Assessing national values to protect the health of the Great Barrier Reef

John Rolfe and Jill Windle
Centre for Environmental Management
CQUniversity, Rockhampton, Q4702
http://resourceeconomics.cqu.edu.au/

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Abstract

The aim of this study was to estimate the values to protect the health of the Great Barrier Reef (GBR) at the national level and to examine the effects of distance decay on valuation estimates. A split-sample choice-modelling experiment was conducted in six locations: a regional town within the GBR catchment area (Townsville); Brisbane, the state capital approximately 450 km from the southern limit of the GBR; and four other capital cities (Sydney, Melbourne, Adelaide and Perth) ranging from nearly 1,000 km to over 4,000 km from Brisbane.

The results suggest that the average WTP across Australian households is $21.68 per household per annum for five years. There was some evidence of distance decay in values. Most decline occurred once outside the home state, and little further decline once away from the east coast. There was no evidence to suggest any difference in patterns of use and non-use values. The values of the potential future users were most influential in determining WTP estimates.

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 and the population base 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).

In this paper, the national values to improve protection of the Great Barrier Reef (GBR) in Australia are assessed in two split sample CM experiments across six geographically distant population samples to identify if distance decay effects exist. The *a priori* expectation is that willingness-to-pay (WTP) will be higher in the local population where residents are able to use the GBR more frequently, and values will decay with distance from the GBR. A key aim of the study is to examine the potential for benefit transfer for iconic resource values across different population groups.

This paper makes an important contribution to the valuation literature in three main ways. First, it provides an important assessment 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 paper is structured as follows. In the next section, a brief overview is provided of the literature which guided the *a priori* expectations. The case study details are presented in the third section followed by the results in section four. The discussion and conclusions are presented in the final section.

2. Background literature

Sometimes it is hard to tell whether protection 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 no distance decay 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 protection values for well known iconic assets such as the GBR. Loomis (1996) estimate that while distance had an impact on WTP values for restoration of the well known, if not iconic, salmon species, people across the whole USA had significant values for achieving this 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 and geographic location (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 a 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 hold mostly 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 assess the national values in Australia for the iconic GBR across two choice experiment formats. Both experiments involved a split sample CM survey with responses collected in Townsville, a regional centre located within the GBR catchment area; Brisbane, the State capital located outside the GBR catchment area, and four other State capital cities (Sydney, Melbourne, Adelaide and Perth) ranging from nearly 1,000 km to over 4,000 km from Brisbane (Figure 1).

FIGURE 1 ABOUT HERE

The format of the first split sample focused on protection of the GBR as a single attribute, but expanded the choice dimension in two key ways. Certainty was included as a primary attribute to describe predicted levels of improvement in the condition of the GBR in the choice profiles. The main reason certainty was included as an attribute was to help frame the variability surrounding any predictions about current and future health of the GBR. 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 dimensions of the choice task relatively uniform.

FIGURE 2 ABOUT HERE

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.

TABLE 1 ABOUT HERE

Two D-efficient experimental designs were created, one for the single attribute profiles and one for the multiple attribute profiles. Both designs involved 12 choice sets, which were blocked into two versions so that each respondent was assigned a random block of six choice sets. Surveys were collected in Townsville and Brisbane in both a paper-based and web-based modes between August and December 2009 (survey mode did not have a significant influence on results). Further surveys were collected in a web-based mode using an internet panel in September 2010 in Sydney, Melbourne, Adelaide and Perth. A total of 1919 surveys were collected across the two survey formats and from six population groups.

