ISSN 1835-9728

Environmental Economics Research Hub

Research Reports

Do values for protecting iconic assets vary across populations? A Great Barrier Reef case study

John Rolfe and Jill Windle

Research Report No. 65

May 2010

About the authors

John Rolfe is a Professor in Regional Development Economics in the Faculty of Business and Informatics at CQ University

Dr Jill Windle is a Research Fellow with the Centre for Environmental Management at CQ University

Environmental Economics Research Hub Research Reports are published by The Crawford School of Economics and Government, Australian National University, Canberra 0200 Australia.

These Reports present work in progress being undertaken by project teams within the Environmental Economics Research Hub (EERH). The EERH is funded by the Department of Environment and Water Heritage and the Arts under the Commonwealth Environment Research Facility.

Crawford School of Economics and Government
THE AUSTRALIAN NATIONAL UNIVERSITY
http://www.crawford.anu.edu.au

Table of Contents

Abstract
A number of studies have examined the effects of distance decay and the influence it might have on both use and non-use values. However, the relationship between environmental values and distance effects is less clear cut when iconic or special assets are involved. In this report, the effects of distance decay on protection values of the Great Barrier Reef in Australia are explored using two split sample choice experiments. The results suggest that the Townsville (local) population had larger use values than the Brisbane (distant) population. However, for iconic resources, where perceptions of responsibility, substitutes and information are reasonably consistent across population groups, non-use values remain constant across spatially different population groups.

Keywords: Choice modelling experiment, distance decay, population effects, iconic assets, Great Barrier Reef, use values, non-use values.

1. Introduction

A key issue in assessing values for environmental protection with stated preference techniques is identification of the relevant population base. It is generally assumed that as distance from the resource of interest increases, the values per person or household will decrease (Pate and Loomis 1997; Hanley et al. 2003; Bateman et al. 2006). This means that an inverse relationship can be expected between increasing the population base and the average protection values that are generated. A number of researchers have examined the importance of distance decay in stated preference experiments using the contingent valuation (CV) or choice modelling (CM) techniques (e.g., Sunderland and Walsh 1985; Pate and Loomis 1997; Hanley et al. 2003; Bateman et al. 2006; Concu 2007, Salazar and Menedez 2007). This has allowed the calculation of use and non-use values as a function of distance from the site of interest (e.g. Concu 2007).

Four groups of reasons can be identified why protection values might decline with increased distance. First, actual use of an environmental resource, such as for recreation, is likely to be lower for people who live further away from it (Sunderland and Walsh 1985; Pate and Loomis 1997; Hanley et al. 2003; Bateman et al. 2006). Second, there are more likely to be different substitutes available as the set of resource possibilities expands (Pate and Loomis 1997; Rolfe et al. 2002; Hanley et al. 2003; Bateman et al. 2006). Third, people may feel less responsible for more distant environmental assets in different jurisdictions (Rolfe and Bennett 2002; Hanley et al. 2003; Bateman et al. 2005, Bateman et al. 2006; Johnston and Duke 2009), and fourth, there may be lower awareness and knowledge of more distant environmental assets (Sunderland and Walsh 1985; Pate and Loomis 1997; Hanley et al. 2003). While the first reason helps to explain why use values may decline with distance, the other reasons suggest that both use and non-use values may decline with increased distance.

The relationship between environmental values and distance effects is less clear cut when iconic or special assets are involved (Pate and Loomis 1997; Loomis 1996). While access and availability can be expected to decline with increasing distance from an iconic resource, there may be little change in substitutes, responsibility or awareness with populations that live within reasonably proximate areas (such as within the same region or state). This is because iconic assets may be unique across population groups, so that non-use values remain relatively constant across distance. Most research on distance decay functions have focused on generic environmental or land assets (e.g. Johnston and Duke 2007), with few studies focusing on more definable assets (e.g. Bateman et al. 2006 valued protection of the Norfolk Broads in the UK).

The hypothesis to be tested in this report is that there is no distance decay in non-use values for iconic assets within reasonably proximate population groups. For very major iconic assets, the relevant population base may be a national one, while for other iconic assets the base may be a state or regional one. Minor hypotheses are that use values for iconic assets will decline with distance effects, and that decay functions for underlying attributes will be sensitive to the combinations of use and non-use values. These hypotheses are tested with CM experiments assessing the protection value of the Great Barrier Reef (GBR) in Australia.

The GBR in north-eastern Australia is an iconic environmental asset at the international level. It stretches more than 2,300 km along the coast of Queensland, is up to 300 kilometres wide, and consists of more than 2,900 individual reefs and 940 islands. The area of approximately 35 million hectares is protected by the Australian and Queensland Governments as a marine park, and has had World Heritage site status since 1981. While the GBR remains one of the most healthy coral reef ecosystems in the world, its condition has declined significantly since European settlement and the overall resilience of the reef has been reduced (Furnas 2003; GBRMPA 2009). A key policy issue is to determine if the public benefits of increased protection measures are sufficiently large to outweigh the costs involved.

Assessing the non-market values for an extensive and iconic environmental good such as the GBR involves identifying the extent of the relevant population who are likely to hold protection values. The hypothesis is tested by estimating the protection values for close and more distant population groups within the same state for the iconic asset. A split sample survey was conducted in a regional town within the GBR catchment area (Townsville) and in Brisbane, the state capital approximately 450 km from the southern limit of the GBR. The *a priori* expectation is that willingness to pay (WTP) will be higher in the Townsville population where residents are able to use the GBR more frequently, but that non-use values will be constant across the population groups.

This report makes an important contribution to the valuation literature in three main ways. First, it provides the first comprehensive valuation of both use and non-use values for the GBR. Second, it provides information about the effects of distance decay for an iconic and internationally significant marine ecosystem. Third, it demonstrates how the CM technique can be employed to distinguish distance-decay effects across choice attributes. The report is structured as follows. In the next section a brief overview is provided of the literature which guided the *a priori* expectations associated with the hypothesis. The case study details are presented in the third section followed by the results and discussion in section four. Conclusions are presented in the final section.

2. Background literature

Sometimes it is hard to tell whether values from distant respondents are driven by use or by non-use values (Bateman and Langford 1997). While there is a recognisable relationship between distance and a decline in use values (e.g. Salazar and Menedez 2007), the relationship with distance and non-use values is not so clear. Some researchers have asserted that there is no reason why these values should decline over distance (e.g. Bateman et al. 2006), while others have noted that non-use values are not always sensitive to proximity (Pate and Loomis 1997; Johnston and Duke 2009).

