist satisfaction. Simplistically, life satisfaction researchers seek to understand more about factors (demographic factors such as age and gender, plus various social, economic and environmental factors) affecting people's overall quality of life, or subjective 'well-being'[20]. They frequently ask survey questions of the type "how satisfied are you with your life as a whole these days?" (with responses recorded using a Likert scale – similar to the approaches used to measure tourist satisfaction) and then undertake statistical analyses to identify factors that contribute to, or detract from, overall life satisfaction (column 4, Table 9). Many similarities can be seen between factors found to impact on tourist overall trip satisfaction and on overall life satisfaction (compare columns 3 and 4, Table 9) – perhaps the most significant being that both researchers (who are interested in tourist satisfaction and those interested in overall life satisfaction) have found that 'satisfaction' (along with many other attitudes and behaviours) is influenced by factors from social, economic and environmental *domains*, complemented by personal factors relating to the respondent in terms of age, country of origin etc.

It should be noted that the factors identified within Table 9 are not intended to be a definitive guide. Instead this table includes a wide range of factors that different studies identified as having a statistically significant relationship with life satisfaction, trip satisfaction or the likelihood that a tourist will return; many of these finding are likely to be context specific to the particular region/country being studied whilst other findings may be more generic.

[20] The terms happiness, life satisfaction (LS) and subjective well-being (SWB) are frequently used interchangeably although the term 'happiness' is less closely related to LS than is SWB (Engelbrecht, 2009).

Table 9 Compendium of findings from previous studies of statistically significant relationships between various socio-economic and demographic factors and the probability that a tourist will return, tourist trip satisfaction and overall satisfaction with life (for references from which factors were drawn, see Appendix 3.5, Table 17)

	Probability that a tourist will return	**Tourist's overall trip satisfaction**	**Overall satisfaction with life**
Age	Older visitors and younger visitors have been found to be more likely to return.	Younger tourists are more satisfied.	Age is significant, although relationship may be U shaped rather than linear, with lowest LS observed amongst those aged in their 30s. Studies frequently include age and/or age squared to reflect non-linear relationship.
Gender	Males more likely to return.	Females are more satisfied.	Females generally found to have higher LS than males.
Education level	Those with higher education levels are more likely to return.	Tourists with lower education levels found to be more satisfied.	Higher education level frequently related to higher LS. However this effect may be indirect – since those with more education are likely to also have higher incomes.
Marital status	Married people are more likely to return		Married people generally happier.
Country of origin	Significant relationship – different nationalities have different likelihood of repeating their visit.	Significant relationship – different nationalities report different levels of trip satisfaction	There may be country specific time invariant personal characteristics which impact on LS. Living in your country of origin rather than being a foreigner improves LS.
Income	Low income visitors less likely to return.	Higher income tourists are more satisfied.	Higher incomes generally increase LS. However relative income (both relative to others, impacting on status in society, and relative to previous periods, which impacts on habits and the view of what is the norm), and future material aspirations and their relationship to anticipated future income levels have been found to be important. Some research found a negligible or statistically insignificant relationship to LS.
Health status			Higher LS reported by those who report better levels of health.
Employed or unemployed			Employed people report higher LS than unemployed people.
Overall satisfaction with trip	Higher level of satisfaction contributes to the increased likelihood of returning	Not applicable	Not applicable
Previously visited region	Positive relationship, having visited before increases chance of visiting again	Weak relationship	Not applicable

	Probability that a tourist will return	**Tourist's overall trip satisfaction**	**Overall satisfaction with life**
Trip cost / perceived value for money	Higher travel costs reduce likelihood of returning; perception that trip offers good value for money increases likelihood of returning	More expensive prices reduce trip satisfaction, prices in line with budget or considered good value for money increase satisfaction	Not applicable
Facilities at tourist destination – accommodation, restaurants etc.	Better facilities increase chance of returning	Better and more varied facilities increase satisfaction	Not applicable
Climate	Good climate and sunshine increases repeat visits	Reporting high satisfaction with climate increases satisfaction with trip	Significant impact on LS
Economic development	Negative relationship between level of development within the region and the tourist's likelihood of returning to the location; indications of overdevelopment and congestion significantly reduce the likelihood of returning.	High level of development increases tourist dissatisfaction; indications of overdevelopment and congestion significantly reduce tourist satisfaction. Peace, quiet and not overcrowded important to satisfaction.	Significant positive relationship between economic growth or development and LS (e.g. using growth in GDP rates as a proxy for this factor).
Quality of social capital	Fear of becoming a victim of crime and concerns about safety can be a factor in deciding whether to revisit and many would not recommend a high crime location to friends or family.	Positive relationship with tourism; tourists don't wish to visit locations with high crime levels or regions considered dangerous due to risk of terrorism, crime or natural disasters.	Positive relationship with LS, including measures of local political autonomy, political stability, rule of law and control of corruption, perceptions of crime levels and personal safety, degree of freedom and personal choice, and trust in others or society.
Quality of natural environment	Declining environmental quality, at least partly attributable to tourism, can cause stagnation or decline by reducing the attractiveness of the area, as described in the tourist area life cycle model; environmental degradation and visitor numbers above the environmental carrying capacity has been found to be a limit to growth.	Better quality of environment, or being satisfied with environment, increases satisfaction with trip	Environmental factors significant impacts on LS. Pollution, including air pollution and noise levels, significantly reduce LS. High quality environmental amenities, such as living near the coast or having good views, enhance LS whilst proximity to landfill sites reduces LS. The quality of ecosystem services provided by the environment enhances LS whilst environmental disasters, such as forest fires and flooding, have a negative impact.

Similarities aside, an important difference between the tourism satisfaction and LS research is that this later group of researchers have explicitly evaluated genetic or hereditary factors

(Lyubomirsky et al., 2005). Empirical investigations have measured the impact of genetics on variations in life satisfaction, now widely accepted as explaining around 50% of all observed differences[21]. Consequently most studies evaluating non-genetic factors influencing life satisfaction are able to explain only 10% - 30% of variations in LS as the impact of genetic factors (probably explaining around 50% of the variation) cannot be controlled for within cross-sectional survey based life satisfaction studies. It seems likely that genetic factors would also influence tourist satisfaction levels; the inability to measure or control for these factors will consequently reduce the variation in trip satisfaction that can be explained by such studies.

To summarise key points made thus far: there is evidence to suggest that the GBR tourism industry may be 'stagnating', the key question being "WHY". Research suggests that this might be occurring if external factors are influencing overall trip satisfaction and/or the probability of repeat visitation. This research thus sets out to answer three specific questions that could shed light on the problem:

1) What is the influence of trip satisfaction on the likelihood of repeat visits to the GBR region? This study evaluates the impact of many different factors on the likelihood of tourists returning to the region to determine how significant trip satisfaction is to this decision.
2) What factors influence the trip satisfaction experienced by tourists visiting the GBR? This study considers the influences on trip satisfaction through a different lens to previous research, incorporating insights gleaned from the field of life satisfaction research. This research extends the use of objective data in explaining tourist responses, and matches the objective secondary data more precisely to each tourist's specific trip (spatially and for precise visit dates), than has been attempted in previous research, as far as I am aware.
3) What is the potential financial impact of changes in the number of returning visitors consequent to changes in economic, social and environmental factors that influence tourist trip satisfaction? This provides important information regarding the potential magnitude of the risk to the tourism industry resulting from changes to influencing factors and provides a useful tool for policy developers in tourist regions.

[21] The original article on which this chapter is based discussed this matter in further detail, but this discussion has been edited to prevent unnecessary duplication. For a full discussion of empirical work regarding the impact of genetic factors on LS please refer to section 1.2.2 of this thesis.

Our empirical estimates are clearly most relevant to the GBR region; however the methods used to generate those empirical insights are, I believe, of generic interest to all who wish to learn more about factors that influence tourist satisfaction and repeat visitation in general, and are transferable to anywhere in the world.

4.2 Materials and Methods

4.2.1 Case study region

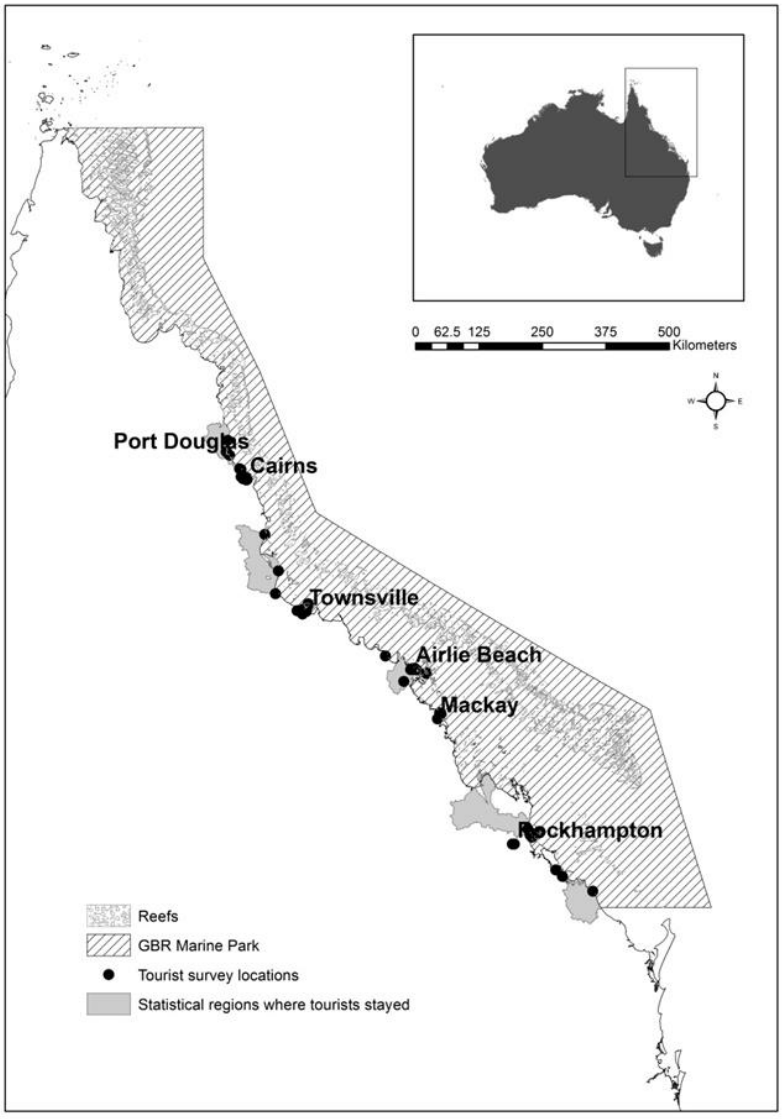


Figure 9 The study region

The GBR, situated in the Coral Sea off the coast of Queensland, Australia (Figure 9), is the world's largest reef system comprising over 2500 reefs covering an area of 348,700 km^2. It

was proclaimed a World Heritage Area (WHA) in 1981, and at that date was believed to comprise an ecosystem of over 1500 species of fish, around 400 species of coral, 4000 species of mollusc, 242 species of birds plus a great variety of sponges, anemones etc., and also provides feeding and/or nesting grounds for the endangered dugong and two endangered species of marine turtle (UNESCO World Heritage Convention, 1981).

4.2.2 Questionnaire development and data collection

The surveys used for this study were developed after a literature review and pre-tested amongst colleagues, in workshops and in a pilot study, with questions being refined at each stage before the survey was finalised and formal data collection commenced. Surveys were translated into Japanese and Chinese in addition to the original version in English, to avoid bias in the results towards Anglo-Saxon origin visitors. Tourist surveys were gathered from 59 different locations along the Queensland coastline adjacent to the GBR from the Daintree in the North, through to Agnes Waters at the southern end of the reef at regular periods over a 12 month period (to control for seasonality) between July 2012 and June 2013[22]. The GBR region offers a wide diversity of accommodation types, from back-packer hostels to high end resorts, at each location (particularly in the most highly visited Cairns/Port Douglas and Airlie Beach areas). Thus, the sample of tourists includes those staying in both low and high end accommodations, all of whom would have experienced the same economic and environmental features of the location in which they were staying.

The GBR region is currently visited by a mix of new and repeat tourists, this was reflected in the sample with 57% of the 1428 tourists surveyed being first time visitors. More than half of the respondents were female (55%), the average age was 38, and a fairly similar proportion of respondents were married or in legal partnership (51%) or were single (49%). Almost half of the visitors were from Australia (48%).

Visitors who stayed within the GBR region for more than 14 days were excluded from the analysis, because I specifically sought to link the characteristics of the particular area being visited (at a particular time – e.g. the amount of rain during the visit) with overall satisfaction. Those staying for more than 14 days were likely to have visited several locations along the coast, making such analysis impractical.

[22] The original article on which this chapter is based discussed the survey development and data collection more fully; this has been edited to prevent unnecessary duplication. For a full discussion please refer to section 2.4 within this thesis.

4.2.3 Variables and methods used to determine whether trip satisfaction influences the likelihood of repeat visits to the GBR region

My first research question sought to identify factors – other than trip satisfaction – that were associated with repeat visitation. Formally, I hypothesised that the:

Likelihood of returning = f (trip satisfaction, other factors)

Data relating to the dependent variable (likelihood of returning) were collected from a question that asked respondents to indicate the likelihood that they would return to the region using a 5 point Likert scale from "will definitely not return" to "will definitely return"; the frequencies of responses to this question are shown in Table 10.

This research thus adopts the ex-ante approach to assessing the likelihood of returning, based on future behavioural intentions regarding the likelihood of the tourist revisiting the region (C.-F. Chen & Tsai, 2007; Hui et al., 2007; Kozak & Rimmington, 2000)[23]. Importantly, I did not ask respondents to indicate which part of the region they would return to; instead they were presented with a map (with inland catchment region matching that shown in Figure 9), and they were asked their likelihood of returning to anywhere within that area. As such, I was able to determine whether people who visited (and were interviewed) at different locations have a higher/lower stated propensity to return, but I cannot determine where, within the GBR catchment, the planned repeat visits might occur. That stands as an important issue for future research.

The model has a categorical dependent variable. Studies investigating the likelihood of tourists revisiting an attraction or region have used a range of techniques, some suitable for categorical or ordinal dependent variables (Alegre & Cladera, 2006; Alegre & Garau, 2010; Ledesma et al., 2005) and others more appropriate for continuous data models. However, there has been considerable debate in the literature as to whether techniques designed for use with continuous data can also be used with ordinal Likert scale data; the overwhelming conclusion from LS studies that have compared results from different techniques is that the choice of technique is more important in theory than in practice, empirical evidence

[23] An alternate ex-post methodology is also common in the literature, whereby researchers use the number of times a respondent has visited the location previously as the dependent variable, and identifying factors associated with it (Assaf et al., 2013; Ledesma et al., 2005; Randriamboarison, Rasoamanajara, & Solonandrasana, 2013). Ideally, the ex-post approach could be adopted as part of a time series research project, tracking the tourists surveyed in this study to determine whether they did indeed return or not at a later date; unfortunately such research was beyond the scope (time and budget) of this study. Thus, whilst the ex-post approach has not been used for this study but could be considered for future research.

demonstrating that very similar results are obtained from using either continuous or ordinal regression methods (Ferrer-i-Carbonell & Frijters, 2004; Helliwell, 2003; MacKerron & Mourato, 2009)[24].

In this study, as the dependent variable, the likelihood of returning, is an ordinal variable I have used the ordinal regression technique, using a complementary log-log linking function (appropriate when there are more responses at in the higher categories than the lower – see Table 10). Following the lead of other tourism researchers (Hui et al., 2007; Kozak, 2001; Yuksel, 2001), I also used OLS regression, allowing us to compare results and make a methodological contribution to the literature on the appropriate use of these techniques.

As regards the independent variables, I firstly used the literature review to identify variables which previous researchers have found to be associated with repeat visitation (see Table 9 for a summary). The final set of variables (shown in Table 10) was obtained after a series of estimations starting with a specification that included all potential variables and gradually dropping insignificant ones. Careful consideration was given to variables which are likely to affect both satisfaction with the current trip and the likelihood of returning. For variables whose main impact on repeat visits is likely to be indirect via the effect on trip satisfaction, efforts were made to recognise these variables within the trip satisfaction model rather than the likelihood of returning model (since that includes trip satisfaction and thus captures these effects).

Table 10 Summary of variables used within likelihood of returning model

	%
Likelihood of returning	
The likelihood of returning reported by the tourist on a 5 point Likert scale	
Will definitely not return	1.3
Unlikely to return	3.7
Neutral	18.3
Likely to return	33.0
Will definitely return	43.7
Overall trip satisfaction	
The tourist's level of satisfaction with their experience as a whole on the trip reported using a 5 point Likert scale	
Very unsatisfied	.8
Unsatisfied	1.5
Neutral	12.5
Satisfied	40.1
Very satisfied	45.0

[24] The original article on which this chapter is based discussed this matter in further detail, but this discussion has been edited to prevent unnecessary duplication. For a full discussion of the use of techniques designed for continuous or ordinal data within LS studies please refer to section 2.6.1 of this thesis.

	%
Number of previous visits	
Tourist's number of previous visits to GBRWHA indicated by selecting from 5 different grouping	
First visit	57.3
One previous visit	8.8
2 - 4 previous visits	17.1
5 - 10 previous visits	8.5
More than 10 previous visits	8.3
Continent of origin	
Originates from Europe	21.2
Originates from North America	7.1
Originates from Asia	19.1
Sample size: n = 1428	

4.2.4 Variables and methods used to determine what factors influence the trip satisfaction experienced by tourists visiting the GBR

My second research question set out to identify factors influencing trip satisfaction. Formally, I thus set out to parameterise the following model:

Trip satisfaction = f (factors relating to the specific tourist and their specific trip, climate, factors relating to society, the economy and the environment)

Data relating to the dependent variable (trip satisfaction) were collected from a question that asked respondents to indicate their level of satisfaction with their experience as a whole on this trip, reported using a 5 point Likert scale. This is the same variable that is used as an explanatory factor within the likelihood of returning discussed above.

This study thus adopts the performance approach whereby factors explaining tourist trip satisfaction relate entirely to the actual experiences and perceptions of the tourist on the trip, rather than the disconfirmation approach whereby tourist expectations, and the degree to which these were met, are evaluated to explain overall trip satisfaction. Whilst many tourism satisfaction studies (for example Shahrivar, 2012) have focused on expectations, a body of literature has suggested that the performance approach (i.e. ignoring prior expectations and focussing instead on actual perceptions of satisfaction with the tourism experience) is a valid and probably better alternative to the expectations based approach. Whilst research can thus use the performance approach or the expectations approach, or both combined, my dataset restricted me to using the performance approach alone, which is sufficient as the research literature suggests that the performance approach yields more robust results. Empirical research has demonstrated the performance approach to better explain tourist trip satisfaction (Baker & Crompton, 2000; Hui et al., 2007); suggested reasons for this include that even a

poor visit experience may be reported as meeting expectations if the level of expectation were low (Assaker et al., 2011; Fuchs & Weiermair, 2003) and expectations may be updated as the holiday progresses resulting in difficulties distinguishing between initial expectations and actual satisfaction with their experiences (Kozak & Rimmington, 2000). The performance approach also accords with general LS research, based on the respondent's current life satisfaction and circumstances rather than the respondent's expectations.

Like the likelihood of returning model, this model also has a categorical dependent variable. Here too, I choose to estimate the model using ordinal regression (with a complementary log-log linking function because of the higher number of satisfied / very satisfied responses) and also OLS regression enabling comparisons between the two approaches.

As regards the independent variables, I firstly consulted literature relating to both tourist satisfaction and overall life satisfaction to identify variables likely to be significant (see Table 9). These can be broadly categorised into those describing the tourist and their trip plus those associated with society, the economy, and the environment.

I thus included variables capturing several socio-demographic factors (e.g. age, marital status) and factors relating specifically to the trip (e.g. cost of trip, length of trip, whether or not the visitor had been to reef while in the area). Some variables which previous researchers have found to influence LS could not, however, be included within this study; for example, tourists were not asked any questions regarding their employment/unemployment status, or the state of their health. The omission of these factors is acknowledged as a limitation to this research.

Objective data relating to social factors were considered but not used. This is because all tourists were visiting an admittedly large region (GBRWHA) – but a relatively homogenous one since it is part of a single state in a single country. As such, little variation in the actual social capital levels across the different tourist locations would be expected. However, tourists often perceive locations differently based on their own personal characteristics (including their views on social capital in Australia compared to their home location). Consequently, tourist perceptions of social factors are likely to be relevant to trip satisfaction. Data for this variable were collected in a question that asked respondents how safe they felt whilst visiting the region, by indicating how much they agreed or disagreed with the statement: "if I lost my wallet/purse somewhere in the town I am now visiting, I would get it back with all the money and cards still in it." The perceived likelihood of a lost wallet being

returned has been used in a number of satisfaction studies as a measure of social capital, representing a proxy for the level of trust in society (Helliwell & Wang, 2011). It has been found to have a significant impact on life satisfaction; hence the decision to test its impact on tourist satisfaction.[25]

Data representing economic activity were obtained from the Australian Bureau of Statistics (ABS); it was determined that a suitable proxy to represent the varying levels of development across the GBRWHA would be the intensity of construction work being undertaken within the different statistical regions visited by the tourists, measured by the percentage of the workforce employed in the construction industry. The use of this variable was selected after considering and testing a range of other measures, including the percentage of the workforce employed within agriculture, percentage of workforce employed within mining, and percentage of land area used for mining[26]. The search for suitable variables focused on those relating to the mining, minerals processing and agricultural industries, as mining and minerals processing are the largest industries within the region by value of production (PDP Australia Pty Ltd, 2003), whilst mining and agriculture dominate the exports of the region (Great Barrier Reef Marine Park Authority, 2014a). The region has seen, and continues to see, huge construction projects including the development of new mines, expansion of existing mines, development of extensive minerals processing plants (such as the LNG processing plant at Curtis Island, off Gladstone), along with extensive development of associated infrastructure (such as the expansion of the coal terminals at Gladstone Harbour, Hay Point and Abbott Point, already amongst the world's largest coal ports). Given the large scale of these projects and their dominance of industrial activity within the region, the number of people employed in construction was considered to be a suitable proxy for economic activity within the region. Objective data of this type has not been used to represent the level of development in specific regions in previous research as far as I am aware, and thus is an innovative contribution to this field of study. I chose to use this measure for the SA2 statistical region (as defined by

[25] Researchers have also compared perceptions about the chances of a wallet being returned to actual rates of return using a real experiment (Helliwell & Wang, 2011). They found that perceptions underestimated trustworthiness. Studies have found a similar underestimation of social capital (van Dijk, Kesferen, & Smit, 2007). These observations accord with findings from our data. I compared responses to our 'trust' question with actual crime statistics for 2012-2013 for each of the local government areas where the tourists visited; no statistical relationship was found between the actual levels of recorded crime and either the tourist's perceptions that their wallet would be returned, or the tourist's level of satisfaction with their trip.

[26] Alternate variables tested, and found to have lower explanatory power, were % businesses in mining, % of land used for mining, % of workforce employed in mining, % of workforce employed within agriculture, forestry and fishing , distance from major coal port (Abbot Point, Hay Point or Gladstone), distance to main road, average traffic count, average heavy vehicle traffic count, and population density

the ABS) visited by the tourist. SA2 statistical regions are a general-purpose medium-sized area which aims to represent a community that interacts together socially and economically, generally having a population range of 3,000 to 25,000 persons, with an average of about 10,000 persons (Australian Bureau of Statistics 2010 Statistical Area Level 2).

Objective data on various climate variables suggested by previous research (see Table 9), including maximum or minimum temperatures, hours of sunshine, rainfall and wind speed, were obtained from the Australian Bureau of Meteorology (BOM), using daily data from the measuring stations located closest to where each of the tourist's survey responses were obtained. Thus a precise measure of the weather experienced by each tourist was obtained, for the specific days of their visit at the actual location where they stayed. This precise matching of objective climate condition measures to tourist visit has not been included within previous research as far as I am aware.

Other environmental factors are expected to be important to tourists visiting the GBRWHA as intuitively it seems likely that the quality of the environment itself (in the form of the reef, the lagoon, beaches and islands), and the opportunity to enjoy and experience environmental features (through activities such as swimming, diving, spending time on the beach etc.), is an important reason why this location was chosen. This intuition is supported by the survey responses gathered for this study; visitors were asked how important a number of different factors were to them when they chose their holiday, the most important factors were the importance of clear oceans, healthy coral reefs, healthy reef fish and lack of rubbish (Stoeckl et al., 2013). Interestingly, many factors traditionally considered to be important within the tourism literature were not considered to be so by a large proportion of tourists to the region; the environmental factors were considered much more important than factors such as the availability of good quality accommodation, shops and restaurants and that the price of the holiday matched their budget (Stoeckl et al., 2013). The findings for the visitors to the GBR are supported by other studies of nature or environment based tourism; for example the importance of good underwater visibility (Ziegler et al., 2012).

Based on this, measures of the clarity of the ocean and the health of the coral reef and the reef fish would appear to be important when researching factors influencing the satisfaction of visitors to the region, and are also likely to be an important (indirect) factor influencing the likelihood of the tourist returning. Water turbidity, referred to as "the cloudy appearance of water caused by fine suspended particles (Fabricius, De'ath, Humphrey, Zagorskis, &

Schaffelke, 2013, p. 57) is important of its own right as indicated by the preference of tourists for clear ocean waters, and is also an important factor within coastal marine systems impacting on both coral reef and seagrass ecosystems. Poor water quality, including the effects of land-based pollutants such as suspended solids, nutrients and pesticides contained within river runoff, is a major contributor to factors such as Crown of Thorns Starfish (COTS) outbreaks, storms, coral bleaching and disease (Kroon et al., 2012), particularly contributing to COTS outbreaks and to disease (Waterhouse, Brodie, Lewis, & Mitchell, 2012), all of which are believed to adversely affect the health of coral reefs (Brodie & Waterhouse, 2012; Osborne, Dolman, Burgess, & Johns, 2011; Sweatman, Delean, & Syms, 2011). Thus a variable representing water turbidity[27] can also act as a proxy for the health of the reef due to the complex direct and indirect impacts that turbidity has on the coral. By including such a variable within my factors explaining trip satisfaction I am also reflecting the indirect impact that these variables have on the likelihood of returning, as trip satisfaction is an important variable explaining variations in the likelihood of a tourist returning to the region.

Measures of water turbidity within the lagoon itself and measures of sediment and pollutant loads within the rivers discharging into the lagoon were considered for inclusion within this study as water turbidity has been demonstrated to be strongly effected by terrestrial runoff and rainfall (which are themselves related) (Fabricius et al., 2013). However, water turbidity is influenced by rainfall and other climatic variables, so to include both water turbidity and climate as independent variables would be to introduce endogeneity into the model. To control for this, a two-step regression model (instrumental variable approach) was adopted.

To be more specific, I firstly used OLS to model the relationship between water turbidity and other climatic variables (described in Table 11). The predicted values from this model were retained, and used as regressors within the trip satisfaction model, which was estimated using ordinal regression, recognising the ordinal nature of the dependent variable. Thus, trip satisfaction was modelled using a two stage regression process.

[27] Water turbidity is measuring the amount of suspended solids in the water. Turbidity can directly impact the health of the coral by preventing/reducing the photosynthesis required for the coral to survive, and can indirectly impact the health of the reef, in conjunction with other pollutants, by contributing to poor water quality.

Table 11 Variables used in the overall trip satisfaction model - step 1

Variable	Description	Mean	Std. Dev.	Skew	Kurtosis
Dependent Variables					
Natural log of water turbidity data from AIMS	Data obtained from the Australian Institute of Marine Science (AIMS) who conducted water quality monitoring in the inshore lagoon at 14 fixed coral reef locations. Monitoring included measurements of water turbidity, measured by nephelometers detecting the scattered light from a red (700 nm) LED at 140 degrees to a detector every 10 min (Schaffelke et al., 2010). Daily water turbidity data, measured in nephelometric turbidity units (NTU), was compiled by AIMS from these readings for each of the 14 locations. The data was then matched to the specific dates of each tourist's visit at the location closest to where the tourist was staying to determine the water quality experienced by each tourist. The natural log of water turbidity was then calculated.	.38	.86	.88	.20
Instrumental Variables					
Average daily rainfall during trip	Obtained from BOM website, defined as all forms of water particles that fall from clouds and reach the ground. The rain gauge is the standard instrument for recording rainfall in millimetres, generally observed daily at 9 am local time, thus measuring the total rainfall that has been received over the previous 24 hours.	2. 55	5.07	2.51	5.85
TSS kilotonnes/annum in river	Best estimates of current mean tonnes per annum of TSS in each of 35 river basins discharging into the GBR lagoon had been compiled by researchers combining information from a number of sources and studies over the period 1983 to 2009 (Kroon et al., 2012) for each of the river basins. From this information, levels were identified for each of tourist survey locations by selecting the data for the river mouth closest to the location where the tourist was staying.	312.20	670.18	4. 27	16.90

Sample size: n =641

The final set of variables explaining variations in overall trip satisfaction, shown in Table 12 was obtained after a series of estimations; starting from a specification including all potential variables within one equation[28]. Insignificant variables were gradually dropped.

Table 12 Variables use in the overall trip satisfaction model - step 2

Variable	Description	Mean	Std. Dev.	Skew	Kurtosis
Dependent Variable					
Overall trip satisfaction	The tourist's level of satisfaction with their experience as a whole on this trip, reported using a 5 point Likert scale from "very unsatisfied" (-2) to "very satisfied" (+2)	1.30	.75	a	a

[28] The original specification of the model included the factors set out in table 9 (age, gender etc.), but these variables were statistically insignificant and thus excluded from the final model.

Variable	Description	Mean	Std. Dev.	Skew	Kurtosis
Explanatory Variables					
Midpoint income divided by equivalence factor	Tourists were asked the question "On average, how much pre-tax income does your household (you and everyone you live with) earn each year?" Respondents selected the appropriate category from a list, the midpoint of each category was used for the study. The household income was converted to individual income using the modified OECD scale adopted by the ABS (Australian Bureau of Statistics, 2010).	58,873.76	36,787.52	.66	.22
Construction intensity by place of work in SA2 region	Obtained from the ABS website detailing the industry sector within which each member of the workforce was employed, coded by the statistical region where the employee actually worked (as opposed to their normal place of residence) using 2011 census data by Statistical Area 2[29] regions	7.23	2.86	.29	.69
Unstandardized predicted value LnTurbidity on TSS, Rainfall	Predicted values of natural log of water turbidity derived from first step of modelling process	.38	.52	1.96	3.12
Stayed more than 1 night	Dummy variable = 0 if tourist had just arrived in the GBRWHA, having spent 1 night or less in the region, 1 if tourist spent more than 1 night in region	.85	.36	a	a
Believe would get lost wallet and contents back	The tourist response to the question "To help us gauge how 'safe' you have felt whilst here, please tell us how much you agree or disagree with the following statement: if I lost my wallet/purse somewhere in the town I am now visiting, I would get it back with all the money and cards still in it." were reported using a 5 point Likert scale ranging from strongly agree to strongly disagree, responses were coded as a dummy variable with a value of 1 for those agreeing and a value of 0 for those who were neutral or disagreed.	.35	.48	a	a
Did visit offshore reefs	Dummy variable = 1 if tourist did visit the offshore reefs at least once	.61	.49	a	a

Sample size: n = 641; a: skew and kurtosis are not relevant for categorical data; see Table 13 for frequency table.

Table 13 Frequencies for variables used within trip satisfaction model

	%
Overall trip satisfaction	
Very unsatisfied	.2
Unsatisfied	1.7
Neutral	11.1
Satisfied	42.0
Very satisfied	45.1

[29] SA2 regions are a general-purpose medium-sized area and their aim is to represent a community that interacts together socially and economically. SA2s generally have a population range of 3,000 to 25,000 persons, and have an average population of about 10,000 persons (Australian Bureau of Statistics 2010 Statistical Area Level 2)

	%
Stayed more than 1 night within the region	
Stayed more than 1 night	84.7
Spent 0 or 1 night in GBR - Just arrived	15.3
Perception that lost wallet would be returned	
Neutral or don't believe would get lost wallet and contents back	65.2
Believe would get lost wallet and contents back	34.8
Visited reef	
Didn't visit offshore reefs	38.8
Did visit offshore reefs	61.2

4.2.5 Variables and methods used to value the impact on tourist revenues from reduced likelihood of returning resulting from changes to factors influencing trip satisfaction

My final research question sought to use coefficients from the models above to assess the likely financial impact (in terms of changed tourism revenues) of changes in social, economic, or environmental variables in the GBR region.

In simple terms, the coefficients of the trip satisfaction model were first used to evaluate the impact on trip satisfaction that result from a change in construction intensity, water turbidity or the tourists perception that a lost wallet would be returned. This calculated change to trip satisfaction was then used within the likelihood of returning model to determine the impact on the likelihood that the tourist will return resulting from that initial change to construction intensity, water turbidity or perception that the lost wallet would be returned. Using secondary data to obtain a value for each repeat visitor, I was then able to estimate the income to the region that would be lost due to that reduced number of repeat visitors.

A complication resulting from using ordinal regression methods is that the coefficients cannot be easily interpreted, unlike when working with OLS models. With OLS, the coefficient can easily be interpreted as showing the amount the dependent variable would change as a result of a one unit change in the explanatory variable. However, with ordinal regression techniques this is not the case; rather the coefficients can be used to derive the probability that the response to the dependent variable will fall into each of the possible categories available. The calculation of probabilities depends on the cumulative link model used, as the cumulative link model is the function linking the conditional cumulative probabilities; for the

complementary log-log linking function used here this is specified as log (- log (1 - $\gamma_{i,k}$))[30]. This formula can be transformed to derive the probability of the dependent variable adopting each potential value, resulting in an equation as follows:

> Probability of particular trip satisfaction level = 1 – exp (- exp (coefficient of predictor variable under consideration)

Specifically, the approach adopted here was to use the transformed linking equation to determine the number of visitors changing from being satisfied to neutral or dissatisfied that would result from a number of specified scenarios, such as a 10% increase in water turbidity (scenarios are discussed in detail in 3.3.3 with the presentation of results). This reduced number of satisfied visitors is then applied to the likelihood of returning model, again using the transformed complementary log-log linking function equation, to estimate the reduced probability of the tourist repeating the visit.

4.3 Results and discussion

4.3.1 Likelihood of returning

As discussed above, ordinal regression using a complementary log-log linking function was used to estimate the relationship between the likelihood of a tourist returning and the factors impacting on this. The ordinal regression parameter estimates from my first model are provided in Table 14. As expected from the literature, my OLS regressions (results available on request) produced very similar results with regard to significant variables and the direction of impact on the dependent variable.

Table 14 Results of likelihood of returning model using ordinal regression

	Coefficients	Standard error	Significance
Dependent variable			
Likelihood of returning			
Will definitely not return	-3.886	.391	***
Unlikely to return	-2.478	.334	***
Neutral	-.755	.317	**
Likely to return	.527	.316	*
Will definitely return	Reference group		

[30] As explained in McCullagh (1980), this is based on the proportional hazards model, one model that can be applied to discrete data, where the response variable is measured on an ordinal scale whereby the categories can be thought of as contiguous intervals on some continuous scale. The model is an instantaneous risk function which can be used to define the probability of survival beyond a category subject to given covariate values. Should the ordinal data be such that there is only two categories (a binary model) then the complementary log-log linking model equates to the proportional odds or logit model.

	Coefficients	Standard error	Significance
Independent variables:			
Overall trip satisfaction			
Very unsatisfied	-1.083	.371	***
Unsatisfied	-1.474	.252	***
Neutral	-1.253	.113	***
Satisfied	-.651	.082	***
Very satisfied	Reference group		
Number of previous visits			
First visit	-.999	.188	***
One previous visit	-.714	.217	***
2 - 4 previous visits	-.602	.198	***
5 - 10 previous visits	-.090	.243	
More than 10 previous visits	Reference group		
Continent of origin			
Doesn't originate from Europe	.558	.100	***
Originates from Europe	Reference group		
Doesn't originate from North America	.830	.140	***
Originates from North America	Reference group		
Doesn't originate from Asia	.904	.105	***
Originates from Asia	Reference group		

*** Significant at 0.01 level ** Significant at 0.05 level * Significant at 0.1 level Observations 1,428 PseudoR^2 .229 (Cox and Snell), .251 (Nagelkerke) Model $\chi 2$ (11) 371.540, p<.001

Evidently, tourists are more likely to return to the region if they have reported a high degree of satisfaction on this trip or if they have previously visited the region, whilst they are less likely to return if they are from Europe, Asia or North America. These findings are in accordance with previous studies which found trip satisfaction to be an important factor in explaining the likelihood of a tourist returning (including Alegre & Cladera, 2006; C.-F. Chen & Tsai, 2007; Kozak, 2001; Yoon & Uysal, 2005) including studies focussing specifically on the GBR (Moscardo et al., 2004; Saltzer, 2002b). Additionally, these findings also accord with previous research which found that those who have previously visited a region are more likely to return (for example Alegre & Cladera, 2006; Assaker & Hallak, 2012; Kozak, 2001; Yuksel, 2001) and that the country of origin can significantly impact on whether a tourist is likely to return or not (Assaker & Hallak, 2012; Hui et al., 2007; Saltzer, 2002b).

4.3.2 Trip satisfaction

Our water turbidity regression results are presented in bottom half of Table 15; the trip satisfaction results (which use the predicted values of water turbidity) are in the top half. As previously, the OLS model results (set out in 4.5.2) were found to be very similar.

Table 15 Results of two-stage trip satisfaction model

	Coefficients	Standard error	Significance
Second stage – ordinal regression			
Dependent variable			
Overall trip satisfaction			
Very unsatisfied	-7.300	1.018	***
Unsatisfied	-4.805	.347	***
Neutral	-2.787	.220	***
Satisfied	-.959	.192	***
Very satisfied	Reference group		
Independent variables:			
Midpoint income divided by equivalence factor	4.712E-006	1.577E-006	***
Construction intensity by place of work in SA2 region	-.055	.020	***
Unstandardized predicted value LnTurbidity on TSS, Rainfall	-.457	.098	***
Stayed more than 1 night in region			
Spent 0 or 1 night in GBR - Just arrived	-.651	.139	***
Stayed more than 1 night	Reference group	.	
Perception that lost wallet would be returned			
Neutral or don't believe would get lost wallet and contents back	-.347	.120	***
Believe would get lost wallet and contents back	Reference group	.	
Visited reef			
Didn't visit offshore reefs	-.274	.115	**
Did visit offshore reefs	Reference group	.	
Observations	641		
Pseudo R^2	.100 (Cox and Snell), .114 (Nagelkerke)		
Model $\chi 2$ (7)	67.598, p<.001		
First stage – OLS regression			
Dependent variable	LnWaterTurbidity		
Excluded instruments:			
TSS kilotonnes/annum in river	.000	.000	***
Average daily rainfall during trip	.092	.006	***
Included instruments	Yes		
Observations	641		
Adjusted R^2	.355		

*** Significant at 0.01 level ** Significant at 0.05 level * Significant at 0.1 level

This model shows that trip satisfaction is positively associated with income, perceptions of personal safety, length of stay in the region or a visit to the reef. Trip satisfaction was negatively associated with construction intensity and water turbidity.

The finding that higher income tourists are more satisfied confirms previous tourism research (Shahrivar, 2012); this may reflect that the better off tourists are able to benefit from high end accommodation, entertainment and trips. This finding is also in accordance with LS research

where those with higher incomes are generally happier with life overall (for example Di Tella et al., 2003; Ferrer-i-Carbonell & Frijters, 2004; Frey & Stutzer, 1999; Welsch, 2007b).

The positive relationship between perceptions that a lost wallet would be returned and increased trip satisfaction corroborates previous findings that tourists don't wish to visit locations perceived to have high crime levels or be dangerous (Demos, 1992; Handszuh, 2006; Tarlow, 2006) and accords with research that LS is related to perceptions of crime and personal safety (Michalos & Zumbo, 2000) and to trust in others and society (Engelbrecht, 2009; Helliwell, 2003; Helliwell & Wang, 2011; MacKerron & Mourato, 2009; Stanca, 2009).

The finding that a higher intensity of construction work contributes to a lower level of tourist satisfaction is in accordance with previous research indicating that tourists were dissatisfied by overdevelopment and congestion including too much building development, noise and congestion (Alegre & Garau, 2010).

The finding that lower levels of water turbidity enhance tourist satisfaction, combined with tourists who have visited the reef reporting higher trip satisfaction, confirms my initial hypothesis that tourists prefer clear water and a healthy reef. This finding is in accordance with research demonstrating the importance of environmental quality to tourist satisfaction (Alegre & Garau, 2010, 2011; Brau & Cao, 2008; Hernández & León, 2007), that tourist satisfaction of visitors to the GBR specifically is highly impacted by the quality of the coral and the level of marine bio-diversity (Coghlan, 2012), and that higher levels of LS result when there are high quality environmental amenities (Ambrey & Fleming, 2011; Brereton et al., 2008) or low levels of pollution (Levinson, 2012; MacKerron & Mourato, 2009; van Praag & Baarsma, 2005; Welsch, 2006).