4. Results

As expected, use of the GBR was much higher for local Townsville respondents, with the main difference being in the frequency of use generally, and for fishing in particular. However, it was difficult to accurately assess recreational fishing use, particularly in Townsville, as there was a high rate of missing values for this question in the paper-based survey (54% and 30% in the Brisbane and Townsville surveys respectively). There was a steady increase with distance in the proportion of respondents who had never used the GBR for recreational purposes (apart from Perth) (Figure 3.). In contrast, there was a more segmented increase in the proportion of respondents who had no intention of using the GBR in the future. There was little difference in the proportion of potential future users within the three more accessible eastern states (Townsville, Brisbane, Sydney and Melbourne) and those within the two least accessible states (Adelaide and Perth). The main differences appeared between the two groups (Figure 3).

FIGURE 3 ABOUT HERE

These results suggest that if current usage patterns are a major determinant of WTP values then a steady decline in values may be associated with increasing distance, whereas, if future usage patterns are the major determinant, then distance decay may be manifest in a two segment separation.

4.1. Results of the two split sample experiments

Responses to the choice sets were analysed with mixed logit (ML) models 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 and other model variables are explained in Table 2.

TABLE 2 ABOUT HERE

In all models presented in this section, a standard format was applied where the five main socio-demographic variables (Table 3) were included in all models whether or not they were significant. The extent of significance (or lack of it) provides important information for potential use in subsequent benefit transfer applications. The socio-demographic variables were modelled to explain the choice of the base or status quo alternative. Only the ASCs were randomised to capture the heterogeneity around choices between the current policy (SQ) and the three protection alternatives. This meant that all single and multiple attributes were treated in a uniform manner as non-random parameters. Results of the single GBR attribute survey are presented in Table 3.

TABLE 3 ABOUT HERE

The models for all 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.

Some difference in models can be identified. First, the CERTAINTY attribute is not significant in the Townsville sample but is in all the other population samples. Second, parameters for the three randomised alternative labels vary in strength and significance across samples. There are significant unobserved reasons why respondents avoided selecting the different labelled (management options) alternatives in Townsville, Brisbane and Adelaide, but not in the three other capital cities. The coefficient values for the labelled alternatives are larger in the Townsville sample (a higher level of unexplained effects) but in all three cases the REDUCE GREENHOUSE GAS option was the least preferred. 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, the INCOME variable is not significant in the Townsville and Melbourne samples. The EDUCATION variable is a significant influence on choice selection in all locations apart from Sydney; people with higher education levels were more likely to select one of the improvement options. A further variation between the population responses is in the proportion of potential protest votes. The biggest difference is in the two Queensland samples with 25% and 15% of respondents always selecting the status quo option in the Townsville and Brisbane samples respectively. In the other capital cities, 18%, 21%, 24% and 17% of respondents always selected the status quo option in Sydney, Melbourne, Adelaide and Perth respectively.

Log likelihood ratio tests indicate that there is no significant difference between the two Queensland samples, but there is between each of them and the other out-of-state samples. There is also a significant difference between some of the out-of-state samples. There is no difference between the Perth and Sydney and between Perth and Melbourne models but there is between Sydney and Melbourne, and between Adelaide and all other locations.

The final comparison to be made between population samples is in the WTP estimates. There is a clear decline in WTP estimates (annual household values for a one per cent improvement in GBR CONDITON for a five year period) as distance from the GBR increases, with approximately equivalent values after Brisbane (apart from the anomaly of Adelaide) (Figure 4). Mean WTP estimates drop from $38 in Townsville to $20 in Sydney and then only decline to $18 in the most distant capital city of Perth. The large range in confidence intervals (CI) is limited to the Townsville sample, with smaller and similar ranges in all other capital cities. A Poe et al. (2005) procedure, which calculates the proportion of differences greater than zero, indicates there is no significant difference (at the 5% level) between WTP estimates for the two Queensland samples (Townsville and Brisbane) or between either of them and Sydney or Adelaide. Apart from Adelaide there is no difference in estimates between the more distant capital cities.

FIGURE 4 ABOUT HERE

Excluding the anomaly of Adelaide, the results suggest two patterns of distance decay may be occurring. WTP may be higher but declining with distance within the GBR state (Queensland), and then lower and reasonably uniform across the out-of-state populations.