Hanley et al. (2003) found that more rapid distance decay exists for use values than non-use values. They suggest distance decay relationships will vary across different resource types and spatially within a type where there are many substitutes for the resource in question. Bateman et al. (2006) find that the choice of welfare measure will determine the influence of distance decay on the values of current non-users. They report significant distance decay in overall WTP but not in present non-use values when measuring an equivalent loss (future environmental condition remains the same as present levels). In contrast, when applying a welfare measure of compensating surplus (an improvement in environmental levels in the future) they find the effects of distance decay not only in the overall sample value but also in values stated by present non users.

There are few studies that provide guidance on how distance decay may affect values for well known iconic assets such as the GBR. Loomis (1996) estimate that while distance had an impact on WTP values, people across the whole USA had significant values for restoration of the well known, if not iconic, salmon species by removing two dams in the Elwha River in Washington State, suggesting only moderate distance decay effects. Other studies suggest that non-use values for notable assets will be constant. Pate and Loomis (1997) found no evidence of declining WTP for a salmon improvement program across more distant populations, while Bateman et al. (2006) found constant values for protection of the Norfolk Broads across more distant non-users.

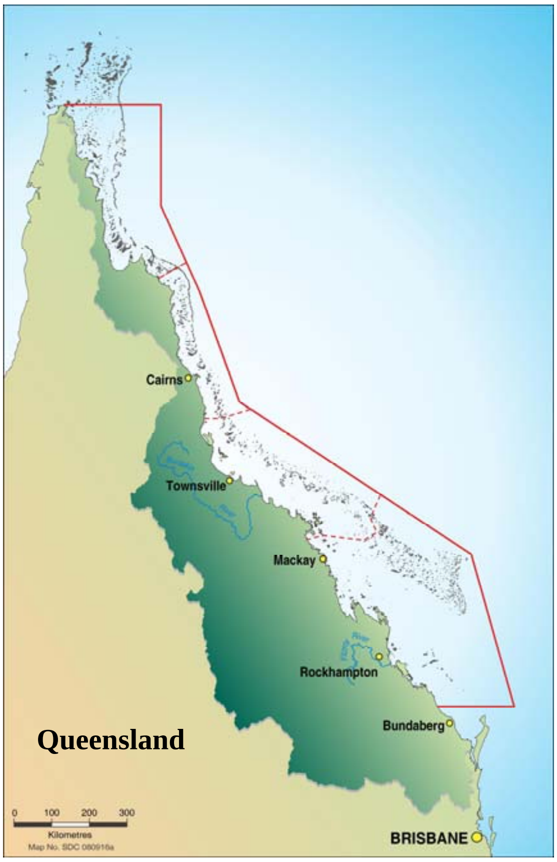
There is potential for CM experiments to provide greater insight into distance decay functions because the attributes used to describe choice experiments can be related to the choices made (Concu 2007). Several CM studies have involved tests for values by population proximity. Morrison and Bennett (2004) explored how protection values for rivers in New South Wales, Australia, varied across within-catchment and out-of-catchment populations, finding that use values were higher for within-catchment populations, and that non-use values were higher for out-of-catchment populations. Van Beuren and Bennett (2004) found statistically equivalent within-region and out-of-region values for biodiversity protection, with lower values in the city samples likely to reflect lower use of assets by that group. In developing distance function for protection values for Kings Park in Perth, Western Australia with CM, Concu (2007) found that distance effects take different and sometimes complex forms across attributes, but that failure to account for spatial heterogeneity could bias results.

These results allow several key expectations to be identified. First, local populations with both use and non-use values are likely to have higher total values than distant populations which only hold non-use values (Bateman et al. 2006). Second, use values can be expected decay with distance from the site of interest. Third, the effect of distance on non-use values is much more open, with evidence of both declining and constant value effects. Fourth, there are a number of different effects likely to impact on value functions, most of which remain hidden in the experimental and decision processes.

3. The choice modelling case study

The research project outlined in this report was designed to explore the population effects of valuing an iconic asset across two survey experiments. Both experiments involved a split sample CM survey with responses collected in Townsville, a regional centre within the GBR catchment area, and Brisbane, the State capital located outside the GBR catchment area (Figure 1).

Figure 1. Great Barrier Reef



Source: Great Barrier Reef Marine Park Authority

Choice modelling involves the presentation of the issue of interest as different choice options, each described by several attributes that vary across the options. The split sample experiments used to explore the population effects varied in both choice design and dimensions to determine if the patterns of responses and values for two population groups were consistent across different survey formats. The split sample experiments were designed so that the choice effort required was roughly equivalent across the two survey formats.

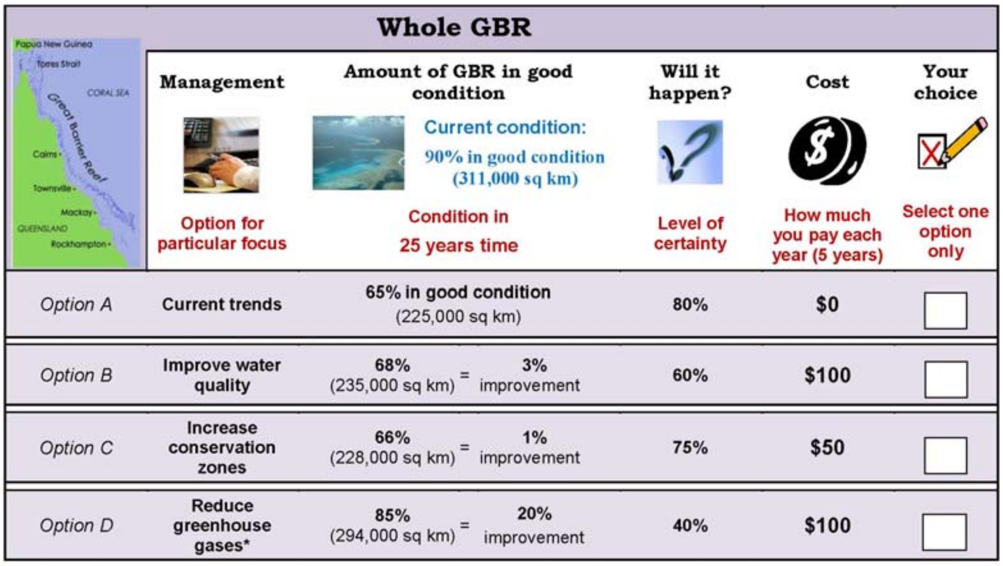
The first split sample focused on protection of the GBR as a single attribute, but expanded the choice dimension in two key ways. Uncertainty was included as a primary attribute and related to the level of certainty associated with the predicted levels of improvement in the condition of the GBR in the choice profiles. The other key design feature was the use of labelled alternatives in each choice task which described the management option that would be applied to achieve the predicted benefits.