Finally, the significance of the variable indicating lower satisfaction from tourists who have just arrived in the region is in accordance with previous tourism research that has found higher satisfaction levels to be reported by tourists making longer stays (Shahrivar, 2012).

4.3.3 Valuation of the impact on tourist revenues resulting from changes to economic, social and environmental factors via their impact on overall trip satisfaction and ensuing impact on the likelihood of the tourist returning

Coefficients from the ordinal regression models associated with trip satisfaction were used to make predictions about the likely impact, on satisfaction from a change in each of the 'core'

variables (perceptions of 'crime', construction activity, and water turbidity) representing factors associated with the social, economic and environmental domains. These estimates were then used in conjunction with the coefficients relating to the likelihood of a tourist returning, to make predictions about the way in which social, economic, or environmental changes might affect repeat visitation. A more detailed explanation of the calculation process for each of the triple bottom line factors is given below.

Calculations show that a small adverse change in each of these variables (increase in water turbidity or construction intensity, decreased perception that lost wallet would be returned) has a small adverse impact on the likelihood of a tourist returning to the region, and may appear to be too small to give concern regarding future visitor numbers within the region. However, when considered in the context of the potential scale by which these factors could change, combined with the number of tourists visiting the GBRWHA each year and the revenue generated for the region by repeat tourist visits, the resulting impact on the economy from changes to any of the triple bottom line factors could be significant.

A recent report for the year 2011/2012 identified that there were almost 35 million visitor nights, including international and domestic visitors, spent within the GBRWHA, with an average daily expenditure of $155.65 (Deloitte Access Economics, 2013). Based on the data from the survey responses, 42.7% of visitors have been to the region before (see Table 10). Applying this percentage of repeat visits to the total number of visitor nights in the region and the average spend per visitor implies a total spend by repeat visitors to the region, per year, of approximately $2.3bn. Thus, if the proportion of visitors saying they were likely to return should reduce, by 10% for example, then the revenue earned in the region would reduce by 10% of $2.3bn, that is $230m, per annum. The models developed to explain trip satisfaction and the likelihood of returning can be used to estimate the reduction in repeat visitors in different scenarios, and hence the reduction in annual revenues. Each of the explanatory variables representing the triple bottom line will be considered in turn, explaining the processes adopted and results obtained; the processes were different in each case due to differences in the type of explanatory variable.

Firstly, the tourist's perception that a lost wallet would be returned; this is a dummy variable rather than being of a continuous nature, that is the tourist either believes the wallet will be returned or that it will not be returned with no-other response possible. The probabilities of the tourist trip satisfaction response being within each categories, from very unsatisfied to

very satisfied, were calculated with the current proportion of respondents expecting their wallet to be returned (34.8% as in Table 13). The proportions for each category were then recalculated should every tourist perceive their wallet would not be returned, that is a 100% reduction from current levels. The changes in proportions of satisfied responses were then applied to the likelihood of returning model, estimating from this the reduction in the proportion of tourists that would revisit if all had perceived their wallet would not be returned. This analysis showed that the 100% reduction in the number of current tourists expecting their wallet back would reduce the likelihood of a repeat visit by 0.13%. Applying this proportionate reduction to the $2.3bn annual revenue received from repeat visitors, described above, tourism revenue in the region would fall by $3m. Whilst it is overly pessimistic to assume all tourists currently expecting their wallet to be returned may change their views, it is reasonable to consider what could happen should the perceptions of a proportion of these change; hence the scenario results shown in Table 16 demonstrate the outcome should the proportion of those expecting their wallet to be returned fall by 10%.

Considering the construction intensity variable, this is a continuous variable and therefore the method adopted to value a change in this is a little different to that for the perception that a lost wallet would be returned. For this variable, the trip satisfaction model was used to estimate the change in the proportion of tourist providing each satisfaction response should the mean construction intensity across the region change by a specified amount. These changes in proportions were then applied to the likelihood of returning model to calculate the reduction in repeat visitors consequent to that change; the value of this reduction in repeat visitors could then be calculated. The reductions in annual tourist revenue in the region estimated to result from the possible scenario of a 10% increase in construction intensity across the region is shown in Table 16. Construction intensity for this sample on average is 7.23% (as shown in Table 12), this average encompasses a range from a minimum of 2.10% in Cairns City to a maximum of 18.77% at Callemondah, near Gladstone. The GBR region includes some districts where construction comprises an even larger proportion of employment by place of work, such as the region of Shoal Point – Bucasia near Mackay at 23.88% or Bohle Plains near Townsville at 33.47%. Given the degree of construction intensity in some locations across the GBRWHA, a scenario showing a 10% increase does not appear to be overdramatizing the potential scale of change to this variable.

For the water turbidity variable, a similar approach was followed as for the construction intensity variable as water turbidity is also a continuous variable. However, the model uses

the natural log of water turbidity; the use of logs means this is not a particularly meaningful measure to discuss within scenario analysis hence the calculation was extended to calculate the impact of changes on absolute, rather than logged, water turbidity, as shown in Table 16.

This impact assessment technique can also be considered from the reverse point of view. Instead of calculating the cost in terms of potentially lost tourist revenue resulting from a worsening of economic, social or environmental factors, the technique can also be used to calculate the benefit in terms of increased tourist revenue that could result from improvements to these factors. These benefits may be sufficient to cover costs incurred in making the improvement, and may in fact be able to demonstrate a net benefit to the region from expenditure invested in making improvements to the region, thus encouraging improvement projects to be undertaken. For example, biophysical scientists have recommended that requiring land holders within the GBR catchment to transition to best practice land management techniques could, over a period of time, reduce total suspended sediment (TSS) in the rivers by 25%. Future advancements in farming practices and technology could reduce TSS more effectively, resulting in reductions of 50%. Alternately, farmers in certain catchments could be required to stop cane farming altogether, reducing TSS in those rivers to pre-industrial levels over time, whilst other catchments could continue at current levels. Table 16 provides the revenue benefits that could result from the adoption of these possible policy initiatives.

As can be seen, the impacts estimated by this analysis are fairly small compared to total visitor expenditure; I believe this may be due to two reasons. Firstly, I have only considered the reduced spend resulting from visitors not returning to the region again who otherwise would do so. That is, the impact I have calculated does not include any reduction in first time visitors that would result from the region becoming less attractive to visitors. Based on my data first time visitors comprise 57.3% of visitors to the region each year. Secondly, the impacts have been estimated for scenarios based around a 10% change in each of the factors. It is possible that tourists would not be particularly aware of a change of this magnitude (for example a one off 10% decrease in water clarity may not be overly obvious to most visitors), whilst much bigger impacts could result over time as the cumulative effect of a continuing worsening off the factor (for example 10% decrease in water clarity year on year) would have a far more substantial impact on repeat visits and visitor spending.

Table 16 The impact on tourist revenue resulting from various possible scenarios

Change to particular factor	Scenario explaining change to factor	Policy decisions that could result in this change	Estimated impact on annual tourist revenue in GBRWHA
Negative scenarios			
Perception that a lost wallet would be returned reduces	10% decrease in the average perception of tourists visiting the region that a lost wallet would be returned	n/a	Reduction of $305,000
Construction intensity increases	10% increase in average proportion of workers in the region employed in the construction industry	n/a	Reduction of $392,000
Water turbidity increases (that is water clarity worsens)	10% increase in true (not logged) average water turbidity in the lagoon	n/a	Reduction of $430,000
Positive scenarios			
Total suspended solids (TSS) reduce in all rivers, consequently reducing water turbidity (that is water clarity improves)	25% reduction in TSS in each of the rivers flowing in to the GBR lagoon	Land holders across the GBR catchment area could be required to adopt strategies that would reduce the level of total suspended sediment	Increase of $89,000
Total suspended solids (TSS) reduce in all rivers, consequently reducing water turbidity (that is water clarity improves)	50% reduction in TSS in each of the rivers flowing in to the GBR lagoon	Land holders across the GBR catchment area could be required to adopt strategies that would reduce the level of total suspended sediment	Increase of $178,000
Total suspended solids (TSS) reduce in certain rivers only, consequently reducing water turbidity (that is water clarity improves)	Daintree and Russell-Mulgrave catchments reduce the TSS within those rivers back to the levels experienced before the arrival of European settlers, TSS loads in the other rivers maintained at current levels, thus reducing water turbidity in the GBR lagoon	Land holders in specific river catchments could be required to adopt aggressive strategies to reduce sediments whilst land holders in the remaining river catchments could be required to maintain loads at current levels.	Increase of $12,000

Ideally, for this estimation process, I would have used the trip satisfaction model developed earlier in the research to predict the satisfaction levels for each of the survey respondents, then included these predicted satisfaction data within the likelihood of returning model in place of the actual satisfaction levels; thus fully recognising the nested nature of the models. Unfortunately limitations in my data prevented this, as the predicted satisfaction responses failed to show sufficient variation to allow the calculation of meaningful estimates of the impact on the likelihood of tourists returning to the region. For future research I would recommend that the survey questions regarding trip satisfaction and likelihood of returning are posed with a wider range of possible responses than we used; use of a 7 or 9 point Likert

scale (as opposed to the 5 point scale adopted here) would give more variation in the respondent's answers which should also result in a wider range of predicted responses to the level of trip satisfaction. Better resolution in the data should enable the predicted satisfaction responses to be used in the likelihood of returning model, better representing the nested nature of these models. However, this limitation to this particular case study does not detract from the potential usefulness of this technique in future studies focusing on many different tourist locations around the world.

Prior research has identified the 'environmental paradox' of tourism, based on environmental resources being one of the core ingredients for a tourism industry; tourism requires high quality natural resources but tourism itself places stresses on those very resources that the industry requires if it is to continue (Williams & Ponsford, 2009). Excluding the effect of this paradox from the study introduces a risk that the effects of increased/decreased numbers of visitors on the environment may also affect satisfaction and hence repeat visitation rates. The omission of this interaction between visitor numbers and the environment from the analysis is admitted as a limitation to this study, and could be usefully addressed in future research. However, I feel that for this particular region, the impact of tourism itself on the factors influencing trip satisfaction is likely to be small in comparison to the impact of other industries. Indeed an analysis of threats to the health of the GBR has identified that the major threat to water quality arises from the agriculture of the region and the main construction work and coastal development results from mining, minerals processing and related infrastructure development, particularly relating to ports (Great Barrier Reef Marine Park Authority, 2014a).

Evidently, increases (decreases) in perceptions of crime rate, in construction activity or in water turbidity could generate a significant decrease (increase) in tourism revenues within the GBRWHA. These finding have important policy implications for those concerned with society, the economy or the environment of the region, as they demonstrates how different industries directly and indirectly affect each other. The examples demonstrated here show that a booming construction industry (perhaps supporting a booming mining and/or minerals processing industry) can adversely impact the apparently unrelated tourism industry, whilst a requirement to change agricultural practices to improve the environment could positively enhance tourism despite tourism being an industry seemingly unrelated to agriculture. The linkages between industries must be considered by those assessing development proposals to ensure the future viability of all industries and the region as a whole.

4.4 Conclusion

This research investigated three important issues relating to: the factors influencing tourist satisfaction; the likelihood of tourists returning; and the potential regional economic impact from variations in tourist satisfaction that occur in response to social, environmental and economic changes. For example, the GBR case study reveals that tourist satisfaction in this region is influenced by increased perceptions of crime, increased construction activity or increased water turbidity. However, the methodology used in this case study can be transferrable to any other tourist location around the world. These results can be seen as proof of concept, and future research opportunities exist to determine how robust these finding are to alternate measures of social, economic and environmental factors, and to other parts of the world.

A significant positive relationship was also found to exist between trip satisfaction and the likelihood of repeat visits in the GBR case. Based on this finding, it is apparent that tourism regions can increase the numbers of repeat visitors if tourist trip satisfaction can be increased. This clearly calls attention to the importance of research that improves understanding of these influencing factors.

Moreover, trip satisfaction was found to be affected by environmental, social and economic factors, in addition to income, whether they visited the area and whether they had just arrived in the region, as indicated in the GBR case. The importance of the economic, social and environmental factors indicates that tourist satisfaction is impacted by the actions of those outside of the tourism industry (such as the agriculture and construction industries in this case). It points out that important links exist between superficially unconnected industries; and these links must be taken into account when considering developments to other industries to ensure the future success of the tourism industry in attracting new and repeat visitors.

Furthermore, changes to perceptions of crime, construction and water turbidity could have a significant regional economic impact – because these factors affect tourist satisfaction which, in turn, affects the likelihood that tourists will return in future. Another important contribution from this research is that it enables the impact on annual tourist revenue resulting from changes to these factors to be quantified, enabling sophisticated cost-benefit analysis of different scenarios to be conducted as part of any policy development process.

This approach has great potential to be used in the research areas where non-market evaluation technique is needed.

In conclusion for tourism to remain viable into the future, one requirement is for visitors to experience high levels of trip satisfaction, therefore having a greater likelihood of returning to the region. Environmental, social and economic factors all have quantifiable impacts on the tourist's trip satisfaction and therefore their likelihood of revisiting, evidencing the complex interactions between industries. The successful development of the tourism industry cannot be achieved in isolation but requires a holistic view to be taken of the development of all industries across the region as a whole.

4.5 Appendix to Chapter 4

4.5.1 References used to compile Table 9

Table 17 References used to compile Table 9

	Probability that a tourist will return	**Tourist's overall trip satisfaction**	**Overall satisfaction with life**
Age	Assaf et al. (2013); Saltzer (2002b)	Alegre & Cladera (2006); Shahrivar (2012)	Alesina, Di Tella, & MacCulloch (2004); Brereton et al. (2008); Cuñado & de Gracia (2013); Di Tella et al. (2003); Ferrer-i-Carbonell & Gowdy (2007); Ferrer-i-Carbonell & Frijters (2004); Frey & Stutzer (1999, 2000, 2002); Helliwell (2003); Michalos & Zumbo (2000); Oswald (1997); Stanca (2009); van Praag & Baarsma (2005); Welsch (2007b); Winkelmann & Winkelmann (1998)
Gender	Assaf et al. (2013)	Saltzer (2002a)	Alesina et al. (2004); Brereton et al. (2008); Di Tella et al. (2003); Ferrer-i-Carbonell & Gowdy (2007); Frey & Stutzer (1999); Michalos & Zumbo (2000); Stanca (2009); Welsch (2007b)
Education level	Assaf et al. (2013)	Shahrivar (2012)	Relationship found by Abdallah et al. (2008); Alesina et al. (2004); Arifwidodo & Perera (2011); Brereton et al. (2008); Cuñado & de Gracia (2013); Di Tella et al. (2003); Ferrer-i-Carbonell & Gowdy (2007); Frey & Stutzer (2000, 2002); Helliwell (2003); Stanca (2009); Welsch (2007b). Finding that may be indirect via effect on income rather than direct found

	Probability that a tourist will return	Tourist's overall trip satisfaction	Overall satisfaction with life
			by Diener et al. (1999)
Marital status	Assaf et al. (2013); Randriamboarison et al. (2013)		Alesina et al. (2004); Arifwidodo & Perera (2011); Cuñado & de Gracia (2013); Di Tella et al. (2003); Diener et al. (1999); Ferrer-i-Carbonell & Gowdy (2007); Ferrer-i-Carbonell & Frijters (2004); Frey & Stutzer (1999, 2000, 2002); Helliwell (2003); Michalos & Zumbo (2000); Stanca (2009); Welsch (2007b); Winkelmann & Winkelmann (1998)
Country of origin	Assaf et al. (2013); Assaker & Hallak (2012); Hui et al. (2007); Saltzer (2002b)	Alegre & Cladera (2006); Hui et al. (2007); McElroy & Parry (2010); Saltzer (2002a); Shahrivar (2012)	Country specific characteristics found by Welsch (2006, 2007b). Difference between being national or foreigner found by Frey & Stutzer (1999, 2000, 2002)
Income	Assaker & Hallak (2012)	Shahrivar (2012)	Higher income effect found by Abdallah et al. (2008); Brereton et al. (2008); Cuñado & de Gracia (2013); Di Tella et al. (2003); Diener et al. (1999); Easterlin (2001); Engelbrecht (2009); Ferrer-i-Carbonell & Gowdy (2007); Ferrer-i-Carbonell & Frijters (2004); Frey & Stutzer (1999, 2000, 2002); Helliwell (2003); MacKerron & Mourato (2009); Michalos & Zumbo (2000); Rehdanz & Maddison (2005); Stanca (2009); van Praag & Baarsma (2005); Welsch (2002, 2006, 2007b); Winkelmann & Winkelmann (1998). Relative income studied by Daly (1987); Diener et al. (1999); Dixon (1997); Easterlin (1995, 2003); Layard (2003); Stutzer & Frey (2010). Future material aspirations and their relationship to anticipated future income levels considered by Easterlin (1995, 2001). Income effect found to be negligible or not significant by Easterlin (1995); Oswald (1997)
Health status			Ambrey & Fleming (2011); Brereton et al. (2008); Cuñado & de Gracia (2013); Di Tella et al. (2003); Ferrer-i-Carbonell & Gowdy (2007); Ferrer-i-Carbonell & Frijters (2004); Frey & Stutzer (1999, 2002); Helliwell (2003); Levinson (2012); MacKerron & Mourato (2009); Seghieri & Desantis

	Probability that a tourist will return	Tourist's overall trip satisfaction	Overall satisfaction with life
			(2006); Winkelmann & Winkelmann (1998)
Employed or unemployed			Alesina et al. (2004); Brereton et al. (2008); Cuñado & de Gracia (2013); Ferrer-i-Carbonell & Gowdy (2007); Frey & Stutzer (1999); Helliwell (2003); Levinson (2012); Luechinger & Raschky (2009); Welsch (2007b); Winkelmann & Winkelmann (1998)
Overall satisfaction with trip	Alegre & Cladera (2006); Assaf et al. (2013); Assaker et al. (2011); C.-F. Chen & Tsai (2007); Choo & Petrick (2014); Hui et al. (2007); Jang & Feng (2007); Kozak (2001); Kozak & Rimmington (2000); Ledesma et al. (2005); Moscardo et al. (2004); Neuts, Romão, Van Leeuwen, & Nijkamp (2013); Petrick & Backman (2002); Petrick, Morais, & Norman (2001); Saltzer (2002b); Yoon & Uysal (2005)		
Previously visited region	Alegre & Cladera (2006); Assaker & Hallak (2012); Kozak (2001); Kozak & Rimmington (2000); Ledesma et al. (2005); Petrick et al. (2001); Yuksel (2001)	Alegre & Cladera (2006); Kozak & Rimmington (2000); Shahrivar (2012)	
Trip cost / perceived value for money	Assaf et al. (2013); C.-F. Chen & Tsai (2007); Petrick et al. (2001); Randriamboarison et al. (2013); Saltzer (2002b)	Alegre & Cladera (2006); Alegre & Garau (2010); C.-F. Chen & Tsai (2007); Lu & Stepchenkova (2012); Ziegler et al. (2012)	
Facilities at tourist destination – accommodation, restaurants etc.	Assaf et al. (2013); Randriamboarison et al. (2013); Saltzer (2002b)	Alegre & Garau (2011); Casagrandi & Rinaldi (2002); Cerina (2007); Giannoni & Maupertuis (2007); Hernández & León (2007); Lu & Stepchenkova (2012); McElroy & Parry (2010); Saltzer (2002a); Torres-Sovero et al. (2012)	
Climate	Assaf et al. (2013); Randriamboarison et al. (2013)	Alegre & Cladera (2006); Alegre & Garau (2011); Coghlan (2012); Coghlan & Prideaux (2009)	Abdallah et al. (2008); Brereton et al. (2008); Cuñado & de Gracia (2013); Rehdanz & Maddison (2005)
Economic development	Alegre & Garau (2010)	Development increasing tourist dissatisfaction found by Alegre & Garau (2010) Peace, quiet and not overcrowded found	Kountouris & Remoundou (2011); Welsch (2007b)

	Probability that a tourist will return	Tourist's overall trip satisfaction	Overall satisfaction with life
		important by Alegre & Cladera (2006); Alegre & Garau (2010); Brau & Cao (2008); Cerina (2007); Hernández & León (2007); McElroy & Parry (2010); Ziegler et al. (2012)	
Quality of social capital	Assaf et al. (2013); Demos (1992); Randriamboarison et al. (2013)	Demos (1992); Handszuh (2006); Tarlow (2006).	Various measures studied, including measures of local political autonomy by Abdallah et al. (2008); Frey & Stutzer (2000), political stability by Abdallah et al. (2008), rule of law and control of corruption by Abdallah et al. (2008), perceptions of crime levels and personal safety by Michalos & Zumbo (2000), degree of freedom and personal choice by Stanca (2009), and trust in others or society by Engelbrecht (2009); Helliwell (2003); Helliwell & Wang (2011); MacKerron & Mourato (2009); Stanca (2009)
Quality of natural environment	Environmental impacts of tourism discussed by Commission on Sustainable Development (1996). The tourist area life cycle model was developed by Butler (1980). Environmental impact on sustainable tourism discussed by Casagrandi & Rinaldi (2002); Giannoni & Maupertuis (2007); Hernández & León (2007, 2013); Wilkinson (1989).	Alegre & Garau (2010, 2011); Brau & Cao (2008); Casagrandi & Rinaldi (2002); Cerina (2007); Coghlan (2012); Giannoni & Maupertuis (2007); Hernández & León (2007, 2013); Saltzer (2002a)	Pollution effects investigated by Cuñado & de Gracia (2013); Levinson (2012); MacKerron & Mourato (2009); van Praag & Baarsma (2005); Welsch (2002, 2006, 2007a), environmental amenities considered by Ambrey & Fleming (2011); Brereton et al. (2008), whilst proximity to landfill sites studied by Brereton et al. (2008). Effect of ecosystem services researched by Abdallah et al. (2008); Vemuri & Costanza (2006) whilst environmental disasters, (e.g. forest fires, flooding) studied by Kountouris & Remoundou (2011); Luechinger & Raschky (2009)

4.5.2 Results of two stage trip satisfaction model using OLS regression

Table 18 Results of two stage trip satisfaction model using OLS regression

	Coefficients	Standard error	Significance
Second stage – OLS regression			
Dependent variable	Overall trip satisfaction		
Independent variables:			
Midpoint income divided by equivalence factor	2.395E-006	7.728E-007	***
Construction intensity by place of work in SA2 region	-.024	.010	**
Unstandardized predicted value LnTurbidity on TSS, Rainfall	-.212	.056	***
Spent 0 or 1 night in GBR - Just arrived	-.336	.078	***
Believe would get lost wallet and contents back	.157	.059	***
Visited reef			
Did visit offshore reefs	.201	.060	**
Constant	1.285	.113	***
Observations	641		
Adjusted R^2	.096		
First stage – OLS regression			
Dependent variable	LnWaterTurbidity		
Excluded instruments:			
TSS kilotonnes/annum in river	.000	.000	***
Average daily rainfall during trip	.092	.006	***
Included instruments	Yes		
Observations	641		
Adjusted R^2	.355		

*** Significant at 0.01 level ** Significant at 0.05 level * Significant at 0.1 level

4.5.3 Results of likelihood of returning model using OLS regression

Table 19 Results of likelihood of returning model using OLS regression

	Coefficients	Standard error	Significance
Dependent variable	Likelihood of returning		
Independent variables:			
Overall trip satisfaction	.348	.027	***
Number of previous visits	.124	.019	***
Continent of origin			
Doesn't originate from Europe	.351	.061	***
Doesn't originate from North America	.586	.090	***
Doesn't originate from Asia	.566	.065	***
Constant	-.705	.136	***
Observations	1428		
Adjusted R^2	.218		

*** Significant at 0.01 level ** Significant at 0.05 level * Significant at 0.1 level

Chapter 5 Spatial differences in the contributors to life satisfaction: Implications for electoral boundaries

In the previous two chapters I demonstrated that the LS approach can be used to gain insights into factors that influence customer satisfaction, using the tourism industry as my example, and demonstrated a valuation technique based upon this approach. I now move on to use the LS approach to investigate the more traditional topic of LS of residents of the region. Having demonstrated within chapters 3 and 4 that factors from all three domains impact on TS, I now seek to determine which domain(s) are the most important determinants. Also, having demonstrated within chapters 3 and 4 that little empirical difference results from using continuous data techniques such as OLS (rather than those designed for an ordinal dependent variable), I now test whether the use of geographically weighted regression can provide insights into spatial variations within the factors influencing satisfaction. Thus, this chapter addresses research objective three.

This chapter is based on a draft article that is ready for submission to either Urban Studies or Urban Policy and Research (yet to be decided); the anticipated citation for this article is:

Jarvis, D., Stoeckl, N., & Liu, H.-B. Spatial differences in the contributors to life satisfaction: Implications for electoral boundaries.

This draft article has been edited for inclusion within this thesis, to remove duplication of information already discussed elsewhere. Footnotes within the text indicate when notable amendments have been made to the original article. Minor amendments have also been made to ensure consistent use of terminology within this thesis.

Abstract

I find that the contribution which different factors make to life satisfaction vary spatially, and demonstrate that these observed spatial differences in preferences can provide useful information regarding the likely success or otherwise of local government amalgamations.

Within the study region of north east Queensland, Australia, those amalgamations combining residents with fairly homogenous preferences were found to be successful, whilst those amalgamations that brought together residents with relatively heterogeneous preferences were unsuccessful and were subsequently reversed. This methodology, combining the life

satisfaction approach with geographically weighted regression techniques, is transferable to any location considering local government amalgamations.

5.1 Introduction

A substantial body of literature considers issues about the level at which government decisions should be made. Much of this literature considers the 'efficiency' or 'effectiveness' of local government, highlighting factors affecting local government's performance including the physical environment (topography, climate etc.), and the social, economic and demographic profile of constituents – all of which vary spatially (Dollery, Byrnes, & Crase, 2008). As such, discussions about which level of government (e.g. local, state or federal) should make decisions about which issues (e.g. taxes, roads, education) have an inextricable spatial element. Known as fiscal federalism or the subsidiarity principle (Oates, 1999), there is general agreement that decisions made about 'the composition and quality of local services should be decided by local councils' (Dollery et al., 2008 p.173), since decentralisation helps ensure that decisions reflect local preferences (Briffault, 1996), and since 'locals' may be better able to find innovative ways of servicing local needs (Oates, 1999) improving government accountability and effectiveness (Oates, 2005).

But that leaves open the fundamental question of how large/small should local councils be? Different methodological approaches have been adopted to consider this question, frequently focusing on efficiency gains and/or cost savings relating to the scale of local government (Callanan, Murphy, & Quinlivan, 2014; Marques, Kortt, & Dollery, 2015; Reingewertz, 2012). From the 20th century onwards, many countries have seen local government amalgamations including Australia, Canada, Great Britain, Germany, Ireland and Sweden (Callanan et al., 2014; Hinnerich, 2009). Amalgamation proposals are usually justified on cost savings grounds through economies of scale (Hinnerich, 2009; Reingewertz, 2012), or if more of any service can be provided at the same total cost, without a reduction of any other service (Tiebout, 1956). Other suggested benefits include economies of scope (Hinnerich, 2009), lower regulation costs by central government, improved accountability of local politicians and performance of local government staff (Reingewertz, 2012), and reduced spillovers of costs and benefits from one jurisdiction to another (Oates, 1999).

Dollery et al. (2008) argue that no theoretical foundations support the arguments for economies of scale in local government, and there is little empirical evidence of cost savings

from amalgamations (Byrnes & Dollery, 2002; Dollery et al., 2008; Hinnerich, 2009) or that larger councils are more efficient than smaller ones (Callanan et al., 2014; Marques et al., 2015). For example, whilst some efficiency gains have been found from amalgamating municipalities (Reingewertz, 2012), the opposite has also been found (Hinnerich, 2009). Additionally, many scale efficiency benefits can be gained without amalgamations (Arcelus, Arocena, Cabasés, & Pascual, 2015). Moreover, a range of potentially significant adverse effects may result from amalgamation, for example, amalgamation may require local governments to deal with constituents that have heterogeneous preferences and needs (Oates, 1999). This can hinder the performance of local government (Reingewertz, 2012), and generate significant electoral disquiet, that may require reversals in decisions about the placement of electoral boundaries (Newton-Farrelly, 2009).

Therefore, the likely homogeneity of resident preferences should be considered when setting electoral boundaries (Briffault, 1996; Oates, 1999, 2005), although that importance may differ contextually (Jenkins, 1998). (For example, such issues may be less important in densely populated urban centres than in geographically large, sparsely populated region (Rallings, Johnston, & Thrasher, 2004)). This study uses insights from the life satisfaction[31] (LS) literature to consider the homogeneity of resident preferences in a region that has seen recent changes, and the subsequent reversal of a subset of those changes, in electoral boundaries: the north-east coast of Queensland, Australia. Specifically, the aim of this research is to answer the following questions:

1) Are there spatial variations in the preferences of residents within a region; that is, do different features contribute differently to resident LS in different places?
2) Do observed differences (and similarities) in preferences relate to the electoral boundaries that existed before the round of local government amalgamations and subsequent reversal of some decisions?
3) Can the LS approach contribute an improved understanding of spatial variations in preferences thus informing discussion on local government electoral boundaries?

[31] The terms happiness, subjective well-being and life satisfaction are generally used interchangeably within the literature studying satisfaction with life overall. Here, the term life satisfaction (LS) is used throughout for consistency and simplicity.

5.2 Materials and methods

5.2.1 Case study area

The Wet Tropics, situated on the north-east coast of Queensland (Figure 10), encompasses some 894,420 hectares of mostly tropical rainforest, with a rich and unique biodiversity, recognised in 1988 as a World Heritage Area (UNESCO World Heritage Convention, 1988). At 630km, the distance between the most southern town (Townsville) and the most northern (Cooktown) is greater than the distance from London to Edinburgh (approx. 530km); so there are substantial variations in economic activity and environmental conditions within the region.

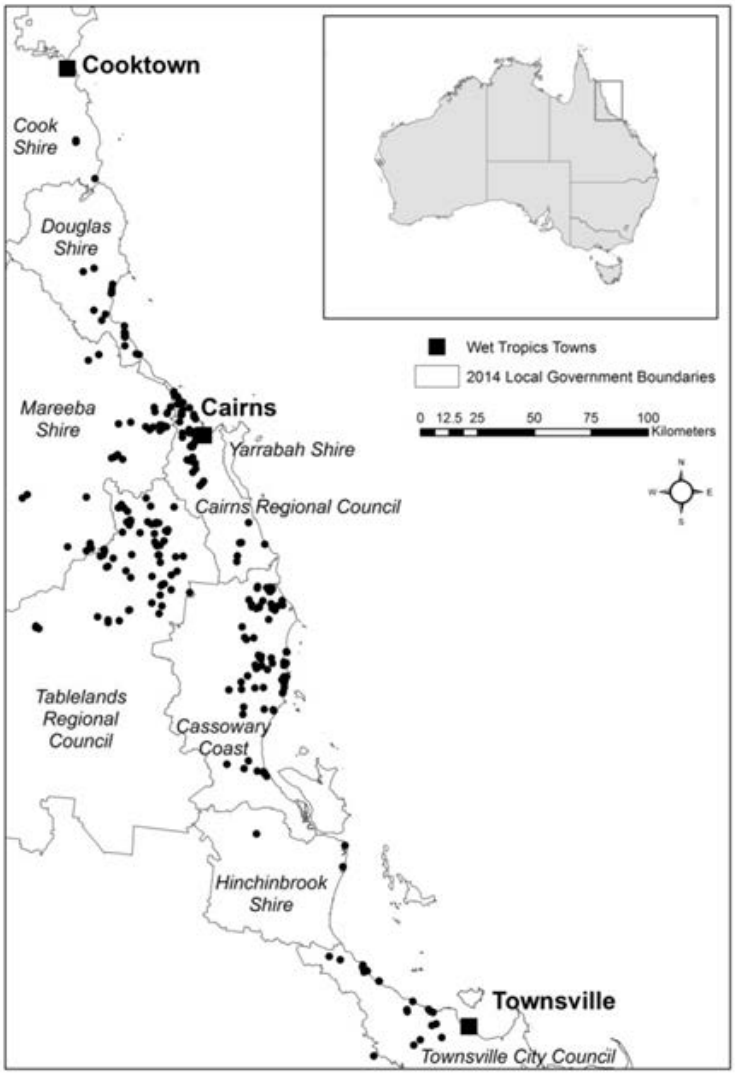


Figure 10 The study area showing current local government boundaries and survey respondent locations

In 2007, the State Government established an independent commission to consider local government boundaries based on a range of criteria including economies of scale, community of interest and financial sustainability. Across Queensland, the number of local councils was reduced from 156 to 72, Torres Strait Islander and Aboriginal councils were reduced from 32 to 14, with changes coming into effect during March 2008. The amalgamations relevant to the Wet Tropics, reducing the number of councils in the region from 13 to 7, are listed below:

1) The Shires of Cardwell and Johnstone were merged to form the Cassowary Coast Regional Council
2) The City of Townsville was merged with the City of Thuringowa to form the Townsville City Council
3) Cairns City Council and Douglas Shire Council were amalgamated to form the Cairns Regional Council
4) The Shires of Herberton, Atherton, Eacham and Mareeba were amalgamated to form the Tablelands Regional Council

The first two amalgamations were largely successful and those councils continue in operation today. However, 3 and 4 were unsuccessful with local voters lobbying for deamalgamation, effected from 1 January 2014. Cairns and Douglas Shire Councils were re-established as separate councils. Mareeba Shire Council was re-established whilst the Tablelands council remained comprising the three other shires (Atherton, Herberton, Eacham) from which it had been formed; thus establishing the 9 local governments in the region today. Maps showing the changing local government boundaries over time within this region are set out in Appendix 5.5.6.

This region is thus an ideal one in which to undertake such a study.

5.2.2 Relevant literature

5.2.2.1 Factors known to influence LS studies

At the risk of oversimplifying matters, many LS studies seek to assess how 'satisfied' people are with life as a whole and/or which factors contribute most/least to LS. Researchers interested in the latter aim to use cross-sectional or panel data to identify statistically significant relationships between LS and various explanatory factors (Layard, 2010). Different factors have been tested and found to influence LS, including demographic, economic, social and environmental variables; some studies have incorporated a long list of

independent variables whilst others have developed more concise models. A number of the most widely used factors are set out in Table 1.

One of the most studied LS relationships is that of income. The *income paradox* was identified by Easterlin (1973) noting that an individual experiencing an increase in income at one point in time, will report increased LS, but that a general rise in incomes over time across the country does not increase the LS of that country's population. Time series studies considering income growth and LS changes frequently fail to find any income/LS link. The human development literature offers one explanation for this paradox (others consider income of an individual relative to others): the marginal contribution of income to LS is high when people are poor but once basic needs are met social and/or environmental factors become increasingly important (Mellander et al., 2012).

Thus, factors from multiple domains (economic, social and environmental) should be included within explanations of LS (Larson, 2009; van Kamp et al., 2003). However, socioecological systems are complex and composed of non-linear, interdependent components. As such these factors may not 'enter' the LS as separable and additive components (Stoeckl, Farr, Larson, et al., 2014; Windle & Rolfe, 2005), some preliminary analysis of the relationship between variables is thus required before simply 'entering' as regressors. Moreover, to assess the relative importance of social, environmental and/or economic factors, it is important to control for other potentially confounding factors known to be associated with LS.

5.2.2.2 Indicators used to measure influential factors

To estimate a function that describes the relationship between LS and various economic, social, environmental and/or demographic factors, one needs to identify variables that can be used to measure those factors. One can use 'objective' indicators (e.g. 'hard facts' such as income earned), or 'subjective' indicators (e.g. people's stated satisfaction with income earned (Veenhoven, 2002)). In practice, economic factors have generally been measured objectively, whilst subjective measures are frequently preferred for social factors; within the environmental domain the findings regarding which measure is preferred are more mixed. One may need to use both objective and subjective indicators (Diener & Suh, 1997; Veenhoven, 2002), across a variety of domains, when modelling LS; else run the risk of biased results (Chasco & Le Gallo, 2013; Kataria et al., 2012). It may also be appropriate to weight (subjective) indicators (e.g. satisfaction with income or family relationships);

combining 'satisfaction with', and 'importance of', specified needs provides a single measurement representing the degree to which needs of varying priorities are being met (Costanza et al., 2007; Hsieh, 2003, 2012; Larson, 2010)[32].

For this research I evaluated both subjective and objective indicators, as shown in Table 24. However a potentially fruitful area of future research would be to investigate the relationships between the subjective variables from each domain, and objective measures from those same domains. Such research could be of great use to policy makers, as they are generally more able to influence the objective, rather than subjective, indicators[33].

5.2.2.3 The importance of space

It is clearly demonstrated that location specific factors (such as pollution and climate) impact LS (see also Morrison, 2011). People's satisfaction with the community in which they live (subtly different from satisfaction with life overall) also depends on numerous inter-related economic, social, environmental and aesthetic factors (Clark, 2003; Florida et al., 2013; Florida, Mellander, & Stolarick, 2011). But people's subjective satisfaction with those factors and/or the importance that people assign to them (as contributors to wellbeing or LS) are likely to vary across both time and space (Costanza et al., 2007), and this has important implications for researchers wishing to estimate LS functions.

Specifically, it suggests that merely including descriptors of location specific factors when assessing LS (a practice that is becoming increasingly common (Brereton et al., 2008; Ferreira & Moro, 2010; MacKerron & Mourato, 2009)), and then estimating a single (regression) equation for all, implicitly assumes that all factors contribute similarly to the LS of all individuals (equivalent to assuming all people have the same functional form and parameters in universal utility function). Some researchers have attempted to account for regional differences using, for example, multi-level statistical models (Ballas & Tranmer, 2012) or incorporating regional dummy variables (Clark, 2003; Morrison, 2011; Oswald & Wu, 2009) or dummy variables to indicate rural or urban location (Sørensen, 2014) within models. However, so far as I am aware, the only study to have specifically addressed the

[32] The original article on which this chapter is based discussed this matter in further detail, but this discussion has been edited to prevent unnecessary duplication. For a full discussion of the choice between subjective objective indicators, and the use of importance to weight satisfaction measures, please refer to section 2.6.2 of this thesis.

[33] This would be a non-trivial exercise requiring the gathering of an extensive data set of related objected and subjective indicators in addition to LS data. This could then be analysed using a two step process, determining how the objective indicators influenced the related subjective indicators, the predicted subjective indicators could then be used to estimate LS.

issue of spatial variation in the relationship between LS and explanatory variables was Stanca (2010), who investigated whether geographic proximity affected the relationships between unemployment, income and LS in different countries; investigations of the '… spatial dimensions of LS … [is a] somewhat neglected… [research topic]' (MacKerron, 2012, p. 725). Hence my geographic focus. However, whilst my research is investigating whether space is indeed an important factor, it does not attempt to answer the question of why space is important; this remains an important topic for future research.

5.2.3 Data collection and survey design

Insights from the literature (above), and feedback/input from the Wet Tropics Management Authority, were used to develop a questionnaire to collect data on people's overall LS, about their satisfaction with 27 different contributors to LS (Table 20) and their perceived importance of these factors to their overall LS as follows:

> *'The following question comprises two parts. First, tell us how important each of the following items are to your overall quality of life? Second, tell us how satisfied you are with each item?'*

Responses were recorded on a 5 point scale from 1 for very unimportant/very unsatisfied to 5 for very important/very satisfied[34].

Table 20 Benefits assessed in the questionnaire and groupings determined using principal components analysis

Benefiting either directly or indirectly from the jobs & incomes created by:	
The tourism industry	Economic/income
The mining industry	Economic/income
The agricultural industry	Economic/income
Other industry/sector (e.g. fishing, retail, education etc.)	Economic/income
Being able to access the rainforest via:	
Walking tracks &/or dirt roads	Economic/income
Bitumen roads & bridges	Economic/income
Rail/Skyrail	Economic/income
Being able to:	
Learn more about a unique & ancient Australian environment	Culture
Hear from Aboriginal people about their sense of place (culture & country)	Culture
Go on rainforest walks	Environment Use
Visit Waterfalls &/or swim in clear, clean rivers/stream/waterfalls	Environment Use

[34] In addition to analysis based on actual responses to the questions, a separate analysis was conducted based, for each respondent, on their response to each question relative to their response to other questions. This analysis was designed to detect whether any respondents were systematically scoring every question high or low. Comparing the results from this 'relative response' analysis to the results from the analysis presented here, a greater number of PCA groupings were found and the explanatory power of the regression models were less; however the key findings were similar in that (1) society was the more important domain and economic/income domain the least and (2) notable spatial patterns in the influence of the different domains were found. The results of the 'relative responses' analysis, is set out in 5.5.5.