In the second split sample experiment, the health of the GBR was presented as three component attributes, with results presented in Table 4. Models for all population samples are significant 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.

TABLE 4 ABOUT HERE

There are fewer differences between the models compared with the single attribute survey. First, the ASC is only significant in the Townsville model with very high negative values indicating there are unobserved reasons why respondents did not select the status quo option. Second, there is less influence associated with the socio-demographic variables compared to the single attribute survey, and therefore fewer differences across models. In particular, EDUCATION is only significant in the Adelaide model and then only at the 10% level. The INCOME variable is not significant in the Townsville (as in the single attribute survey) and Adelaide samples (where it had been significant in the single attribute survey).

There is no difference in the proportion of potential protest votes across population samples with 16% and 15% of respondents always selecting the status quo option in the Townsville and Brisbane samples respectively. In the other capital cities, 18%, 14%, 23% and 18% of respondents always selected the status quo option in Sydney, Melbourne, Adelaide and Perth respectively.

Log likelihood ratio tests indicate that there is no significant difference between the two Queensland models, Townsville and Brisbane, but there is between Townsville and all the other out-of-state sample models. There is no difference between the Brisbane model and all other out-of-state models, and the only other difference amongst the more distant population samples is between Adelaide and Perth.

In contrast to the results from the single attribute survey, the WTP estimates from the multiple attribute survey do not show a consistent decline with distance, nor does Adelaide stand out as an anomaly (Figure 5). In terms of improvements in coral reef health, as well as in seagrass health, a Poe et al. (2005) procedure indicates there is no significant difference (at the 5% level) between WTP estimates across all samples and therefore no notable effects of distance decay.

FIGURE 5 ABOUT HERE

However, a number of differences appear in WTP estimates for improvements in the health of fish species. The most obvious is that estimates in the most distant populations are higher than those on the east coast (Figure 7). Poe et al. (2005) tests reveal that at the 5% level of significance, there is no difference between Townsville estimates or those from any of the other population samples. Estimates for Brisbane are particularly low and are significantly different to those from Melbourne, Adelaide and Perth, but not Sydney. Sydney estimates are significantly different from Melbourne, Adelaide and Perth, but there is no difference between estimates for Melbourne, Adelaide and Perth.

A comparison of the WTP estimates from the single attribute and multiple attributes (aggregated) experimental formats is provided in Table 5. There is no difference in values for Townsville and Brisbane across formats, but values for all other population samples are higher in the multiple attribute format, particularly in the non-east coast samples.

TABLE 5 ABOUT HERE

4.2 Assessing the influence of use and non-use values

To better understand the influences of current knowledge and future intentions about use, respondents were identified into three separate groups; current users, future users and non-users. Identification was based on past and future intentions for visiting (Figure 3), with substantial overlap between the current and future user groups. A separation between current and future users was made because while the former may have practical experience of the GBR to guide their choices, the choice experiments were framed in terms of improvements in GBR condition in the future, which was of direct relevance to respondents who intended to use the GBR in the future. The third group of respondents who had never visited the GBR and never intended to in the future were identified as having mainly non-use values for the GBR. Comparing the WTP estimates of the different groups allowed some assessment of the relative importance of use and non-use values and how these may vary across locations. The results from separate models for the single attribute survey for each group by location are presented in Table 6.

TABLE 6 ABOUT HERE

The results allow three general conclusions to be drawn. First, respondents who intend to visit in the future tend to have higher values than those who have visited in the past, suggesting that future recreation use was a more important driver of protection values than familiarity. Second, values of future users were highest for the local population, but then relatively invariant by distance across Brisbane and other out-of-state groups. Third, the values of the non-users declined with distance, with highest non-use values identified for the Brisbane sample, and lowest for the more distant Adelaide/Perth sample. As these two findings are at odds with prior expectations, it is worth noting a potential confounding effect with the proportion of non-users by capital city group, with 8%, 16% and 29% non-users in Brisbane, Sydney-Melbourne and Adelaide-Perth respectively.