The second split sample focused on a multiple attribute version of the survey. Instead of describing the GBR as a single all encompassing attribute, it was disaggregated into three separate attributes, with no use of a certainty attribute or labels. The valuation scenario was described in terms of a cost attribute and three environmental attributes:

- Area of coral reef in good health
- No of fish species in good health
- Area of seagrass in good health

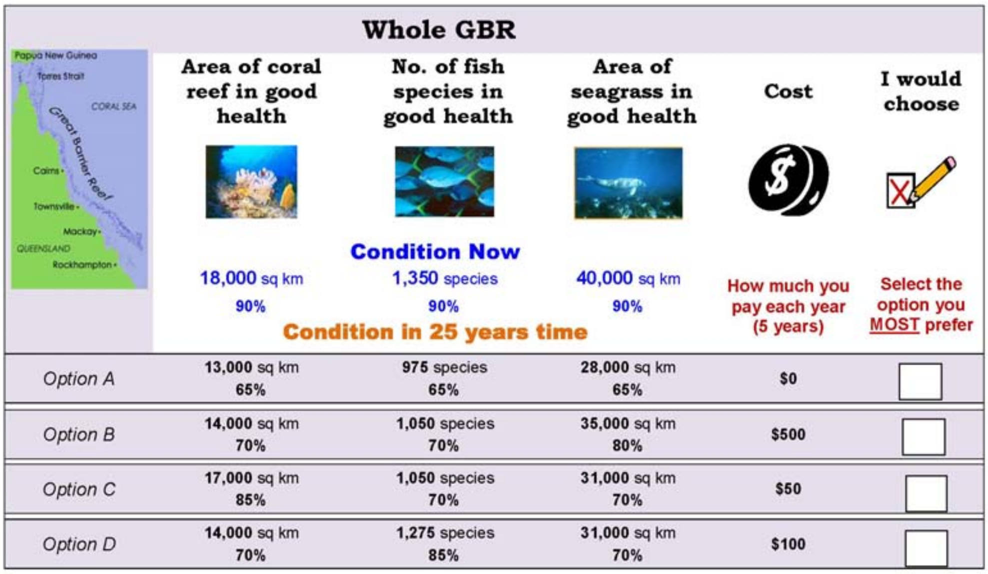
An example of the choice sets in both split-sample experiments is provided in Figure 2. There were four alternatives in each choice task in both experiments, with the first alternative constant across choice sets. One experiment involved three attributes and labelled alternatives, while the other involved four attributes but was unlabelled. This kept the choice dimensions relatively uniform. While the split sample experiments allowed a range of comparative tests to be conducted, only those relevant to the two population groups are presented in this report.

Figure 2. Example multiple and single attribute choice sets



Whole GBR

	Management	Amount of GBR in good condition	Will it happen?	Cost	Your choice
	Option for particular focus	Current condition: 90% in good condition (311,000 sq km) Condition in 25 years time	Level of certainty	How much you pay each year (5 years)	Select one option only
Option A	Current trends	65% in good condition (225,000 sq km)	80%	$0	
Option B	Improve water quality	68% (235,000 sq km) = 3% improvement	60%	$100	
Option C	Increase conservation zones	66% (228,000 sq km) = 1% improvement	75%	$50	
Option D	Reduce greenhouse gases*	85% (294,000 sq km) = 20% improvement	40%	$100	



The attribute descriptions and levels used in the surveys are presented in Table 1. In both surveys, the first alternative was a constant base depicting the amount of the GBR expected to be in good condition in 25 years time under current policy settings and with no additional investment. Based on the predictions of Wolanski and De'ath (2005), Lough (2007) and Garnaut (2008) this was set at 65% of the GBR, down from approximately 90% in current times (GBRMPA 2009; Wolanski and De'ath 2005). The other alternatives provided scenarios where protection of the GBR could be improved through additional investment.

Table 1. Attribute levels[1] for choice alternatives

Attribute	Description	Base (Status quo)	Option levels
Single attribute survey[2]			
Cost	How much you pay each year (5 years)	$0	$20, $50, $100, $200. $300, $500
GBR	Amount of GBR in good condition	65% (225,000 sq km),	66%, 68%, 70%, 72%, 75%,76%, 80%, 85% (228,000 to 294,000 sq km)
Certainty	Will it happen? Level of certainty	80%	10%, 20%, 30%, 40%, 50%, 60%, 70%, 75%, 80%, 85%
Multiple attribute survey			
Cost	How much you pay each year (5 years)	$0	$50, $100. $200, $500
Reef	Area of coral reef in good health	65% (13,000 sq km)	70%, 80%, 85% (14,000, 16,000, 17,000 sq km)
Fish	No of fish species in good health	65% (975 species)	70%, 80%, 85% (1050, 1200, 1275 species)
Seagrass	Area of seagrass in good health	65% (40,000 sq km)	70%, 80%, 85% (31,000, 35,000, 38,000 sq km)

[1] All attribute levels were described both in absolute terms as well as percentage terms, but for brevity all results in this report are reported in percentage terms only.
[2] Attribute levels varied for each labelled alternative

Two D-efficient experimental designs were created, one for the multiple attribute profiles and one for the single attribute. As both designs involved 12 choice sets, to avoid respondent fatigue they were blocked into two versions so that each respondent was assigned a random block of six choice sets.

Surveys were collected in both a paper-based and web-based modes with details presented below. The paper-based surveys were collected to provide a check on the accuracy of the online responses. The effects of collection mode were tested for, but little significant difference could be identified (Windle and Rolfe, 2010), supporting the results of Olsen (2009).