See Iconic species in the wild (e.g. cassowary, kangaroos, riffle birds, etc.)	Environment Use
Relax and/or reflect in a natural environment	Environment Use
Enjoy uncrowded camping & picnic areas	Environment Use
Enjoy the scenic beauty & peacefulness of the rainforest (sights, sounds & smell)	Environment Use
Having:	
Healthy native plants & animals (e.g free from diseases, pests & weeds)	Environment Non use
Beautiful undeveloped scenery to look at	Environment Non use
Two world heritage sites side by side (i.e. the WTWHA and the GBRWHA)	Environment Non use
Protecting:	
Places that have Aboriginal cultural values	Environment Non use
Places that have other cultural values (e.g. European/Asian)	Environment Non use
The WTWHA, either for its own sake or for future generations (even if you have never been there & never plan to go)	Environment Non use
Being able to:	
Spend time with friends & family	Society
Enjoy city entertainment (e.g. spending time in cafes, museums, etc.)	Society
Have some 'control' over what is happening in your life	Society
Join in community activities (e.g. attend cultural/environmental festivals)	Society
Knowing that:	
Friends & family are healthy and safe	Society
Good quality roads, hospitals, schools etc. are there if need be	Culture

The questionnaire was pre-tested amongst colleagues, in workshops and in a pilot study (to 100 residents living within, or adjacent to, the region), with questions being refined at each stage before the survey was finalised and formal data collection commenced. As survey respondents have been found to be highly sensitive to the order in which questions are presented, particularly if asked to evaluate a long list of items (Cai et al., 2011; Lasorsa, 2003), 24 different versions were produced where the questions about the 'importance of', and 'satisfaction with', various benefits were presented in a different order[35].

Data were collected from residents of the region (Figure 10) using a mail out of self-completing questionnaires. The surveys were posted to a geographically stratified randomly selected sample of households from 33 postcodes that lay either partially or entirely within the WTWHA[36].

5.2.4 Analytical techniques

I hypothesised that LS can be explained by a model of the form:

$$LS_i = f\,(X_i, Y_i, E_i, S_i, R_i)$$

[35] Dummy variables representing different orders that the questions were asked were incorporated within an enlarged form of the global OLS model; these dummy variables were not significant; thus question order does not appear to have influenced our analysis. Results are set out in 5.5.1.

[36] A similar number of each type of questionnaire (i.e. with benefits presented in different orders) were sent to each postcode, ensuring that the order of the questions did not influence results.

Where LS for each individual *i* (LS_i) is affected by numerous factors, including demographic (X_i), economic/income (Y_i), environmental (E_i) and social (Si) factors, plus geographic/spatial factors relating to the specific region where the individual lives (Ri).

As noted earlier, there is much potential overlap between factors (examples focusing on the environment include Stoeckl, Farr, Larson, et al., 2014; Windle & Rolfe, 2005); the implication being that one needs to test for relationships/overlap before simply entering each factor as a separate contributor to LS. Principal Components Analysis (PCA) is frequently used prior to regression analysis, as it identifies if there are any variables with significant correlations to one another, and capture any multicollinearity found between the variables. PCA firstly calculates the amount of variability between the explanatory variables, which prevents variables with similar properties from being incorporated into the model as this could cause bias. The variables are then entered into a rotated component matrix which identifies clusters of variables that can be combined to create new variables. This allows for a reduction in variables leading to a more parsimonious model. I thus used PCA with Varimax rotation and Kaiser normalization to check for separability between the factors listed in Table 20. I did this several times, looking at responses to the questions relating to:

1) Satisfaction;
2) Importance;
3) Satisfaction weighted by importance (the satisfaction score multiplied by the importance score);
4) Satisfaction weighted by a dummy variable indicating whether the benefit was important (responses of very important or important coded 1, other responses to importance question coded 0, calculated as satisfaction score multiplied by importance dummy).

The factor loadings were similar across approaches, so I selected approach 4 (loadings are shown in Table 21)[37]. This has the most theoretical appeal because, simplistically, it is as if the importance dummy indicates presence or absence of a particular factor within an individual's utility function, and the satisfaction score tells one how much utility is derived from the factor. So this captures both presence and weight. The groups associated with this formulation also make intuitive sense[38]. I used the clustered variables identified by the PCA

[37] Factor scores from the other PCA are set out in section 5.5.5.
[38] PCA groups of factors, being purely based on correlations, can generate factors that do not intuitively make sense; thus it is important if we are to use results for policy analysis to ensure that the make logical sense in addition to statistically satisfying specified critea.

results to generate a new overarching variable for each domain; the mean level of satisfaction associated with each of the variables found to be within each group (identified in the right hand column of Table 20)[39][40].

Table 21 Factor scores from principal components analysis for satisfaction score multiplied by importance dummy

Economic/Income	Culture	Environment Use	Environment Non use	Society
Mean score for Satisfaction x Importance Dummy (minimum = 0, maximum = 5 for all groupings)				
2.814	2.983	3.659	3.205	3.758
Benefiting from the tourism industry (.642)	Being able to learn more about a unique & ancient Australian environment (.681)	Being able to go on rainforest walks (.685)	Having healthy native plants & animals (e.g free from diseases, pests & weeds) (.593)	Being able to spend time with friends & family (.571)
Benefiting from the mining industry (.726)	Being able to hear from Aboriginal people about their sense of place (culture & country) (.745)	Being able to visit Waterfalls &/or swim in clear, clean rivers/stream/waterfalls (.790)	Having beautiful undeveloped scenery to look at (.563)	Being able to enjoy city entertainment (e.g. spending time in cafes, museums, etc.) (.626)
Benefiting from the agricultural industry (.720)	Knowing that good quality roads, hospitals, schools etc. are there if need be (.469)	Being able to see Iconic species in the wild (e.g. cassowary, kangaroos, riffle birds, etc.) (.742)	Having two world heritage sites side by side (i.e. the WTWHA and the GBRWHA) (.607)	Being able to have some 'control' over what is happening in your life (.675)
Benefiting from other industry/sector (e.g. fishing, retail, education etc.) (.730)		Being able to relax and/or reflect in a natural environment (.789)	Protecting places that have Aboriginal cultural values (.693)	Being able to join in community activities (e.g. attend cultural/environmental festivals) (.654)
Able to access via walking tracks &/or dirt roads (.612)		Being able to enjoy uncrowded camping & picnic areas (.669)	Protecting places that have other cultural values (e.g. European/Asian) (.654)	Knowing that friends & family are healthy and safe (.672)
Able to access via bitumen roads & bridges (.590)		Being able to enjoy the scenic beauty & peacefulness of the rainforest (sights, sounds & smell) (.765)	Protecting the WTWHA, either for its own sake or for future generations (even if you have never been there & never plan to go) (.671)	

[39] The regressions using approach four also outperformed regressions using similarly constructed composite variables from the other approaches (in terms of goodness of fit).

[40] The groupings categories resulted from the PCA. I have given the groupings names that seemed to be generally appropriate; however the name itself is irrelevant to the analysis. Thus, whilst some of the benefits classified as non-use could be argued to also have a use component, the PCA analysis has demonstrated that these factors are separable from those others classed as having use value. For example, having healthy native plants and animals have important non-use component – for both bequest and option purposes we need plants to remain healthy. Likewise with "having beautiful undeveloped scenery to look at" – the undeveloped concept implies this is a bequest for the future.

Economic/Income	Culture	Environment Use	Environment Non use	Society
Able to access via rail/Skyrail (.495)				

The addresses of these respondents were matched with the Queensland Atlas information service provided by the Queensland Government[41], enabling each property, and the related survey responses, to be accurately mapped on the Queensland Cadastre. I used the Koenker BP test to check for the presence of spatial non-stationarity between explanatory variables and the dependent variable. It was present[42] suggesting that GWR is an appropriate estimation technique (Bateman et al., 2002; Stanca, 2010). I used the Global Moran's I test to check for spatial autocorrelation. It was absent[43], indicating that no important spatial variations were omitted. I conducted the Wu-Hausman (J. A. Hausman, 1978; D.-M. Wu, 1973) and Durbin (Durbin, 1954) tests for endogeneity[44] (a common problem in LS studies (Kountouris & Remoundou, 2011; Luechinger, 2009)), finding no evidence of its presence. There was thus no need to control for it, with, for example, instrumental variables.

The AIC method was used to determine the extent of the kernel (the optimal distance or number of neighbours) to be used within the GWR and results were grouped into regional areas to more clearly demonstrate spatial patterns. When determining these groups, I considered sample size: if there were few respondents in an area, it was reclassified into the nearest larger group. In the end, each region (Far North, Cairns, Tablelands, Cassowary Coast and Townsville) included between 9% and 32% of the sample, and no group was so small that an outlying response could significantly distort the average for the region. Whilst sample sizes for individual regions are fairly small, the GWR approach utilises all of the observations within the whole database as part of the estimation process, thus results are not unreliable because of small sample sizes[45] provided the overall sample size is sufficient (as it is here). The significance of spatial variations in coefficients across regions was confirmed

[41] http://qspatial.information.qld.gov.au/IQAtlas/
[42] The Koenker BP Statistic was 19.02, significant at 1% level.
[43] The Global Moran's I test value was .004, not significant even at 25% level.
[44] Details of test results and instrumental variables are discussed in 5.5.2.
[45] If an alternate approach had been adopted of using OLS to estimate a separate model for each region then each separate regression would have only used the sample data for that specific region, and may have resulted in unreliable results due to small sample sizes (particularly with regard to the Townsville sample of 27). The use of GWR reduces this problem.

by the use of Tukey Post Hoc tests[46]; they were statistically significant (at the 1% level) for satisfaction with Economy/Income, Environment Use and Society, for each region.

5.3 Results

Of 2,000 surveys distributed, 386 completed questionnaires were received, an overall response rate of 24.8% (after adjusting for 447 surveys that were 'returned to sender'). Of these responses, 292 (75.6%) answered all of the questions relevant to this study; incomplete responses were excluded. Their location can be seen from the map (Figure 10).

The final set of variables explaining variations in overall LS are shown in Table 22; information on the responses to individual questions that were 'grouped' using PCA is shown in Figure 11[47].

Table 22 Descriptive statistics for explanatory variables

Variable	Mean (or proportion if dummy variable)	Std. Dev.	Skew	Kurtosis
Age: expressed in years	55.09	12.77	-0.09	-0.45
Married (Dummy variable set to 1 if married or in legal partnership, otherwise 0)	0.80	0.40	a	A
Year 12 or higher (Dummy variable set to 1 if completed year 12 at high school or higher, otherwise 0)	0.76	0.43	a	a
Mean Satisfaction Economic/Income Grouping	3.28	0.74	0.00	0.50
Mean Satisfaction Environment Use Grouping	3.88	0.76	-0.50	0.42
Mean Satisfaction Society Grouping	3.83	0.61	-0.48	1.30

a: skew and kurtosis are not relevant for categorical data n = 292

[46] Post hoc tests that do not assume equal variances were also tested (Tamhane's T2, Dunnett's T3, Games-Howell, Dunnett's C tests); all results were the same as the Tukey test results other than the satisfaction with environment use variable, where all regions were significantly different from each other at 1% level other than the regions at the extreme south and north, Townsville and Far North.

[47] Frequencies of responses to the other satisfaction questions are set out in 5.5.3 and frequency of responses to importance questions are set out in 5.5.4.

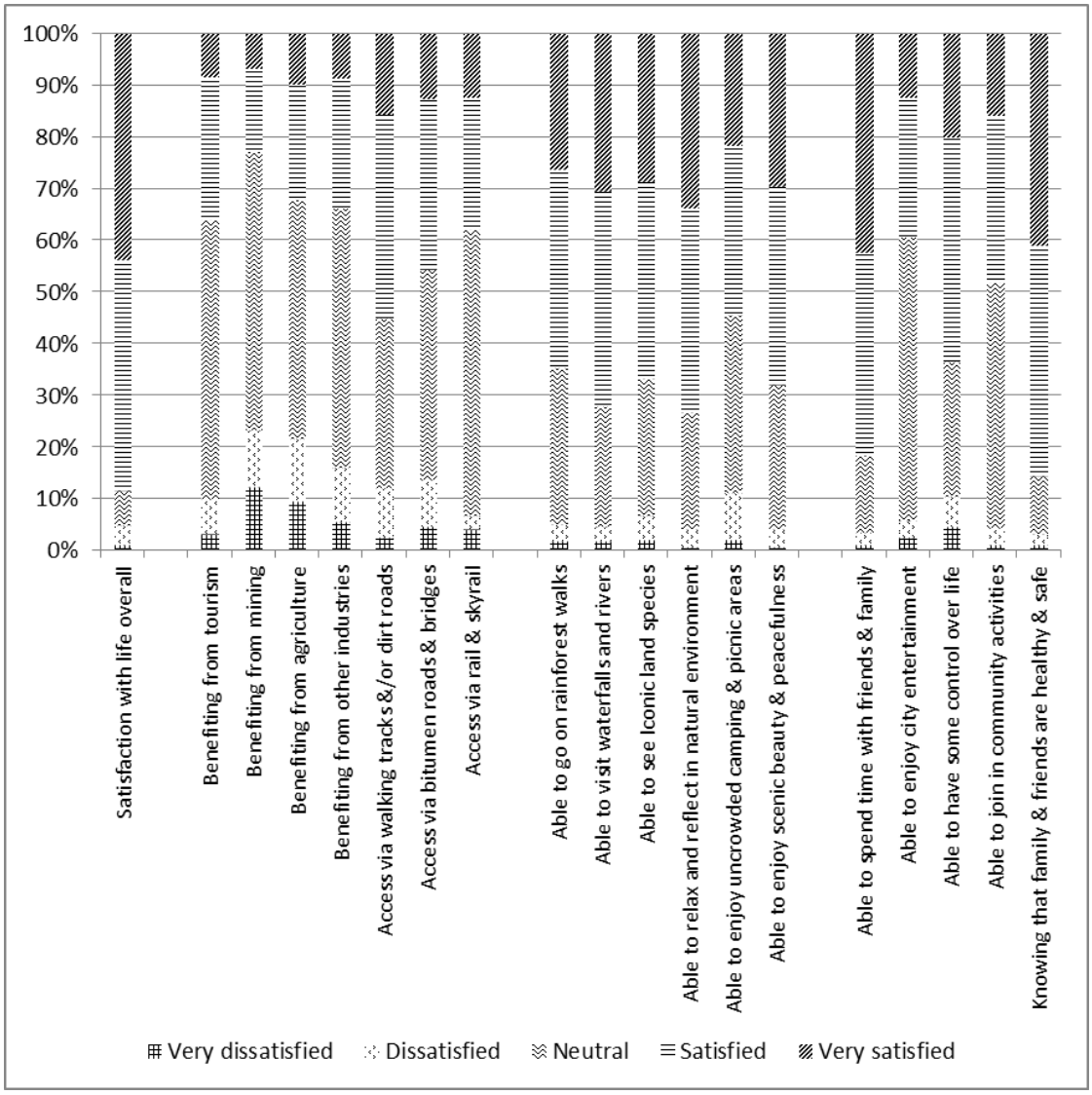


Figure 11 Frequency of responses for satisfaction with life overall and for satisfaction with variables within Economic/income, Environment use and Society groupings

The regression results (Table 23) were obtained after a series of estimations starting from a specification that included all potential variables within one equation (set out in Table 24). Insignificant variables that did not contribute to the explanatory power of the model were gradually dropped; however, insignificant control variables that improved the explanatory power of the model were retained[48]. Comparing the model fit statistics overall for the GWR model with those of the global OLS model, we found a higher adjusted R^2 statistic (0.1333 and 0.116 respectively) and a lower AIC (688.73 and 690.57 respectively). Evidently, the

[48] Initially I adopted the same process as used within my other papers, of gradually dropping insignificant variables from the regression using 5% significance as the cut off level for determining whether a variable should be included or excluded. However, for this dataset, this process resulted in only explanatory variable remaining, that of satisfaction with society. This model would not have allowed me to explore the relative importance of the three domains across the region. Hence an alternate approach based on the overall F-test for the joint significance of the variables was used: if the inclusion of the variable increased the joint significance of all the variables using the F test then the variable was retained.

GWR models provide better goodness of fit (than the global OLS model), further confirming the existence of spatial variation and the appropriateness of this technique.

Table 23 Summary of GWR and OLS regression results

	Far North	Cairns	Tablelands	Cassowary Coast	Townsville	Global OLS
Sample size	40	41	92	92	27	292
Intercept	-0.695 * (0.508)	-0.719 * (0.456)	-0.821 ** (0.450)	-1.026 *** (0.455)	-0.462 (0.691)	-0.680 ** (0.412)
Age	-0.002 (0.005)	-0.002 (0.004)	-0.001 (0.004)	0.000 (0.004)	0.001 (0.006)	-0.001 (0.004)
Marital Dummy	0.168 * (0.136)	0.084 (0.123)	0.049 (0.122)	0.038 (0.125)	0.164 (0.205)	0.129 (0.115)
Yr 12 Education Dummy	-0.240 ** (0.132)	-0.155 * (0.119)	-0.121 (0.118)	-0.072 (0.118)	-0.050 (0.182)	-0.155 * (0.109)
Satisfaction Economic /Income	0.046 (0.083)	0.061 (0.075)	0.066 (0.074)	0.093 * (0.075)	0.148 * (0.122)	0.075 (0.069)
Satisfaction Environment Use	0.059 (0.084)	0.141 ** (0.077)	0.184 *** (0.076)	0.211 **** (0.078)	0.013 (0.130)	0.107 ** (0.072)
Satisfaction Society	0.452 **** (0.108)	0.362 **** (0.095)	0.331 **** (0.093)	0.308 **** (0.095)	0.271 ** (0.141)	0.355 **** (0.088)
Local R^2	0.158	0.144	0.151	0.163	0.098	

Significant at: * 25% level ** 10% level *** 5% level **** 1% level; standard errors shown in brackets.

The results presented in Table 23 include a 25% significance level in addition to the normally presented levels of 1%, 5% and 10% significance. This has been included to aid the readers understanding of the result, for example, making it clear that although the impact of economic/income factors is not particularly significant anywhere, it is more significant in the southern part of the region compared to the north where it is not even significant at the 25% level.

Table 24 List of potential explanatory variables tested within the model

Category	Objective	Subjective
Demographic	Age and age squared Gender Marital status Educated to year 12 or above Educated at university or above How many adults/children live with you Born in Australia Born in Queensland Indigenous	
Economic	Income and Ln Income Various sources of household income (denoted by dummy variables for different industries) Unemployment rate in region where live Concentration of different industry sectors in region where	Responses to various survey questions concerning importance & satisfaction in Table 20

Category	Objective	Subjective
	live Relative socio-economic index for region where live % households in poverty for region where live Average income in region where live Death rates in region where live	
Environment	Rainfall in previous year – mm, number of days of rain, number days of intense (>100mm) rain, number of days no rain Total suspended sediment load in river closest to where live Dissolved inorganic nitrogen in river closest to where live Water turbidity in GBR lagoon closest to where live Vegetation type where live Soil type where live Estimates of species richness for birds, reptiles, amphibians and mammals in region where live	Responses to various survey questions concerning importance & satisfaction in Table 20.
Social	Crimes per head in region where live Remoteness indicator for region where live (dummy variables denoting very remote, remote, outer regional, inner regional)	Responses to various survey questions concerning importance & satisfaction in Table 20.

The model, levels of significance, and coefficients varied, with distinct north – central - south patterns apparent, for both the control (demographic) factors and the variables representing subjective assessments of satisfaction with the economy, environment use and society.

Considering the control variables, only education was found to be statistically significant in the global model, however including age and marital status as control factors improved the explanatory power (R^2) of GWR and OLS models, and reduced the AIC. [49]

- Age was not significant in any region, failing to confirm the findings of previous research (Ambrey & Fleming, 2014d; MacKerron & Mourato, 2009).
- Married respondents who lived in the most Northern part of the region reported higher levels of LS than others; consistent with previous findings that marriage positively affects LS (Helliwell, 2003; MacKerron & Mourato, 2009).
- Respondents who had completed year 12 education or above had lower LS than those who were less educated (in the Far North, Cairns and in the global model). Whilst some studies have found a positive relationship between education and LS (Frey & Stutzer, 2000; Helliwell, 2003) when researchers control for income effects (as here), education has frequently been found to have an insignificant or negative effect (Diener et al., 1999),

[49] Furthermore, the inclusion of age, marital status and education levels as variables, and finding their insignificance (that they are thus not correlated with the dependent variable, LS), means that the apparent sample bias towards older, married and more educated persons identified earlier within section 2.5 will not bias my results here.

possibly due to education raising aspirations to a level that cannot be met (Diener et al., 1999). Additionally, it has been found that education has a more significantly positive impact on LS for residents of metropolitan as opposed to rural areas (Florida et al., 2013), which may also help explain the negative/insignificant relationship found within this study region located far from any major metropolis.

The coefficients defining the relationships between Economic/income, Environment use and Society factors with LS are shown in Figure 12. The overarching variable representing Satisfaction with Economic/Income factors was found to contribute relatively less to overall LS in the north than in the south: indeed it is only a significant contributor to overall LS in the two most southerly regions of Cassowary Coast and Townsville; as shown in Figure 12. The mildly significant to insignificant relationship between the proxy for income and LS supports earlier findings of a negligible or barely significant relationship (Oswald, 1997).

The overarching variable representing Satisfaction with Environment Use was found to be significant overall, and particularly significant within the central section of the region. It was insignificant in both the Far North and the most southerly region of Townsville; Figure 12 clearly shows a similar spatial variation in the value of the coefficient. These findings support those of earlier studies that have found that environmental quality affects LS (Ambrey & Fleming, 2011; Brereton et al., 2008).

The overarching variable representing Satisfaction with Society was highly significant overall and within each region; the level of significance increasing from south to north, as does the coefficient values (see Figure 12). These results support previous findings that social factors are important LS influencers (Inglehart et al., 2008; Myers & Diener, 1995).

From examining the coefficients on the variables for the three domains of life, it seems that society has the greatest impact on LS; the environment also has a noticeably greater impact than the economy/income. These findings strongly support the discussions summarised earlier, that once survival can be taken for granted, improvements in non-economic aspects of life, particularly social, may make a more significant contribution to LS than income (Inglehart, 1997; Inglehart et al., 2008; Mellander et al., 2012; Sen, 1999).

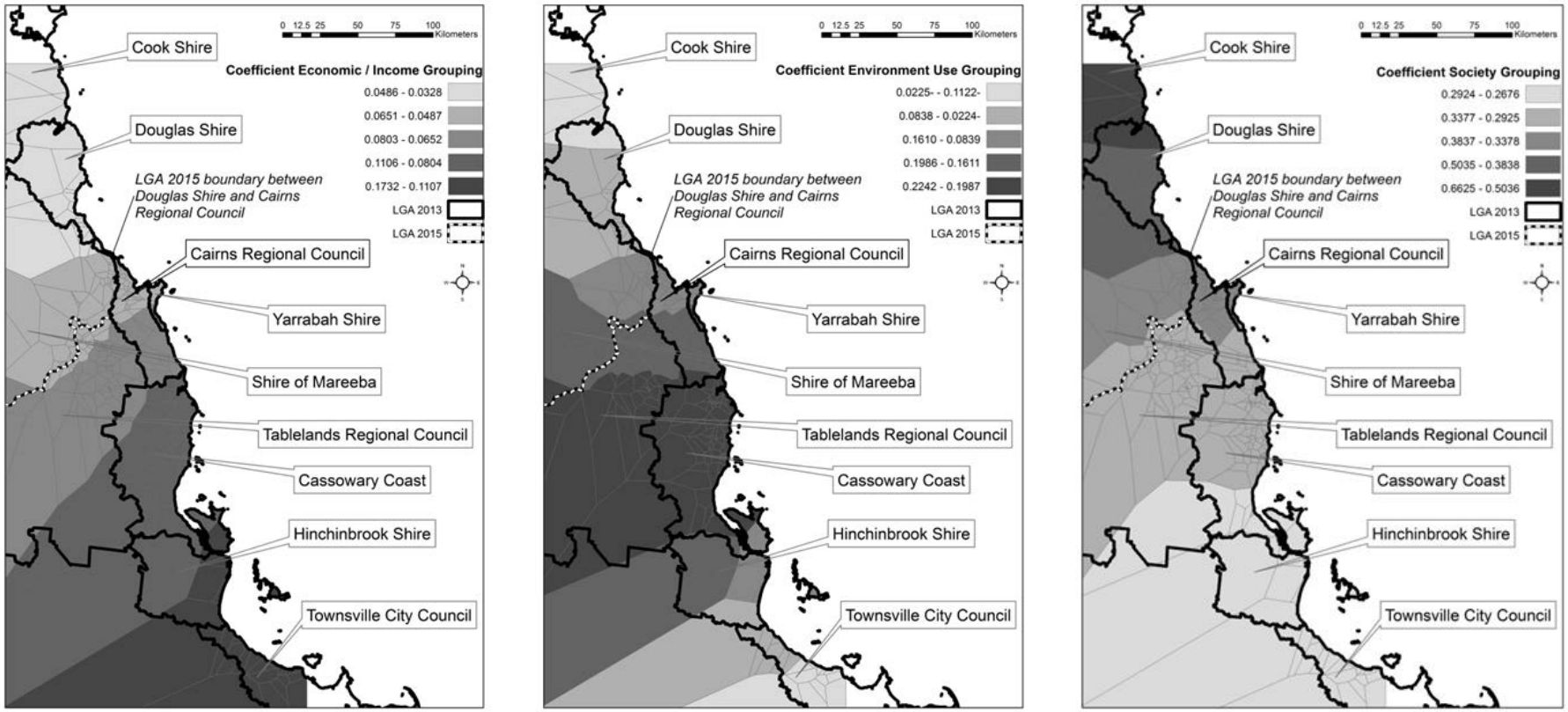


Figure 12 **Coefficients of variable indicating satisfaction with Economy/income (Panel a), Environment use (Panel b) and Society (Panel c)**

5.4 Discussion and conclusions

This study aimed to address three specific questions.

Firstly, I sought to establish whether there are spatial variations in the preferences of residents within a region; that is, do different features contribute differently to resident LS in different places? This question was prompted by the theory that the law of one price (whereby arbitrage ensures that goods sell for the same price in all locations (Gans et al., 2009)) may also apply to LS. As Tiebout (1956) explains, a (rational) individual (with perfect information) will choose to live in (or move to) the community which best satisfies his own personal preferences for public goods and community services. In this context, 'moving or failing to move [replaces] the usual market test of willingness to buy a good' (Tiebout, 1956 p.420). A region with inherent negative characteristics (such as a harsh climate) may thus have to offer compensating benefits to persuade people to move to, or stay, in the region (Oswald & Wu, 2010) and evidence has shown that both local taxes and local services affect location decisions and migration patterns (Dowding et al., 1994). However this compensating differentials theory is not proved for all factors, for example, the negative impact of commuting time on LS has been found not to be fully compensated for by other factors (Stutzer & Frey, 2008).

My findings have demonstrated that, even within a relatively small region, significant differences can be found between the factors influencing LS; thus there are significant variations in the preferences of residents. Whilst social factors generally had the strongest impact across the region, the second strongest influencer could be either environmental or income dependent on location. Overall, income was the least important domain, with society (comprising factors such as being able to spend time with family and friends, knowing they are safe, and feeling in control of your life) being far more important to overall LS, as theory has suggested would be the case for a region of a developed, affluent country. Having demonstrated that space is an important influence on happiness, this prompts a future research topic: why is this the case? Future research (which would be a non-trivial exercise: the determination of cause and effect is likely to require data regarding LS and the many possible explanatory factors gathered over both space and time and analysed using panel data techniques, and may also involve both qualitative and quantitative elements) is required to answer this important question.

My second task was to determine whether variations in preferences corresponded to the electoral boundaries that existed prior to the local government amalgamations and subsequent reversals of some decisions. Considering the boundary changes discussed in section 6.2, it becomes apparent that those amalgamations that were successful comprised combinations of regions with fairly homogenous preferences whilst the unsuccessful amalgamations tried to combine residents with very different preferences. The maps in Figure 11 utilise the different coefficients estimated by the GWR technique for each survey respondent in the region to clearly show in graphical form the results of the statistical analysis.

Considering the failed amalgamation of Cairns and Douglas Shire Councils, it can be seen from Figure 12 that the Economic/Income domain and the Environment Use domain are relatively more important to the residents of Cairns, whilst the Society domain is clearly more important to the residents of Douglas Shire. Coefficients for society variable towards the north of Douglas Shire are around 1.5 times the size of those towards the south of Cairns Council (ranging from 0.5 in the north to 0.34 in the south), with the converse being true for the Economy/income (range 0.04 to 0.07) and the most extreme difference, of 1600%, being seen in the Environment use variable (ranging from 0.01 to 0.17). Similarly, considering the failed amalgamation of Mareeba with the other Tablelands Shire Councils, it can be seen from Figure 12 that the Economic/Income domain (coefficients range from 0.05 to 0.07) and the Environment Use domain (coefficients range from 0.08 to 0.22) are relatively more important to the residents remaining within the Tablelands Council, whilst the Society domain is more important to the residents of Mareeba Shire than to the rest of the Tablelands (coefficients range from 0.3 to 0.42); the most significant of these differences relating to the environment use variable with a percentage difference of 175%.

Conversely, when considering the successful amalgamation that formed Cassowary Coast council, Figure 12 reveals that the residents of the combined council have fairly homogenous preferences (coefficients for Economy/income varied from 0.06 to 0.11, for Environment use from 0.14 to 0.22 and for Society from 0.29 to 0.36; far smaller than the differences between Cairns/Port Douglas and Mareeba/Tablelands, particularly with regard to the Environment Use variable). The standard deviation around the mean factor coefficient for each of Economy/income, Environment use and Society are very small for the Cassawary Coast region, representing 8%, 3% and 3% of the mean respectively. The combined Cairns/Port Douglas and combined Tablelands/ Mareeba regions were similar for Economy/income but much larger for the other factors, demonstrating the wide diversity of factor importance

within those regions. E.g. For environment use, the standard deviation as a % of mean was over 4 times higher in Tablelands/Mareeba and more than twice as high in Cairns/Port Douglas, as it was seen in the Cassawary Coast. Thus, spatial variations in preferences can be related to the local government boundaries within the region, providing clear indications why some of the 2008 amalgamations were successful whilst others were subsequently reversed.

Finally I sought to investigate whether using the LS approach to gain an improved understanding of spatial variations in preferences could inform discussions on local government boundaries. Again my findings are affirmative; if this analysis had been prepared prior to finalising amalgamations it could have assisted with preventing unsuccessful amalgamations that needed to be reversed at a later date.

In summary, there are clear spatial variations in the relative importance of the different domains in explaining LS. What makes you happy does indeed depend on where you live. Gaining an understanding of these spatial variations prior to redrawing electoral boundaries or amalgamating existing electorates could provide clear benefits.

5.5 Appendix to Chapter 5

5.5.1 Testing to determine whether question order influences results

Tests were conducted to determine whether the order that the questions were posed to the survey respondents appeared to impact the responses that were given. Four dummy variables were created, each representing the type of questions that were asked first within the section of the questionnaire regarding satisfaction with community benefits. The full list of benefits are set out in Table 18. The dummy variables used were as follows:

- D1 – The questions regarding satisfaction with the benefits received from different industries, and being directly able to access the rainforest, were asked first
- D2 – The questions regarding satisfaction with your opportunities for participating in activities learning about the environment, hearing from aboriginal people, go on walks and visit waterfalls etc., were asked first
- D3 – The questions regarding having healthy native plants and animals, beautiful undeveloped scenery etc., and protecting places that have cultural values and the WTWHA were asked first

- D4 – The questions regarding social features such as being able to spend time with family and friends and knowing family and friends are healthy and safe were asked first.

The OLS regression analysis, using the final variables as set out in Table 21, was then repeated including these dummy variables. Four regression analysis were completed, in each case including three of the dummy variables and excluding the remaining. Should any of the dummy variables have been significant in the regressions then this would indicate that the order of the question does influence the response given. However, in all cases all of the dummy variables were insignificant; even the least insignificant dummy failed to be significant at the 25% significance level.

Thus for this dataset the order that the questions were asked did not appear to have any impact on the responses given, and thus have not introduced any bias into the results.

5.5.2 Testing for evidence of endogeneity within the LS Model

If endogeneity is present the problem can be resolved by using one or more instrumental variables (IVs). If the explanatory variables are exogenous, then estimating the model directly (rather than using IVs) will be more efficient; thus the IV should only be used if truly needed.

A model can be tested for endogeneity using a number of different tests, of which the most widely known are the Durbin test (Durbin, 1954) and the Wu-Hausman test (Hausman, 1978; Wu, 1973). To conduct these tests potential Instrumental Variables (IVs) are identified, and used within a two stage least squares regression process. In both tests, the null hypothesis is that the variables are exogenous; if a significant result is found the null hypothesis is rejected, the implication being that endogeneity is present. I thus looked for IVs and conducted both the Durbin and Wu-Hausman tests for endogeneity. I also considered an alternate approach based on insights from Hausman (1978). In this paper he formally demonstrated that for large samples the probability limit of the covariance of X and ε approaches zero if X is exogenous; therefore the null hypothesis here is that X is exogenous. Thus, I saved the residuals from the GWR regression and tested the statistical significance of the correlation between the saved residuals and the potentially endogenous variables.

The potential endogenous variables within the model explaining overall satisfaction with life are the three variables representing the respondent's satisfaction with economic/income

factors, environment use factors and societal factors. A suitable IV needs to be highly correlated with the potentially endogenous variable, but not with the dependent variable. Thus bivariate correlation tests were conducted on a wide range of variables, and a number of suitable IVs were selected. These were: number of times spent driving along scenic routes per annum (significant with economy/income), crimes per 1000 population, how often per annum do you go camping, how often do you spend enjoying scenic beauty per annum (significant with environment), and how often did you go mountain biking per annum, how often did you pay for a tour per annum (significant with society).

Testing for endogeneity using Durbin and Wu-Hausman tests: Endogeneity tests were conducted using the IVs identified above, considering each potential endogenous variable separately, and then considering all potentially endogenous variables together. The results of these endogeneity tests in all cases were insignificant, and thus providing no evidence that the null hypothesis should be rejected. Evidently endogeneity is not present.

Testing for endogeneity based on insights from Hausman (1978): The residuals from the GWR model developed and set out in Table 21 were tested for correlation with the potentially endogenous variables, the income of the respondent, and the respondent's satisfaction with non-use values. In both instances the correlation was insignificant, thus failing to provide any evidence that the null hypothesis of exogeneity should be rejected.

Overall, multiple lines of evidence (the formal Durbin test, the Wu-Hausman test, and the correlation between independent variable and the error term) suggest that endogeneity is not present. Regression models will thus be more efficient if IVs are not used.

5.5.3 Frequency of responses for satisfaction with variables not included within the Economic/income, Environment use and Society groupings

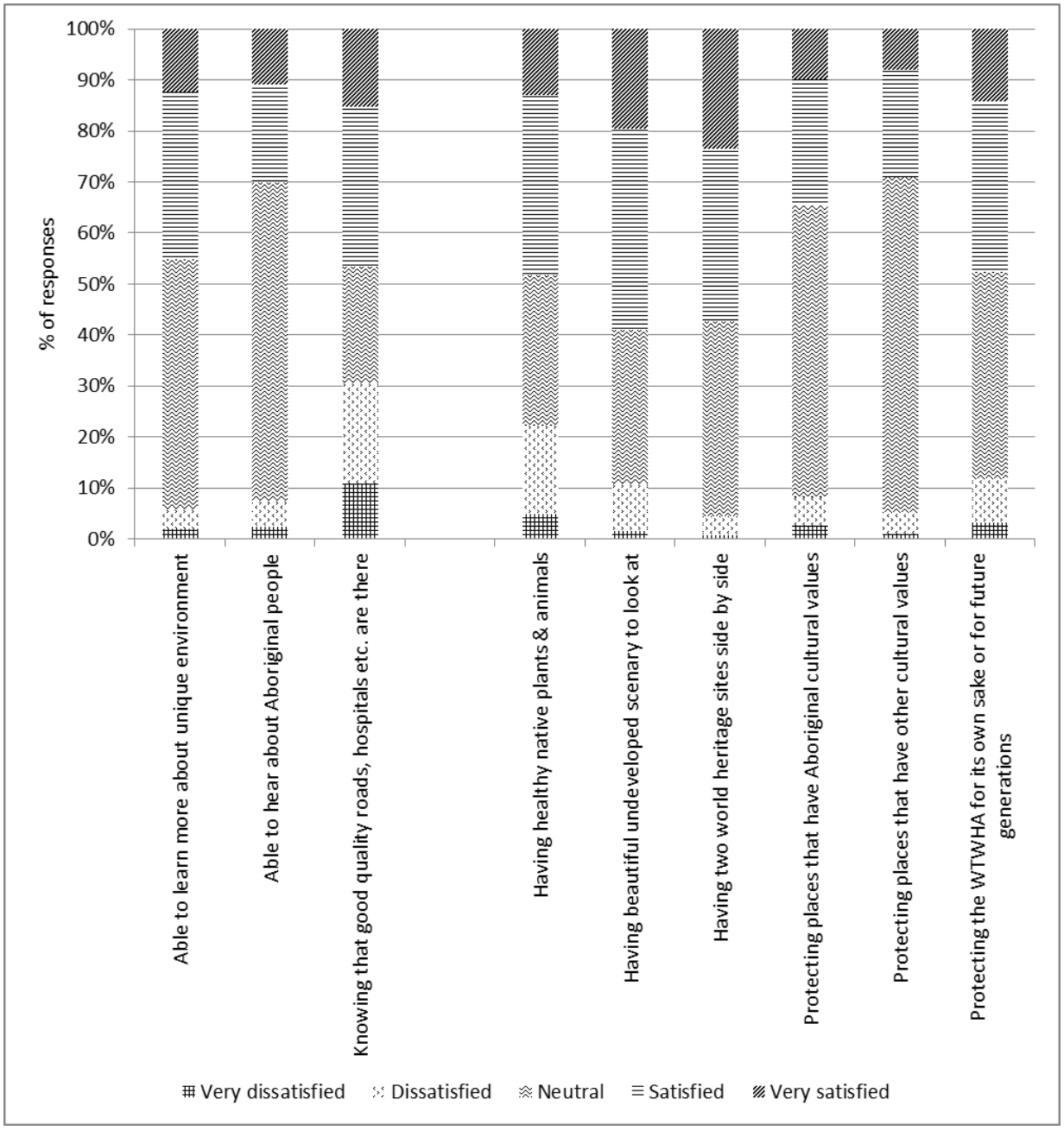


Figure 13 Frequency of responses for satisfaction with variables not included within Economic/income, Environment use and Society groupings