4.3 Developing a national value transfer function

To better understand the pattern of value estimates at a national level, a pooled data set for the single attribute survey was used to predict values by respondent characteristics and location (Table 7). Three additional variables were added to the analysis to help predict the choice between the No Control (Status Quo) alternative and an improvement alternative. A variable to indicate residence in the home state of Queensland (QUEENSLAND) was added to account for additional feelings of responsibility that might be present, and a variable to capture the amount of future use in terms of the number of planned visits (FUTURE USE) was added to reflect use values. A distance variable (in log form) (LOGDISTANCE) was added to capture differences in location.

Results (Table 7) show a highly significant model with strong explanatory power that replicates the pattern of results from the models reported in Table 3. The significance of the QUEENSLAND attribute indicates that Queenslanders do have additional feelings of responsibility towards the asset because of its location within their state, while the negative coefficient means that they are more likely to choose an improvement option. The significance and sign of the FUTURE USE coefficient indicates that respondents who plan to visit more often in the future are more likely to choose a protection option. The significance and sign of the LOGDISTANCE variable indicates that respondents from further away were more likely to choose a protection option. While this is contrary to expectations, it indicates that protection values for a national icon may be relatively consistent across the country, and that apparent distance effects may be largely explained by variations in usage and perceptions of responsibility.

TABLE 7 ABOUT HERE

5. Discussion and conclusions

The results of the CM experiments reported in this paper confirm that distance-decay functions can exist, but revealed a number of complexities in the effects. A key result is that distance-decay effects appear to be limited for iconic resources. In the single attribute study the protection values of the GBR declined by less than 50% from the local population to the out-of-state populations, and remained relatively invariant outside of the local state. When attributes reflecting state responsibility and future usage rates were added in the pooled model for the single attribute study, the distance effects became slightly negative. These results are consistent with an important and unique asset such as the GBR, where it is typically framed as a national asset, there are no realistic substitutes, and there is widespread knowledge and awareness of its condition. An implication is that the relevant population base is larger when iconic resources are involved.

As expected, patterns of direct use appear to explain some variation in protection values, with local residents having both greater opportunities for use and higher overall protection values. However, contrary to initial expectations, use values did not decline linearly as a function of distance for interstate communities. Instead, future use values appeared to be very consistent for populations more then several hundred kilometres from the asset. This may be because most Australians, including those in Brisbane, would choose to fly to visit the GBR, and distance is therefore not a good proxy for their accessibility and use.

Values were higher for the people planning to visit in the future, and were significantly related in the pooled model to the number of planned future visits. This suggests that option values for direct use are an important component of total economic value, and may be a key driver of protection values. Value estimates from the pooled model suggest that the average WTP across Australian households is $21.68 per household per annum for five years, and that those values are higher for respondents with higher levels of education and income, respondents who live in Queensland, respondents who live further away, and respondents who plan to visit more often in the future.

The results from the multiple attribute survey showed that distance decay functions varied across survey formats. The WTP estimates for Townsville and Brisbane were virtually the same across formats, but in the other four capitals values were much higher in the multiple attribute format compared with the single attribute format. Disaggregating the GBR into separate attributes may have made each attribute more specific and realistic, elevating its relative importance and value compared with the very general single GBR attribute.

These results generate some promise and challenges for analysts assessing protection values for environmental assets. Distance decay functions are likely to be limited for iconic assets, meaning that the population base supporting their protection is likely to be larger. In this study higher values were associated with potential for future visitation, suggesting option values were an important driver of responses. However, it appears that patterns of distance decay are also influenced by the way that choice tasks are framed, and that care has to be taken to consider this in the design of valuation surveys.