3.1 Respondent characteristics

In the single attribute survey, a total of 257 surveys were collected from households in Brisbane, the state capital. This included 160 online surveys (collected through access to an internet panel) and 97 paper-based surveys. A further 90 paper-based surveys were collected from respondents in Townsville. In the multiple attribute survey, a total of 258 surveys were collected from households in Brisbane, the state capital. This included 163 online surveys (collected through access to an internet panel) and 95 paper-based surveys. A further 91 paper-based surveys were collected from respondents in Townsville. All surveys were collected between August and December 2009.

The paper-based surveys yielded a high response rate of over 85% in both population samples. It is not realistic to estimate accurate response rates for the online surveys because emails were sent to over 40,000 panellists and there is no way of knowing what proportion of panellists responded before the target sample size was attained and the survey closed. The use of age and gender quotas further confounded the issue. However, an approximate response rate of 68% was estimated.

The socio-demographic characteristics of survey respondents were reasonably well aligned with those of the population (Table 2), apart from education levels which were higher for the sample than the population. There were also some differences in the age categories for both samples in the paper-based survey compared to population data.

Table 2. Respondent characteristics

		Brisbane		**Townsville**	
		Sample	**Population[1]**	**Sample**	**Population[1]**
Gender	Female	50%	50%	52%	50%
Children	Have children	67%	n/a	71%	na
Average age	Online respondents	43 years	43 years		
Age category	Paper based respondents				
	18-29 years	13%	24%	21%	27%
	30-45 years	27%	31%	28%	31%
	46-65 years	39%	30%	41%	28%
	66-89 years	20%	16%	10%	14%
Education	Post school qualification	63%	56%	54%	45%
	Tertiary degree	37%	24%	35%	15%
Income	less than $499 per week	16%	17%	21%	17%
	$500 – $799 per week	21%	18%	16%	18%
	$800 – $1199 per week	22%	21%	20%	22%
	$1200 – $1999 per week	27%	24%	29%	25%
	$2000 or more per week	14%	21%	14%	18%

[1] Australian Bureau of Statistics 2006 Census

4. Results

The results from the CM surveys are presented in two sub-sections. Population sample differences in the use of the GBR and attitudes towards its protection and management are outlined in the first. This helps to identify similarities and highlight differences in attitudes towards the protection of the GBR and the relative importance of use and non-use values in the two samples. The CM experiments for the single and multiple attribute surveys are then presented in the following sub-section.

4.1 Usage and attitudinal differences between population samples

As expected, use of the GBR was much higher for Townsville than Brisbane respondents, with the main difference being in the frequency of use generally, and for fishing in particular (Table 3). However, it was difficult to accurately assess recreational fishing use, particularly in Townsville, as there was a high rate of missing values (mv) for this question in the paper-based survey (54% and 30% in the Brisbane and Townsville surveys respectively). Nonetheless, while the frequency of recreational use was higher in Townsville, there was less difference between population samples in the proportion of respondents who had never used the GBR for recreation (33% and 24% in Brisbane and Townsville respectively) and had no intention of doing so in the future (22% and 23% respectively).

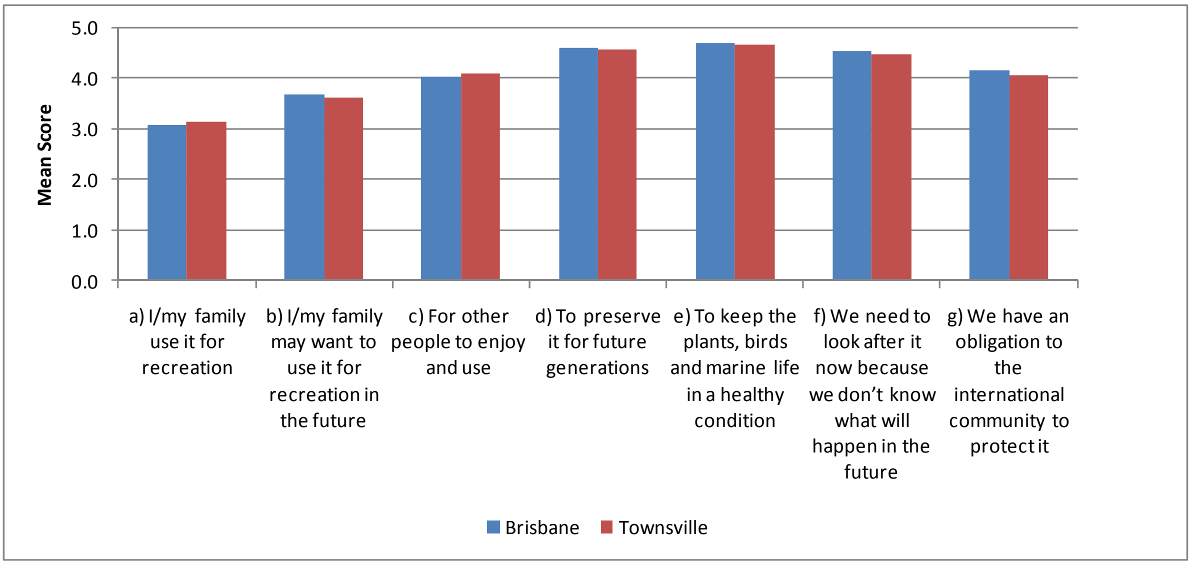
Table 3. Past and future use of the Great Barrier Reef

	Brisbane respondents (n=515)	Townsville respondents (n=181)
Recreational fishing use (excluding missing values)		
Never	77%	37%
Once	8%	15%
More than once	14%	48%
Other recreational use		
Never	33%	24%
Once	27%	17%
More than once	40%	59%
Future recreational use		
Never	21%	23%
At least once in next 5 years	48%	29%
More than once in next 5 years	7%	7%
At least once next year	24%	40%

There was a significant difference (Pearson's chi squared crosstab at 1%) in opinions about how the condition of the GBR had changed in the last 10 years. While only 2-3% of respondents in both locations thought that it had improved, there was a higher proportion in Brisbane who thought it had declined compared with Townsville (70% and 50% respectively). However, there was no significant difference between the two population groups when respondents were asked to rate their knowledge of issues concerning the GBR.