5.5.4 Frequency of responses for importance of different factors

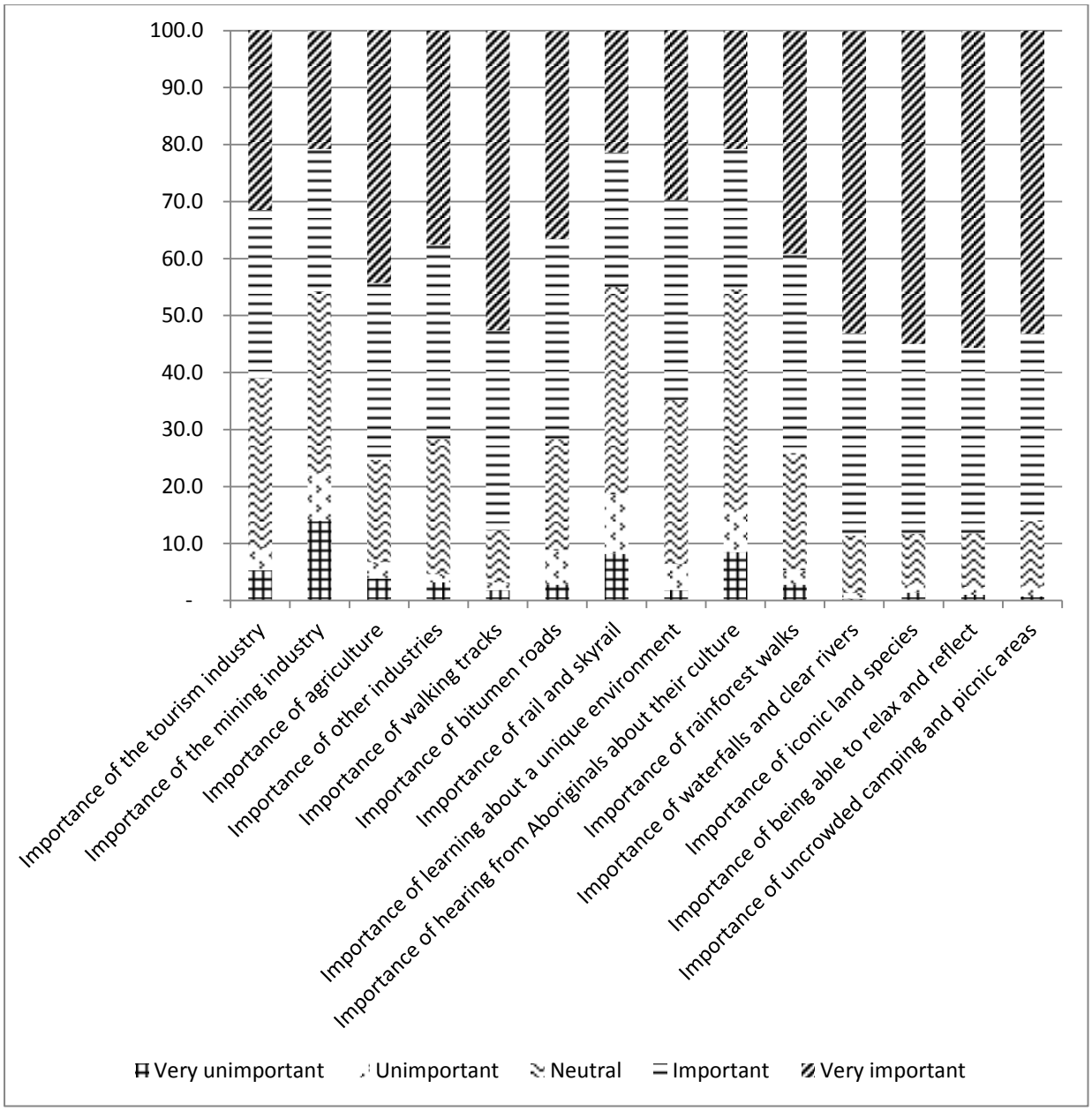


Figure 14 Frequency of responses for importance of various factors

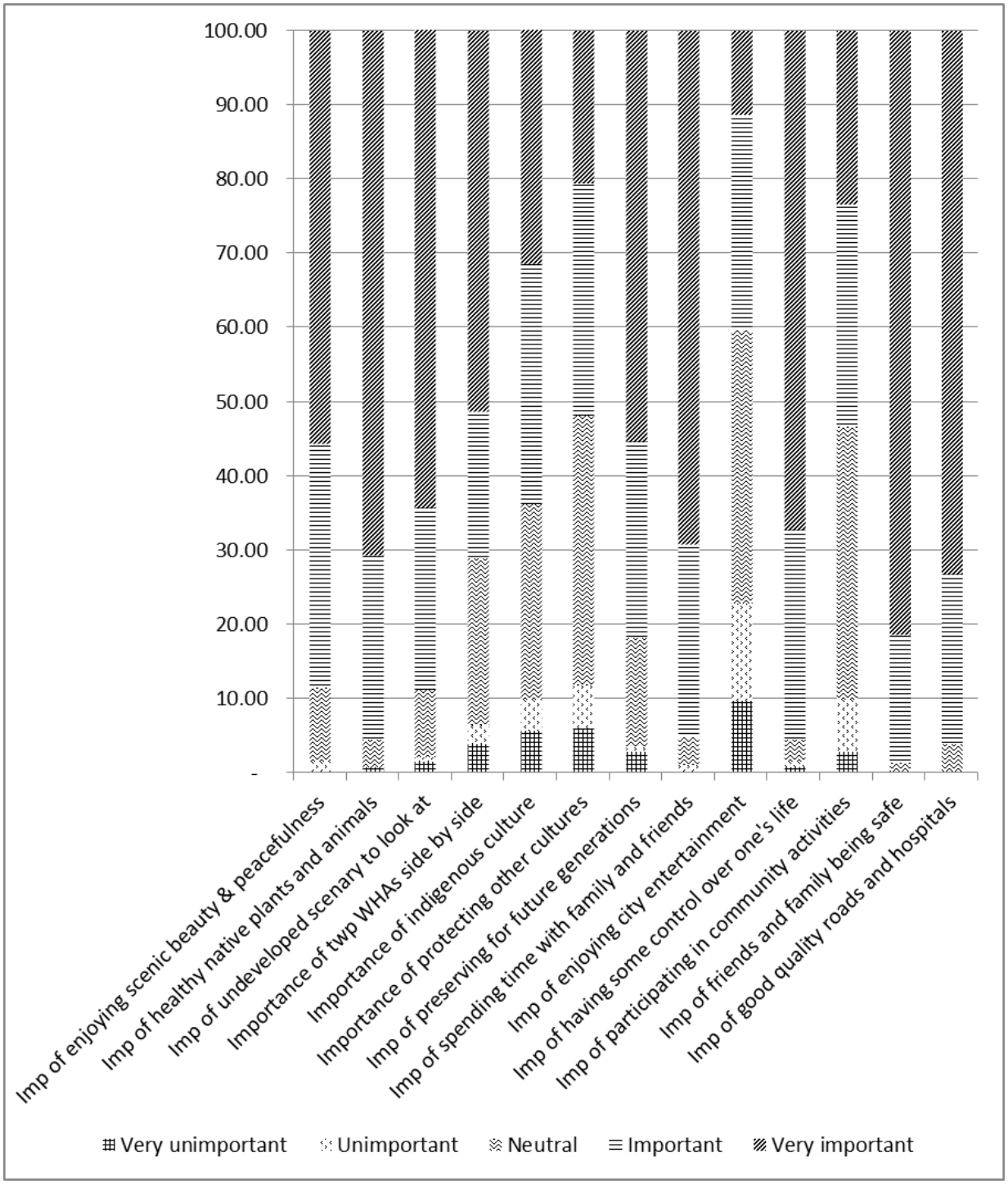


Figure 15 Frequency of responses for importance of various factors (continued)

5.5.5 Factor scores from alternate PCAs

Table 25 Factor scores from principal component analysis for satisfaction scores

Economic/ income	City	Culture	Environment Use	Environment Non use	Society
Benefiting from the tourism industry (.673)	Able to access via rain/Skyrail (.621)	Being able to learn more about a unique and ancient Australian environment (.674)	Being able to go on rainforest walks (.775)	Having healthy native plants & animals (.430)	Being able to spend time with friends & family (.542)
Benefiting from the mining industry (.687)	Being able to enjoy city entertainment (.710)	Being able to hear from Aboriginal people about their sense of place (.612)	Being able to visit waterfalls &/or swim in clear, clean rivers/streams/waterfalls (.799)	Having two World Heritage Sites side by side (.550)	Being able to have some 'control' over what is happening in your life (.666)
Benefiting from the agricultural industry (.756)	Being able to join in community activities (.620)	Knowing that good quality roads, hospitals, schools etc are there if need be (.440)	Being able to see iconic species in the wild (.794)	Protecting places that have Aboriginal cultural values (.785)	Knowing that friends & family are healthy & safe (.730)
Benefiting from other industry/sector (.801)			Being able to relax and/or reflect in a natural environment (.799)	Protecting places that have other cultural values (.732)	
Able to access via walking tracks and/or dirt roads (.538)			Being able to enjoy uncrowded camping & picnic areas (.685)	Protecting the WTWHA, either for its own sale or for future generations (.618)	
Able to acces via bitumen roads and bridges (.567)			Being able to enjoy the scenic beauty & peacefulness of the rainforest (.777)		
			Having beautiful undeveloped scenary to look at (.523)		

Table 26 Factor scores form principal component analysis for importance scores

Economic/ income	Access to nature	City	Culture	Environment Use	Environment Non use	Society
Benefiting from the tourism industry (.732)	Able to access via walking tracks and/or dirt roads (.702)	Being able to enjoy city entertainment (.756)	Being able to learn more about a unique and ancient Australian environment (.757)	Being able to visit waterfalls &/or swim in clear, clean rivers/streams/ waterfalls (.699)	Having healthy native plants & animals (.760)	Being able to spend time with friends & family (.711)
Benefiting from the mining industry (.738)	Able to acces via bitumen roads and bridges (.774)	Being able to join in community activities (.749)	Being able to hear from Aboriginal people about their sense of place (.878)	Being able to relax and/or reflect in a natural environment (.672)	Having beautiful undeveloped scenary to look at (.763)	Being able to have some 'control' over what is happening in your life (.478)
Benefiting	Able to access		Being able to	Being able to	Having two	Knowing that

Economic/ income	Access to nature	City	Culture	Environment Use	Environment Non use	Society
from the agricultural industry (.851)	via rain/Skyrail (.559)		go on rainforest walks (.540)	enjoy uncrowded camping & picnic areas (.755)	World Heritage Sites side by side (.718)	friends & family are healthy & safe (.872)
Benefiting from other industry/sector (.833)			Being able to see iconic species in the wild (.566)	Being able to enjoy the scenic beauty & peacefulness of the rainforest (.705)	Protecting the WTWHA, either for its own sale or for future generations (.631)	Knowing that good quality roads, hospitals, schools etc are there if need be (.730)
			Protecting places that have Aboriginal cultural values (.784)			
			Protecting places that have other cultural values (.585)			

Table 27 Factor scores from principal component analysis for satisfaction scores multiplied by importance scores

Economic/Income	Culture	Environment Use	Environment Non use	Society
Benefiting from the tourism industry (.645)	Being able to learn more about a unique & ancient Australian environment (.704)	Being able to go on rainforest walks (.724)	Having healthy native plants & animals (e.g free from diseases, pests & weeds) (.653)	Being able to spend time with friends & family (.529)
Benefiting from the mining industry (.702)	Being able to hear from Aboriginal people about their sense of place (culture & country) (.783)	Being able to visit Waterfalls &/or swim in clear, clean rivers/stream/waterfalls (.775)	Having beautiful undeveloped scenery to look at (.601)	Being able to enjoy city entertainment (e.g. spending time in cafes, museums, etc.) (.718)
Benefiting from the agricultural industry (.765)	Protecting places that have Aboriginal cultural values (.690)	Being able to see Iconic species in the wild (e.g. cassowary, kangaroos, riffle birds, etc.) (.715)	Having two world heritage sites side by side (i.e. the WTWHA and the GBRWHA) (.640)	Being able to have some 'control' over what is happening in your life (.617)
Benefiting from other industry/sector (e.g. fishing, retail, education etc.) (.817)	Protecting places that have other cultural values (e.g. European/Asian) (.654)	Being able to relax and/or reflect in a natural environment (.758)	Protecting the WTWHA, either for its own sake or for future generations (even if you have never been there & never plan to go) (.644)	Being able to join in community activities (e.g. attend cultural/environmental festivals) (.593)
Able to access via bitumen roads & bridges (.587)		Being able to enjoy uncrowded camping & picnic areas (.683)	Knowing that good quality roads, hospitals, schools etc. are there if need be (.450)	Knowing that friends & family are healthy and safe (.562)
Able to access via rail/Skyrail (.561)		Being able to enjoy the scenic beauty & peacefulness of the rainforest (sights, sounds & smell) (.773)		
		Able to access via		

Economic/Income	Culture	Environment Use	Environment Non use	Society
		walking tracks &/or dirt roads (.525)		

Table 28 Factor scores from principal component analysis for relative satisfaction scores multiplied by relative importance dummy

Economic/ income	Access to nature	City	Culture	Environment Use	Environment Non use	Family & Friends	Society
Benefiting from the tourism industry (.640)	Able to access via walking tracks &/or dirt roads (.649)	Being able to enjoy city entertainment (e.g. spending time in cafes, museums, etc.) (.680)	Being able to learn more about a unique & ancient Australian environment (.674)	Being able to go on rainforest walks (.486)	Having healthy native plants & animals (e.g free from diseases, pests & weeds) (.737)	Being able to spend time with friends & family (.769)	Knowing that good quality roads, hospitals, schools etc. are there if need be (.860)
Benefiting from the mining industry (.698)	Able to access via bitumen roads & bridges (.748)	Being able to have some 'control' over what is happening in your life (.564)	Being able to hear from Aboriginal people about their sense of place (culture & country) (.714)	Being able to visit waterfalls &/or swim in clear, clean rivers/streams/waterfalls (.725)	Having beautiful undeveloped scenery to look at (.778)	Knowing that friends & family are healthy and safe (.817)	
Benefiting from the agricultural industry (.376)	Able to access via rail/Skyrail (.617)	Being able to join in community activities (e.g. attend cultural/environmental festivals) (.577)	Protecting places that have Aboriginal cultural values (.807)	Being able to see iconic species in the wild (.677)	Having two world heritage sites side by side (i.e. the WTWHA and the GBRWHA) (.460)		
Benefiting from other industry/sector (e.g. fishing, retail, education etc.) (.679)			Protecting places that have other cultural values (e.g. European/Asian) (.665)	Being able to relax and/or reflect in a natural environment (.815)	Protecting the WTWHA, either for its own sake or for future generations (even if you have never been there & never plan to go) (.520)		
				Being able to enjoy uncrowded camping & picnic areas (.592)			
				Being able to enjoy the scenic beauty & peacefulness of the rainforest (.735)			

5.5.6 Maps showing changes to Local Government boundaries over time

Figure 16 2007 Local government boundaries before initial restructure

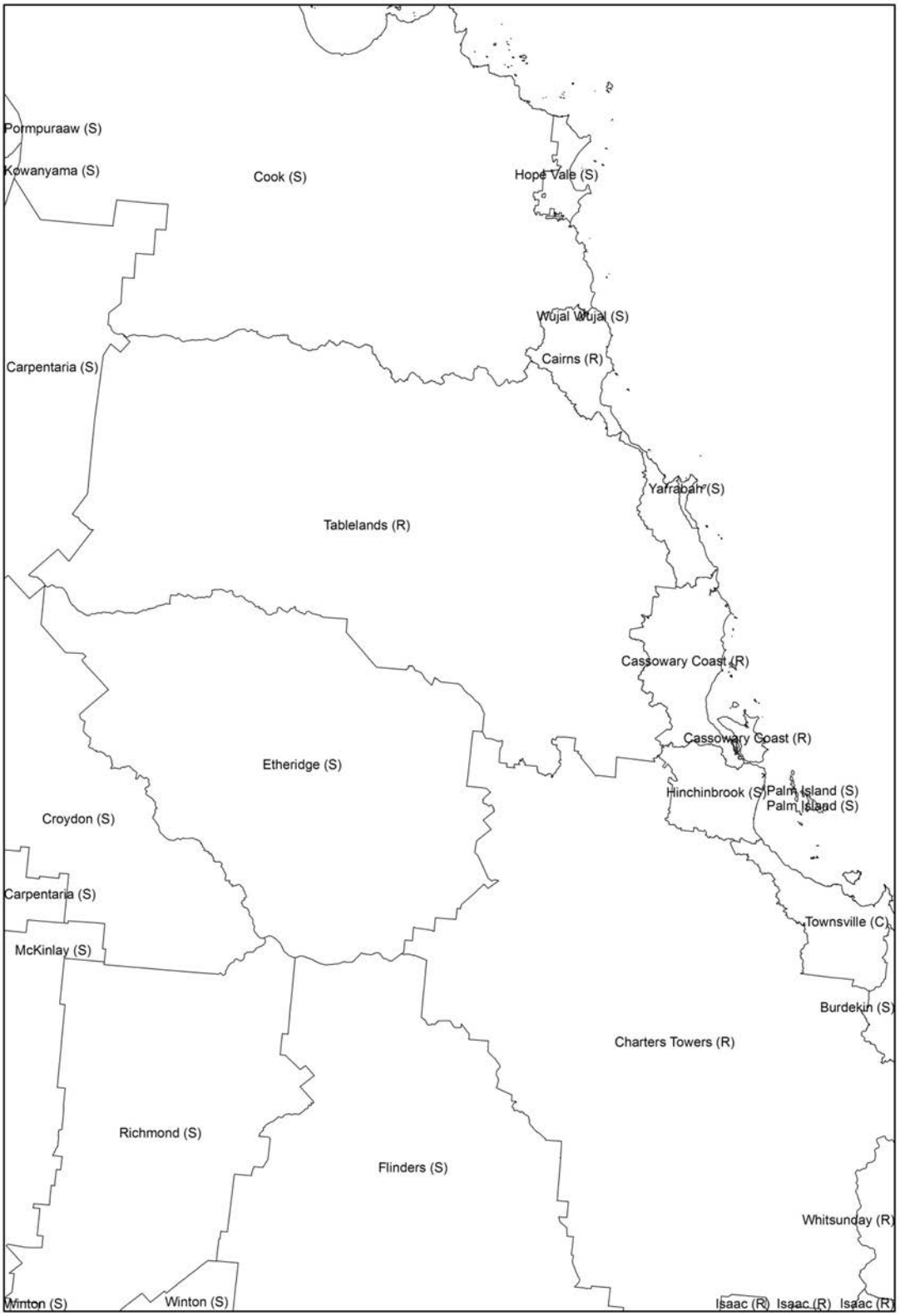


Figure 17 2013 Local government boundaries after initial restructure

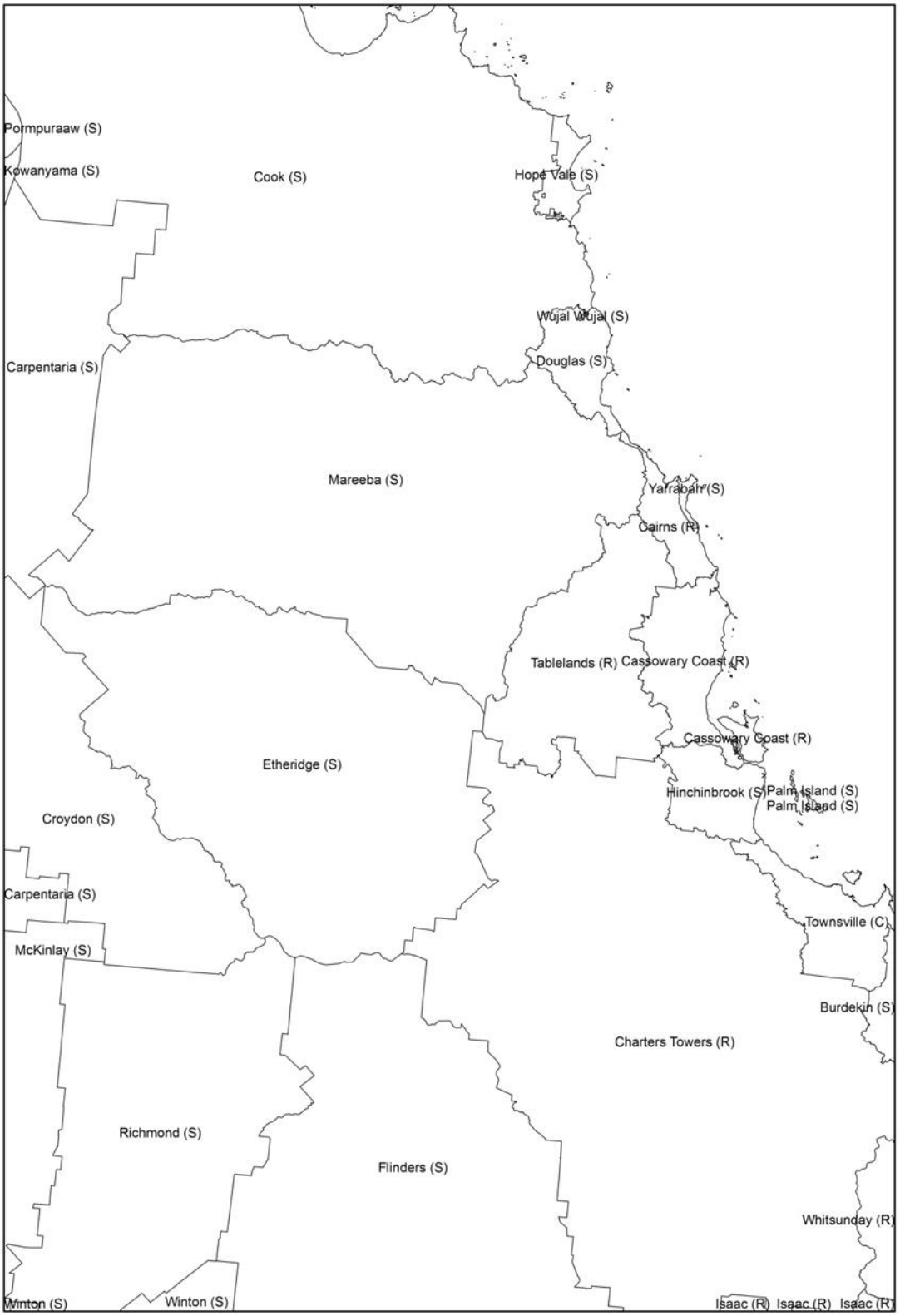


Figure 18 2015 Local government boundaries after deamalgamation

Chapter 6 New methods for valuing, and for identifying spatial variations, in cultural services: A case study of the Great Barrier Reef

In the previous chapter I demonstrated that the social domain appeared to be the most important in explaining variations in LS; whilst the environment was generally more important than the economic domain, significant spatial variations in preferences were found and in the extreme south of the study region the economic domain was more important than the environment. This chapter further explores the spatial variations in the impact of economic and environmental factors on LS. Previous research has demonstrated that the LS valuation approach can be used for estimating use values; I seek to demonstrate the versatility of the technique within different contexts. Within chapter 4 I demonstrated an innovative way of estimating values within the commercial sector; in this chapter I further extend the use of the LS valuation approach by using this to estimate the hard to monetise non-use values. Thus this chapter addresses my fourth research objective.

This chapter is based on a journal article that has been submitted and is currently under review; the anticipated citation for this article is:

Jarvis, D., Stoeckl, N., & Liu, H.-B. New methods for valuing, and identifying spatial variations, in cultural services: A case study of the Great Barrier Reef. Ecosystem Services

This article has been edited for inclusion within this thesis, to remove duplication of information already discussed elsewhere. Footnotes within the text indicate when notable amendments have been made to the original article. Minor amendments have also been made to ensure consistent use of terminology within this thesis.

Abstract

There are numerous methods for estimating the 'value' of the environment and associated ecosystem services (ES). Traditional techniques for estimating the 'value' of ES that are not related to the market require one to construct hypothetical markets, but the life satisfaction (LS) approach does not. It has been used to estimate the value of regulating services, but to the best of my knowledge has never been used to estimate the 'value' of Cultural services (CS).

I trial the efficacy of the approach in this paper, using geographically weighted regression (GWR) to examine the relationship between LS and CS provided by the Great Barrier Reef (GBR). GWR allows us to look for spatial variations in 'value'. After controlling for other factors, I find that income is more important to LS in the south than the north; the opposite is true for CS.

The coefficients are used to estimate the amount of income that would be required, to keep overall LS constant should the cultural values of the GBR not be preserved. This is in the order of $8.7bn annually. I acknowledge the imperfections of this work, note the need for research on better measures of CS, but feel that the general approach may add another useful tool to the valuation toolbox.

6.1 Introduction

Ecosystem services (ES) are the benefits people receive from ecosystems, frequently categorised as either provisioning, regulating or cultural services along with supporting services that are needed to maintain the other services (Haines-Young & Potschin, 2013). Monetising the value of ES can help inform resource allocation decisions; omitted or under-stated values contribute to the over-exploitation of ecosystems (de Groot et al., 2012). However, some ES (generally those within the provisioning category) are easier to value than others; accordingly some services have been the subject of multiple valuation studies whilst others have been relatively neglected. This study aims to address that gap, demonstrating the potential usefulness of the life satisfaction approach for estimating the value of the more difficult to monetise ES – specifically: cultural services.

Cultural services (CS) are the "nonmaterial benefits people obtain from ecosystems through spiritual enrichment, cognitive development, reflection, recreation and aesthetic experiences" (Millennium Ecosystem Assessment, 2005, p. 40) and include "…existence and bequest constructs that may arise from people's beliefs or understandings" (Haines-Young & Potschin, 2013, p. 18). Recreation and tourism aside, many CS are what economists would term non-use values (Krutilla, 1967; Weisbrod, 1964); CS itself is essentially a hybrid of use and non-use values. In contrast to provisioning services (comprising, predominantly use values), non- use values are not traceable through well-functioning markets, or indeed through any market at all (Costanza, d'Arge, et al., 1997). So whilst those interested in valuing provisioning services can use information provided from observable, functioning

markets, those interested in valuing *non-use* values (such as the existence and bequest values relating to CS), must reply on 'hypothetical' markets (Harris & Roach, 2013; Turner et al., 1994) – hence the significant body of literature relating to methods such as contingent valuation (CV) and choice modelling (CM).

Traditional non-market valuation approaches (such as CV and CM) assume that utility is cardinally unobservable (Gowdy, 2005), requiring researchers to work with indirect utility functions. But an emerging body of research has established that measures of life satisfaction or subjective well-being[50] can serve as a proxy for utility (Kristoffersen, 2010). So researchers have begun to use what is now termed the 'life satisfaction' (LS) approach, to estimate the 'value' of environmental goods and services at both the microeconomic (Ferreira & Moro, 2010), and macroeconomic (Engelbrecht, 2009; Vemuri & Costanza, 2006) level. Simplistically, these researchers ask questions, such as "how satisfied are you with your life as a whole?", and responses are then regressed against a variety of other factors, the coefficients of the equations providing information about the contribution which these factors make to overall LS (or 'utility').

LS studies have looked at air pollution (Ferreira & Moro, 2010; Levinson, 2012; Luechinger, 2009; MacKerron & Mourato, 2009; Welsch, 2006, 2007a), air and water pollution (Welsch, 2002), noise pollution (van Praag & Baarsma, 2005), greenhouse gases (Beja Jr, 2012), scenic amenities (Ambrey & Fleming, 2011), ecosystem diversity (Ambrey & Fleming, 2014d), drought (Carroll et al., 2009), forest fires (Kountouris & Remoundou, 2011), floods (Luechinger & Raschky, 2009), climate and climate change (Ferreira & Moro, 2010; Frijters & Praag, 1998; Maddison & Rehdanz, 2011). But to the best of my knowledge, no-one has yet attempted to use the LS approach to assess the 'value' of CS - the focus of this paper. Previous literature suggests that people's perceptions of reality are often more important determinants of behaviour, or satisfaction with life, than scientifically measurable ('objective') indicators (Cummins, 2000a; Schneider, 1975). Additionally, the LS approach assumes that each factor enters the function in a separable and additive manner, as noted earlier within Chapter 5; however previous literature has observed that there is much potential overlap between factors (Stoeckl, Farr, Larson, et al., 2014; Windle & Rolfe, 2005), the implication being the need to test for overlap before simply entering each factor as a separate contributor to LS using a technique such as PCA. So I use a perception based proxy

[50] The terms happiness, life satisfaction (LS) and subjective well-being (SWB) are frequently used interchangeably although the 'happiness' is less closely related to LS than is SWB (Engelbrecht, 2009)

for CS values (namely, the satisfaction with cultural services associated with the GBR) in a LS model, using PCA with Varimax rotation and Kaiser normalization to check for separability between the factors on which this proxy. This paper thus extends the scope of the LS literature to demonstrate a way of assessing the value of CS, whilst also employing a more sophisticated estimation technique (geographically weighted regression) than those used in previous studies.

To be more specific, using the Great Barrier Reef World Heritage Area (GBRWHA) as a case study, two research questions are addressed:

1) Do reported levels of satisfaction with the CS associated with the GBR contribute to the overall satisfaction with life reported by residents, and is there spatial variation within this relationship?
2) Can we use coefficients from the LS model to generate estimates of the CS value of the GBR?

After briefly describing the case study area (section 5.2.1), I discuss the development of the model, the selection of the independent variables, and the design of the questionnaire (section 5.2.2). I then describe how the data were collected (section 5.2.3), the estimation techniques (sections 5.2.4 and 5.2.5), and the method of estimating the value of CS (section 5.2.6). Results are provided and discussed in section 5.3, whilst section 5.4 draws conclusions from this research.

6.2 Materials and methods

6.2.1 Case study area

The GBR, situated in the Coral Sea off the coast of Queensland, Australia, is the world's largest reef system comprising over 2,500 reefs covering an area of 348,700 km^2 and was proclaimed a World Heritage Area in 1981 (UNESCO World Heritage Convention, 1981). There have been marked increases in the amount of nutrients, sediments and pesticides flowing into the GBR since European settlement (Furnas, 2003; Kroon et al., 2012; Lewis et al., 2009) and substantive declines in coral cover in areas where sediment loads have increased the most (De'ath, Fabricius, Sweatman, & Puotinen, 2012). The GBR is close to being added to the World Heritage in Danger list (UNESCO World Heritage Centre, 2014a), but many desire to further develop the ports and mines along the coast. It is therefore

important to assess both the economic 'benefit' of further economic growth, and the economic 'cost'.

Numerous studies in recent decades have generated estimates of the monetary worth of various values associated with the GBR, although there have been many more studies of the services provided via markets where values are relatively easy to obtain (Stoeckl et al., 2011). Studies of non-use values are relatively sparse but include: a contingent valuation study of 'vicarious' users (tourists and Australian residents living outside the GBR catchment) (Hundloe et al., 1987); a choice modelling study of the non-use value of an estuary within the GBR catchment (Windle & Rolfe, 2005); and an attempt to estimate the collective value of numerous community defined benefits which were grouped together to represent either provisioning services, regulation and maintenance services, cultural services, or a mix of cultural and regulation and maintenance service (Stoeckl, Farr, Larson, et al., 2014).

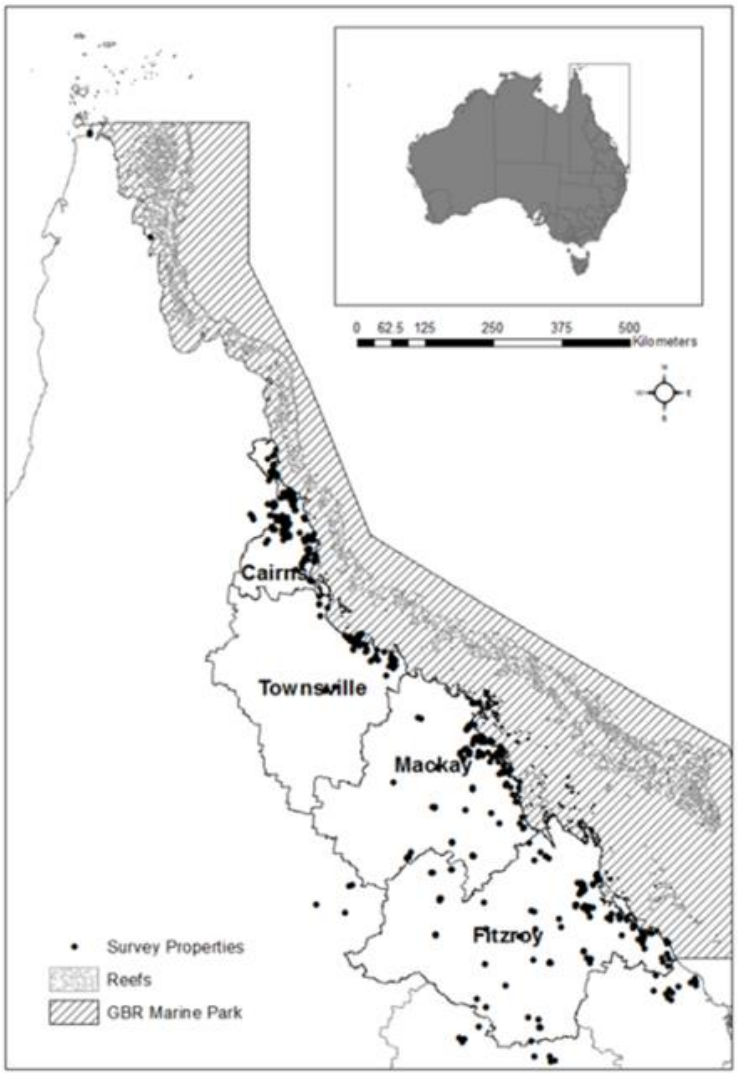


Figure 19 Study area: The Great Barrier Reef World Heritage Area

6.2.2 Questionnaire design and data collection

My underlying hypothesis was that each individual *i*'s life satisfaction (LS*i*) is affected by numerous factors (X_i) including values associated with the CS provided by the GBR (CSV*i*):

$$LS_i = f\ (X_i, CSV_i) \qquad (1)$$

My first task, therefore, was to determine how best to measure LS_i, X_i and CSV_i and how to empirically estimate the relationship between them.

There are numerous different ways of measuring LS – all of which involve asking respondents to indicate how 'satisfied' they are, either with life overall, or with various aspects of life (e.g. the Cantril Ladder (Cantril, 1965)). I chose to use a single question,

asking respondents to consider their own life and personal circumstances, and to then indicate, on a 5 point likert scale, how satisfied they were with life overall.

As regard 'other' variables (X_i): studies of identical and non-identical twins and siblings have establised that genetic/hereditary factors are key determinants of LS and 'happiness (Lyubomirsky et al., 2005; Zidanšek, 2007). Indeed genetic factors have been estimated to explain between 39% and 58% (Tellegen et al., 1988) and between 40% and 55% (Diener et al., 1999) of differences; in young children (Braungart et al., 1992) the estimated influence of genetic factors is between 35% and 57%. However, like most other researchers, I did not have access to genetic data, so instead used a range of socio-demographic and economic variables, selected from those about which I had data, which previous researchers have found to be significantly related to LS (a summary of articles using different determinants is provided in Table 1. As such, the survey included numerous background questions about age, gender, marital status, income, etc. (Table 30 summarises those used in the empirical analysis).

Determining how best to assess CSV_i was a little more problemmatic. If wishing to assess the contribution which a standard economic good (say, *widgets)* makes to overall LS (wellbeing, or utility), one would ideally count the number of *widgets* consumed by each individual over a given period of time (say one year), and include that in the regression equation. To provide a more environmentally based example, contingent valuation exercises that seek to place a value on conservation activities often seek the willingness to pay for a specified increase in a population size (Richardson & Loomis, 2009). However, that cannot easily be done for CS values, particularly those relating to non-use values: there is no meaningful way to measure quantity, since the service is either there (for all people) or not. This relates to questions surrounding 'scope' in CV studies, which discuss the importance of "distinguishing between the benefits of preventing a species from going extinct versus the benefits of certain gains in the species population above the minimum viable population" (Richardson & Loomis, 2009, p1540). I am seeking to value the benefit of the GBR continuing to exist as opposed to becoming marginally less available . I am thus considering a total value (all or nothing), rather than a marginal value, where the problem of 'scope' may be significant[51]. Still, it is difficult to determine how to measure this – particularly given the

[51] When estimating marginal values it is important to be aware that the marginal value can vary depending on the starting point; for example people are likely to be willing to pay a lot more to save 100 animals if they are the last of their species than they would be to save 100 animals where the species is far from extinct. Whilst

complex inter-relationships between various use and non-use value (or between cultural and other ecosystem services). I chose to focus on people's perceptions of their satisfaction with numerous ecosystem service (and other) values using a coarse Likert Scale to gauge 'satisfaction' and principal components analysis[52] to identify items associated with CS.

To be more specific, the questionnaire included a list of 18 different community defined benefits (Table 29), developed by undertaking a substantive literature review and by consulting numerous regional stakeholders/managers/decision makers during workshops held in Cairns, Brisbane and Townsville (see Stoeckl, Farr, Jarvis, et al. (2014) for details). The questionnaire asked, amongst other things, *"How satisfied are you with each item below? Indicate whether all is well (very satisfied) or if there is something wrong (very unsatisfied)"*. Responses were recorded on a 5 point scale.

Table 29 Community-defined benefits assessed in the questionnaire

The status/health of the region's: *Beaches and islands – undeveloped and uncrowded *Beaches and islands – without visible rubbish (bottles, plastic) *Coral reefs *Reef fish *Iconic marine species (whales, dugongs, turtles) *Oceans – clear water (with good underwater visibility) *Mangroves and wetlands
*The chances that the GBRWHA will be preserved for future generations
The benefits you receive from: The reef-based tourism industry The commercial fishing sector The mining and agricultural sectors Cheap shipping transport
The health/status of traditional/indigenous cultural values
The status of your 'bragging rights' – knowing that people envy you for living near the Great Barrier Reef
Your opportunities to: Eat fresh locally caught seafood Go fishing, spear-fishing or crabbing Spend time on the beach, go swimming, diving etc. Go boating, sailing or jet-skiing

* Benefits included with the composite single variable for CS values as a result of PCA

estimating the total value should reduce this problem there is still some risk of bias should the sample on which the value is based include a larger proportion of respondents who are concerned about the GBR compared to the general population. Whilst this risk can be reduced by adopting an appropriate sampling technique, the risk remains that those who choose not to respond may have different preferences to those who do respond. As with any survey based social science study, the risk of sampling bias must always be remembered when considering results. This is discussed further within section 7.4 within chapter 7.

[52] The use of the PCA is important to reduce the risk of bias due to non-separability of preferences, as discussed earlier in the thesis, which can increase or decrease the importance or value of a feature by relatively large amounts depending on the nature of the non-separability of preferences (Carbone & Smith, 2013).

Some of the community defined benefits listed in Table 29 clearly represented provisioning services. Of these, some were strongly associated with the market and are priced, such as benefiting from the jobs and incomes associated with the commercial fishing industry, whilst other were non-priced e.g. being able to eat fresh locally caught seafood. Other benefits were arguably more strongly associated with CS values (e.g. 'having' healthy iconic marine species, reefs and reef fish, knowing that the GBRWHA will be preserved for future generations). At issue here, is the problem of deciding which measure to use as a proxy for CS values.

This is a non-trivial problem because ecosystems are complex, composed of non-linear, interdependent components, and the value of the services they produce are interdependent and overlapping (Costanza, d'Arge, et al., 1997). Several researchers have suggested that it may be most appropriate to work with a collective measure of value than to work with single measures (Stoeckl, Farr, Larson, et al., 2014; Windle & Rolfe, 2005). Therefore, I sought to develop such a measure using responses to questions about satisfaction with benefits most closely associated with measures of CS.

In the first instance, I checked for separability by looking at correlation coefficients and using principle components analysis (with Varimax rotation and Kaiser normalization), finding that these benefits collapsed into 5 separable factors. The groupings were the same as those found by Larson, Stoeckl, Farr, and Esparon (2014) and Stoeckl, Farr, Larson, et al. (2014) who grouped the benefits based on importance (rather than satisfaction) scores; thus the groupings appear robust to whichever measure is chosen. The factor scores resulting from the PCA are set out in Table 33 within Appendix 6.5.3. Having identified that these responses did, in fact, appear to be 'separable' to responses about other benefits, I generated a single variable for CS values, estimated as the median[53] level of 'satisfaction' associated with each of the starred variables in Table 29; the frequencies of each of the responses to these questions can be seen in Figure 20.

Importantly, this proxy for CS values focuses on residents' perceptions and does not consider the actual condition of the GBR. It is noted, however, that respondent's perceptions have frequently, and successfully been used within LS studies, including perceived water quality

[53] I chose to use the median rather than the mean as the median is generally a better measure of 'average' when working with skewed samples (as frequently seen in environmental data), being more stable and less affected by extreme values (Helsel, 1990). The median is also frequently preferred when working with skewed financial data such as levels of personal wealth (OECD, 2013).

(Guardiola et al., 2013), perceived aircraft noise (van Praag & Baarsma, 2005) and self-assessed perceptions of health (Diener et al., 1999). Relatedly, researchers have found evidence to suggest that perceptions (of water quality) do a better job of explaining willingness to pay (for improvements in water quality), than do objective measures (of water quality) (Farr et al., 2014). Thus it is my attempt to include a measure of CS values within the LS model that adds something new to the literature; use of perceptions (rather than of objective measures) is neither novel nor controversial.

6.2.3 Sampling / data collection

24 different versions of the questionnaire were generated – each version presenting the list of benefits (Table 29) in a different order, since survey respondents have been found to be highly sensitive to the order in which questions are presented[54] (Cai et al., 2011; Lasorsa, 2003). Questionnaires were pre-tested amongst colleagues and in a pilot study that included 200 residents from 100 different postcodes within the GBR catchment area.

The surveys were mailed out (with explanatory letter) to a geographically stratified random selection of households from postcodes that lay either partially or entirely within the GBR catchment area (Figure 19). The Dilman (2007) method was followed; recording returned questionnaires as they arrived, sending a replacement questionnaire to those who had not responded shortly after the first contact, and a further replacement shortly after that. It was ensured that an equal number of each version of the questionnaires was sent to each postcode to ensure that the order of the questions did not influence the results. It was estimated that 3,977 reached their intended recipient and 902 completed questionnaires were received, giving an overall response rate of 22.7%. Only one half of our residents were asked to tell us about both importance and satisfaction – those given the shorter questionnaire had to be excluded from this research as the satisfaction variables were at the core of this study.

6.2.4 Econometric issues

Previous LS studies have used a range of techniques, some suitable for categorical or ordinal dependent variables and others more appropriate for continuous distributions. Drawing on

[54] Dummy variables representing the order that the questions were asked were incorporated within an enlarged form of the overall OLS model developed by this study; these order of question dummy variables were not found to be significant. Thus our results do not appear to be influenced by the order in which the questions were asked. Results are set out in section 6.5.1.

insights gained from the LS research literature it was determined that the use of estimation technique designed for use with continuous data would be appropriate for this research[55].

A more neglected econometric issue is space/location (MacKerron, 2012). Some researchers have used spatially derived data within their analysis including, for example, variables that indicate proximity to features such as the coast, landfill sites, airports, major roads (Brereton et al., 2008). Researchers have also included measures of climate (specifically rainfall, temperature and wind speed data) (Brereton et al., 2008; Ferreira & Moro, 2010); and local measures of pollution (Luechinger, 2009; MacKerron & Mourato, 2009). But, so far as we are aware, only one study has specifically addressed the issue of spatial variation in the relationship between LS and other explanatory variables: Stanca (2010), who sought to determine if the relationships between unemployment, income and LS were 'similar' for countries that were geographically close, concluding that "in order to understand the links between economics and happiness, geography matters" (Stanca, 2010, p. 132). I thus used geographically weighted regression (GWR) to estimate the LS model[56] .