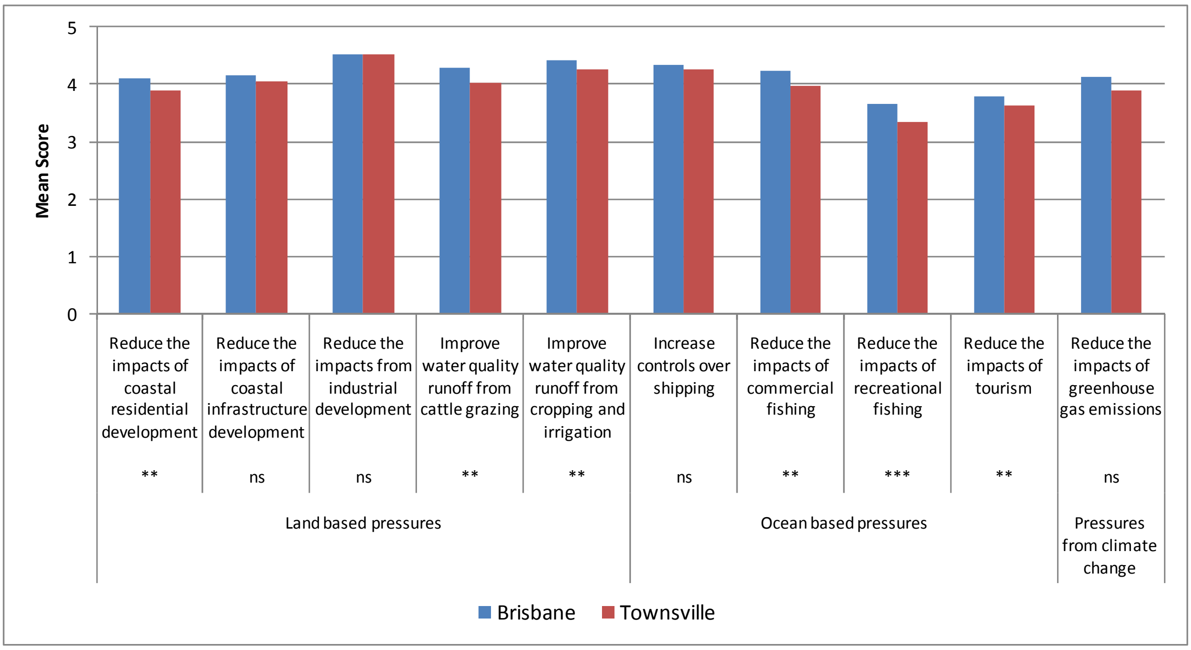
To gauge the relative importance of the different components of total economic value (comprising use and non-use values) on how respondents made their choices, they were asked in the survey to rate a series of reasons for support with a score from (1) NOT important to (5) VERY important. The reasons were designed to represent key categories of value as closely as possible. Results show that existence values (e), bequest values (d) and quasi option values (f) were the most important in both population samples (Figure 3). The results indicate there was no significant difference (Pearson's chi squared crosstab) in the importance of either use values (a-c), or non-use values (d-g) across the sample populations.

Figure 3. Reasons for supporting environmental protection of the Great Barrier Reef



In a series of follow-up questions respondents were asked to rate the importance of different management options to reduce pressure on the GBR. There was little difference in the opinions of the two population samples apart from issues that might directly affect local residents and impact on the local economy. Reducing the impacts of coastal development, commercial fishing, tourism and recreation, as well as agriculture (both cropping and grazing) were rated slightly more highly in Brisbane than Townsville (Figure 4).

Figure 4. Importance of different management options to reduce pressure on the GBR



*** = significant at the 1% level; *** = significant at 5%; ns = no significant difference.

Overall, as usage of the GBR is higher in Townville than Brisbane (Table 3) some distance decay in use values might be expected. However, the similarity between populations in attitudes to why the GBR needs to be protected (Figure 3) and preferences for options to achieve any improvements (Figure 4), suggest that no differences in non-use values should be expected. Results of the CM experiments provide a more detailed insight into these relationships.

4.2. Results of the two choice modelling surveys

Mixed logit (ML) models were developed to explore the influence of population effects on protection values in both split sample experiments. Details of the attribute descriptions and levels were presented in Table 1, with other model variables explained in Table 4.

Table 4. Model variables

Main variables	Description
ASC	Alternative specific constant
SQ…	Prefix to denote status quo (current situation) alternative
WQ…	Prefix to denote management option: Improve water quality (Experiment 1)
CZ…	Prefix to denote management option: Increase conservation zones (Experiment 1)
GG…	Prefix to denote management option: Reduce greenhouse gases (Experiment 1)
AGE	Age in years. Only categorical details were collected in the paper survey, so the mid point of each category was applied.
GENDER	Male = 0; Female = 1
CHILDREN	Children = 1; no children = 2
EDUCATION	Coded from 1= primary to 5 = tertiary degree or higher
INCOME	Categories 1-5 (see Table 2 for details). The mid point of each category was used for analysis with an additional 25% added to the last category.

In all models presented in this section, the socio demographic variables were modelled to explain the choice of the base or status quo alternative. Only the ASCs were randomised which meant that all single GBR and multiple GBR attributes were treated in a uniform manner as non-random parameters. Results of the single GBR attribute survey are presented in Table 5.

The models for both population groups are significant (high chi-squared values) and the COST and GBR CONDITION attributes are significant and signed as expected. Higher levels of GBR CONDITION and lower levels of COST are consistently preferred across models. A Log Likelihood Ratio test indicates that there is no significant difference between the models.

Some difference in models can be identified. First the CERTAINTY attribute is significant in the Brisbane but not the Townsville sample. Second, parameters for the three randomised alternative labels are all significant and negative, indicating that there are unobserved reasons why respondents avoided selecting the different labelled (management options) alternatives. The coefficient values are larger in the Townsville sample (a higher level of unexplained effects) and the difference in values indicates that Townsville respondents preferred the *Improve water quality* management option while Brisbane respondents preferred the *Increase conservation zones* management option. The standard deviations of random parameter estimates are all significant, indicating there is significant heterogeneity in influences underlying the selection of the management alternatives. The third key difference between the models is in the significance of the socio-demographic variables, notably with the INCOME variable not significant in the Townville sample. The fourth difference between the populations was in the proportion of potential protest votes with 25% and 15% of respondents always selecting the status quo option in the Townsville and Brisbane samples respectively.

Table 5. Mixed logit models for the single GBR attribute survey

	Townsville				Brisbane			
	Coefficient		St Error	WTP (CI)	Coefficient		St Error	WTP (CI)
Random parameters in utility functions								
WQ_ASC	-9.3550	***	2.4922		-4.2399	***	1.0970	
CZ_ASC	-10.3197	***	2.5974		-4.0749	***	1.0625	
GG_ASC	-12.5589	***	3.0483		-6.3322	***	1.2292	
Derived standard deviations of parameter distributions								
WQ_ASC	2.7681	***	0.4535		2.2643	***	0.1812	
CZ_ASC	4.6013	***	1.0265		2.2761	***	0.2108	
GG_ASC	5.3913	***	1.0151		3.5707	***	0.3799	
Non Random parameters in utility functions								
COST	-0.0049	***	0.0011		-0.0062	***	0.0005	
GBR CONDITION	0.1877	***	0.0435	$38.11 ($17-$86)	0.1639	***	0.0172	$26.37 ($20-$34)
CERTAINTY	0.0123		0.0136		0.0150	***	0.0055	
AGE	-0.0689	***	0.0213		-0.0119		0.0090	
GENDER	-0.5836		0.5744		-0.6322	**	0.2613	
CHILDREN	-1.4920	*	0.7935		-0.2699		0.2241	
EDUCATION	-0.6970	***	0.2371		-0.3492	***	0.1204	
INCOME	-0.8E-06		0.1E-05		-0.1E-05	***	0.4E-06	
Model statistics								
No of Observations			522				1500	
Log L			-485				-1580	
Finite sample: AIC			1.914				2.126	
Info. Criterion: BIC			2.027				2.175	
McFaddon R-sqrd			0.3295				0.2400	
Chi Sqrd			477				998	

*** significant at 1%; ** significant at 5%; * significant at 10%

The WTP estimates for attribute changes are also reported in Table 5. The mean estimate for the Townsville sample is $38.11 per household (per year for five years) for a 1% improvement in the condition of the GBR compared with a value of $26.37 for the Brisbane sample. This suggests that WTP estimates are 44% higher in Townsville compared with Brisbane, providing some evidence of a distance decay effect. There is also more heterogeneity in the Townsville values evidenced by the wider range in confidence intervals (CI). However, the results showed overlapping confidence intervals, and the Poe et al. (2005) procedure, which calculates the proportion of differences greater than zero, indicates there is no significant difference between the value estimates for GBR CONDITION in the two samples (Poe statistic of 0.19). Together with the results of the log-likelihood test, these outcomes indicate that there is no significant difference in values between the two population groups.

The second split sample experiment allowed more detailed tests by disaggregating values across different GBR attributes, with results presented in Table 6. Models for both population groups are significant (high chi-squared values) and coefficients for the four main attributes are all significant and signed as expected. Higher levels of REEF, FISH and SEAGRASS and lower levels of COST are all consistently preferred across models. However, a Log Likelihood Ratio test indicates that there is no significant difference between the two models, consistent with the results of first split-sample experiment.

Table 6. Mixed logit models for the multiple attribute survey

	Townsville				**Brisbane**			
	Coefficient		St Error	WTP (CI)	Coefficient		St Error	WTP (CI)
Random parameters in utility functions								
SQ_ASC	-17.9130	**	7.9207		1.2072		3.7294	
Derived standard deviations of parameter distributions								
ASC	6.9067	***	1.6949		6.0271	***	0.7997	
Non Random parameters in utility functions								
COST	-0.0029	***	0.0005		-0.0043	***	0.0003	
REEF	.04480	***	0.0095	$15.58 ($9-$24)	0.0530	***	0.0053	$12.45 ($10-$15)
FISH	0.0392	***	0.0099	$13.61 ($7-$21)	0.0340	***	0.0055	$8.00 ($6-$10)
SEAGRASS	0.0269	**	0.0117	$9.37 ($2-$16)	0.0260	***	0.0066	$6.10 ($3-$9)
AGE	0.1619	**	0.0743		0.0086		0.0356	
GENDER	3.5673	*	1.9944		-0.7387		0.9620	
CHILDREN	2.9714		2.4502		-0.5053		1.2404	
EDUCATION	-1.6323	*	0.8884		-0.2615		0.4338	
INCOME	0.4E-05		0.3E-05		-0.3E-05	***	01E-05	
Model statistics								
No of Observations			522				1500	
Log L			-556				-1548	
Finite sample: AIC			2.174				2.078	
Info. Criterion: BIC			2.262				2.117	
McFaddon R-sqrd			0.232				0.256	
Chi Sqrd			335				1064	

*** significant at the 1% level; *** significant at 5%; *significant at 10%

In the Townsville model, the ASC is significant with very high negative values indicating there are unobserved reasons why respondents did not select the status quo option. In the Brisbane model the ASC is not significant. The standard deviation for the ASC distribution in both models is highly significant indicating there is considerable heterogeneity in the unobserved effects. There is a notable difference in the influence of the socio-demographic variables. In the Townsville model, older people and females were more likely to select the status quo option and respondents with higher levels of education were less likely to select this option. None of these variables were a significant influence on choice in the Brisbane model. Income was a significant influence on choice in the Brisbane model, but not in Townsville. There was no difference in the proportion of potential protest votes in either population sample with 16% and 15% of respondents always selecting the status quo option in the Townsville and Brisbane samples respectively.

One of the main difficulties of separating the GBR into separate attributes is the potential correlation between them, especially between coral reefs and fish populations. To test for the significance of correlated attributes, three new interaction variables were introduced into the models presented in Table 6[1]. When these interactions were included in the models along with the single attributes the interactions were not significant. When only the interactions were included in the models, similar results were identified for both population samples:

- The REEF and FISH interaction was significant at the 1% level;
- The REEF and SEAGRASS interaction was significant at the 5% level in Townsville and at the 1% level in Brisbane ; and
- The FISH and SEAGRASS interaction was not significant.