The final set of variables used in the regression was obtained after a series of estimations; starting from a specification including a wide range of variables suggested by the literature (described within Table 1). Insignificant variables were gradually dropped[57]. When running these models, I generated a single, OLS 'global' model and also used GWR[58]. I tested for the presence of spatial non-stationarity between explanatory variables and LS with the Koenker BP test, confirming the need to use GWR. Spatial autocorrelation was tested for using the Global Moran's I test which indicated that the final model reflected the inherent spatial nature of the data with no important spatial variable having been omitted (thus omitted variable bias is unlikely).

[55] The original article on which this chapter is based discussed this matter in further detail, but this discussion has been edited to prevent unnecessary duplication. For a full discussion of the use of techniques designed for continuous or ordinal data within LS studies please refer to section 2.6.1 of this thesis.
[56] The original article on which this chapter is based discussed this matter in further detail, but this discussion has been edited to prevent unnecessary duplication. For a full discussion of GWR please refer to section 2.6.3 of this thesis.
[57] Cairns, is far more densely populated with 10.2 persons per km^2 compared to 1.8 - 2.8 for the other regions (ABS from census 2011). Population density has been found to impact overall LS, although from prior research the direction of impact remains unclear. A positive effect has been found and attributed to the better range of amenities available (Brereton et al., 2008), whilst alternate research found a negative effect (Maddison & Rehdanz, 2011). For this study, the relationship between population density and overall LS was not found to be significant.
[58] The AIC method within ArcGIS was used to determine the kernel (the optimal distance/number of neighbours to be used) for estimating the regression for each location, rather than the researchers imposing their view of the appropriate kernal.

Recognising that endogeneity could be present (a common problem with LS studies (Kountouris & Remoundou, 2011; Luechinger, 2009)), particularly given the potential for simultaneity between the indicator of satisfaction with ecosystem services and the measure of overall satisfaction with life, I conducted the Wu-Hausman (J. A. Hausman, 1978; D.-M. Wu, 1973) and Durbin (Durbin, 1954) tests. These tests provided no evidence of its presence, suggesting that the measures of both satisfaction with ecosystem services and income are exogenous, and that use of instrumental variables would not be appropriate[59]. However it should be noted that even with the use of such tests it is impossible to be sure that endogeneity is not present as *"...this condition is empirically untestable because one cannot observe u [the error term]. We repeat there is no way to empirically test whether a variable is correlated with the regression error term because the error term is unobservable. Consequently, there is no way to statistically ensure that an endogeneity problem has been solved"* (p9, Roberts & Whited, 2012).

6.2.5 Exploring spatial patterns

The mean value of each estimated coefficient was calculated for two different geographic areas: (1) for four different Australian Bureau of Statistics' 'SA4 regions' in the GBR catchment area (see Figure 19); and (2) for 10 different local government areas (LGA) in that same region. If there were fewer than 15 respondents in any region, those observations were combined with observations from the adjacent region, thus ensuring that all groupings included a reasonable proportion of the overall sample (ranging from 16% to 34% of the total for SA4 groupings), therefore no group was so small that an outlying response could significantly distort the region's average. The geographical patterns were very similar in both cases, so I report only those associated with the SA4 regions. Results by LGA are available on request.

6.2.6 Using coefficients from the model to generate a monetary estimate of the value of cultural ecosystem services

Most LS studies use coefficients from the LS model to calculate the marginal rate of substitution (MRS) between income and some other variable (e.g. pollution). This is entirely appropriate if working with variables for which marginal changes are possible, but is not appropriate to think about 'marginal' changes in quantity when considering the future of a

[59] Details of test results and instrumental variables are set out in 6.5.2.

non-rivalrous common-property good such as the GBR; the Reef either will be preserved for future generations in it's current condition, or it will be allowed to deteriorate and die. That said, it IS possible to have marginal changes in quality: it could be preserved in excellent, good, or some other condition. This proxy for non-use values is far from perfect but it does incorporate a measure of people's perceptions about the state of the region (specifically, satisfaction with the quality of various aspects of the GBRWHA such as coral reefs, reef fish). Moreover, for the moment I can offer no alternative variable that is both theoretically correct and empirically practical. I thus replicate the estimation process. That is, I estimate the (average) amount of additional income that each respondent would need to adequately compensate them (i.e. to keep overall life satisfaction constant) should there be a reduction in their satisfaction with the various non-use values associated with the GBRWHA.

$$\text{Average compensation per person} = \frac{\frac{\partial LS}{\partial CSV}}{\frac{\partial LS}{\partial Income}} \times \Delta CSV$$

The ΔCSV included here is that resulting from satisfaction levels falling from current levels to zero. A single estimate of 'value' was calculated using the coefficients from the global GWR model, and 'values' were estimated for each of the four SA4 regions, using the spatially differentiated coefficients to do so. I then multiply this per-capita figure by the number of employed persons in the region[60], to generate an aggregate estimate of the (primary) value of CS.

6.3 Results and Discussion

6.3.1 Regression results

The analysis uses only a subset of all responses (n=245): those who answered every question, and for which I had enough locational information to identify the latitude and longitude of the residence, so that GWR could be used. Whilst sub-sample sizes for individual regions are fairly small, the GWR approach utilises all of the observations within the whole database as part of the estimation process, thus results are not unreliable because the overall sample size

[60] The calculation used the number of employed persons rather than total number of persons because the per capita income was derived only from employed persons; to multiply that income across the total population would have resulted in an overstated valuation.

is sufficient (as it is here)[61]. The survey respondent's home locations are indicated in the map at Figure 19 (drawn at a scale that prevents identification of respondents to preserve confidentiality).

The distribution of responses to the question about satisfaction with life overall (LS), and the distribution of responses to the questions regarding satisfaction with the cultural ecosystem services (CSV) associated with the GBR are shown in Figure 20, while Table 30 provides summary statistics for the other variables used in the LS model (the X's)[62].

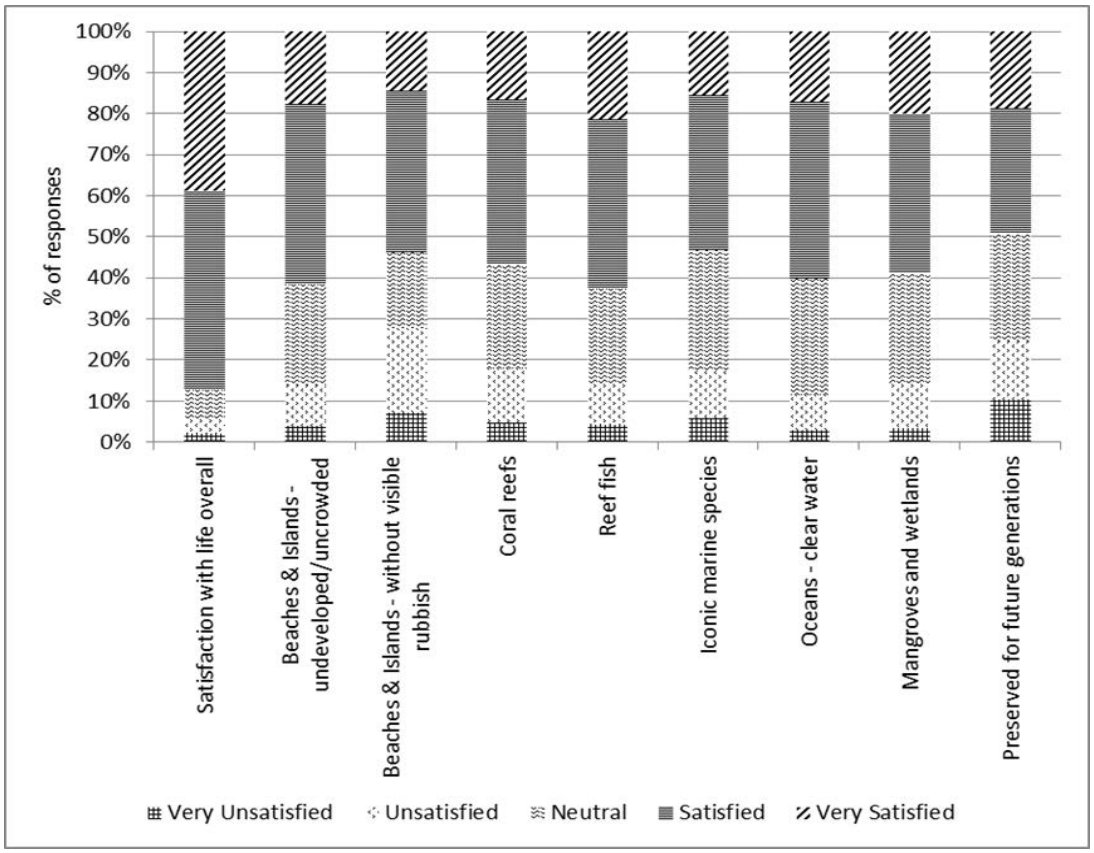


Figure 20 Responses to questions regarding satisfaction with life overall and with the cultural ecosystem services values associated with the GBR

[61] If an alternate approach had been adopted of using OLS to estimate a separate model for each region then each separate regression would have only used the sample data for that specific region, and may have resulted in unreliable results due to small sample sizes (particularly with regard to the Townsville sample of 40). The use of GWR reduces this problem.

[62] The original specification of the model included a far larger number of different factors found in previous research to influence LS, but these variables were statistically insignificant and were thus excluded from the final model.

Table 30 Other explanatory variables used in the LS model

Variable	Mean (or proportion if dummy variable)	Std. Dev.	Skew	Kurtosis
Age[2]: expressed in years	3,257.92	1,546.42	0.52	0.05
Male (Dummy variable set to 1 if male, otherwise 0)	0.52	0.50	a	a
Married (Dummy variable set to 1 if married or in legal partnership, otherwise 0)	0.75	0.43	a	a
Year 12 or higher (Dummy variable set to 1 if completed year 12 at high school or higher, otherwise 0)	0.77	0.42	a	a
Australian born (Dummy variable set to 1 if born in Australia, otherwise 0)	0.81	0.39	a	a
Income: individual income in $[63]	51,373.27	33,889.68	1.20	2.51

a: skew and kurtosis are not relevant for categorical data

The results from the OLS, the overall GWR and each of the four SA4 models (Cairns, Townsville, Mackay and Fitzroy, in order from north to south) are presented in Table 31.

The Koenker BP Statistic was 13.138 significant at 10% level, thus indicating that spatial variations are present. The GWR estimation process provided a higher adjusted R^2 statistic and a lower AIC than the global OLS model indicating that the GWR models provides better goodness of fit, further confirming the existence of spatial variation. The Global Moran's I test value was -0.007, not significant even at 10% level; this confirms that spatial autocorrelation is not present in the regression residuals, indicating the model reflects the inherent spatial nature of the data with no important spatial variable having been omitted.

I thus focus on the GWR results, firstly considering the overall model. All explanatory variables were significant at 5% level. The adjusted R2 is fairly low at .140, but as discussed in section 2.2 genetic factors have been found to explain up to 50% of variation in LS, therefore the variation in LS explained by this study is consistent with previous research.

6.3.2 Discussion of regression results

The signs and statistical significance of socio-demographic variables were as expected from the literature:

> age had a statistically significant and positive relationship with LS (as per Ambrey & Fleming, 2014d; Brereton et al., 2008; MacKerron & Mourato, 2009);

[63] For this study survey respondents were asked the question "On average, how much pre-tax income does your household earn each year?", with respondents selecting the appropriate category from a list with the midpoint of each category used for the study. Household income was then converted to individual income using the modified OECD scale adopted by the ABS (Australian Bureau of Statistics, 2010)

females were, on average, more satisfied with life than male respondents as were those who were married or in legal partnership (as per Welsch, 2007b);

those who had completed year 12 education or above were more satisfied than those who had not (as per Frey & Stutzer, 2000), although we note that the coefficient may also be incorporating the indirect effect that education has on improving health (Dolan, Peasgood, & White, 2008);

those born in Australia had higher LS than migrants (confirming earlier research that has found living within your country of origin increases LS (Frey & Stutzer, 1999));

income had a significant factor and positive impact on LS (as per Di Tella et al., 2003; Ferrer-i-Carbonell & Frijters, 2004)[64].

The proxy for CS values was highly significant. I am not aware of previous research that has considered the interaction between ecosystem services values and overall LS; however a positive relationship has been found between LS and sustainable development (Zidanšek, 2007), ecosystem diversity (Ambrey & Fleming, 2014d), and being concerned about the extinction of species (Ferrer-i-Carbonell & Gowdy, 2007). Thus, the finding that the services provided by an ecosystem are important to LS accords with findings from studies in a similar field.

For the regional models, the R^2 is highest for the most northern region (Cairns) followed by Townsville and then the other regions. This indicates that the model does a slightly better job explaining the relationship between the independent variables and overall life satisfaction in the north than the south.

Table 31 GWR and OLS model results for dependent variable: Satisfaction with Life Overall

	GWR model Cairns	GWR model Townsville	GWR model Mackay	GWR model Fitzroy	GWR model Overall	OLS global model
Variables	**Coefficients Standard errors in brackets**					
Age^2	.00014*** (.00004)	.00014*** (.00004)	.00014*** (.00004)	.00015*** (.00004)	.00014*** (.00004)	.00015*** (.00004)
Male	-.3447*** (.1208)	-.2879** (.1117)	-.2320** (.1117)	-.2014* (.1251)	-.2727** (.1179)	-.2790** (.1089)
Married	.5143*** (.1394)	.3828*** (.1279)	.2333* (.1265)	.0985 (.1429)	.3232** (.1349)	.3073** (.1237)
Year 12 or	.5295***	.4788***	.4033***	.3199**	.4398***	.4231***

[64] Previous studies have found that taking the natural log of income can improve the explanatory power of the model. I tested this, but found little difference (also found by Welsch, 2002) and use the linear version for ease of interpretation of results.

	GWR model Cairns	GWR model Townsville	GWR model Mackay	GWR model Fitzroy	GWR model Overall	OLS global model
higher	(.1511)	(.1403)	(.1403)	(.1576)	(.1480)	(.1375)
Australian born	.4863*** (.1538)	.3664** (.1426)	.2286 (.1428)	.1267 (.1654)	.3162** (.1517)	.3204** (.1388)
Income	3.012E-06 (2.012E-06)	3.000E-06 (2.000E-06)	4.000E-06** (2.000E-06)	4.857E-06** (2.000E-06)	3.694E-06* (2.004E-06)	4.000E-06** (2.000E-06)
CSV	.1412** (.0614)	.1351** (.0572)	.1314** (.0575)	.1352** (.0655)	.1362** (.0606)	.1467*** (.0561)
Constant	-.5223 (.3108)	-.3180 (.2857)	-.0826 (.2838)	.0752 (.3216)	-.2357 (.3020)	-.2559 (.2777)
Sample size	84	40	65	56	245	245
Adjusted R^2					.140	.113
Local R^2	.178	.146	.121	.119		
AIC					603.034	608.375

*** p<0.01, ** p<0.05, * p<0.1

Coefficients also vary across models/regions, with a distinct north/south pattern. Income contributes relatively less to overall LS in the north than in the south: indeed it is not even a significant contributor to overall LS in the two most northern regions. The contribution of other variables is generally greater in the north than the south. This is so for CSV: the models indicate that they are a more important contributor to overall LS for residents of the north than of those in the south.

Tukey Post Hoc tests[65] confirmed the statistical significance (at the 1% level) of differences between each coefficient for each region with three exceptions: (i) the coefficient for age squared for Fitzroy was significantly different to all other regions, however Cairns and Townsville, and Townsville and Mackay, did not have significant differences, and the coefficients for Cairns and Mackay were only significantly different at the 5% level (ii) the coefficient for income was not significantly different between Cairns and Townsville, and (iii) the coefficient on CSV was not significantly different between Mackay and Fitzroy.

Visual inspection of Figure 19 clearly shows that some of the respondents reside much closer to the coast, and thus the GBR, than others. An inverse relationship is generally expected between protection values applied to environmental assets and distance from the asset, referred as distance decay (Rolfe & Windle, 2012). Virtually all of the sampled properties within Townsville region were very close to the coast; those of Cairns region were also fairly close, although many respondents were further inland on the Atherton Tablelands. However, the survey respondents within Mackay and Fitzroy regions are widely dispersed. Indeed, respondents from the southern part of the study area were, on average, more than 2.5 times

[65] Post hoc tests that do not assume equal variances were also tested (Tamhane's T2 test, Dunnett's T3 test, Games-Howell test and Dunnett's C test); all results were the same as the Tukey test results other than for the age squared variable where all regions were significantly different from each other at 1% level other than Townsville and MacKay.

further from the coast than respondents from the northern section. Recognising that geographical proximity to the Reef may impact results, a variable measuring proximity to the Reef was included and the regressions were run again. This variable was not significant, suggesting 'distance decay' is not an issue. This confirms observation from other studies of values in the GBR region (Rolfe & Windle, 2012). However, this topic could be further explored in future research into the importance of space by including an interactive term based on the proximity to the reef and the CS variable.

6.3.3 Estimating the valuation of cultural ecosystem services provided by the GBR

Table 32 presents estimates of the additional annual income that would be required to compensate residents should current (median) levels of satisfaction with CS values drop to zero (equivalent to a situation where residents are neither satisfied nor dissatisfied). These range from almost $30k per capita per annum for Cairns to $17k - $23k per annum per capita in the other regions. Multiplying this amount by the number of employed persons in the GBR region, being 394,878 in total (Australian Bureau of Statistics, 2011), suggests that aggregate 'regional' compensation, representing the CS value of the GBR, would be about $8.7 billion per annum. Whilst numerous studies have attempted to estimate marginal non-use values in the GBR (see, for example the research of Rolfe and colleagues), I know of only one other study that has looked at total values: Stoeckl, Farr, Larson, et al. (2014). They did not focus exclusively on CS, and used a very different methodological approach, but predicted that CS would be worth more than $4 billion per annum associated with the GBR based tourism industry. So my results are not inconsistent with theirs. The calculation of estimated values resulting from marginal changes is more widespread as in most cases it is more appropriate for decision makers to focus on the impact of marginal changes; however there are occasions when total values are more appropriate. For example, the current (early 2016) total bleaching event being experienced by the GBR has seen reports from the ARC Centre of Excellence for Coral Reef Studies that 81% of the reefs in the northern section (from Port Douglas northward) severely bleached and mortality has already been measured at close to 50% of these, with the final death toll at some reefs expected to exceed 90% (https://www.coralcoe.org.au/media-releases/only-7-of-the-great-barrier-reef-has-avoided-coral-bleaching). In such circumstances a total value would more appropriately estimate these damages than a marginal value.

Table 32 Estimated value of CS provided by the GBR to residents of the regions and overall

	Cairns	Townsville	Mackay	Fitzroy	Overall
Income increase required should satisfaction with CSV decline to zero	$29,296	$19,138	$23,001	$16,655	
Number of workers in region	102,879	105,992	84,877	101,130	394,878
Estimated value of the CS provided by the GBR	$3.0bn	$2.0bn	$2.0bn	$1.7bn	$8.7bn

That point aside, it should be noted that although the coefficient on income is significant overall, and significant within the Mackay and Fitzroy regions, it was not significant in the Cairns or Townsville regions. This result could be interpreted to mean that there is no amount of income that could adequately recompense the residents of these regions should the CS cease to satisfy them. In accordance with the law of diminishing marginal utility, once income reaches a certain level then further increases to income will only have a very small impact on utility; the insignificant income coefficients found here indicate that for many of the residents of the northern section of the region this position may have been reached and thus additional income is unable to compensate for the loss of another benefit (the CS of the GBR) which contributes significantly towards LS. Furthermore, the finding of an insignificant coefficient for income in explaining LS (which results in the large value assigned to the CS) in these regions is not unique to this study (and hence should not be dismissed as a function of a weakness in the study); indeed this is the core of Easterlin's income paradox as discussed in detail in Chapter 1, within section 1.2.2.1.

6.4 Conclusions

This research seeks to extend the existing literature based on the LS approach to environmental valuation. Using the GBR as a case study I have tested if it is, in principle, possible to use this technique to estimate the value of the cultural ecosystem services provided by an environmental feature. The findings are cautiously affirmative – although I stress the need for much further research on methods of using questionnaires to measure CS for use in LS studies.

My estimate of 'value' indicates that the CS provided by the GBR to residents of the catchment are likely to be 'worth' about $8.7 billion per annum; however this result should be regarded with some caution as my estimate is based on imperfect data, as described above. The less cautious, and potentially much more significant, finding relates to the observed

spatial variation in 'values': residents of the north appear to gain relatively more satisfaction from CS (and less satisfaction from income) than residents of the south. This highlights the important role that aggregation plays in all non-market valuation studies: it may be possible to calculate the 'average' amount of compensation required to maintain utility should the environment be damaged and ES eroded, but for some individuals, no amount of compensation will ever be enough. Evidently, in this region, it is the residents of the north who will likely feel most aggrieved by development that erodes CS of the GBR.

6.5 Appendix to Chapter 6

6.5.1 Testing to determine whether question order influences results

Tests were conducted to determine whether the order that the questions were posed to the survey respondents appeared to impact the responses that were given. Four dummy variables were created, each representing the type of questions that were asked first within the section of the questionnaire regarding satisfaction with community benefits. The full list of benefits are set out in Table 23. The dummy variables used were as follows:

- D1 – The questions regarding satisfaction with the benefits received from different industries were asked first
- D2 – The questions regarding satisfaction with your opportunities for participating in activities such as eating fresh local caught seafood , going fishing etc., were asked first
- D3 – The questions regarding indinenous values, status of bragging rights and preserving the GBR for future generations were asked first
- D4 – The questions regarding the status/health of various environmental features were asked first.

The OLS regression analysis, using the final variables as set out in Table 25, was then repeated including these dummy variables. Four regression analysis were completed, in each case including three of the dummy variables and excluding the remaining. Should any of the dummy variables have been significant in the regressions then this would indicate that the order of the question does influence the response given. However, in all cases all of the dummy variables were highly insignificant, with the least insignificant dummy, D2, only recording a significance level of .695.

Thus for this dataset the order that the questions were asked did not appear to have any impact on the responses given, and thus have not introduced any bias into the results.

6.5.2 Testing for evidence of endogeneity within the LS Model

If endogeneity is present the problem can be resolved by using one or more instrumental variables (IVs), whilst if the explanatory variables are exogenous, then estimating the model directly (rather than using IVs) will be more efficient; thus the IV should only be used if truly needed. As explained in 5.5.2, a model can be tested for endogeneity using a number of different tests, of which the most widely known are the Durbin test (Durbin, 1954) and the Wu-Hausman test (Hausman, 1978; Wu, 1973). I thus looked for IVs and conducted both the Durbin and Wu-Hausman tests for endogeneity. I also considered an alternate approach (as described in 5.5.2) based on insights from Hausman (1978).

The potential endogenous variables within the model explaining LS are the variables measuring the income of the respondent, and the respondent's satisfaction with non-use values. A suitable IV needs to be highly correlated with the potentially endogenous variable, but not with the dependent variable. Thus bivariate correlation tests were conducted on a wide range of variables, and suitable IVs selected as follows:

(i) Potential IV for income – mean level of household income within the area where the respondents lives. This data was obtained from ABS website at SA1 statistical area level. This IV has a very strong correlation with income (significant at 1% level) but not with LS.

(ii) Potential IV for satisfaction with non-use values – the frequency that the respondent reported having visited offshore reefs. The data were obtained as part of the resident survey, in response to the question "Please tell us how often you do each of the following in the GBRWHA – spend time on offshore reefs". This IV was correlated with satisfaction with non-use values at 11% level but was not significantly correlated with LS.

Endogeneity tests, using Durbin and Wu-Hausman tests, were conducted using the IVs identified above, considering each potential endogenous variable separately, and then considering both potentially endogenous variables together. The results of these endogeneity tests in all cases were insignificant, and thus providing no evidence that the null hypothesis should be rejected. Evidently endogeneity is not present.

I also tested for endogeneity based on insights from Hausman (1978), using the residuals from the GWR model developed and set out in Table 28, and testing for correlation with the potentially endogenous variables, the income of the respondent, and the respondent's satisfaction with non-use values. In both instances the correlation was insignificant, thus failing to provide any evidence that the null hypothesis of exogeneity should be rejected.

Overall, multiple lines of evidence (the formal Durbin test, the Wu-Hausman test, and the correlation between independent variable and the error term) suggest that endogeneity is not present. Regression models will thus be more efficient if IVs are not used.

6.5.3 Factor scores from principal component analysis for satisfaction scores for community-defined benefits assessed in the questionnaire

Table 33 Factor scores from principal component analysis for satisfaction scores

Cultural ecosystem services	Economic benefits	Benefits from activities	Other benefits
Beaches and islands – undeveloped and uncrowded (.736)	The reef-based tourism industry (.749)	Eat fresh locally caught seafood (.597)	The health/status of traditional/indigenous cultural values (.689)
Beaches and islands – without visible rubbish (bottles, plastic) (.793)	The commercial fishing sector (.812)	Go fishing, spear-fishing or crabbing (.861)	The status of your 'bragging rights' – knowing that people envy you for living near the Great Barrier Reef (.794)
Coral reefs (.844)	The mining and agricultural sectors (.750)	Spend time on the beach, go swimming, diving etc. (.807)	
Reef fish (.863)	Cheap shipping transport (.762)	Go boating, sailing or jet-skiing (.857)	
Iconic marine species (whales, dugongs, turtles) (.821)			
Oceans – clear water (with good underwater visibility) (.824)			
Mangroves and wetlands (.801)			
The chances that the GBRWHA will be preserved for future generations (.644)			

Chapter 7 Conclusion

Abstract of Chapter 7

This research has investigated the influences of economic, social and environmental factors within a spatial context on the overall satisfaction with life reported by residents and the overall level of satisfaction with their trip reported by tourists. In this chapter I summarise the key findings of my thesis, discuss the contributions of my work, and make recommendations for future research.

7.1 Introduction

This thesis began by explaining that the world is facing many different crises, and consequently governments have adopted a range of policies, to address these and other challenges. The majority of policies adopted by governments all around the world aim to foster economic growth, believing that GDP at the macro level, or individual incomes at the micro level, acts as an indicator for overall progress; that is, GDP can act as a proxy for overall well-being.

However, research has shown that, particularly in the developed world, increasing levels of GDP does not necessarily increase the levels of well-being experienced by individuals. GDP does not measure progress in all aspects of life; indeed it was specifically designed to measure economic market activity, rather than to be a measure of the broader aspects of human welfare. The contributions of all the many different factors that influence an individual's wellbeing are likely to be interrelated and overlapping, together forming a highly complex, dynamic system, of which economic activity is likely to form only a small part. If governments focus purely on GDP they are failing to take account of the myriad of other factors that may contribute equally, or even more, to overall welfare than GDP itself.

My research has used insights from the LS literature to improve understanding of the trade-offs that arise within complex interlinked social-economic-environmental systems, within a spatial context; gaining insights that in the public arena will truly help us to improve welfare, not just to increase GDP, and in the commercial sector will enable us to improve customer satisfaction, recognising that this is influenced by many things in addition to price. Thus the

overall aim of my thesis is to improve understanding of the trade-offs that arise within complex interlinked social-economic-environmental systems.

Within the private sector, I focused on the tourism industry, investigating the satisfaction of tourists visiting the region. I investigated the likely impact of climate change (in the form of global warming) based on visitors preferred temperature levels (in Chapter 3) and I investigated how the preferences of the visitors can be used to estimate the financial impact of changes to factors from within the social, environmental or economic domain (in Chapter 4). Within the public arena, the research investigated trade-offs and provided insights for public policy on two particular topics; firstly, investigating how understanding the preferences of residents can be used when evaluating proposed changes to electoral and local government boundaries (in Chapter 5), and secondly, investigating how preferences of residents can be used to derive non-use values for an environmental feature (in Chapter 6).

7.2 Thesis outcomes

The original research for this thesis has been set out within Chapters 3 to 6; each of these chapters comprises a separate journal article or conference paper, each of which addresses the specific research objectives identified within Chapter 1. In this section I will summarise each of these chapters, explaining how the specific objectives of my research were addressed.

7.2.1 Summary of Chapter 3 – Could climate change redistribute global tourism activity by impacting trip satisfaction

The objective of this research was to demonstrate that the determinants of LS derived from the LS approach could be used to investigate factors influencing TS whilst addressing the gap in the literature on the relationship between objectively measured temperatures and tourist TS. Thus this chapter specifically addresses research objective 1 set out with Chapter 1. The specific research question addressed was: What is the impact of the actual average daily maximum temperatures experienced by tourists on overall TS?

This study aims to explain variations in TS, using both ordinal regression and OLS regression techniques. TS was found to be affected by environmental, social and economic factors (represented by temperatures, perceptions of water quality and of crime and income), in addition to whether they had just arrived in the region. The model included a measure of the average of the maximum daily temperatures that the tourist had experienced during their trip. This differs

from the more usual approach within the tourism literature of considering tourists satisfaction with the climate or weather they experienced (Alegre & Garau, 2011; Coghlan & Prideaux, 2009) as opposed to objective climate measures.

My research found that (whichever regression technique was used) the relationship between maximum temperatures and TS is not linear, but instead has an inverted U shape, with the average maximum daily temperature that optimises TS found to be around 29 degrees centigrade.

This could have global implications for the tourism industry if temperatures around the world increase due to continued global warming; there could be a redistribution of tourists between regions, with hotter regions suffering due to the negative relationship between temperatures and trip satisfaction above 29 degrees, whilst currently cooler regions benefit from the positive relationship between maximum temperatures and tourist satisfaction at lower temperatures.

These implications are consistent with research into the impact of climate change on LS where researchers concluded that increases to temperatures globally would increase LS in cooler countries, such as those of northern Europe, and reduce LS in hotter countries, such as those in Africa (Maddison & Rehdanz, 2011).

7.2.2 Summary of Chapter 4 – The impact of economic, social and environmental factors on trip satisfaction and the likelihood of visitors returning

The objective of this Chapter was to address the gap in the literature whereby previous research has not sought to determine how changes to factors impacting TS may subsequently affect the likelihood of tourists returning, and has not attempted to estimate the financial impact (in terms of lost revenues from reduced numbers of returning visitors) that could result from changes to factors impacting satisfaction. Thus this chapter specifically addresses research objective 2 set out with Chapter 1. Three specific research questions were addressed in the paper:

1) What is the influence of TS on the likelihood of repeat visits to the GBR region?
2) What factors influence the TS experienced by tourists visiting the GBR?
3) What is the potential financial impact of changes in the number of returning visitors consequent to changes in economic, social and environmental factors that influence tourist TS?

Two stage ordinal regression with instrumental variables was used to estimate the model explaining variations in TS, then ordinal regression was used to estimate the model

explaining variations in the likelihood of the tourist returning, including TS as one of the explanatory variables. The financial value of changes in tourist revenue resulting from changes in repeat visitor numbers caused by changes in the independent variables explaining TS could then be estimated.

This research found a significant positive relationship between TS and the likelihood of repeat visits in the GBR case, confirming findings from studies in other locations of the world (such as Alegre & Cladera, 2006; Hui et al., 2007). TS was again found to be affected by environmental, social and economic factors (represented by water turbidity, perceptions of crime and intensity of construction activity, respectively), in addition to income, whether they visited the Reef and whether they had just arrived in the region (as found in Chapter 3).

The potential financial impact to the economy of the region as a result of changes to perceptions of crime, construction activity and water turbidity was estimated, as deterioration in any of these factors reduces TS which, in turn, reduces the likelihood that tourists will return in future. It was estimated that a deterioration of 10% to any one of the factors, all other factors held constant, would reduce the income in the region from tourism by between $300,000 and $400,000 per annum.

7.2.3 Summary of Chapter 5 – Spatial differences in the contributors to life satisfaction: Implications for electoral boundaries

The objective of this research was to determine the relative importance of the different domains to the overall LS of people living in different places, and determining whether understanding the spatial variations in the influence of different factors on LS can help when drawing/redrawing local government boundaries. Thus this chapter specifically addresses research objective 3 set out with Chapter 1. The study addressed three specific research questions, as follows:

1) Are there spatial variations in the preferences of residents within a region; that is, do different features contribute differently to resident LS in different places?
2) Do observed differences (and similarities) in preferences relate to the electoral boundaries that existed before the round of local government amalgamations and subsequent reversal of some decisions?
3) Can the LS approach contribute an improved understanding of spatial variations in preferences thus informing discussion on local government electoral boundaries?

Principal component analysis was used to group different factors that may explain variations in LS into separable discrete categories, based on subjective data regarding the importance of, and the satisfaction with, these factors. Following the LS approach, the combined overarching variables calculated from these groupings were used to explain variations in LS, confirming my intuitive expectation that the significant composite variables would represent the social, environmental and economic domains. The model was estimated using GWR to enable spatial variations in the impact and significance of the different domains to be identified and evaluated.

The study found that different features do indeed contribute differently to resident LS in different places; significant differences were found between the factors influencing LS across a relatively small region, indicating that there are significant variations in the preferences of residents. Social factors had the strongest impact across the region, but the second strongest influencer was generally the environment in the northern and central sections of the region, and income for the south of the region. Overall, income was the least important influencer, with society (comprising factors such as being able to spend time with family and friends, knowing they are safe, and feeling in control of your life) being far more important to overall LS, as theory has suggested would be the case for a region of a developed, affluent country (Inglehart, 1997; Inglehart et al., 2008; Sen, 1999).

The variations in preferences across the region were then compared to the electoral boundaries that existed prior to the fairly recent local government amalgamations. It was apparent that those amalgamations that were successful comprised combinations of regions with fairly homogenous preferences whilst the unsuccessful amalgamations tried to combine residents with very different preferences. Thus, spatial variations in preferences could be related to the local government boundaries within the region, providing clear indications why some of the recent amalgamations were successful whilst others were subsequently reversed. Thus, my research provides evidence of spatial variations in the relative importance of the different domains in explaining LS, and demonstrates that using the approach to gain an understanding of these spatial variations in preferences could provide clear benefits if used to inform discussions on local government boundaries prior to redrawing electoral boundaries, or amalgamating existing electorates.

7.2.4 Summary of Chapter 6 – New methods for valuing, and identifying spatial variations, in cultural services: A case study of the Great Barrier Reef

The objective of this research was to address the lack of knowledge about the spatial distribution of values within the GBR region noted in the literature, and to extend the existing literature based on environmental valuation using the LS approach to include the hard to monetise non-market

non-use values. Thus this chapter specifically addresses research objective 4 set out with Chapter 1. This study addressed the following specific research questions:

1) Do reported levels of satisfaction with the cultural ecosystem services associated with the GBR contribute to the overall LS reported by residents, and is there spatial variation within this relationship?
2) Can I use coefficients from the LS model to generate estimates of the cultural ecosystem services value of the GBR?

The LS approach is used to develop a model explaining variations in the LS of residents, with a composite variable derived using principal components analysis being used to represent the satisfaction of the residents with the cultural ecosystem services provided by the GBR. Cultural ecosystem services comprise a wide range of values including the nonmaterial benefits people obtain from ecosystems through spiritual enrichment, cognitive development, reflection, recreation and aesthetic experiences and include existence and bequest constructs that may arise from people's beliefs or understandings (Haines-Young & Potschin, 2013). Thus the services being valued included the satisfaction or otherwise of residents that the services provided by the GBR exist now and are being preserved for the future, such services including maintaining healthy coral, reef fish, iconic marine species, mangroves and wetlands, and clean and undeveloped beaches and islands, and clean waters.

GWR was used to specifically identify and evaluate the spatial heterogeneity of values within the GBR catchment region, finding significant spatial variation, with those of the north appearing to gain relatively more satisfaction from the cultural ecosystem services (and less satisfaction from income) than residents of the south. Following the LS valuation approach, the coefficients from this model were then used to estimate the compensation that would be required to maintain the level of LS of the residents should there be a decline in their satisfaction with the cultural ecosystem services provided by the GBR.

The research found that the LS valuation approach offers promise as an alternate method for determining non-use values; the cultural ecosystem services provided by the GBR were found to contribute to the LS of the residents of the region, with an estimated value of around $8.7 billion per annum. This estimate is not inconsistent with research used a very different methodological approach that predicted that non-use values would be worth significantly more than $4 billion per annum value associated with the GBR based tourism industry (Stoeckl, Farr, Larson, et al., 2014).

7.3 Summary of key findings and the contribution of this research

This research, based around addressing the specific objectives set out in Chapter 1, has made a number of empirical and methodological contributions to the literature.

My research has demonstrated that insights from the LS literature can be used beyond the study of the satisfaction of people with their lives; they can also be used within the commercial arena to investigate customer satisfaction, as demonstrated using tourism as an example.

My key findings are that factors from all domains of life impact on satisfaction, and that the preferences of individuals are unlikely to be homogeneous across space. These contributions are widely relevant i.e. they are likely to be useful to researchers investigating a broad range of different issues and 'values' in many different parts of the world, and are relevant for the development of both public policies and commercial developments within many sectors of the economy.

7.3.1 Improved understanding of impact of social-environmental-economic factors on satisfaction

With regard to the overall aim of my thesis, which is to improve understanding of the factors that impact on life and tourist trip satisfaction, I found that factors from all three domains impact on satisfaction, whether considering satisfaction of customers within the commercial domain or the satisfaction of residents with their lives. A summary of the key findings in this regard are summarised in Table 34.

Table 34 Summary of key findings of impact of different domains on satisfaction

	Chapter 3	Chapter 4	Chapter 5	Chapter 6
	Customer satisfaction	**Customer satisfaction**	**Life satisfaction**	**Life satisfaction**
Empirical findings for this region				
Do economic factors influence satisfaction?	Yes	Yes	Yes	Yes
Do environmental factors influence satisfaction?	Yes	Yes	Yes	Yes
Do social factors influence satisfaction?	Yes	Yes	Yes	a
Order of importance of domains in their influence on satisfaction:				
Environment > economic?	a	a	In most regions	Yes
Social > environment or economic factors?	a	a	Yes	a

a Not tested in this study

Empirically, for many residents of this particular region the social domain appears to be the most important for explaining variations in satisfaction, followed by the environment, with economic factors including income being the least important. For tourists to the region, factors from all three domains were found to be important influences of their satisfaction levels, although my research did not attempt to place relative importance of these factors.

Given that the current State and Federal governments appears to be strongly in favour of mining and port development in the region (placing GDP growth ahead of caring for and preserving the environment), it appears their focus may be misguided, and will not serve to improve the welfare of the region's residents, or tourists visiting the region. For example, the increase in construction activity associated with such development will result in decreased TS, and thus a contraction of the tourism industry. This demonstrates that the economic dependencies between industries (here being mining, construction and tourism) that work through the effects on tourist's perceptions and satisfaction levels extend beyond the economic dependences modelled in standard general equilibrium models (e.g. IO and CGE model dependencies only through expenditures). That the environment also matters to residents suggest interdependencies are strong there too. Thus, the insights gained indicate the need for better ways to model linkages, beyond merely focusing on expenditures.

That all three domains of life have been found to be important influencers of LS and TS in this region highlights the importance of taking a holistic view when conducting analysis. This finding is likely to be replicated in other parts of the world. Within the public sector, a focus on economic growth may not best satisfy the preferences of the residents; for many people preserving the environment and the social fabric are far more important than increasing GDP. Within the commercial sector, the analogy to this is that a focus on price alone is unlikely to best satisfy the preferences of customers; many other things are important to customer satisfaction beyond the price of the good or service being purchased. In particular with regard to tourism, for many tourism regions the environment is as fundamental to customer satisfaction as price, if not even more so. Thus, research focusing on just one part of the big picture is likely to provide biased results, such as when conducting partial equilibrium analysis to investigate the relationship between the economy and the environment whilst excluding the influence of the social domain.

7.3.2 Understanding the spatial dimension of influencers of satisfaction

My research revealed significant spatial heterogeneity within the preferences of residents across the study region, with the relative importance of the different domains varying across the region. The lack of knowledge of the spatial distribution of environmental values across the GBR region was addressed in Chapters 5 and 6, finding that generally income was relatively more important to those residing in the south compared to residents elsewhere in the region, whilst environmental factors were more important than economic to those residing further north. Chapter 5 (focusing on the Wet Tropics within the northern part of the GBR catchment region) also included social factors within the analysis, and found that the social domain was relatively more important than the environment or the economy for residents across the region.

The issue of spatial heterogeneity of the preferences of tourists was not specifically addressed within this thesis. However, the tourism research did include location specific factors within the explanatory variables (the maximum temperatures, water quality and degree of construction intensity varies spatially within the region), and the significance of these factors in explaining tourist TS indicates the importance of spatially varying factors on satisfaction within the commercial sector.