The WTP estimates for improvements (per 1%) in the condition of the REEF, FISH and SEAGRASS appear to be higher in Townsville than Brisbane, but with overlapping confidence intervals (Table 6). When the values for a one percent change are summed across the attributes, Townsville residents have a larger WTP ($38.56) compared to WTP for Brisbane residents ($26.55). The Poe et al. (2005) procedure indicates there is no significant difference between populations for the estimates for REEF and SEAGRASS but there is for FISH (Poe statistic of 0.046). Respondents in Townsville had a significantly higher WTP to improve the condition of fish in the GBR compared with Brisbane respondents. Given the links between fish stocks and recreational activities, this suggests that Townsville residents have much higher use values than Brisbane residents.

Further tests were conducted to explore reasons why population differences might exist. While the results from the mixed logit models suggest there was some similarity between responses from the two sample populations, latent class models[2] for the second experiment suggest there were significant differences (confirmed with a Log Likelihood Ratio test) in the pattern of preferences for the different attributes (Figure 5). Latent class models for both population centres had a strong fit, each with McFadden Pseudo R-squared values of 0.32.

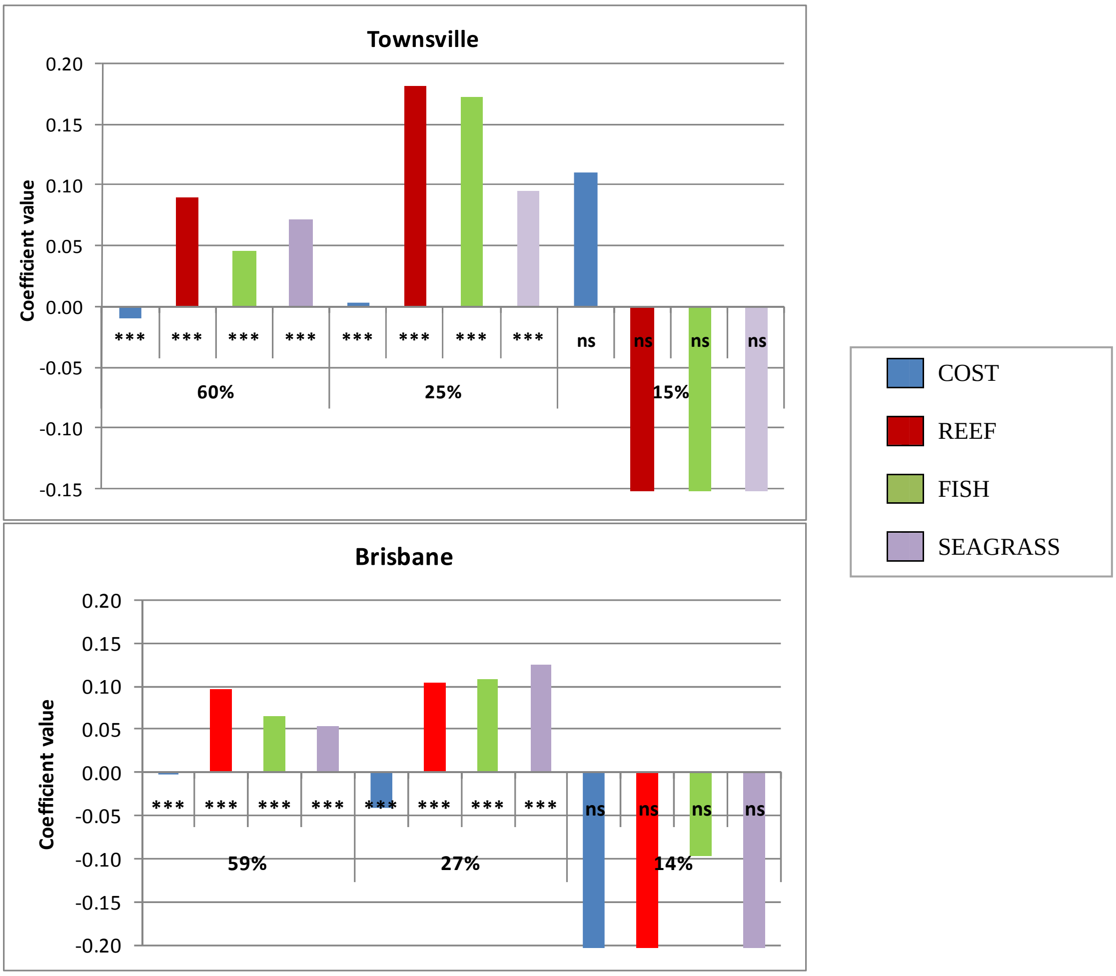
The main latent class, accounting for nearly 60% of responses in both samples, has negative values for COST and similar positive values for REEF, FISH and SEAGRASS. The third class, accounting for nearly 15% of responses, was also similar in both groups with none of the attributes being significant. Larger differences between population groups were

[1] Models are available on request from the authors.
[2] Models are available on request from the authors.

identified in the second class, accounting for about a quarter of responses in both samples. In Townsville, this group had very strong preferences for REEF and FISH, and to a lesser extent SEAGRASS. This group had very low but positive preferences for COST, perhaps viewing higher cost options as more likely to succeed, or giving strategic responses to choose better environmental outcomes. In the second class, Brisbane preferences for the three GBR attributes were stronger than the first class, but followed a reverse preference order compared with Townsville. Moreover, Brisbane respondents in this class were more sensitive to cost compared with the first class.

While these results indicate that there were differences between these groups in the sample populations, further modelling could not link membership of the latent classes with activity, demographic or attitudinal factors. The latent class models do not identify protection of FISH as a key driver for Townsville respondents, with REEF being the most important attribute for the first and second latent classes. While it is possible that access to reefs are an important driver of recreation choices, the lack of any significant relationship between class membership and recreation activities suggests that it is likely that non-use values within a subgroup in the Townsville (local) population are driving the higher values for protection.

Figure 5. Latent class models for attribute selection



*** = significant at 1%; ** = significant at 5%; ** = significant at 10%; ns = not significant

5. Discussion and conclusions

The focus of the experiments reported in this report have been to identify whether the protection values for a major iconic asset, such as the Great Barrier Reef, vary between close and more distant populations. The tests have been conducted across two different CM experiments to control for framing and design differences. The results indicate little statistical difference in attitudes and values held by the two populations involved in this case study, indicating that for iconic assets values may be relatively stable across broad jurisdictional areas.