Thus distinct spatial variations in the importance of different factors to satisfaction may exist across the region; this has important consequences for future commercial and public policy development as "one size fits all" policy prescriptions are not likely to be successful. Instead, public policies should be tailored to meet the spatially varying preferences of the residents of the region and commercial decisions should reflect the different preferences of customers in different locations.

Chapter 5 demonstrated a public sector example of this, whereby a greater understanding of these spatial preferences in factors from all domains of life can assist with the redrawing of electoral boundaries or amalgamating electoral regions; local governments comprised of individuals with fairly homogenous preferences appear to be more stable and successful than those which are comprised of individuals with spatially heterogeneous preferences.

Chapter 3 demonstrated an example with both public and private sector implications. This study demonstrated that global warming is likely to have different impacts on the TS of tourists in different places, due to the non-linear relationship found between TS and

objectively measured temperatures. Thus a consequence of global warming is likely to be a global redistribution of tourism activity which will require responses by both private sector firms involved in the tourism industry and by the public sector in regions heavily dependent on tourism for jobs and income. The better the understanding of this likely global redistribution of tourists, the more appropriate decisions made in response are likely to be.

Having confirmed (in chapters 3 & 4) the findings of others, such as Ferrer-i-Carbonell and Frijters (2004), that the choice between using regression techniques designed for continuous or ordinal variables has little impact on the results of empirical LS studies, I then tested the use of another continuous data technique, GWR (in chapters 5 and 6). I found that GWR (which estimates separate model coefficients for each respondent based on the spatial distance between respondents) can be used to develop spatially varying models to explain variations in LS, and can provide valuable insights revealing that different factors become more or less important in different places.

Macroeconomic studies investigating LS across different countries have frequently found similar things matter to residents of different countries, but these studies have generally recognised that country specific personal preferences may exist (by using dummy variables representing different countries (for example Welsch, 2007b)), and research comparing rural and urban areas have found variations in preferences between residents of different types of location (Florida et al., 2013). However GWR allows spatial factors to be understood at a microeconomic and local scale, enabling far greater granularity within the analysis.

GWR is also likely to have much to offer within the study of customer satisfaction in the commercial arena. If businesses can understand the spatially varying preferences of their customers they can better differentiate their offering of goods and services across the geographic market that they are to serve, increasing customer satisfaction which is likely to also increase the profit of the firm.

7.3.3 Extending the use of LS approach to estimate values

The research set out in this thesis has revealed the versatility of the LS approach, by demonstrating two new ways that the LS approach can be used to estimate values; either estimating the value of a feature or service found within a region, or estimating the financial impact that would result from a change to a factor from each of the different domains that

impact on satisfaction. These innovative valuation processes have applications within both the private and the public sector.

My research in Chapter 4 has demonstrated a method whereby commercial enterprises can predict the likely future impact to their business that is likely to result from changes to factors influencing customer satisfaction. As far as I am aware this is the first time that a customer satisfaction approach has been used to estimate values within a commercial setting. The approach demonstrated in my work could be used within other industries for other product attributes; thus my research has applications far beyond tourism within the GBR region.

My research set out in Chapter 6 has extended the scope of the LS valuation approach, demonstrating that the LS valuation approach, within a public policy setting, offers great potential to estimate non-use values of environmental assets or services, thus providing another tool in addition to the existing contingent valuation and choice modelling methods available to economists seeking to estimate this type of valuation. Whilst this trial was an initial attempt to use the LS approach in this way; thus the research was imperfect and estimated a value for cultural ecosystem services (which comprise non-use but also potentially some use values), it does clearly demonstrate the potential for using the LS approach for non-use valuations. Representing, as far as I am aware, the first attempt to use the LS approach to monetise such a non-market, non-use, value for an environmental service, this research makes both an empirical contribution to our knowledge of the GBR and a methodological contribution towards non-use valuations anywhere within the world.

7.4 Limitations of research and future directions for research

My research has resulted in a number of important insights into the complex, interrelated dynamic systems that impact on satisfaction. However, a number of limitations were noted to my research, and within chapters 3 to 6, specific recommendations were made for further research arising from those specific topics.

Within Chapter 2 I described the sample selection and collection process, and summarised my response rates, and the socio-demographic characteristics of my respondents. Overall, my resident sample over represents the older, married and more educated person compared to the overall population; a similar comparison for my tourist sample cannot be made as the socio-demographic statistics for tourists visiting the GBR is not available, so far as I am aware. Furthermore, a large drop off in responses was found between those respondents who did (at least

partially) complete/return the questionnaire, and those responses that I could use within my study where the respondent had to have answered specific questions within the survey. These factors could have resulted in sample bias being present within my analysis. Consequently, it is possible that those who completed the questions relevant to my research may have had more pro-environment views compared to those that did not complete those questions; this would have had the effect of overstating the importance of environmental features, and inflating the values assigned to those environmental features, within my research results. Addressing this potential sample bias would be a non-trivial exercise, and is further discussed within future research opportunities below.

Chapter 3 found that for the tourists visiting the GBR region, TS is optimised when average maximum temperatures are around 29 degrees centigrade. Further investigation of the impact of rising temperatures on tourist revenues within individual regions of the GBR catchment and to the GBR catchment region as a whole would be a highly useful and non-trivial future research opportunity. Furthermore, further research is required in other regions of the world to determine if this finding can indeed be generalised enabling conclusions to be drawn regarding the potential impact of global warming on the tourism industry. A further important opportunity for future research (which would require a significantly larger and longer term dataset) would be to investigate the indirect impacts of increased temperatures on tourist satisfaction, resulting from the impact of rising temperatures on the health of the coral reefs of the GBR.

Chapter 4 noted that a limitation of the study was that the Likert scale used for recording respondents levels of TS was a 5 point scale, whereas use of a 7 or 9 (or more) point Likert scale may have given more variation in the respondent's answers that may have enabled the calculation of statistically nested models for TS and the likelihood of returning. Indeed, all of my research was based on measures of satisfaction recorded using a 5 point scale, use of a different measure enabling greater granularity of detail within responses may have generated further insights from each of the studies, and thus could be investigated in future research.

Chapter 4 discussed the 'environmental paradox' of tourism; tourism requires high quality natural resources but tourism itself places stresses on those very resources that the industry requires if it is to continue. Extending the model to incorporate the interaction between visitor numbers and the environment could be usefully addressed in future research. Furthermore, the resulted presented in Chapter 4 could be seen as proof of concept; significant and non-trivial future research is needed to determine how robust these finding are to alternate measures of social, economic and environmental factors, and whether the findings are valid in other parts of the world.

Both Chapters 3 and 4 focused on a dataset of tourists who had spent less than 14 days in the region. Future research could usefully investigate whether tourists who visit for longer periods (whether grey nomads, backpackers or others) have different preferences to the shorter term visitors, and determine any policy implications if differences in preferences are found. Such research is likely to involve a fairly complex data collection process, as it would be beneficial to gather views of these tourists at various different times during their stay in the region, allowing the results to be analysed controlling for the influence of different places visited and different climatic conditions experienced during their trip.

Chapter 5 demonstrated that space had an important influence on happiness, with the factors that contribute to LS being different in different places. This prompts a future research topic: why should this be the case? Future research (which may involve both qualitative and quantitative, using panel data analysis techniques, elements) is required to answer this important question. The opportunities are discussed further below. Furthermore, future research opportunities exist to investigate, for each domain, how the subjective indicators relate to the objective indicators. This would be a non-trivial exercise requiring the gathering of an extensive data set of related objected and subjective indicators in addition to LS data. This could then be analysed using a two-step process, determining how the objective indicators influenced the related subjective indicators, the predicted subjective indicators could then be used to estimate LS. Such research would provide highly useful insights for policy makers, who are generally more able to influence objective measures (such as water quality measured by the amount of suspended sediment in the water) rather than subjective measures (such as people's satisfaction with the quality of the water).

Finally, Chapter 6 noted the need for research on better measures of CS, or non-use values in general, to improve the usefulness of the LS approach for estimating non-use values.

Considering my research as a whole, my work has been based on cross-sectional data which has not allowed for any verification or evaluation of the dynamic relationships that I believe to be important within these interrelated complex systems. This highlights significant and important directions for future research.

Potential sample selection bias (as frequently found within survey based social science research) was identified within my dataset (as described above); future research should aim to minimise this risk, and to adopt analytical techniques that control for potential sampling bias. Whilst it is impossible to force those selected to respond to a survey, response rates may perhaps be improved by the use of shorter and highly specific questionnaires which require less time to complete; furthermore future research could consider collecting resident surveys face to face

rather than using mail as this approach generally generates a higher response rate, although at much higher cost and with the risk that the presence of the interviewer may introduce bias to the responses. Provided a sufficiently large sample of responses could be gathered, analytical techniques could be adopted to address any sampling bias. For example, analysis could be conducted by market segment, to determine if preferences do vary between the different sub-samples; estimates for the total population could be derived by weighting the findings for each sub-group by the proportion of each of these sub-groups within the total population.A key finding of my research is that people in the south of the study region think money is more important than those who live in the north, raising the question of why spatial variation in personal preferences should exist. Two distinct and opposite possibilities exist that could explain such a finding: there could be something specific about the more northern regions that causes people who live there to value things other than money (that is the attributes of different regions, or the relative scarcity of certain attributes[66] in different regions, are different), alternately people who have little concern for money may choose to move to this region (that is that people who choose to live in some places are different to those who chose to live in different places[67]). Cause and effect problems of this nature can only be investigated by conducting analysis that incorporates time series data, using panel data or other dynamic analysis techniques, so that it can be determined whether certain types of people are attracted to certain types of regions, or if after people move to certain regions they learn to appreciate what these regions have to offer and thus modify their preferences.

Extending the study to cover a wider geographic space could provide insights into whether the north/south pattern identified has geographic roots (i.e. is there truly a north-south phenomena perhaps due to the impact of the tropical environment and climate, or some other region specific factor), or whether the pattern has more social/man made roots (i.e. the phenomena may be due to distance from a major city or urban area, with income being most important to those who reside in the heart of the city and becoming less important to those individuals who reside further from the city in any geographic direction).

Whilst I found significant spatial variation in factors influencing LS, I was unable to investigate tourist satisfaction using GWR due to insufficient geographic granularity within

[66] Thus suggesting that future research should look at differences in natural, social and economic endowments and conditions across regions.
[67] Thus suggesting that future research should further investigate the differences in the demographic composition of the population of different regions.

my data. Using GWR within future research into tourist TS could provide useful insights to assist the development of the tourism industry.

A further complexity that merits future consideration relates to the issue of overlapping values. I found that many individual factors have overlapping impacts on satisfaction, which we can control for by combining factors into grouped variables representing discrete, separable values. However, there could be changes in the way different underlying factors group over time and/or over space. Investigating and controlling for changing grouping would be an additional important and non-trivial extension to the literature.

Conducting a longitudinal study using panel data could provide further insights into, and verification of, the dynamics identified within this thesis, informing us about whether changes in overall opinions in the region over-time were due to people moving in/out of region (or tourists becoming residents) in response to factors identified, or were due to changes in attitudes in response to features of the region, which will themselves change over time. Including a time series element to the analysis could inform us of the causal direction of the relationship between location and income: that is, do those who reside in the south value income more in response to factors in that area, or do those individuals who value income choose to move towards the south? Such analysis would also allow more explicit investigation of the links between residents and tourists, enabling insights to be gleaned into the longer term impacts on residents (and indeed to future tourists) that results from changing levels of tourism activity as a result to changes across the three domains. Whilst some useful longitudinal and panel data sets exist (e.g. HILDA, discussed in section 2.3), these currently fail to collect both subjective and objective data across multiple domains; thus undertaking analysis such as this would require additional data than that currently available.

Furthermore, to fully investigate the interrelationships within the interlinked economic, environmental and social complex systems in addition to a far more extensive dataset, it would also be important to use dynamic statistical/econometric methods such as structural equation modelling that allow us to fully investigate complex systems. Unfortunately, such a research project would require a very substantial budget and time frame to enable the issues to be fully analysed.

Finally, a non-trivial extension to the satisfaction literation would be to conduct a study investigating the relationships between satisfaction and the social, environmental and economic domains of life across both time and space; that is incorporating the effects of

changes over time and over space within the same analysis. Such an extension as this would be highly complex; statistical techniques that are able to combine panel data and GWR techniques are still in their infancy, and as far as I am aware have not yet been attempted within the field of LS research. A method of geographically weighted panel regression analysis has been pioneered by Yu (2010), and utilised by Bruna and Yu (2013) whereby standard panel data techniques are applied to locally weighted subsets of the data based on the spatial dimension. The application of this technique to satisfaction studies could generate truly new and important insights to inform policy within the public and private sector.

7.5 Final remarks

In my research, I set out to explore what the LS approach could do to help us better understand the complex and interlinked social, economic and environmental systems.

I have demonstrated that the LS approach is a useful, and highly versatile, tool for enabling us to better understand what truly makes people satisfied with their lives or purchases. The approach can provide insights into the various factors that can improve satisfaction levels, and has shown that the importance, and magnitude, of these factors vary across space. Satisfaction is affected by a much greater range of factors over and above those of a financial nature, and indeed for many people in many places income/price is by no means the most important determinant. Thus national or international public policy focusing on increasing GDP is unlikely to meet the preferences of most people, local solutions focused on the local preferences and choices of people in particular areas is much more likely to improve the welfare of the people. Similarly, commercial organisations are likely to find that a better understanding of the preferences of their customers, and the spatial variations within these, will enable them to differentiate their service offering and thus best satisfy the preferences of those people who comprise their potential customer base, rather than focusing purely on price.

Chapter 8 References

Abdallah, S., Thompson, S., & Marks, N. (2008). Estimating worldwide life satisfaction. *Ecological Economics, 65*(1), 35-47. doi: 10.1016/j.ecolecon.2007.11.009

Adamowicz, W., Swait, J., Boxall, P., Louviere, J., & Williams, M. (1997). Perceptions versus Objective Measures of Environmental Quality in Combined Revealed and Stated Preference Models of Environmental Valuation. *Journal of Environmental Economics and Management, 32*(1), 65-84. doi: 10.1006/jeem.1996.0957

Alegre, J., & Cladera, M. (2006). Repeat Visitation in Mature Sun and Sand Holiday Destinations. *Journal of Travel Research, 44*(3), 288-297. doi: 10.1177/0047287505279005

Alegre, J., & Garau, J. (2010). Tourist satisfaction and dissatisfaction. *Annals of Tourism Research, 37*(1), 52-73. doi: 10.1016/j.annals.2009.07.001

Alegre, J., & Garau, J. (2011). The Factor Structure of Tourist Satisfaction at Sun and Sand Destinations. *Journal of Travel Research, 50*(1), 78-86. doi: 10.1177/0047287509349270

Alesina, A., Di Tella, R., & MacCulloch, R. J. (2004). Inequality and happiness: are Europeans and Americans different? *Journal of Public Economics, 88*(9/10), 2009-2042. doi: 10.1016/j.jpubeco.2003.07.006

Ambrey, C. L., & Fleming, C. M. (2011). Valuing scenic amenity using life satisfaction data. *Ecological Economics, 72*, 106-115. doi: 10.1016/j.ecolecon.2011.09.011

Ambrey, C. L., & Fleming, C. M. (2012). Valuing Australia's protected areas: A life satisfaction approach. *New Zealand Economic Papers, 46*(3), 191. doi: 10.1080/00779954.2012.697354

Ambrey, C. L., & Fleming, C. M. (2014a). The causal effect of income on life satisfaction and the implications for valuing non-market goods. *Economics Letters, 123*(2), 131-134. doi: 10.1016/j.econlet.2014.01.031

Ambrey, C. L., & Fleming, C. M. (2014b). Life Satisfaction in Australia: Evidence from Ten Years of the HILDA Survey. *Social Indicators Research, 115*(2), 691-714. doi: 10.1007/s11205-012-0228-0

Ambrey, C. L., & Fleming, C. M. (2014c). Public Greenspace and Life Satisfaction in Urban Australia. *Urban Studies, 51*(6), 1290-1321.

Ambrey, C. L., & Fleming, C. M. (2014d). Valuing Ecosystem Diversity in South East Queensland: A Life Satisfaction Approach. *Social Indicators Research, 115*(1), 45-65. doi: 10.1007/s11205-012-0208-4

Ambrey, C. L., Fleming, C. M., & Chan, A. Y.-C. (2014). Estimating the cost of air pollution in South East Queensland: An application of the life satisfaction non-market valuation approach. *Ecological Economics, 97*, 172-181. doi: 10.1016/j.ecolecon.2013.11.007

Ambrey, C. L., Fleming, C. M., & Manning, M. (2014). Perception or Reality, What Matters Most When it Comes to Crime in Your Neighbourhood? *Social Indicators Research, 119*(2), 877-896. doi: 10.1007/s11205-013-0521-6

Arcelus, F. J., Arocena, P., Cabasés, F., & Pascual, P. (2015). On the Cost-Efficiency of Service Delivery in Small Municipalities. *Regional studies, 49*(9), 1469-1412. doi: 10.1080/00343404.2013.837872

Arifwidodo, S. D., & Perera, R. (2011). Quality of Life and Compact Development Policies in Bandung, Indonesia. *Applied Research in Quality of Life, 6*(2), 159-179. doi: 10.1007/s11482-010-9123-5

Artell, J., Ahtiainen, H., & Pouta, E. (2013). Subjective vs. objective measures in the valuation of water quality. *Journal of Environmental Management, 130*, 288-296. doi: 10.1016/j.jenvman.2013.09.007

Assaf, A., Pestana Barros, C., & Machado, L. P. (2013). Covariates of repeat tourism: an endogenous switching Poisson model. *Tourism Economics, 19*(3), 531-544. doi: 10.5367/te.2013.0296

Assaker, G., & Hallak, R. (2012). European travelers' return likelihood and satisfaction with Mediterranean sun-and-sand destinations: a Chi-square Automatic Identification Detector-based segmentation approach. *Journal of vacation marketing, 18*(2), 105-120. doi: 10.1177/1356766711435977

Assaker, G., Vinzi, V. E., & O'Connor, P. (2011). Examining the effect of novelty seeking, satisfaction, and destination image on tourists'; return pattern: a two factor, non-linear latent growth model. *Tourism Management, 32*(4), 890-901. doi: 10.1016/j.tourman.2010.08.004

Australian Bureau of Statistics. (2010) Statistical Area Level 2. Retrieved 1/06/16, from http://www.abs.gov.au/ausstats/abs@.nsf/Latestproducts/88F6A0EDEB8879C0CA257801000C64D9?opendocument

Australian Bureau of Statistics. 3401.0 Overseas Arrivals and Departures, Australia. Retrieved 30/05/14, from http://www.abs.gov.au/ausstats/abs@.nsf/mf/3401.0

Australian Bureau of Statistics. (2010). 1287.0 Standards for Income Variables 2010. Retrieved 8/3/14, from http://www.abs.gov.au/AUSSTATS/abs@.nsf/Lookup/ED44B2BCB1995523CA2576E40014561A?opendocument

Australian Bureau of Statistics. (2011). Data by Region. Retrieved 27/7/14, from http://stat.abs.gov.au/itt/r.jsp?databyregion#/

Australian Bureau of Statistics. (2015). 3218.0 Regional Population Growth, Australia. Retrieved 30/7/2015, from http://www.abs.gov.au/AUSSTATS/abs@.nsf/DetailsPage/3218.02013- 14?OpenDocument

Baker, D. A., & Crompton, J. L. (2000). Quality, satisfaction and behavioral intentions. *Annals of Tourism Research, 27*(3), 785-804. doi: 10.1016/S0160-7383(99)00108-5

Ballas, D., & Tranmer, M. (2012). Happy people or happy places?: a multilevel modeling approach to the analysis of happiness and well-being. *International Regional Science Review, 35*(1), 70-102. doi: 10.1177/0160017611403737

Bateman, I. J., Jones, A. P., Lovett, A. A., Lake, I. R., & Day, B. H. (2002). Applying geographical information systems (GIS) to environmental and resource economics. *Environmental & Resource Economics, 22*(1/2), 219-269. doi: 10.1023/A:1015575214292

Beja Jr, E. L. (2012). Subjective Well-Being Approach to Environmental Valuation: Evidence for Greenhouse Gas Emissions. *Social Indicators Research, 109*(2), 243-266. doi: 10.1007/s11205-011-9899-1

Bertram, C., & Rehdanz, K. (2015). The role of urban green space for human well-being. *Ecological Economics, 120*, 139-152. doi: 10.1016/j.ecolecon.2015.10.013

Brau, R., & Cao, D. (2008). *Uncovering the macrostructure of tourists' preferences. A choice experiment analysis of tourism demand to Sardinia.* Paper presented at the Papers from the" Second International Conference on Tourism and Sustainable Economic Development: Macro and Micro Economic Issues", Sardinia, Italy, 15-16 September 2005.

Braungart, J. M., Plomin, R., DeFries, J. C., & Fulker, D. W. (1992). Genetic Influence on Tester-Rated Infant Temperament as Assessed by Bayley's Infant Behavior Record: Nonadoptive and Adoptive Siblings and Twins. *Developmental Psychology, 28*(1), 40-47. doi: 10.1037/0012-1649.28.1.40

Brereton, F., Clinch, J. P., & Ferreira, S. (2008). Happiness, geography and the environment. *Ecological Economics, 65*(2), 386-396. doi: 10.1016/j.ecolecon.2007.07.008

Briffault, R. (1996). The Local Government Boundary Problem in Metropolitan Areas. *Stanford law review, 48*(5), 1115-1171.

Brodie, J., & Waterhouse, J. (2012). A critical review of environmental management of the 'not so Great' Barrier Reef. *Estuarine, Coastal and Shelf Science, 104-105*, 1. doi: 10.1016/j.ecss.2012.03.012

Brown, G., & Mendelsohn, R. (1984). The hedonic travel cost method. *Review of Economics and Statistics, 66*, 427-433.

Bruna, F., & Yu, D. (2013). *Geographically weighted panel regression.* Paper presented at the XI Congreso Galego de Estatística e Investigación de Operacións. http://xisgapeio. udc. es.

Butler, R. W. (1980). The concept of a tourist area cycle of evolution: implications for management of resources. *The Canadian Geographer/Le Géographe canadien, 24*(1), 5-12.

Byrnes, J., & Dollery, B. (2002). Do Economies of Scale Exist in Australian Local Government? A Review of the Research Evidence1. *Urban Policy and Research, 20*(4), 391-414. doi: 10.1080/0811114022000032618

Cai, B., Cameron, T. A., & Gerdes, G. R. (2011). Distal order effects in stated preference surveys. *Ecological Economics, 70*(6), 1101-1108. doi: 10.1016/j.ecolecon.2010.12.018

Callanan, M., Murphy, R., & Quinlivan, A. (2014). The Risks of Intuition: Size, Costs and Economies of Scale in Local Government. *The Economic and Social Review, 45*(3), 371.

Campbell, D., Hensher, D. A., & Scarpa, R. (2011). Non-attendance to attributes in environmental choice analysis: a latent class specification. *Journal of Environmental Planning and Management, 54*(8), 1061-1076.

Cantril, H. (1965). *Pattern of human concerns*. New Brunswick, New Jersey: Rutgers University Press.

Carbone, J. C., & Kerry Smith, V. (2013). Valuing nature in a general equilibrium. *Journal of Environmental Economics and Management*.

Carr, L., & Mendelsohn, R. (2003). Valuing Coral Reefs: A Travel Cost Analysis of the Great Barrier Reef. *AMBIO: A Journal of the Human Environment, 32*(5), 353-357.

Carroll, N., Frijters, P., & Shields, M. A. (2009). Quantifying the costs of drought: new evidence from life satisfaction data. *Journal of Population Economics, 22*(2), 445-461. doi: 10.1007/s00148-007-0174-3

Carson, R. T., Flores, N. E., & Meade, N. F. (2001). Contingent valuation: controversies and evidence. *Environmental & Resource Economics, 19*(2), 173-210. doi: 10.1023/A:1011128332243

Carson, R. T., Mitchell, R. C., Hanemann, M., Kopp, R. J., Presser, S., & Ruud, P. A. (2003). Contingent Valuation and Lost Passive Use: Damages from the Exxon Valdez Oil Spill. *Environmental and Resource Economics, 25*(3), 257-286.

Casagrandi, R., & Rinaldi, S. (2002). A theoretical approach to tourism sustainability. *Conservation Ecology, 6*(1), 13.

Cerina, F. (2007). Tourism specialization and environmental sustainability in a dynamic economy. *Tourism Economics, 13*(4), 553-582. doi: 10.5367/000000007782696032

Chasco, C., & Le Gallo, J. (2013). The impact of objective and subjective measures of air quality and noise on house prices: a multilevel approach for downtown Madrid. *Economic geography, 89*(2), 127-148. doi: 10.1111/j.1944-8287.2012.01172.x

Chen, C.-F., & Tsai, D. (2007). How destination image and evaluative factors affect behavioral intentions? *Tourism Management, 28*(4), 1115-1122. doi: 10.1016/j.tourman.2006.07.007

Chen, S.-K., & Lin, S. S. J. (2014). The Latent Profiles of Life Domain Importance and Satisfaction in a Quality of Life Scale. *Social Indicators Research, 116*(2), 429-445. doi: 10.1007/s11205-013-0309-8

Choo, H., & Petrick, J. F. (2014). Social interactions and intentions to revisit for agritourism service encounters. *Tourism Management, 40*, 372-381. doi: 10.1016/j.tourman.2013.07.011

Clark, A. E. (2003). Unemployment as a social norm: psychological evidence from panel data. *Journal of Labor Economics, 21*(2), 323-351. doi: 10.1086/345560

Clark, A. E., Frijters, P., & Shields, M. A. (2008). Relative Income, Happiness, and Utility: An Explanation for the Easterlin Paradox and Other Puzzles. Journal of Economic Literature, 46(1), 95. doi: 10.1257/jel.46.1.95

Coghlan, A. (2012). Facilitating reef tourism management through an innovative importance-performance analysis method. *Tourism Management, 33*(4), 767-775. doi: 10.1016/j.tourman.2011.08.010

Coghlan, A., & Prideaux, B. (2009). Welcome to the wet tropics: the importance of weather in reef tourism resilience. *Current Issues in Tourism, 12:2*, 89-104.

Commission on Sustainable Development. (1996). Sustainable tourism development in small island developing States: United Nations Department of Economic and Social Affairs.

Costanza, R., Cumberland, J., Daly, H. E., Goodland, R., & Norgaard, R. B. (1997). *An Introduction to Ecological Economics*. Boca Raton, Fla: International Society for Ecological Economics.

Costanza, R., d'Arge, R., de Groot, R., Farber, S., Grasso, M., Hannon, B., . . . O'Neill, R. V. (1997). The value of the world's ecosystem services and natural capital. *Nature, 387*, 253-260.

Costanza, R., Fisher, B., Ali, S., Beer, C., Bond, L., Boumans, R., . . . Snapp, R. (2007). Quality of life: An approach integrating opportunities, human needs, and subjective well-being. *Ecological Economics, 61*(2), 267-276. doi: 10.1016/j.ecolecon.2006.02.023

Costanza, R., Hart, M., Talberth, J., & Posner, S. (2009). Beyond GDP: The need for new measures of progress. Pardee Paper No. 4, Boston: Pardee Center for the Study of the Longer-Range Future.

Costanza, R., Wainger, L., Folke, C., & Mäler, K.-G. (1993). Modeling complex ecological economic systems. *BioScience*, 545-555.

Cummins, R. A. (1996). The Domains of Life Satisfaction: An Attempt to Order Chaos. *Social Indicators Research, 38*(3), 303-328. doi: 10.1007/BF00292050

Cummins, R. A. (2000a). Objective and Subjective Quality of Life: An Interactive Model. *Social Indicators Research, 52*(1), 55-72.

Cummins, R. A. (2000b). Personal Income and Subjective Well-being: A Review. *Journal of Happiness Studies, 1*(2), 133-158. doi: 10.1023/A:1010079728426

Cuñado, J., & de Gracia, F. P. (2013). Environment and Happiness: New Evidence for Spain. *Social Indicators Research, 112*(3), 549-567. doi: 10.1007/s11205-012-0038-4

Daly, H. E. (1987). The economic growth debate: What some economists have learned but many have not. *Journal of Environmental Economics and Management, 14*(4), 323-336. doi: 10.1016/0095-0696(87)90025-8

Daly, H. E., & Cobb, J. B. (1989). *For the common good: redirecting the economy toward community, the environment, and a sustainable future*. Boston: Beacon Press.

de Groot, R., Brander, L., van der Ploeg, S., Costanza, R., Bernard, F., Braat, L., . . . van Beukering, P. (2012). Global estimates of the value of ecosystems and their services in monetary units. *Ecosystem Services, 1*(1), 50-61. doi: 10.1016/j.ecoser.2012.07.005

De'ath, G., Fabricius, K. E., Sweatman, H., & Puotinen, M. (2012). The 27–year decline of coral cover on the Great Barrier Reef and its causes. *Proceedings of the National Academy of Sciences, 109*(44), 17995-17999.

Deci, E. L., & Ryan, R. M. (2008). Hedonia, eudaimonia, and well-being: an introduction. *Journal of Happiness Studies, 9*(1), 1-11. doi: 10.1007/s10902-006-9018-1

Deloitte Access Economics. (2013). Economic Contribution of the Great Barrier Reef: Great Barrier Reef Marine Park Authority, Townsville.

Demos, E. (1992). Concern for Safety: A Potential Problem in the Tourist Industry. *Journal of Travel & Tourism Marketing, 1*(1), 81-88. doi: 10.1300/J073v01n01_06

Di Tella, R., MacCulloch, R. J., & Oswald, A. J. (2003). The macroeconomics of happiness. *The Review of Economics and Statistics, 85*(4), 809-827. doi: 10.1162/003465303772815745

Diener, E., Sandvik, E., Seidlitz, L., & Diener, M. (1993). The Relationship between Income and Subjective Well-Being: Relative or Absolute? *Social Indicators Research, 28*(3), 195-223. doi: 10.1007/BF01079018

Diener, E., & Suh, E. (1997). Measuring Quality of Life: Economic, Social, and Subjective Indicators. *Social Indicators Research, 40*(1/2), 189-216. doi: 10.1023/A:1006859511756

Diener, E., Suh, E. M., Lucas, R. E., & Smith, H. L. (1999). Subjective Well-Being: Three Decades of Progress. *Psychological Bulletin, 125*(2), 276-302. doi: 10.1037/0033-2909.125.2.276

Dietz, S., & Maddison, D. J. (2009). New Frontiers in the Economics of Climate Change. *Environmental & Resource Economics, 43*(3), 295-306. doi: 10.1007/s10640-009-9278-4

Dilman, D. A. (2007). *Mail and Internet surveys: the tailored design, —2007 update*. San Fransisco: John Wiley.

Dixon, H. D. (1997). Controversy: economics and happiness. *The Economic Journal, 107*(445), 1812-1858.

Dolan, P., Peasgood, T., & White, M. (2008). Do we really know what makes us happy?: a review of the economic literature on the factors associated with subjective well-being. *Journal of economic psychology, 29*(1), 94-122. doi: 10.1016/j.joep.2007.09.001

Dollery, B., Byrnes, J., & Crase, L. (2008). Australian Local Government Amalgamation: A Conceptual Analysis of Population Size and Scale Economies in Municipal Service Provision. *Australasian Journal of Regional Studies, The, 14*(2), 167-175.

Dowding, K., John, P., & Biggs, S. (1994). Tiebout : A Survey of the Empirical Literature. *Urban Studies, 31*(4-5), 767-797. doi: 10.1080/00420989420080671

Driml, S. (2002). Travel cost analysis of recreation value in the Wet Tropics World Heritage Area. *Economic Analysis and Policy, 32*, 11-26.

Durbin, J. (1954). Errors in Variables. *Revue de l'Institut International de Statistique / Review of the International Statistical Institute, 22*(1/3), 23-32.

Easterlin, R. A. (1973). Does money buy happiness. *Public Interest*(30), 3-10.

Easterlin, R. A. (1995). Will raising the incomes of all increase the happiness of all? *Journal of Economic Behavior and Organization, 27*(1), 35-47. doi: 10.1016/0167-2681(95)00003-B

Easterlin, R. A. (2001). Income and Happiness: Towards a Unified Theory. *The Economic Journal, 111*(Newspaper Article), 465-484. doi: 10.1111/1468-0297.00646

Easterlin, R. A. (2003). Explaining happiness. *Proceedings of the National Academy of Sciences of the United States of America, 100*(19), 11176-11183. doi: 10.1073/pnas.1633144100

Engelbrecht, H.-J. (2009). Natural capital, subjective well-being, and the new welfare economics of sustainability: Some evidence from cross-country regressions. *Ecological Economics, 69*(2), 380-388. doi: 10.1016/j.ecolecon.2009.08.011

Esparon, M., Stoeckl, N., Larson, S., Farr, M., & Schmider, J. (2014). How 'valuable' are the ecosystem services of the Wet Tropics World Heritage Area to residents and tourists? Report to the National Environmental Research Program. Reef and Rainforest Research Centre Limited, Cairns.

Fabricius, K. E., De'ath, G., Humphrey, C., Zagorskis, I., & Schaffelke, B. (2013). Intra-annual variation in turbidity in response to terrestrial runoff on near-shore coral reefs of the Great Barrier Reef. *Estuarine, Coastal and Shelf Science, 116*, 57-65. doi: 10.1016/j.ecss.2012.03.010

Farr, M., Stoeckl, N., Esparon, M., Larson, S., & Jarvis, D. (2014). The importance of water clarity to tourists in the Great Barrier Reef and their willingness to pay to improve it. *Tourism Economics Fast Track*. doi: http://dx.doi.org/10.5367/te.2014.0426

Ferreira, S., Akay, A., Brereton, F., Cunado, J., Martinsson, P., Moro, M., & Ningal, T. F. (2013). Life satisfaction and air quality in Europe. *Ecological Economics, 88*, 1. doi: 10.1016/j.ecolecon.2012.12.027

Ferreira, S., & Moro, M. (2010). On the use of subjective well-being data for environmental valuation. *Environmental & Resource Economics, 46*(3), 249-273. doi: 10.1007/s10640-009-9339-8

Ferreira, S., & Moro, M. (2013). Income and preferences for the environment: evidence from subjective well-being data. *Environment and Planning A, 45*(3), 650-667. doi: 10.1068/a4540

Ferrer-i-Carbonell, A. (2013). Happiness economics. *SERIEs, 4*(1), 35-60. doi: 10.1007/s13209-012-0086-7

Ferrer-i-Carbonell, A., & Gowdy, J. M. (2007). Environmental degradation and happiness. *Ecological Economics, 60*(3), 509-516. doi: 10.1016/j.ecolecon.2005.12.005

Ferrer-i-Carbonell, A., & Frijters, P. (2004). How Important is Methodology for the estimates of the determinants of Happiness? *The Economic Journal, 114*(497), 641-659. doi: 10.1111/j.1468-0297.2004.00235.x

Florida, R., Mellander, C., & Rentfrow, P. J. (2013). The happiness of cities. *Regional studies, 47*(4), 613-627. doi: 10.1080/00343404.2011.589830

Florida, R., Mellander, C., & Stolarick, K. (2011). Beautiful places: the role of perceived aesthetic beauty in community satisfaction. *Regional studies, 45*(1), 33-48. doi: 10.1080/00343404.2010.486784

Fortin, M., & Dale, M. (2005). Spatial analysis: A guide for ecologists. Cambridge. England: Cambridge University Press

Fotheringham, A. S., Brunsdon, C., & Charlton, M. (2002). *Geographically weighted regression: the analysis of spatially varying relationships*. Chichester, England: John Wiley.

Frank, R. H. (1997). The frame of reference as a public good. *The Economic Journal, 107*(445), 1832-1847. doi: 10.1111/j.1468-0297.1997.tb00086.x

Frey, B. S., & Gallus, J. (2013a). Political economy of happiness. *Applied Economics, 45*(30), 4205.

Frey, B. S., & Gallus, J. (2013b). Subjective Well-Being and Policy. *Topoi, 32*(2), 207-212. doi: 10.1007/s11245-013-9155-1

Frey, B. S., Luechinger, S., & Stutzer, A. (2009). The Life Satisfaction Approach to Valuing Public Goods: The Case of Terrorism. *Public Choice, 138*(3/4), 317-345. doi: 10.1007/s11127-008-9361-3

Frey, B. S., & Stutzer, A. (1999). Measuring Preferences by Subjective Well-Being. *Journal of Institutional and Theoretical Economics (JITE) / Zeitschrift für die gesamte Staatswissenschaft, 155*(4), 755-778.
Frey, B. S., & Stutzer, A. (2000). Happiness, Economy and Institutions. *The Economic Journal, 110*(466), 918-938. doi: 10.1111/1468-0297.00570
Frey, B. S., & Stutzer, A. (2002). *Happiness & Economics. How the economy and institutions affect human well-being*: Princeton University Press.
Frey, B. S., & Stutzer, A. (2012). The use of happiness research for public policy. *Social Choice and Welfare, 38*(4), 659-674. doi: 10.1007/s00355-011-0629-z
Frijters, P., & Praag, v. B. M. S. (1998). The effects of climate on welfare and well-being in Russia. *Climatic Change, 39*(1), 61-81. doi: 10.1023/A:1005347721963
Fuchs, M., & Weiermair, K. (2003). New perspectives of satisfaction research in tourism destinations. *Tourism Review, 58*(3), 6-14. doi: 10.1108/eb058411
Furnas, M. (2003). *Catchments and corals: terrestrial runoff to the Great Barrier Reef*. Townsville, Qld: Australian Institute of Marine Science.
Gans, J., King, S., Stonecash, R., & Mankiw, N. G. (2009). *Principles of economics*. South Melbourne, Vic: Cengage Learning.
Giannoni, S., & Maupertuis, M.-A. (2007). Environmental quality and optimal investment in tourism infrastructures: a small island perspective. *Tourism Economics, 13*(4), 499-513.
Gill, T. G. (2008). A psychologically plausible goal-based utility function. *Informing Science: the International Journal of an Emerging Transdiscipline, 11*, 227.
Gladstone Ports Corporation. Retrieved 30/7/2015, from http://www.gpcl.com.au/operations/port-of-gladstone
Gowdy, J. M. (2005). Toward a new welfare economics for sustainability. *Ecological Economics, 53*(2), 211-222. doi: 10.1016/j.ecolecon.2004.08.007
Great Barrier Reef Marine Park Authority. (2014a). Great Barrier Reef Outlook Report 2014: GBRMPA, Townsville.
Great Barrier Reef Marine Park Authority. (2014b). Tourist visits to the entire marine park. Retrieved 29/5/2014, from http://www.gbrmpa.gov.au/visit-the-reef/visitor-contributions/gbr_visitation/numbers/tourist-visits-to-the-entire-marine-park
Guardiola, J., González-Gómez, F., & Lendechy Grajales, Á. (2013). The Influence of Water Access in Subjective Well-Being: Some Evidence in Yucatan, Mexico. *Social Indicators Research, 110*(1), 207-218. doi: 10.1007/s11205-011-9925-3
Haines-Young, R., & Potschin, M. (2013). Common International Classification of Ecosystem Services (CICES): Consultation on Version 4, August-December 2012. EEA Framework Contract No EEA/IEA/09/003 Download at www.cices.eu or www.nottingham.ac.uk/cem.
Handszuh, H. F. (2006). *Safety and Security as a fundamental issue: Risk management and partnership*. Paper presented at the International Seminar: Establishment and Enhancement of Competitive Systems Aimed at Tourism Quality, Algiers, Algeria.
Hanemann, W. M. (1991). Willingness to Pay and Willingness to Accept: How Much Can They Differ? *American Economic Review, 81*(3), 635-647.
Harris, J. M., & Roach, B. (2013). *Environmental and natural resource economics: a contemporary approach 3rd Edition*. Armonk, New York: ME Sharpe.
Hausman, D. M., & McPherson, M. S. (2009). Preference Satisfaction And Welfare Economics. *Economics and Philosophy, 25*(1), 1-25. doi: 10.1017/S0266267108002253
Hausman, J. A. (1978). Specification Tests in Econometrics. *Econometrica, 46*(6), 1251-1271.

Hayes, B. E. (2008). *Measuring customer satisfaction and loyalty: survey design, use, and statistical analysis methods* (Vol. 3rd). Milwaukee, Wis: ASQ Quality Press.

Helliwell, J. F. (2003). How's life? Combining individual and national variables to explain subjective well-being. *Economic Modelling, 20*(2), 331-360. doi: 10.1016/s0264-9993(02)00057-3

Helliwell, J. F., Huang, H., & Wang, S. (2014). Social Capital and Well-Being in Times of Crisis. *Journal of Happiness Studies, 15*(1), 145-162. doi: 10.1007/s10902-013-9441-z

Helliwell, J. F., & Wang, S. (2011). Trust and Wellbeing. *International Journal of Wellbeing, 1*(1). doi: 10.5502/ijw.v1i1.9

Helsel, D. R. (1990). Less than obvious - statistical treatment of data below the detection limit. Environmental Science & Technology, 24(12), 1766-1774. doi: 10.1021/es00082a001

Hernández, J. M., & León, C. J. (2007). The interactions between natural and physical capitals in the tourist lifecycle model. *Ecological Economics, 62*(1), 184-193. doi: 10.1016/j.ecolecon.2006.06.009

Hernández, J. M., & León, C. J. (2013). Welfare and environmental degradation in a tourism-based economy. *Tourism Economics, 19*(1), 5-35.