The values generated in the sample experiments do suggest that the close population had larger values than the more distant one, with the Townsville (local) population values being 44.5% and 45.2% higher than the Brisbane (distant) population in the single GBR attribute and multiple GBR attribute experiments respectively. The consistency of the relative value estimates is notable as the split sample experiments involved very different choice profiles, although similar choice burdens. There are strong theoretical and practical grounds for expecting that higher values in the close population group reflect higher use values, confirming the expectation that local populations with both use and non-use values are likely to have higher total values (Bateman et al. 2006). The evidence from the multi-attribute experiment is that the higher use values may be driven by values for fish protection, reflecting high levels of recreational fishing in the local population.

The results indicate that non-use values are equivalent across the two population groups, consistent with the expectations of Bateman et al. (2006) that non-use values should be invariant with distance. In this case study it appears likely that substitute options, jurisdictional perspective and knowledge base about the Great Barrier Reef were constant across the two population groups, explaining the consistency in value estimates. However, those factors may not be consistent across more distant populations (e.g. international groups), so care has to be taken in extrapolating values more widely.

The forensic analytical benefits of applying the CM technique have been illustrated with the identification of heterogeneity in response patterns and application of the latent class models in this experiment. These have shown both the similarities and the differences between the two population groups. Two of the three latent class models for each population group demonstrated almost identical preference structures and similar proportional support. Differences emerged with the remaining class, accounting for about one-quarter of each respondent group, where the Townsville (close) population had stronger and different preferences for protecting the GBR assets. For this class, there was little evidence that higher values could be linked to recreation behaviour, suggesting that responses may be driven by non-use values or other factors.

These results help to resolve some of the issues around non-use values and distance decay functions. Previous studies (e.g. Pate and Loomis 1997) have shown varying relationships between non-use values and distance effects. Hanley et al. (2003) suggest this effect is a consequence of different resource types and spatial effects. In this study, we have demonstrated that for iconic resources, where perceptions of responsibility, substitutes and information are reasonably consistent across population groups, non-use values remain constant across spatially different population groups.

Acknowledgements

The research outlined in this report has been funded through the Environmental Economics Research Hub funded through the Commonwealth Environment Research Facility in Australia. The contribution of Jeff Bennett and staff from the Great Barrier Reef Marine Park Authority to the design of the project is gratefully acknowledged.

References

Bateman, I. and Langford, I. 1997 Non-users' willingness to pay for a national park: an application and critique of the contingent valuation method. *Regional Studies,* 31(6): 571-582.

Bateman, I.J., Cooper, P., Georgiou, S., Navrud, S., Poe, G.L., Ready, R.C., Reira, P., Ryan, M. and Vossler, C.A. 2005 Economic valuation of policies for managing acidity in remote mountain lakes: examining validity through scope sensitivity testing. *Aquatic Sciences*, 67 (3): 274–291.

Bateman, I., Day, B., Georgiou, S. and Lake, I. 2006 The aggregation of environmental benefit values: Welfare measures, distance decay and total WTP. *Ecological Economics*, 60: 450-460.

Concu, G. 2007 Investigating distance effects on environmental values: a choice modelling approach. *Australian Journal of Agricultural and Resource Economics,* 51: 175-194.

Furnas, M. 2003 *Catchments and Corals: Terrestrial Runoff to the Great Barrier Reef*, Australian Institute of Marine Science and CRC Reef Research Centre, Townsville.

Garnaut, R. 2008 *The Garnaut Climate Change Review*, Cambridge University Press, Melbourne.

Great Barrier Reef Marine Park Authority (GBRMPA) 2009 *Great Barrier Reef Outlook Report 2009*, Great Barrier Reef Marine Park Authority, Townsville.

Hanley, N., Schlapfer, F. and Spurgeon, J. 2003 Aggregating the benefits of environmental improvements: distance decay functions for use and non-use values. *Journal of Environmental Management*, 68: 297-304.

Johnston, R. and Duke, J. 2009 Willingness to pay for land preservation across States and jurisdictional scale: Implications for benefit transfer. *Land Economics,* 85: 217-237.

Loomis, J. 1996 How large is the extent of the market for public goods: evidence from a nationwide contingent valuation survey. *Applied Economics,* 28(7): 779-782.

Lough, J. 2007 Climate and climate change on the Great Barrier Reef, in J. Johnson and P. Marshall (eds), *Climate Change and the Great Barrier Reef: A vulnerability assessment*, Great Barrier Reef Marine Park Authority and Australian Greenhouse Office.

Morrison, M. and Bennett, J. 2004 Valuing New South Wales rivers for use in benefit transfer, *Australian Journal of Agricultural and Resource Economics*, 48: 591-611.

Olsen, S.B. (2009). Choosing between internet and mail survey modes for choice experiments surveys considering non-market goods. *Environmental and Resource Economics*, 44(4): 591-610.

Pate, J. and Loomis, J. 1997 The effect of distance on willingness to pay values: a case study of wetlands and salmon in California. *Ecological Economics,* 20: 199 -207.

Poe, G.L., Giraud, K.L. and Loomis, J.B. 2005 Computational methods for measuring the differences of empirical distributions. *American Journal of Agricultural Economics,* 87(2):353-365.

Rolfe, J.C. and Bennett, J.W. 2002 Assessing rainforest conservation demands, *Economic Analysis and Policy*. 32(2): 51-67.

Rolfe, J.C., Bennett, J.W. and Louviere, J.J. 2002 Stated values and reminders of substitute goods: Testing for framing effects with choice modelling. *Australian Journal of Agricultural and Resource Economics,* 46: 1-20.

Salazar, S. and Menedez, L. 2007 Estimating the benefits of an urban park: Does proximity matter? *Land Use Policy*, 24: 296-305.

Sutherland, R.J. and Walsh, R., 1985. Effect of distance on the preservation value of water quality. Land Economics., 61: 281-291.

van Bueren, M. and Bennett J. 2004 Towards the development of a transferable set of value estimates for environmental attributes. *Australian Journal of Agricultural and Resource Economics*, 48:1-32.

Windle, J. and Rolfe, J. 2010 Comparing responses from web and paper-based collection modes in a choice modelling experiment**.** Paper presented at the 54th Annual Australian Agricultural and Resource Economics Society Conference, 10-12th February, Adelaide.

Wolanski, E. and De'ath, G. 200. Predicting the impacts of present and future human land-use on the Great Barrier Reef. *Estuaries, Coastal and Shelf Science,* 64: 504-508.