Hinnerich, B. T. (2009). Do merging local governments free ride on their counterparts when facing boundary reform? *Journal of Public Economics, 93*(5), 721-728. doi: 10.1016/j.jpubeco.2009.01.003

Hoehn, J. P., Berger, M. C., & Blomquist, G. C. (1987). A hedonic model of interregional wages, rents, and amenity values. *Journal of Regional Science, 27*(4), 605-620. doi: 10.1111/j.1467-9787.1987.tb01184.x

Hole, A. R., & Riise Kolstad, J. (2013). Inferred vs. stated attribute non-attendance in choice experiments: a study of doctors' prescription behaviour. *Journal of economic behavior & organization, 96*, 21-31.

Hsieh, C.-M. (2003). Counting Importance: The Case of Life Satisfaction and Relative Domain Importance. *Social Indicators Research, 61*(2), 227-240. doi: 10.1023/A:1021354132664

Hsieh, C.-M. (2012). Importance is Not Unimportant: The Role of Importance Weighting in QOL Measures. *Social Indicators Research, 109*(2), 267-278. doi: 10.1007/s11205-011-9900-z

Hui, T. K., Wan, D., & Ho, A. (2007). Tourists' satisfaction, recommendation and revisiting Singapore. *Tourism Management, 28*(4), 965-975. doi: 10.1016/j.tourman.2006.08.008

Hundloe, T., Vanclay, F., & Carter, M. (1987). Economic and socio-economic impacts of the crown of thorns starfish on the Great Barrier Reef: Institute of Applied Environmental Research, Griffith University.

Inglehart, R. (1997). Modernization, postmodernization and changing perceptions of risk. *International Review of Sociology, 7*(3), 449-459. doi: 10.1080/03906701.1997.9971250

Inglehart, R., Foa, R., Peterson, C., & Welzel, C. (2008). Development, Freedom, and Rising Happiness: A Global Perspective (1981-2007). *Perspectives on Psychological Science, 3*(4), 264-285. doi: 10.1111/j.1745-6924.2008.00078.x

IPCC. (2013). Summary for Policymakers. In: Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Stocker, T.F., D. Qin, G.-K. Plattner, M. Tignor, S.K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex and P.M. Midgley

(eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

IPCC. (2014). Summary for policymakers. In: Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Field, C.B., V.R. Barros, D.J. Dokken, K.J. Mach, M.D. Mastrandrea, T.E. Bilir, M. Chatterjee, K.L. Ebi, Y.O. Estrada, R.C. Genova, B. Girma, E.S. Kissel, A.N. Levy, S. MacCracken, P.R. Mastrandrea, and L.L. White (eds.)] (pp. 32): Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

Jang, S., & Feng, R. (2007). Temporal destination revisit intention: The effects of novelty seeking and satisfaction. *Tourism Management, 28*(2), 580-590. doi: 10.1016/j.tourman.2006.04.024

Jarvis, D., Stoeckl, N., & Liu, H.-B. (2016). The impact of economic, social and environmental factors on trip satisfaction and the likelihood of visitors returning. *Tourism Management - In press*.

Jenkins, R. (1998). Untangling the Politics of Electoral Boundaries in Canada, 1993-1997. *American Review of Canadian Studies, 28*(4), 517. doi: 10.1080/02722019809481616

Johnson, W., & Krueger, R. F. (2006). How Money Buys Happiness: Genetic and Environmental Processes Linking Finances and Life Satisfaction. *Journal of Personality and Social Psychology, 90*(4), 680-691. doi: 10.1037/0022-3514.90.4.680

Kahneman, D., Wakker, P. P., & Sarin, R. (1997). Back to Bentham? Explorations of Experienced Utility. The Quarterly Journal of Economics, 112(2), 375-406. doi: 10.1162/003355397555235

Kataria, M., Bateman, I., Christensen, T., Dubgaard, A., Hasler, B., Hime, S., . . . Nissen, C. (2012). Scenario realism and welfare estimates in choice experiments--a non-market valuation study on the European water framework directive. *Journal of Environmental Management, 94*(1), 25.

Keita, L. (1999). Welfare Economics and Positive Neoclassical Economics. *Journal of Value Inquiry, 33*(3), 335.

Kopmann, A., & Rehdanz, K. (2013). A human well-being approach for assessing the value of natural land areas. *Ecological Economics, 93*, 20-33. doi: 10.1016/j.ecolecon.2013.04.014

Kountouris, Y., & Remoundou, K. (2011). Valuing the welfare cost of forest fires: a life satisfaction approach. *Kyklos, 64*(4), 556-578. doi: 10.1111/j.1467-6435.2011.00520.x

Kozak, M. (2001). Repeaters' behavior at two distinct destinations. *Annals of Tourism Research, 28*(3), 784-807. doi: 10.1016/S0160-7383(00)00078-5

Kozak, M., & Rimmington, M. (2000). Tourist Satisfaction with Mallorca, Spain, as an Off-Season Holiday Destination. *Journal of Travel Research, 38*(3), 260-269. doi: 10.1177/004728750003800308

Kragt, M. E., & Bennett, J. W. (2011). Using choice experiments to value catchment and estuary health in Tasmania with individual preference heterogeneity. *The Australian Journal of Agricultural and Resource Economics, 55*(2), 159-179. doi: 10.1111/j.1467-8489.2011.00533.x

Kristoffersen, I. (2010). The metrics of subjective wellbeing: cardinality, neutrality and additivity. *The economic record, 86*(272), 98-123. doi: 10.1111/j.1475-4932.2009.00598.x

Kromrey, J. D., & Rendina-Gobioff, G. (2002). An empirical comparison of regression analysis strategies with discrete ordinal variables. *Multiple linear regression viewpoints, 28*(2), 30-43.

Kroon, F. J., Kuhnert, P. M., Henderson, B. L., Wilkinson, S. N., Kinsey-Henderson, A., Abbott, B., . . . Turner, R. D. R. (2012). River loads of suspended solids, nitrogen, phosphorus and herbicides delivered to the Great Barrier Reef lagoon. *Marine pollution bulletin, 65*(4-9), 167. doi: 10.1016/j.marpolbul.2011.10.018

Krutilla, J. V. (1967). Conservation Reconsidered. *The American Economic Review, 57*(4), 777-786.

Kubiszewski, I., Costanza, R., Franco, C., Lawn, P., Talberth, J., Jackson, T., & Aylmer, C. (2013). Beyond GDP: Measuring and achieving global genuine progress. *Ecological Economics, 93*, 57-68.

Larson, S. (2009). Communicating Stakeholder Priorities in the Great Barrier Reef Region. *Society & Natural Resources, 22*(7), 650-664. doi: 10.1080/08941920801992102

Larson, S. (2010). Regional well-being in tropical Queensland, Australia: developing a dissatisfaction index to inform government policy. *Environment and Planning A, 42*(12), 2972-2989. doi: 10.1068/a43193

Larson, S., Stoeckl, N., Farr, M., & Esparon, M. (2014). The role the Great Barrier Reef plays in resident wellbeing and implications for its management. *Ambio*.

Lasorsa, D. L. (2003). Question-order effects in surveys: the case of political interest, news attention, and knowledge. *Journalism & Mass Communication Quarterly, 80*(3), 499-512. doi: 10.1177/107769900308000302

Layard, R. (1980). Human Satisfactions and Public Policy. *The Economic Journal, 90*(360), 737-750.

Layard, R. (2003). *Happiness: Has social science a clue? Lecture 1*. Paper presented at the Lionel Robbins Memorial Lecture 2002/3, London School of Economics, London. http://cep.lse.ac.uk/events/lectures/layard/RL030303.pdf

Layard, R. (2010). Measuring Subjective Well-Being. *Science, 327*(5965), 534-535. doi: 10.1126/science.1186315

Ledesma, F. J., Navarro, M., & Perez-Rodriguez, J. V. (2005). Return to tourist destination: is it reputation, after all? *Applied Economics, 37*(18), 2055-2065. doi: 10.1080/00036840500293474

Lepesteur, M., Wegner, A., Moore, S. A., & McComb, A. (2008). Importance of public information and perception for managing recreational activities in the Peel-Harvey estuary, Western Australia. *Journal of Environmental Management, 87*(3), 389-395. doi: 10.1016/j.jenvman.2007.01.026

Levinson, A. (2012). Valuing public goods using happiness data: the case of air quality. *Journal of Public Economics, 96*(9/10), 869-880. doi: 10.1016/j.jpubeco.2012.06.007

Lewis, S. E., Brodie, J. E., Bainbridge, Z. T., Rohde, K. W., Davis, A. M., Masters, B. L., . . . Schaffelke, B. (2009). Herbicides: A new threat to the Great Barrier Reef. *Environmental Pollution, 157*(8), 2470-2484. doi: 10.1016/j.envpol.2009.03.006

Lu, W., & Stepchenkova, S. (2012). Ecotourism experiences reported online: classification of satisfaction attributes. *Tourism Management, 33*(3), 702-712. doi: 10.1016/j.tourman.2011.08.003

Luechinger, S. (2009). Valuing Air Quality Using the Life Satisfaction Approach. *The Economic Journal, 119*(536), 482-515. doi: 10.1111/j.1468-0297.2008.02241.x

Luechinger, S., & Raschky, P. A. (2009). Valuing flood disasters using the life satisfaction approach. *Journal of Public Economics, 93*(3), 620-633. doi: 10.1016/j.jpubeco.2008.10.003

Lyubomirsky, S., Sheldon, K. M., & Schkade, D. (2005). Pursuing Happiness: The Architecture of Sustainable Change. *Review of General Psychology, 9*(2), 111-131. doi: 10.1037/1089-2680.9.2.111

MacKerron, G. (2012). Happiness economics from 35000 feet. *Journal of economic surveys, 26*(4), 705-735. doi: 10.1111/j.1467-6419.2010.00672.x
MacKerron, G., & Mourato, S. (2009). Life satisfaction and air quality in London. *Ecological Economics, 68*(5), 1441-1453. doi: 10.1016/j.ecolecon.2008.10.004
Maddison, D., & Rehdanz, K. (2011). The impact of climate on life satisfaction. *Ecological Economics, 70*(12), 2437-2445. doi: 10.1016/j.ecolecon.2011.07.027
Manning, M., Fleming, C. M., & Ambrey, C. L. (2015). Life Satisfaction and Individual Willingness to Pay for Crime Reduction. *Regional studies*, 1-16.
Marques, R. C., Kortt, M. A., & Dollery, B. (2015). Determining the Optimal Size of Local Government: The Case of Tasmanian Councils. *Australian Journal of Public Administration, 74*(2), 212-226. doi: 10.1111/1467-8500.12151
McAllister, F. (2005). Wellbeing concepts and challenges (pp. 1-22): discussion paper prepared for the Sustainable Development Research Network, London.
McCullagh, P. (1980). Regression models for ordinal data. Journal of the royal statistical society. Series B (Methodological), 109-142.
McElroy, J. L., & Parry, C. E. (2010). The characteristics of small island tourist economies. *Tourism and hospitality research, 10*(4), 315-328. doi: 10.1057/thr.2010.11
McGhee, A. (1986). What is marketing? *Education + Training, 28*(2), 41-41. doi: 10.1108/eb017229
Mellander, C., Florida, R., & Rentfrow, J. (2012). The creative class, post-industrialism and the happiness of nations. *Cambridge journal of regions economy and society, 5*(1), 31-43. doi: 10.1093/cjres/rsr006
Mentzakis, E., & Moro, M. (2009). The poor, the rich and the happy: Exploring the link between income and subjective well-being. *The Journal of Socio-Economics, 38*(1), 147-158.
Menz, T., & Welsch, H. (2010). Population aging and environmental preferences in OECD countries: the case of air pollution. *Ecological Economics, 69*(12), 2582-2589. doi: 10.1016/j.ecolecon.2010.08.002
Meyerhoff, J., Mørkbak, M. R., & Olsen, S. B. (2014). A Meta-study Investigating the Sources of Protest Behaviour in Stated Preference Surveys. *Environmental and Resource Economics, 58*(1), 35-57. doi: 10.1007/s10640-013-9688-1
Michalos, A. C., & Zumbo, B. D. (2000). Criminal Victimization and the Quality of Life. *Social Indicators Research, 50*(3), 245-295. doi: 10.1023/A:1006930019814
Millennium Ecosystem Assessment. (2005). *Ecosystems and human well-being: general synthesis*. Washington, DC: Island Press.
Moro, M., Brereton, F., Ferreira, S., & Clinch, J. P. (2008). Ranking quality of life using subjective well-being data. *Ecological Economics, 65*(3), 448-460. doi: 10.1016/j.ecolecon.2008.01.003
Morrison, P. S. (2011). Local expressions of subjective well-being: the New Zealand experience. *Regional studies, 45*(8), 1039-1058. doi: 10.1080/00343401003792476
Moscardo, G., Saltzer, R., Norris, A., & McCoy, A. (2004). Changing patterns of regional tourism: implications for tourism on the Great Barrier Reef. *Journal of Tourism Studies, 15*(1), 34-50.
Murray, T., Maddison, D., & Rehdanz, K. (2013). Do Geographical Variations In Climate Influence Life-Satisfaction? *Climate Change Economics, 4*(01), 1350004.
Myers, D. G., & Diener, E. (1995). Who Is Happy? *Psychological Science, 6*(1), 10-19. doi: 10.1111/j.1467-9280.1995.tb00298.x
Neuts, B., Romão, J., Van Leeuwen, E., & Nijkamp, P. (2013). Describing the relationships between tourist satisfaction and destination loyalty in a segmented and digitalized market. *Tourism Economics, 19*(5), 987.

Newsom, J. (2012). Regression models for Ordinal Dependent Variables, Data Analysis 11, Fall 2012, Portland State University. Retrieved 3/7/14, from http://www.upa.pdx.edu/IOA/newsom/da2/ho_ordinal.pdf

Newton-Farrelly, J. (2009). From Gerry-Built To Purpose-Built: Drawing Electoral Boundaries For Unbiased Election Outcomes. *Representation, 45*(4), 471-484. doi: 10.1080/00344890903257565

North Queensland Bulk Ports Corporation Abbot Point Port. Retrieved 30/7/2015, from http://www.nqbp.com.au/abbot-point/

North Queensland Bulk Ports Corporation Hay Point Port. Retrieved 30/7/2015, from http://www.nqbp.com.au/hay-point/

Oates, W. E. (1999). An Essay on Fiscal Federalism. *Journal of Economic Literature, 37*(3), 1120-1149. doi: 10.1257/jel.37.3.1120

Oates, W. E. (2005). Toward A Second-Generation Theory of Fiscal Federalism. *International Tax and Public Finance, 12*(4), 349-373. doi: 10.1007/s10797-005-1619-9

OECD. (2013). Analytic measures OECD Guidelines for Micro Statistics on Household Wealth: OECD Publishing.

Osborne, K., Dolman, A. M., Burgess, S. C., & Johns, K. A. (2011). Disturbance and the Dynamics of Coral Cover on the Great Barrier Reef (1995–2009). *PLoS ONE, 6*(3), e17516. doi: 10.1371/journal.pone.0017516

Oswald, A. J. (1997). Happiness and Economic Performance. *The Economic Journal, 107*(445), 1815-1831. doi: 10.1111/1468-0297.00260

Oswald, A. J., & Wu, S. (2009). *Well-being across America: evidence from a random sample of one million US citizens.* Paper presented at the IZA Prize Conference.

Oswald, A. J., & Wu, S. (2010). Objective confirmation of subjective measures of human well-being: evidence from the U.S.A. *Science (New York, N.Y.), 327*(5965), 576-579. doi: 10.1126/science.1180606

Parsons, G. R., & Thur, S. M. (2008). Valuing Changes in the Quality of Coral Reef Ecosystems: A Stated Preference Study of SCUBA Diving in the Bonaire National Marine Park. *Environmental and Resource Economics, 40*(4), 593-608. doi: 10.1007/s10640-007-9171-y

PDP Australia Pty Ltd. (2003). An Economic and Social Evaluation of Implementing the Representative Areas Program by Rezoning the Great Barrier Reef Marine Park: Report for the Great Barrier Reef Marine Park Authority.

Pendleton, L., Martin, N., & Webster, D. G. (2001). Public Perceptions of Environmental Quality: A Survey Study of Beach Use and Perceptions in Los Angeles County. *Marine pollution bulletin, 42*(11), 1155-1160. doi: 10.1016/S0025-326X(01)00131-X

Petrick, J. F., & Backman, S. J. (2002). An Examination of the Determinants of Golf Travelers' Satisfaction. *Journal of Travel Research, 40*(3), 252-258. doi: 10.1177/0047287502040003003

Petrick, J. F., Morais, D., & Norman, W. (2001). An Examination of the Determinants of Entertainment Vacationers' Intentions to Revisit. *Journal of Travel Research, 40*(1), 41-48. doi: 10.1177/004728750104000106

Powdthavee, N. (2007). Are There Geographical Variations in the Psychological Cost of Unemployment in South Africa? *Social Indicators Research, 80*(3), 629-652. doi: 10.1007/s11205-006-0013-z

Prayaga, P., Rolfe, J., & Stoeckl, N. (2010). The value of recreational fishing in the Great Barrier Reef, Australia: A pooled revealed preference and contingent behaviour model. *Marine Policy, 34*(2), 244-251. doi: 10.1016/j.marpol.2009.07.002

Prideaux, B., Coghlan, A., & Falco-Mannome, F. (2007). Post crisis recovery: The Case of After Cyclone Larry. *Journal of Tourism and Travel Marketing, 23*, 163-174.
Productivity Commission. (2003). Industries, Land Use and Water Quality in the Great Barrier Reef Catchment *Research Report*. Canberra.
Rallings, C., Johnston, R., & Thrasher, M. (2004). Equalising Votes but Enabling Bias: The Electoral Impact of the 1977 and 1999 Ward Boundary Reviews in London. *Urban Studies, 41*(7), 1367-1393. doi: 10.1080/0042098042000214842
Ramis, M., & Prideaux, B. (2013). The importance of visitor perceptions in estimating how climate change will affect future tourist flows on the Great Barrier Reef. In M. Reddy & K. Wilkes (Eds.), *Tourism, Climate Change and Sustainability* (pp. 173-188). Routledge, London.
Randriamboarison, R., Rasoamanajara, F., & Solonandrasana, B. (2013). Tourism return frequency demand in Madagascar. *Tourism Economics, 19*(4), 943.
Rehdanz, K., & Maddison, D. (2005). Climate and happiness. *Ecological Economics, 52*(1), 111-125. doi: 10.1016/j.ecolecon.2004.06.015
Rehdanz, K., & Maddison, D. (2008). Local environmental quality and life-satisfaction in Germany. *Ecological Economics, 64*(4), 787-797. doi: 10.1016/j.ecolecon.2007.04.016
Reingewertz, Y. (2012). Do municipal amalgamations work? Evidence from municipalities in Israel. *Journal of Urban Economics, 72*(2-3), 240-251. doi: 10.1016/j.jue.2012.06.001
Richardson, L., & Loomis, J. (2009). The total economic value of threatened, endangered and rare species: an updated meta-analysis. Ecological Economics, 68(5), 1535-1548.
Roback, J. (1982). Wages, Rents, and the Quality of Life. The Journal of Political Economy, 90(6), 1257.
Roberts, M. R., & Whited, T. M. (2012). Endogeneity in empirical corporate finance.
Rolfe, J., & Windle, J. (2012). Distance decay functions for iconic assets: assessing national values to protect the health of the Great Barrier Reef in Australia. *Environmental & Resource Economics, 53*(3), 347-365. doi: 10.1007/s10640-012-9565-3
Rosen, S. (1974). Hedonic Prices and Implicit Markets: Product Differentiation in Pure Competition. The Journal of Political Economy, 82(1), 34-55. doi: 10.1086/260169
Saltzer, R. (2002a). Understanding Great Barrier Reef visitors: factors that contribute to visitor satisfaction *Report to the CRC Reef Research Centre, Townsville (unpublished)* (Vol. 12).
Saltzer, R. (2002b). Understanding Great Barrier Reef visitors: profile of repeat visitors *Report to the CRC Reef Research Centre, Townsville (unpublished)* (Vol. 13).
Scarpa, R., Gilbride, T. J., Campbell, D., & Hensher, D. A. (2009). Modelling attribute non-attendance in choice experiments for rural landscape valuation. *European Review of Agricultural Economics, 36*(2), 151-174. doi: 10.1093/erae/jbp012
Schaffelke, B., Carleton, J., Doyle, J., Furnas, M., Gunn, K., Skuza, M., . . . Zagorskis, I. (2010). Reef Rescue Marine Monitoring Program. Final Report of AIMS Activities – Inshore water quality monitoring 2009/10. Report for Reef and Rainforest Research Centre. (pp. 81): Australian Institute of Marine Science, Townsville.
Schneider, M. (1975). The quality of life in large American cities: objective and subjective social indicators. *Social Indicators Research, 1*(4), 495-509.
Scitovsky, T. (1975). Income And Happiness. *Acta Oeconomica, 15*(1), 45-53.
Seghieri, C., & Desantis, G. (2006). The richer, the happier?: an empirical investigation in selected European countries. *Social Indicators Research, 79*(3), 455-476. doi: 10.1007/s11205-005-5394-x
Sen, A. (1999). *Development as freedom*. Oxford; New York: Oxford University Press.

Shahrivar, R. B. (2012). Factors That Influence Tourist Satisfaction. *Journal of Travel and Tourism Research (Online), 12*(1), 61.

Sørensen, J. F. L. (2014). Rural–Urban Differences in Life Satisfaction: Evidence from the European Union. *Regional studies, 48*(9), 1451-1466. doi: 10.1080/00343404.2012.753142

Stanca, L. (2009). With or without you? Measuring the quality of relational life throughout the world. *The Journal of Socio-Economics, 38*(5), 834-842. doi: 10.1016/j.socec.2009.03.004

Stanca, L. (2010). The Geography of Economics and Happiness: Spatial Patterns in the Effects of Economic Conditions on Well-Being. *Social Indicators Research, 99*(1), 115-133. doi: 10.1007/s11205-009-9571-1

State Development Queensland. (2014). Galilee Basin State Development Area. Retrieved 30/7/2015, from http://www.statedevelopment.qld.gov.au/coordinator-general/galilee-basin-state-development-area.html

Steinwender, A., Gundacker, C., & Wittmann, K. J. (2008). Objective versus subjective assessments of environmental quality of standing and running waters in a large city. *Landscape and Urban Planning, 84*(2), 116-126. doi: 10.1016/j.landurbplan.2007.07.001

Stoeckl, N., Farr, M., Jarvis, D., Larson, S., Esparon, M., Sakata, H., . . . Costanza, R. (2014). The Great Barrier Reef World Heritage Area: its 'value' to residents and tourists Project 10-2 Socioeconomic systems and reef resilience. Final Report to the National Environmental Research Program. Reef and Rainforest Research Centre Limited. Cairns.

Stoeckl, N., Farr, M., Larson, S., Adams, V., Kubiszewski, I., Esparon, M., & Costanza, R. (2014). A new approach to the problem of overlapping values: A case study in Australia's Great Barrier Reef. *Ecosystem Services, 10*, 61-78.

Stoeckl, N., Farr, M., Reside, A., Curnock, M., Larson, S., Crowley, G., . . . Gillet, S. (2014). Chapter 6: Potential impacts of climate change on industries *Climate Change Issues and Impacts in the Wet Tropics NRM Cluster Region*: James Cook University, Cairns.

Stoeckl, N., Farr, M., & Sakata, H. (2013). Socio-economic systems and reef resilience: Interim report on residential and tourist data collection activities with descriptive summaries of data, Report to the National Environmental Research Program: Reef and Rainforest Research Centre, Cairns.

Stoeckl, N., Hicks, C. C., Mills, M., Fabricius, K., Esparon, M., Kroon, F., . . . Costanza, R. (2011). The economic value of ecosystem services in the Great Barrier Reef: our state of knowledge in "Ecological Economics Reviews". *Annals of the New York Academy of Sciences*(1219), 113-133.

Stutzer, A., & Frey, B. S. (2008). Stress That Doesn't Pay: The Commuting Paradox. *The Scandinavian Journal of Economics, 110*(2), 339-366. doi: 10.1111/j.1467-9442.2008.00542.x

Stutzer, A., & Frey, B. S. (2010). Recent Advances in the Economics of Individual Subjective Well-Being. *Social Research, 77*(2), 679.

Sweatman, H., Delean, S., & Syms, C. (2011). Assessing loss of coral cover on Australia's Great Barrier Reef over two decades, with implications for longer-term trends. *Coral Reefs, 30*(2), 521-531. doi: 10.1007/s00338-010-0715-1

Tarlow, P. (2006). Issues in health, safety and security. *e-Review of Tourism Research, 4*(3), 12-14.

Tellegen, A., Lykken, D. T., Bouchard, T. J., Wilcox, K. J., Segal, N. L., & Rich, S. (1988). Personality Similarity in Twins Reared Apart and Together. *Journal of Personality and Social Psychology, 54*(6), 1031-1039. doi: 10.1037/0022-3514.54.6.1031

The World Tourism Organisation (UNWTO). (2014). UNTWO Tourism Highlights.
Tiebout, C. M. (1956). A Pure Theory of Local Expenditures. *Journal of Political Economy, 64*(5), 416-424. doi: 10.1086/257839
Torres-Sovero, C., Gonzalez, J. A., Martin-Lopez, B., & Kirkby, C. A. (2012). Social-ecological factors influencing tourist satisfaction in three ecotourism lodges in the southeastern Peruvian Amazon. *Tourism Management, 33*(3), 545-552. doi: 10.1016/j.tourman.2011.06.008
Tourism Research Australia. (2013). Regional Tourism Profiles 2012 - 13. Retrieved 1/12/14, from http://www.tra.gov.au/statistics/Regional-overview.html
Turner, R. K. (1993). *Sustainable environmental economics and management: principles and practice*. London: Belhaven Press.
Turner, R. K., Pearce, D. W., & Bateman, I. J. (1994). *Environmental economics: an elementary introduction*. New York: Harvester Wheatsheaf.
UNESCO World Heritage Centre. (2014a). Decision on status of Australia's Great Barrier Reef deferred until 2015. Retrieved 19/6/2014, from http://whc.unesco.org/en/news/1149
UNESCO World Heritage Centre. (2014b). List of World Heritage in Danger. Retrieved 21/8/2014, from http://whc.unesco.org/en/danger/
UNESCO World Heritage Convention. (1981). Great Barrier Reef. Retrieved 13/3/2012, from http://whc.unesco.org/en/list/154/
UNESCO World Heritage Convention. (1988). Wet Tropics of Queensland. Retrieved 9/1/2015, from http://whc.unesco.org/en/list/486
United Nations. (2015). Millennium Development Goals and Beyond 2015. Retrieved 19 December 2015, from http://www.un.org/millenniumgoals/
van Dijk, D., Kesferen, J. V., & Smit, P. (2007). *Criminal Victimisation in International Perspective: Key Findings from the 2004-2005 ICVS and EU ICS*. Hague: Boom Juridischeitgevers.
van Kamp, I., Leidelmeijer, K., Marsman, G., & de Hollander, A. (2003). Urban environmental quality and human well-being. *Landscape and Urban Planning, 65*(1), 5-18. doi: 10.1016/S0169-2046(02)00232-3
van Praag, B. M. S., & Baarsma, B. E. (2005). Using happiness surveys to value intangibles: The case of airport noise. *The Economic Journal, 115*(500), 224-246.
van Praag, B. M. S., Frijters, P., & Ferrer-i-Carbonell, A. (2003). The anatomy of subjective well-being. *Journal of economic behavior & organization, 51*(1), 29-49. doi: 10.1016/S0167-2681(02)00140-3
Veenhoven, R. (2002). Why Social Policy Needs Subjective Indicators. *Social Indicators Research, 58*(1/3), 33-45. doi: 10.1023/A:1015723614574
Vemuri, A. W., & Costanza, R. (2006). The role of human, social, built, and natural capital in explaining life satisfaction at the country level: Toward a National Well-Being Index (NWI). *Ecological Economics, 58*(1), 119-133. doi: 10.1016/j.ecolecon.2005.02.008
Wasserman, I. M., & Chua, L. A. (1980). Objective and Subjective Social Indicators of the Quality of Life in American SMSA's: A Reanalysis. *Social Indicators Research, 8*(3), 365-381. doi: 10.1007/BF00292646
Waterhouse, J., Brodie, J., Lewis, S., & Mitchell, A. (2012). Quantifying the sources of pollutants in the Great Barrier Reef catchments and the relative risk to reef ecosystems. *Marine pollution bulletin*, 394-406. doi: 10.1016/j.marpolbul.2011.09.031
Weisbrod, B. A. (1964). Collective-Consumption Services of Individual-Consumption Goods. *The Quarterly Journal of Economics, 78*(3), 471-477.

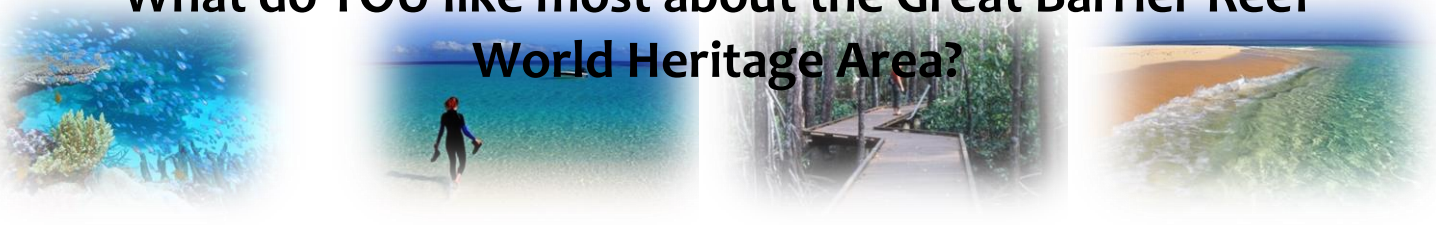
Welsch, H. (2002). Preferences over Prosperity and Pollution: Environmental Valuation based on Happiness Surveys. *Kyklos, 55*(4), 473-494. doi: 10.1111/1467-6435.00198
Welsch, H. (2006). Environment and happiness: Valuation of air pollution using life satisfaction data. *Ecological Economics, 58*(4), 801-813. doi: 10.1016/j.ecolecon.2005.09.006
Welsch, H. (2007a). Environmental welfare analysis: A life satisfaction approach. *Ecological Economics, 62*(3), 544-551. doi: 10.1016/j.ecolecon.2006.07.017
Welsch, H. (2007b). Macroeconomics and Life Satisfaction: Revisiting the "Misery Index". *Journal of Applied Economics, 10*(2), 237.
Welsch, H., & Ferreira, S. (2014). Environment, well-being, and experienced preference: Oldenburg Discussion Papers in Economics.
Welsch, H., & Kühling, J. (2009). Using happiness data for environmental valuation: issues and applications. *Journal of economic surveys, 23*(2), 385-406. doi: 10.1111/j.1467-6419.2008.00566.x
Welzel, C., Inglehart, R., & Kligemann, H. D. (2003). The theory of human development: A cross-cultural analysis. *European Journal of Political Research, 42*(3), 341-379. doi: 10.1111/1475-6765.00086
Wilkinson, P. F. (1989). Strategies for tourism in island microstates. *Annals of Tourism Research, 16*(2), 153-177. doi: 10.1016/0160-7383(89)90065-0
Williams, P. W., & Ponsford, I. F. (2009). Confronting tourism's environmental paradox: Transitioning for sustainable tourism. *Futures, 41*(6), 396-404. doi: 10.1016/j.futures.2008.11.019
Windle, J., & Rolfe, J. (2005). Assessing Non-use Values for Environmental Protection of an Estuary in a Great Barrier Reef Catchment. *Australasian Journal of Environmental Management, 12*(3), 147-155.
Winkelmann, L., & Winkelmann, R. (1998). Why are the Unemployed So Unhappy? Evidence from Panel Data. *Economica, 65*(257), 1-15. doi: 10.1111/1468-0335.00111
Wu, C.-H., & Yao, G. (2006). Do We Need to Weight Item Satisfaction by Item Importance? A Perspective from Locke's Range-of-Affect Hypothesis. *Social Indicators Research, 79*(3), 485-502. doi: 10.1007/s11205-005-5666-5
Wu, D.-M. (1973). Alternative Tests Of Independence Between Stochastic Regressors And Disturbances: 1. Introduction. *Econometrica (pre-1986), 41*(4), 733.
Yoon, Y., & Uysal, M. (2005). An examination of the effects of motivation and satisfaction on destination loyalty: a structural model. *Tourism Management, 26*(1), 45-56. doi: 10.1016/j.tourman.2003.08.016
Yu, D. (2010). *Exploring spatiotemporally varying regressed relationships: the geographically weighted panel regression analysis*. Paper presented at the Joint International Conference on Theory, Data Handling and Modelling in GeoSpatial Information Science. Hong Kong.
Yuksel, A. (2001). Managing customer satisfaction and retention: A case of tourist destinations, Turkey. *Journal of vacation marketing, 7*(2), 153-168. doi: 10.1177/135676670100700205
Zeppel, H. (2011). Climate change and tourism in the Great Barrier Reef Marine Park. *Current Issues in Tourism*, 1-6. doi: 10.1080/13683500.2011.556247
Zhao, M., Johnston, R. J., & Schultz, E. T. (2013). What to Value and How? Ecological Indicator Choices in Stated Preference Valuation. *Environmental and Resource Economics, 56*(1), 3-25. doi: 10.1007/s10640-013-9636-0
Zidanšek, A. (2007). Sustainable development and happiness in nations. *Energy, 32*(6), 891-897. doi: 10.1016/j.energy.2006.09.016

Ziegler, J., Dearden, P., & Rollins, R. (2012). But are tourists satisfied?: importance-performance analysis of the whale shark tourism industry on Isla Holbox, Mexico. *Tourism Management, 33*(3), 692-701.

Appendices

Appendix 1 Reef Resident Survey

What do YOU like most about the Great Barrier Reef World Heritage Area?



Dear ,

My name is Natalie. I am a researcher at James Cook University, and I am working on a project (funded by the *National Environmental Research Program)* which seeks to learn more about what people think is most (and least) important about the Great Barrier Reef World Heritage Area (GBRWHA).

Managers (in both the private and public sector) often have to make choices about development or conservation in this region. But managers do not always know what people think is important when making those choices. This research project hopes to help fix that. **This is your chance to be heard**. Specifically, we hope to find out:

- What you do in the GBRWHA – fishing, walking on the beaches, snorkelling …?
- What you think is important about the GBRWHA – the seafood, the boating, the beaches, and/or the fishing and tourism jobs associated with the region?
- How you would feel if things changed – e.g. if prices rose, if more tourists came to the region, if water quality got worse.
- If you think it is worth 'paying' to protect the GBRWHA (or whether you would prefer to spend your money on other things).

We are asking about 2000 people who live within about 200kms of the GBRWHA the same set of questions (all randomly selected from a large database). So when finished, we should have some good information that will help managers make decisions about this area.

We would be very grateful if one person in your house could complete the questionnaire, and then mail it back to us in the enclosed reply-paid envelope. But please remove this letter before posting – it has your name and address on it and **we don't want anyone to be able to link those details to your answers**. It should take no more than 15-20 minutes to complete.

All of the information we collect will be kept **strictly confidential**. Results will only be released in summary form (e.g. saying that 25% of residents think that fishing is important), and answers will be stored separately from names and addresses, so no one can ever find out 'who said what'.

Should you have any questions about the project, or if you are interested in seeing the results please contact me: **Phone: 07 4781 4868 or email: Natalie.Stoeckl@jcu.edu.au**.

I thank you in advance for your help.

Should you have any concerns about the ethical conduct of this survey, please contact: Helen Griffiths, Ethics Officer, Research Office, James Cook University, Townsville, QLD 4811, Tel: 07 4781 6575; Email: Helen.griffiths@jcu.edu.au

Photos courtesy: GBRMPA, Matt Curnock, Fisheries Queensland (Department of Agriculture, Fisheries and Forestry), Nathan Mappas & Tourism QLD

The Great Barrier Reef World Heritage Area (GBRWHA) is much more than just a reef. It includes islands, bays, beaches, estuaries and creeks, and it extends for more than 2000kms along the coast of Queensland (**see the map below**). This survey seeks the views of residents living 'near' the GBRWHA … within about 200km of the coast.

1. Where do you usually live?
   - ❒ Australia, which postcode?_____
   - ❒ Overseas, which country?

   _____

2. Have you ever visited the GBRWHA
   - ❒ No (go to question 7, page 2)
   - ❒ Yes

3. How long did you spend in the GBRWHA on your most recent trip?

   ❒ Half a day or less ❒ 2-3 nights
   ❒ About a day ❒ 4 nights or more
   ❒ 1 night ❒ Do not remember

4. On the map, shade in the square(s) nearest your favourite place in the GBRWHA. This does not have to be the place you go to most often. Write the name of this place below:

   _____

5. Are there any places **in the GBRWHA** you have not been to but would really like to visit?

   _____

   _____

   _____

6. Please tell us how often you do each of the following **in the GBRWHA**. *(tick one box in each row)*

	Almost every day	A few times a month	About once a month	3-4 times a year	About once a year	Rarely	I have never done this
Spend time on the mainland beaches	❒	❒	❒	❒	❒	❒	❒
Spend time on the islands	❒	❒	❒	❒	❒	❒	❒
Spend time on offshore reefs	❒	❒	❒	❒	❒	❒	❒
Snorkel or scuba dive	❒	❒	❒	❒	❒	❒	❒
Go out on a private motor boat or jet-ski *About how long is the boat? ____metres*	❒	❒	❒	❒	❒	❒	❒
Pay for a boat trip or island visit	❒	❒	❒	❒	❒	❒	❒
Go sailing, kayaking, windsurfing, etc	❒	❒	❒	❒	❒	❒	❒
Go fishing, spear-fishing, or crabbing	❒	❒	❒	❒	❒	❒	❒

7. How important are each of the following items to your overall quality of life? *(tick one box in each row)*

	Very important		Neutral		Very unimportant	I do not know
 BENEFITING FROM the jobs and income linked to: the reef-based tourism industry	❒	❒	❒	❒	❒	❒
the commercial fishing sector	❒	❒	❒	❒	❒	❒
 the mining and agricultural sectors	❒	❒	❒	❒	❒	❒
Benefiting from low prices associated with cheap shipping transport	❒	❒	❒	❒	❒	❒
BEING ABLE TO:						
 eat fresh locally caught seafood	❒	❒	❒	❒	❒	❒
go fishing, spear-fishing or crabbing	❒	❒	❒	❒	❒	❒
 spend time on the beach, go swimming, diving, etc	❒	❒	❒	❒	❒	❒
go boating, sailing or jet-skiing	❒	❒	❒	❒	❒	❒
 Protecting traditional/ Indigenous cultural values	❒	❒	❒	❒	❒	❒
 Preserving the GBRWHA either for its own sake or for future generations	❒	❒	❒	❒	❒	❒
"Bragging rights" - being able to say "I live near the Great Barrier Reef"	❒	❒	❒	❒	❒	❒
HAVING:						
 undeveloped and uncrowded beaches and islands	❒	❒	❒	❒	❒	❒
beaches and islands without visible rubbish (bottles, plastic)	❒	❒	❒	❒	❒	❒
 healthy coral reefs	❒	❒	❒	❒	❒	❒
healthy reef fish	❒	❒	❒	❒	❒	❒
 iconic marine species (whales, dugongs, turtles)	❒	❒	❒	❒	❒	❒
 clear ocean water (with good underwater visibility)	❒	❒	❒	❒	❒	❒
healthy mangroves and wetlands that clean polluted water from the land	❒	❒	❒	❒	❒	❒

8. Are any of the items in the table so important to you that you would move away from the region if it were not here or if it deteriorated?

❒ No ❒ Yes, please tell us what it is_____

9. How satisfied are you with each item below? Indicate whether all is well (very satisfied) or if there is something wrong (very unsatisfied). *(tick one box in each row)*

	Very important		Neutral		Very unimportant	I do not know
 BENEFITING FROM the jobs and income linked to: the reef-based tourism industry	❒	❒	❒	❒	❒	❒
the commercial fishing sector	❒	❒	❒	❒	❒	❒
 the mining and agricultural sectors	❒	❒	❒	❒	❒	❒
Benefiting from low prices associated with cheap shipping transport	❒	❒	❒	❒	❒	❒
BEING ABLE TO:						
 eat fresh locally caught seafood	❒	❒	❒	❒	❒	❒
go fishing, spear-fishing or crabbing	❒	❒	❒	❒	❒	❒
 spend time on the beach, go swimming, diving, etc	❒	❒	❒	❒	❒	❒
go boating, sailing or jet-skiing	❒	❒	❒	❒	❒	❒
 Protecting traditional/ Indigenous cultural values	❒	❒	❒	❒	❒	❒
Preserving the GBRWHA either for its own sake or for future generations	❒	❒	❒	❒	❒	❒
 "Bragging rights" - being able to say "I live near the Great Barrier Reef"	❒	❒	❒	❒	❒	❒
HAVING:						
 undeveloped and uncrowded beaches and islands	❒	❒	❒	❒	❒	❒
beaches and islands without visible rubbish (bottles, plastic)	❒	❒	❒	❒	❒	❒
 healthy coral reefs	❒	❒	❒	❒	❒	❒
healthy reef fish	❒	❒	❒	❒	❒	❒
 iconic marine species (whales, dugongs, turtles)	❒	❒	❒	❒	❒	❒
 clear ocean water (with good underwater visibility)	❒	❒	❒	❒	❒	❒
healthy mangroves and wetlands that clean polluted water from the land	❒	❒	❒	❒	❒	❒

10. To provide us with some background context, please think about your own life and personal circumstances. How satisfied are with your life as a whole? (*tick one box)*

Very satisfied			Neutral		Very unsatisfied	I do not know
❒	❒	❒	❒	❒		❒

What is the reason you feel this way? _____

11. How would each of the following affect your overall quality of life / satisfaction? *(tick one box in each row)*

	I would be much more satisfied				I would be much less satisfied	I do not know
If local prices rose by 20% compared to other places in Australia	❒	❒	❒	❒	❒	❒
If there was twice as much rubbish (e.g. bottles, plastic) on the beaches and islands	❒	❒	❒	❒	❒	❒
If there was half as much chance of catching fish	❒	❒	❒	❒	❒	❒
If there were half as many fish and less variety of fish to look at	❒	❒	❒	❒	❒	❒
If there was half as much live coral	❒	❒	❒	❒	❒	❒
If there were twice as many tourists	❒	❒	❒	❒	❒	❒
If the ocean water changed from clear to murky	❒	❒	❒	❒	❒	❒
If there were twice as oil spills, ship groundings and waste spills	❒	❒	❒	❒	❒	❒

The GBR faces many threats. Some of these are beyond our control (e.g. cyclones), but not all. Three major threats to the GBR are explained below

REDUCTIONS IN WATER QUALITY

IMPACTS: When ocean water is clean and clear, the reef can recover from disasters (e.g. crown of thorns starfish, cyclones, bleaching events) relatively quickly. But sometimes water in the GBRWHA can become unnaturally murky from land runoff and development, which makes affected areas more vulnerable to disease and disasters.

POSSIBLE SOLUTIONS INCLUDE: Maintaining mangroves and wetlands, reducing fertilizer and chemical use, avoiding overgrazing, planting trees on the edges of creeks, improving construction practices, etc.

INCREASES IN PORTS AND SHIPPING ACCIDENTS

photo courtesy Mercator Media 2012

IMPACTS: More than 5000 ships use the shipping lanes inside the GBR each year and there are 10 major trading ports along the coast. Shipping accidents can cause direct damage to the reef and pollution such as oil spills. Port developments can also damage the environment, and it is possible for ships to introduce non-native species.

POSSIBLE SOLUTIONS INCLUDE: Changing where, when, and how many boats pass by the GBR; improving emergency procedures; improving accountability for foreign vessels; early detection of non-native species; mandating local pilots, etc.

OVER-FISHING OF 'TOP PREDATORS'

IMPACTS: If there are too few animals at the top of the food chain (e.g. some types of sharks and mackerels and large cods), other animals can increase in numbers. This can have unexpected, and possibly negative side effects (e.g. too many coral eating fish).

POSSIBLE SOLUTIONS INCLUDE: There are many existing rules and regulations to prevent over-fishing. But it would be possible to: enforce rules more strictly (particularly in no-fish zones); work with residents and fishers to foster 'best practice' fishing methods; closer monitoring of fish populations (stepping in if it looks like there is a problem), etc.

12. Imagine that a fund was set up to help solve the problems described above. Who would you trust to manage that fund? *(tick as many boxes as apply)*

❒ The Commonwealth Government ❒ The Queensland Government ❒ No one

❒ A Not-for-profit, non-government organization ❒ Other (please specify)_____

13. What is the maximum amount (out of your total household income) you would be willing to donate each and every year to that fund? (You could ask for the money to be deducted from your wages/salary/pension, or pay it as a lump sum once a year.)

When answering, please consider your household's current financial situation and also consider how much all your donations add up to if donating to more than one problem. *(tick one box in each row)*

	Money donated EACH YEAR											
	$0	$2	$5	$10	$25	$30	$50	$75	$100	$250	$500	More than $500
Improving ocean water quality	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐ **How much?** $_____
Reducing the risk of shipping accidents	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐ **How much?** $_____
Protecting top predators	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐ **How much?** $_____

14. What method of payment would you most prefer? *(tick one box)*

❒ Annual donation (bpay, cheque or bank-transfer)

❒ Automatic deduction from your salary, pension, or other source of income (so you pay a smaller amount but you pay more often)

❒ One in a life-time payment (a larger amount, but only once)

15. How much do you agree or disagree with each of the following statements? (tick one box in each row)

	Strongly agree		Neutral		Strongly disagree	I do not know
I am willing to volunteer my time to care for the GBRWHA	❒	❒	❒	❒	❒	❒
Only people who live near or visit the GBRWHA have a responsibility to care for it	❒	❒	❒	❒	❒	❒
I am not prepared to pay money to protect the GBRWHA unless	❒	❒	❒	❒	❒	❒
All GBRWHA users pay too	❒	❒	❒	❒	❒	❒
People throughout Australia pay too	❒	❒	❒	❒	❒	❒
People throughout the world pay too	❒	❒	❒	❒	❒	❒
I am not prepared to take costly steps to protect the GBRWHA – those efforts are a waste of time in the face of natural disasters and climate change	❒	❒	❒	❒	❒	❒
The GBRWHA should be preserved for its own sake	❒	❒	❒	❒	❒	❒
If I lost my wallet/purse somewhere in the town I now live in, I would get it back - with all the money and cards still in it	❒	❒	❒	❒	❒	❒

Finally, we would like to collect background information that is used to test if different people (e.g. males, those on high incomes, etc.) feel differently about the GBRWHA.

16. What gender are you? *(tick one box)* ❒ Male ❒ Female
17. What is your marital status? *(tick one box)* ❒ Single ❒ Married ❒ Legal Partnership ❒ Other
18. In what year were you born? *(write the year)* 19_____
19. Where were you born?
    ❒ Australia, which town?_____ and state_____ ❒ Overseas,which country?_____
20. How many people, including yourself, normally live in your household?
    Adults_____ Children (16 and younger) _____
21. Are you or any of the people who normally live with you Aboriginal or Torres Strait Islanders? *(tick as many boxes as apply)* ❒ Yes - Aboriginal ❒ Yes - Torres Strait Islander ❒ No
22. What is the highest level of education that you have completed? *(tick one box)*
    ❒ Primary school ❒ High school (year 12) ❒ University
    ❒ High school (year 10) ❒ Trade / apprenticeship ❒ Other (please specify)_____
23. Do you consider yourself to be a recreational fisherman/woman? *(tick one box)* ❒ No ❒ Yes
24. Do you make contributions to, or volunteer for any conservation organizations? *(tick all that apply)*
    ❒ Yes, International Conservation Organizations ❒ Yes, National & Local Conservation Organizations ❒ No
25. Please indicate which of the industries listed below is the main source (i.e. most important source) of your household's income? *(tick one box)*
    ❒ Retail (e.g. shops) ❒ Agriculture and Forestry ❒ Fishing
    ❒ Accommodation, cafes and restaurants ❒ Manufacturing ❒ Mining
    ❒ Government, Health and Education ❒ Tourism industry (other than above) ❒ Ports
    ❒ None - our household earns most of its money from other sources) ❒ I do not know
26. On average, how much pre-tax income does your household earn each year? *(tick one box)*
    ❒ $1 to $20 000 ❒ $60 000 to $80 000 ❒ $150 000 to $200 000
    ❒ $20 000 to $40 000 ❒ $80 000 to $100 000 ❒ above $200 000
    ❒ $40 000 to $60 000 ❒ $100 000 to $150 000 ❒ prefer not to specify ❒ I do not know

Thank you for your help! ☺

Appendix 2 Reef Tourist Survey

The Great Barrier Reef World Heritage Area (GBRWHA) is much more than just a reef; it includes islands, bays, beaches, estuaries and creeks, and it extends for more than 2000kms along the coast of Queensland (**see the map below**). For the purpose of this survey, the towns and beaches within 200km of the coast should be considered as being 'near' the GBRWHA.

1. Where do you usually live? ❒ Australia, which postcode? _____ ❒ Overseas, which country? _____

2. How often have you been to the coast near the GBRWHA?
   - ❒ This is my first visit
   - ❒ Once
   - ❒ 2-4 times
   - ❒ 5-10 times
   - ❒ more than 10 times
   - ❒ I do not remember

3. In total, how long do you plan to spend away from your home on this trip?
   - ❒ Half a day or less
   - ❒ About a day
   - ❒ At least one night, how many_____?

   How many of those nights will be spent near the GBRWHA? _____ nights

   How many nights have you spent near the GBRWHA so far? _____ nights

4. On the map, shade the area(s) you have visited or plan to visit **ON THIS TRIP.**

5. Place a number '1' next to the best place in the GBRWHA that you have been to so far **ON THIS TRIP** and write the name of the place below.

   _____

6. Are there any places **in the GBRWHA** you have not yet visited but are really looking forward to visiting?

   _____

   _____

7. In total, about how often did you do each of the following **ON THIS TRIP**? *(tick one box in each row)*. If you have not finished your trip, please tell us how often you THINK you will end up doing them.

	Never	Once	Twice	3 times	4 times	5 times	More than 5 times
Spend time on the mainland beaches	❒	❒	❒	❒	❒	❒	❒
Spend time on the islands	❒	❒	❒	❒	❒	❒	❒
Spend time on offshore reefs	❒	❒	❒	❒	❒	❒	❒
Snorkel or scuba dive	❒	❒	❒	❒	❒	❒	❒
Go out on a private motor boat or jet-ski *About how long is the boat? ____metres*	❒	❒	❒	❒	❒	❒	❒
Pay for a boat trip or island visit	❒	❒	❒	❒	❒	❒	❒
Go sailing, kayaking, windsurfing, etc	❒	❒	❒	❒	❒	❒	❒
Go fishing, spear-fishing, or crabbing	❒	❒	❒	❒	❒	❒	❒

8. How IMPORTANT were each of the following factors when <u>you made the decision to come to this part of Australia</u> **ON THIS TRIP**? *(tick one box in each row)*

		Very important		Neutral		Very unimportant	I do not know
	Visiting friends and/or relatives	❒	❒	❒	❒	❒	❒
	Attending to business, going to a meeting and/or conference	❒	❒	❒	❒	❒	❒
	Visiting a place which is close to where I live	❒	❒	❒	❒	❒	❒
	Finding a place where the price matched my budget	❒	❒	❒	❒	❒	❒
	Having good quality accommodation, shops and restaurants	❒	❒	❒	❒	❒	❒
	BEING ABLE TO: eat fresh local seafood	❒	❒	❒	❒	❒	❒
	go fishing, spear-fishing or crabbing	❒	❒	❒	❒	❒	❒
	spend time on the beach, go swimming, diving, etc	❒	❒	❒	❒	❒	❒
	go boating, sailing or jet-skiing	❒	❒	❒	❒	❒	❒
	ENJOYING: Indigenous cultural experiences	❒	❒	❒	❒	❒	❒
	Sunshine and warmth	❒	❒	❒	❒	❒	❒
	"Bragging rights" - being able to say "I have been to the Great Barrier Reef"	❒	❒	❒	❒	❒	❒
	SEEING/EXPERIENCING: undeveloped and uncrowded beaches and islands	❒	❒	❒	❒	❒	❒
	beaches and islands without visible rubbish (bottles, plastic)	❒	❒	❒	❒	❒	❒
	healthy coral reefs	❒	❒	❒	❒	❒	❒
	healthy reef fish	❒	❒	❒	❒	❒	❒
	Iconic marine species (whales, dugongs, turtles)	❒	❒	❒	❒	❒	❒
	clear oceans (with good underwater visibility)	❒	❒	❒	❒	❒	❒
	the wet tropics world heritage rainforests	❒	❒	❒	❒	❒	❒
	iconic land species (kangaroos, cassowaries)	❒	❒	❒	❒	❒	❒
	mangroves and wetlands	❒	❒	❒	❒	❒	❒

9. And how satisfied have you been with each item below **ON THIS TRIP?** *(tick one box in each row)*

	Very satisfied – all is good		Neutral		Very unsatisfied – something is wrong	Not applicable	I have not been here long enough to assess
Local prices / the cost of your visit	❒	❒	❒	❒	❒	❒	❒
The quality of Fresh local seafood	❒	❒	❒	❒	❒	❒	❒
 The quality of accommodation, shops and restaurants	❒	❒	❒	❒	❒	❒	❒
 Your experiences: fishing, spear-fishing or crabbing	❒	❒	❒	❒	❒	❒	❒
on the beach, go swimming, diving, etc	❒	❒	❒	❒	❒	❒	❒
 boating, sailing or jet-skiing	❒	❒	❒	❒	❒	❒	❒
 Your ability to enjoy: Indigenous cultural experiences	❒	❒	❒	❒	❒	❒	❒
Sunshine and warmth	❒	❒	❒	❒	❒	❒	❒
 "Bragging rights" - being able to say "I have been to the Great Barrier Reef"	❒	❒	❒	❒	❒	❒	❒
Your experiences &/or ability to see: undeveloped and uncrowded beaches and islands	❒	❒	❒	❒	❒	❒	❒
 beaches and islands without visible rubbish (bottles, plastic)	❒	❒	❒	❒	❒	❒	❒
 healthy coral reefs	❒	❒	❒	❒	❒	❒	❒
 healthy reef fish	❒	❒	❒	❒	❒	❒	❒
Iconic marine species (whales, dugongs, turtles)	❒	❒	❒	❒	❒	❒	❒
 clear oceans (with good underwater visibility)	❒	❒	❒	❒	❒	❒	❒
the wet tropics world heritage rainforests	❒	❒	❒	❒	❒	❒	❒
 iconic land species (kangaroos, cassowaries)	❒	❒	❒	❒	❒	❒	❒
mangroves and wetlands	❒	❒	❒	❒	❒	❒	❒

10. To help us gauge how 'safe' you have felt while here, please tell us how much you agree or disagree with the following statement

If I lost my wallet/purse somewhere <u>in the town I am now visiting</u>, I would get it back with all the money and cards still in it.

Strongly agree		Neutral		Strongly disagree	I do not know
❒	❒	❒	❒	❒	❒

11. To provide us with some background context, please think about the time you have spent near the GBRWHA **ON THIS TRIP**. How satisfied are with your experience as a whole? (*tick one box)*

Very Satisfied		Neutral		Very Unsatisfied	I do not know
❒	❒	❒	❒	❒	❒

12. So far, how well has this trip met your expectations? (*tick one box)*

Well above my expectations		Neutral		Well below my expectations	I do not know
❒	❒	❒	❒	❒	❒

13. How likely is it that you will return to visit the region in the future? (*tick one box)*

Will definitely return		Neutral		Will definitely NOT return	I do not know
❒	❒	❒	❒	❒	❒

14. How would the following hypothetical changes have affected your decision to visit this part of Australia (i.e. near the GBRWHA)**?** *(tick one box in each row)*

	POSITIVE impact I may have stayed longer	ALMOST NO IMPACT This would not have affected my decision at all	SOME IMPACT I would have still visited but reduced the length of my stay by about 25%	50%	75%	HUGE NEGATIVE IMPACT I would not have come here at all	I do not know
If local prices rose by 20% (compared to other places in Australia)	❒	❒	❒	❒	❒	❒	❒
If there was twice as much rubbish (bottles, plastic) on the beaches and islands	❒	❒	❒	❒	❒	❒	❒
If there was half as much chance of catching fish	❒	❒	❒	❒	❒	❒	❒
If there were half as many fish to look at	❒	❒	❒	❒	❒	❒	❒
If there was half as much live coral	❒	❒	❒	❒	❒	❒	❒
If there were twice as many tourists	❒	❒	❒	❒	❒	❒	❒
If the ocean water changed from clear to murky	❒	❒	❒	❒	❒	❒	❒
If there were twice as many large ships and ports along the coast twice as many oil spills, ship groundings and waste spills from the ports	❒	❒	❒	❒	❒	❒	❒

We would like to learn more about the money that you have spent in and around the GBRWHA (i.e. within about 200km of the coast) while on this trip away from home.

15. On average, how much have you and your travel party (e.g. family) spent PER DAY (in and around the GBRWHA) on each of the following items while **ON THIS TRIP?** *(tick one box for each row)* If you are not at the end of your trip, please just tell us approximately how much you THINK you will spend on each item, each day you are here.

SPENDING PER DAY (AU$) while in the GBRWHA region	$0	$1-20	$21-50	$51-100	$101-151	$151-200	$201-300	More than $300 per day
Food and drinks bought at grocery and convenience stores	❒	❒	❒	❒	❒	❒	❒	❒, how much? $_____
Food and drinks bought at cafés, restaurants, bars, etc (including takeaways)	❒	❒	❒	❒	❒	❒	❒	❒, how much? $_____
Accommodation	❒	❒	❒	❒	❒	❒	❒	❒, how much? $_____

16. What is the approximate TOTAL amount that you and your travel party (e.g. family) has spent (in and around the GBRWHA) on these other items? *(tick one box for each row)* If you are not at the end of your trip, please just tell us approximately how much you THINK you will spend on each of these items IN TOTAL while here.

TOTAL SPENDING (AU$) while in the GBRWHA region	$0	$1-20	$21-50	$51-100	$101-200	$201-400	$401-600	More than $600
Hire cars	❒	❒	❒	❒	❒	❒	❒	❒, how much? $_____
Fuel	❒	❒	❒	❒	❒	❒	❒	❒, how much? $_____
Fishing charters	❒	❒	❒	❒	❒	❒	❒	❒, how much? $_____
Other boating trips and excursions (including non-fishing boat charters, ferries and snorkelling/diving trips)	❒	❒	❒	❒	❒	❒	❒	❒, how much? $_____
Entry into other local attractions / tours not covered above	❒	❒	❒	❒	❒	❒	❒	❒, how much? $_____
Souvenirs	❒	❒	❒	❒	❒	❒	❒	❒, how much? $_____
Other (please specify) _____	❒	❒	❒	❒	❒	❒	❒	❒, how much? $_____

17. How many people does this expenditure cover?
    Adults _____
    Children (16 and younger) _____

18. For your entire trip away from home, what was your total expenditure for all people you told us about in question 17? Include airfares, train travel or other costs getting to this region, accommodation, tours and other expenses.
    AU$_____
    If you do not know how much using Australian dollars, please tell us how much in your own currency
    amount: _____ currency: _____

Finally, we would like to collect background information about you and your trip – this is used to test if different people (e.g. families, those on high incomes, etc) feel differently about the GBRWHA.

19. How did you travel from your home to this survey location? *(tick all that apply)*

❒ Bus ❒ Boat ❒ Rail ❒ Air
❒ Privately owned car ❒ Rented car ❒ Other (please specify) _____

20. Which of these best describes your travel party (i.e. the group you are travelling with)? *(tick one box)*

❒ Single ❒ Couple ❒ Family with children ❒ Relatives ❒ Friends ❒ Club ❒ Tour group
❒ Other (please specify) _____

21. What gender are you? *(tick one box)* ❒ Male ❒ Female

22. What is your marital status? *(tick one box)* ❒ Single ❒ Married ❒ Legal Partnership ❒ Other

23. In what year were you born? *(write the year)* 19_____

24. Where were you born?

❒ Australia, what town?_____ and state?_____ ❒ Overseas, what country?_____

25. How many people, including yourself, normally live in your household?

Adults _____ Children (16 and younger) _____

26. Are you or any of the people who normally live with you Aboriginal or Torres Strait Islanders? *(tick as many boxes as apply)* ❒ Yes - Aboriginal ❒ Yes - Torres Strait Islander ❒ No

27. What is the highest level of education that you have completed? *(tick one box)*

❒ Primary school ❒ High school (year 12) ❒ University
❒ High school (year 10) ❒ Trade / apprenticeship ❒ Other (please specify)_____

28. Do you consider yourself to be a recreational fisherman/fisherwoman? *(tick one box)*

❒ No ❒ Yes.

29. Do you make contributions to, or volunteer for any conservation organizations? *(tick all that apply)*

❒ Yes, International Conservation Organizations ❒ Yes, National & Local Conservation Organizations
❒ No

30. Please indicate which of the industries listed below is the most important source of income for your household? *(tick one box)*

❒ Retail (e.g. shops) ❒ Agriculture and forestry ❒ Fishing
❒ Accommodation, cafes and restaurants ❒ Manufacturing ❒ Mining
❒ Government, health and education ❒ Tourism industry other than above ❒ Ports
❒ None of these industries (our household earns most of its money from other sources) ❒ I do not know

31. On average, how much pre-tax income does your household (you and everyone you live with) earn each year? *(tick one box)*

❒ $1 to $20 000 ❒ $60 000 to $80 000 ❒ $150 000 to $200 000
❒ $20 000 to $40 000 ❒ $80 000 to $100 000 ❒ above $200,000
❒ $40 000 to $60 000 ❒ $100 000 to $150 000 ❒ prefer not to specify ❒ I do not know

If you do not know how much using Australian dollars, please tell us how much in your own currency

amount: _____ currency: _____

Thank you for your help

Appendix 3 Rainforest Resident Survey

What do YOU like most about the Wet Tropics World Heritage Area?











Dear ,

My name is Natalie. I am a researcher at James Cook University, and I am working on a project (funded by the *National Environmental Research Program)* which seeks to learn more about what people think is most (and least) important about the Wet Tropics World Heritage Area (WTWHA).

Managers (in both the private and public sector) often have to make choices about development or conservation in this region. But managers do not always know what people think is important when making those choices. This research project hopes to help fix that. **This is your chance to be heard**. Specifically, we hope to find out:

- What you do in the WTWHA – visiting waterfalls, swimming, camping …?
- What you think is important about the WTWHA – the scenery, the uniqueness of the rainforest, and/or the tourism jobs associated with the region …?
- How satisfied you are with your chances to enjoy the things you think are 'important'?
- How you would feel if things changed – e.g. if prices rose, if more tourists came to the region, if water quality got worse?
- If you think it is worth 'paying' to protect the WTWHA (or whether you would prefer to spend your money on other things).

We are asking about 500 people who live within and around the WTWHA the same set of questions (all randomly selected from a large database). When finished, we should have some good information that will help managers make decisions about this area.

We would be very grateful if one person in your house could complete the questionnaire, and then mail it back to us in the enclosed reply-paid envelope. But please remove this letter before posting – it has your name and address on it and **we don't want anyone to be able to link those details to your answers**. It should take no more than 15-20 minutes to complete.

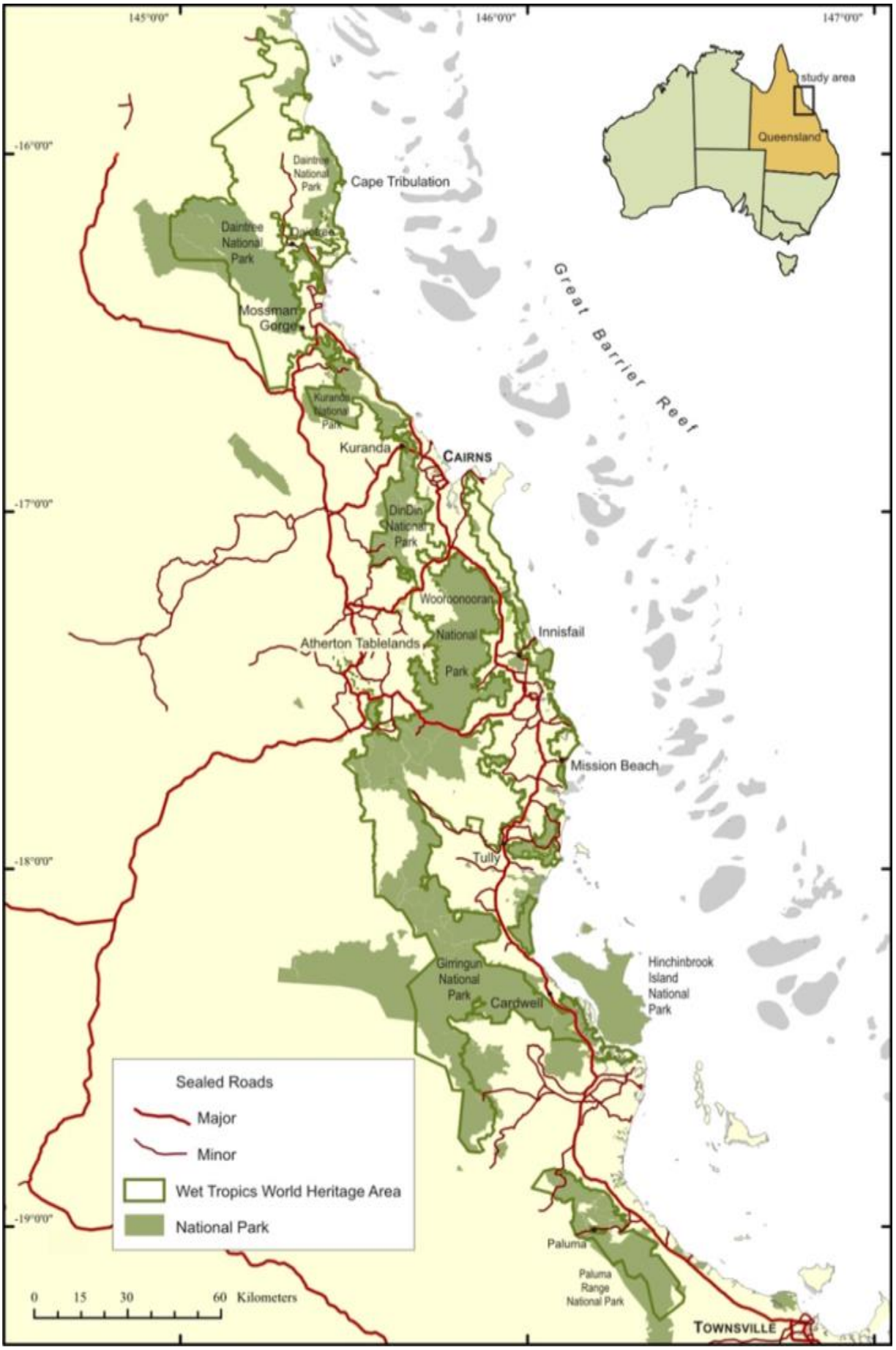
All of the information we collect will be kept **strictly confidential**. Results will only be released in summary form (e.g. saying that 25% of residents think that fishing is important), and answers will be stored separately from names and addresses, so no one can ever find out 'who said what'.

Should you have any questions about the project, or if you are interested in seeing the results please contact me: **Phone: 07 4781 4868 or email: Natalie.Stoeckl@jcu.edu.au**.

I thank you in advance for your help.

Should you have any concerns about the ethical conduct of this survey, please contact: Helen Griffiths, Ethics Officer, Research Office, James Cook University, Townsville, QLD 4811, Tel: 07 4781 6575; Email: Helen.griffiths@jcu.edu.au

Photos courtesy: Wet Tropics Management Authority, Mike Trenerry, Skyrail Rainforest Cableway, Tourism Queensland, Environment Protection Authority



The Wet Tropics World Heritage Area (WTWHA) and surrounding areas

The Wet Tropics World Heritage Area (WTWHA) extends from near Cooktown in the north to near Townsville in the south and borders the Great Barrier Reef World Heritage Area (GBRWHA). It contains almost 900,000 hectares of tropical rainforest with a distinctive and diverse collection of plants and animals (see map on the preceding page). The area is famous for its exceptional natural beauty, comprising of spectacular landscapes and landforms such as waterfalls, rugged gorges, and crater lakes. It is also the traditional estate of 20 Tribal Groups and its cultural values have been recently added to the National Heritage Listing. This survey seeks the views of residents living within and around the WTWHA …

1. **Where do you usually live?** ❒ Australia, which postcode? _____

2. **The table below lists some regions within the WTWHA. Please indicate which area you have been to or would really like to go to.**

Regions of the WTWHA		Have been to this area	Have not been, but would really like to go
Cooktown		❒	❒
Bloomfield		❒	❒
Cape Tribulation		❒	❒
Tablelands	North (e.g. Mareeba)	❒	❒
	Central (e.g. Atherton, Yungaburra)	❒	❒
	South (e.g. Ravenshoe, Mt Garnett)	❒	❒
	West (Herberton)	❒	❒
Daintree		❒	❒
Kuranda		❒	❒
Mossman Gorge		❒	❒
Innisfail/Wooroonooran/Palmerston		❒	❒
Mission Beach/Tully/Cardwell		❒	❒
Paluma		❒	❒

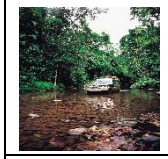
If you have been to these areas, which one was your favourite?

……

3. **Please tell us how often you do each of the following in the WTWHA.** *(Tick one box in each row)*

	Almost every day	About once a week	About once a month	3-4 times a year	About once a year	Rarely	I have never done this
Spend time visiting key (free) rainforest attractions (e.g. crater lakes, curtain fig tree)	❒	❒	❒	❒	❒	❒	❒
Spend time visiting waterfalls, swimming and/or participating in river-based activities (e.g. white water rafting, canoeing, kayaking)	❒	❒	❒	❒	❒	❒	❒
Spend time camping in the WTWHA	❒	❒	❒	❒	❒	❒	❒
Spend time driving along the scenic routes	❒	❒	❒	❒	❒	❒	❒
Spend time enjoying the scenic beauty & peacefulness of the rainforest (sights, sounds & smell)	❒	❒	❒	❒	❒	❒	❒
Spend time with Aboriginal Traditional Owners learning about culture and country	❒	❒	❒	❒	❒	❒	❒
Spend time bush walking/hiking	❒	❒	❒	❒	❒	❒	❒
Spend time mountain biking/horse-riding							
Spend time quad biking or four-wheel driving	❒	❒	❒	❒	❒	❒	❒
Pay for a tour or to visit an attraction within the WTWHA (e.g. zoos, jungle surfing, skyrail)	❒	❒	❒	❒	❒	❒	❒
Spend time doing other activities not listed here. Please specify below							
……	❒	❒	❒	❒	❒	❒	❒
……	❒	❒	❒	❒	❒	❒	❒
……	❒	❒	❒	❒	❒	❒	❒

4. The following question comprises two parts. First, please tell us <u>how IMPORTANT are each of the following items to YOUR OVERALL QUALITY OF LIFE</u>? *(Tick one box in each row – from very important to very unimportant)*. **Second, tell us <u>how SATISFIED are you with each of the item?</u>** *(Tick one box in each row – from very satisfied to very unsatisfied).*

		IMPORTANCE			SATISFACTION			
		Very important	Neutral	Very unimportant	Very satisfied	Neutral	Very unsatisfied	I do not know
	***Benefiting either directly or indirectly from the jobs & incomes created by:***							
	The tourism industry	❒ ❒	❒	❒ ❒	❒ ❒	❒	❒ ❒	❒
	The mining industry	❒ ❒	❒	❒ ❒	❒ ❒	❒	❒ ❒	❒
	The agricultural industry	❒ ❒	❒	❒ ❒	❒ ❒	❒	❒ ❒	❒
	Other industry/sector (e.g. fishing, retail, education etc.)	❒ ❒	❒	❒ ❒	❒ ❒	❒	❒ ❒	❒
	***Being able to access the rainforest via:***							
	Walking tracks &/or dirt roads	❒ ❒	❒	❒ ❒	❒ ❒	❒	❒ ❒	❒
	Bitumen roads & bridges	❒ ❒	❒	❒ ❒	❒ ❒	❒	❒ ❒	❒
	Rail/Skyrail	❒ ❒	❒	❒ ❒	❒ ❒	❒	❒ ❒	❒
	***Being able to:***							
	Learn more about a unique & ancient Australian environment	❒ ❒	❒	❒ ❒	❒ ❒	❒	❒ ❒	❒
	Hear from Aboriginal people about their sense of place (culture & country)	❒ ❒	❒	❒ ❒	❒ ❒	❒	❒ ❒	❒
	Go on rainforest walks	❒ ❒	❒	❒ ❒	❒ ❒	❒	❒ ❒	❒
	Visit waterfalls &/or swim in clear, clean rivers/streams/waterholes	❒ ❒	❒	❒ ❒	❒ ❒	❒	❒ ❒	❒
	See iconic species in the wild (e.g. cassowary, kangaroos, riffle birds, etc.)							
	Relax and/or reflect in a natural environment	❒ ❒	❒	❒ ❒	❒ ❒	❒	❒ ❒	❒
	Enjoy uncrowded camping & picnic areas	❒ ❒	❒	❒ ❒	❒ ❒	❒	❒ ❒	❒
	Enjoy the scenic beauty & peacefulness of the rainforest (sights, sounds & smell)	❒ ❒	❒	❒ ❒	❒ ❒	❒	❒ ❒	❒
	***Having:***							
	Healthy native plants & animals (e.g. free from diseases, pests & weeds)	❒ ❒	❒	❒ ❒	❒ ❒	❒	❒ ❒	❒
	Beautiful undeveloped scenery to look at	❒ ❒	❒	❒ ❒	❒ ❒	❒	❒ ❒	❒
	Two world heritage sites side-by-side (i.e. the WTWHA and the GBRWHA)	❒ ❒	❒	❒ ❒	❒ ❒	❒	❒ ❒	❒
	Protecting:							
	Places that have Aboriginal cultural values	❒ ❒	❒	❒ ❒	❒ ❒	❒	❒ ❒	❒
	Places that have other cultural values (e.g. European/Asian)	❒ ❒	❒	❒ ❒	❒ ❒	❒	❒ ❒	❒
	The WTWHA either for its own sake or for future generations (even if you have never been there & never plan to go)	❒ ❒	❒	❒ ❒	❒ ❒	❒	❒ ❒	❒
	***Being able to:***							
	Spend time with friends & family	❒ ❒	❒	❒ ❒	❒ ❒	❒	❒ ❒	❒
	Enjoy city-entertainment (e.g. spending time at cafés, museums, etc.)	❒ ❒	❒	❒ ❒	❒ ❒	❒	❒ ❒	❒
	Have some 'control' over what is happening in your life	❒ ❒	❒	❒ ❒	❒ ❒	❒	❒ ❒	❒
	Join in community activities (e.g. attend cultural/environmental festivals)	❒ ❒	❒	❒ ❒	❒ ❒	❒	❒ ❒	❒
	Knowing that:							
	Friends & family are healthy & safe	❒ ❒	❒	❒ ❒	❒ ❒	❒	❒ ❒	❒
	Good quality roads, hospitals, schools, etc. are there if need be	❒ ❒	❒	❒ ❒	❒ ❒	❒	❒ ❒	❒

5. Are any of the items or groups of items in the table so important to you that you would move away from the region if it were not here or if it deteriorated? ❒ No ❒ Yes, please tell us what it is .....

6. To provide us with some background context, please think about your own life and personal circumstances. How satisfied are you with your life as a whole? (*Tick one box)*

Very satisfied		Neutral		Very unsatisfied	I do not know
❒	❒	❒	❒	❒	❒

What is the reason you feel this way? .....

.....

7. How would each of the following affect your overall quality of life / satisfaction? *(Tick one box in each row)*

	I would be much more satisfied				I would be much less satisfied	I do not know
If local prices rose by 20% compared to other places in Australia	❒	❒	❒	❒	❒	❒
If there were twice as much rubbish (e.g. bottles, plastic) in the rainforest & in the rivers	❒	❒	❒	❒	❒	❒
If there was half as much chance of seeing an iconic animal (e.g. cassowary, kangaroo, rifle birds, musky-rat kangaroo)	❒	❒	❒	❒	❒	❒
If there were fewer native plants & animals to look at & twice as many pests & weeds	❒	❒	❒	❒	❒	❒
If there were half as many walking tracks	❒	❒	❒	❒	❒	❒
If there were twice as many tourists	❒	❒	❒	❒	❒	❒
If the rivers changed from clear to murky	❒	❒	❒	❒	❒	❒
If the undeveloped scenic beauty & peacefulness of the area declined	❒	❒	❒	❒	❒	❒
If you could spend only half as much time with friends & family (compared to now)	❒	❒	❒	❒	❒	❒
If there were half as many cafés, shops, theatres, etc. in your local area	❒	❒	❒	❒	❒	❒
If there were half as many good quality roads, hospitals & schools in your local area	❒	❒	❒	❒	❒	❒
If there was more public information about Aboriginal cultural values of the area	❒	❒	❒	❒	❒	❒

8. The rainforests of the Wet Tropics faces many threats. Some of these are beyond our control (e.g. cyclones), but not all. For example, we could choose to spend more money controlling pests and less on something else. If a fund was set up to help solve the problems listed below, what is the maximum amount (out of your total household income) you would be willing to donate each and every year to that fund? (You could ask for the money to be deducted from your wages/salary/pension, or pay it as a lump sum once a year.)

When answering, please consider your household's current financial situation and also consider how much all your donations add up to if donating to more than one problem. *(Tick one box in each row)*

	Money willing to donate EACH YEAR											
	$0	$2	$5	$10	$25	$30	$50	$75	$100	$250	$500	More than $500
Protecting native plants and animals from weeds & pests	❒	❒	❒	❒	❒	❒	❒	❒	❒	❒	❒	❒ How much? $---------
Improving/maintaining undeveloped scenic beauty & peacefulness of the area	❒	❒	❒	❒	❒	❒	❒	❒	❒	❒	❒	❒ How much? $---------
Improving/maintaining quality & clarity of rivers & streams	❒	❒	❒	❒	❒	❒	❒	❒	❒	❒	❒	❒ How much? $---------
Protecting the Aboriginal cultural values of the area	❒	❒	❒	❒	❒	❒	❒	❒	❒	❒	❒	❒ How much? $---------

9. How much do you agree or disagree with each of the following statements? (Tick one box in each row)

	Strongly agree		Neutral		Strongly disagree	I do not know
I am willing to volunteer my time to care for the WTWHA	❒	❒	❒	❒	❒	❒
Only people who live near or visit the WTWHA have a responsibility to care for it	❒	❒	❒	❒	❒	❒
I am not prepared to pay money to protect the WTWHA unless All WTWHA users pay too	❒	❒	❒	❒	❒	❒
People throughout Australia pay too	❒	❒	❒	❒	❒	❒
People throughout the world pay too	❒	❒	❒	❒	❒	❒
I am not prepared to take costly steps to protect the WTWHA – those efforts are a waste of time in the face of natural disasters and climate change	❒	❒	❒	❒	❒	❒

Finally, we would like to collect background information that is used to test if different people (e.g. males, those on high incomes, etc.) feel differently about the WTWHA.

10. What gender are you? ❒ Male ❒ Female

11. What is your marital status ❒ Single ❒ Married or in partnership ❒Other

12. In what year were you born? *(Write the year)* 19_____

13. Where were you born? ❒ Australia, which town? _____and state? _____ ❒ Overseas, which country

14. How many people, <u>including yourself,</u> normally live in your household? Adults_____ Children (16 and younger) ___

15. Are you or any of the people who normally live with you Rainforest Aboriginal persons or other Aboriginal and/or Torres Strait persons? *(Tick as many boxes as apply)*

❒ Yes - Rainforest Aboriginal ❒ Yes - Other Aboriginal &/or Torres Strait Islander ❒ No

16. What is the highest level of education that <u>you</u> have completed? *(Tick one box)*

❒ Primary school ❒ High school (year 12) ❒University or higher
❒ High school (year 10) ❒ Trade / apprenticeship ❒ Other (please specify)_____

17. Do you make contributions to, or volunteer for any conservation organizations? *(Tick all that apply)*

❒ Yes, International Conservation Organizations ❒ Yes, National & Local Conservation Organizations
❒ Yes, Rainforest Aboriginal Organizations ❒ No

18. Please indicate which of the industries listed below is the main source (i.e. most important source) of your <u>household's</u> income? *(Tick one box)*

❒ Retail (e.g. shops) ❒ Agriculture and Forestry ❒ Fishing
❒ Accommodation, cafes and restaurants ❒ Manufacturing ❒ Mining
❒ Government, Health and Education ❒ Tourism industry (other than above) ❒ Ports
❒ None - our household earns most of its money from other sources ❒ I do not know

19. On average, how much pre-tax income does <u>your household</u> earn each year? *(Tick one box)*

❒ $1 to $20 000 ❒ $60 000 to $80 000 ❒ $150 000 to $200 000
❒$20 000 to $40 000 ❒ $80 000 to $100 000 ❒ above $200 000
❒ $40 000 to $60 000 ❒ $100 000 to $150 000 ❒ prefer not to specify ❒ I do not know

Thank you for your help ☺