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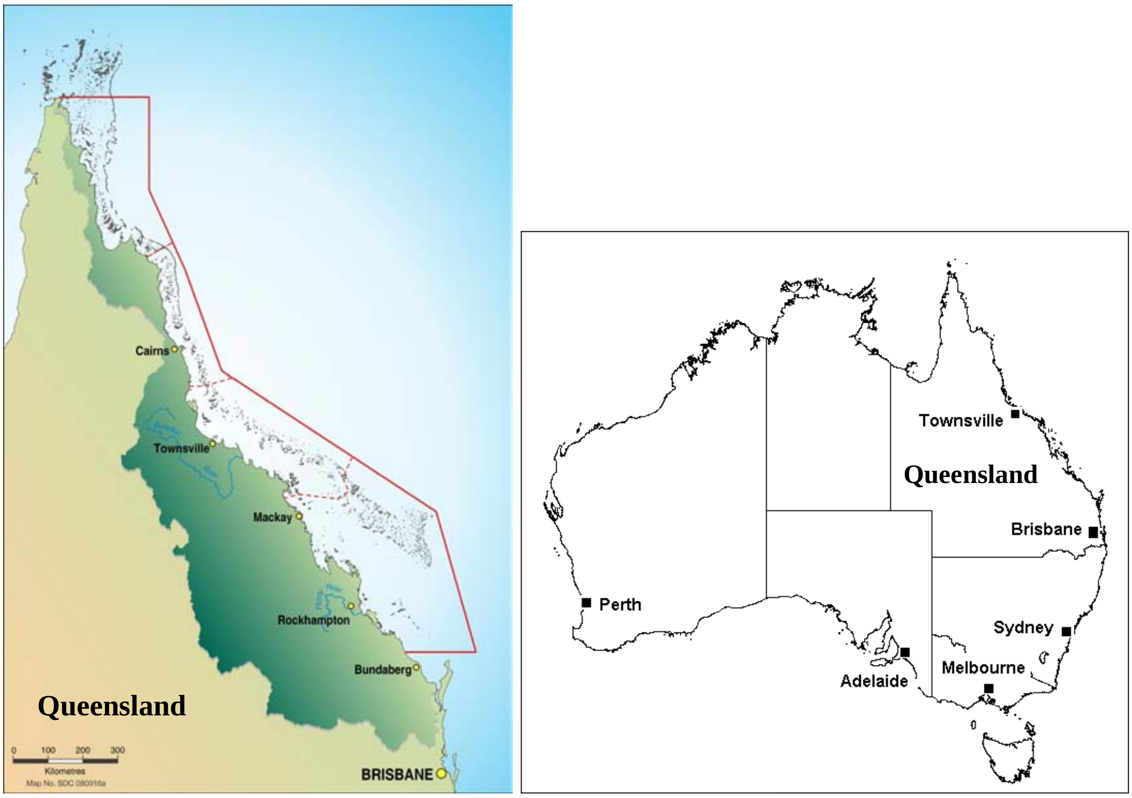


Figure 1. Great Barrier Reef and population sample locations

Whole GBR

	Management Option for particular focus	Amount of GBR in good condition Current condition: 90% in good condition (311,000 sq km) Condition in 25 years time	Will it happen? Level of certainty	Cost How much you pay each year (5 years)	Your choice 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	☐

Whole GBR

	Area of coral reef in good health	No. of fish species in good health	Area of seagrass in good health	Cost	I would choose
Condition Now	18,000 sq km 90%	1,350 species 90%	40,000 sq km 90%	How much you pay each year (5 years)	Select the option you MOST prefer
Condition in 25 years time					
Option A	13,000 sq km 65%	975 species 65%	28,000 sq km 65%	$0	☐
Option B	14,000 sq km 70%	1,050 species 70%	35,000 sq km 80%	$500	☐
Option C	17,000 sq km 85%	1,050 species 70%	31,000 sq km 70%	$50	☐
Option D	14,000 sq km 70%	1,275 species 85%	31,000 sq km 70%	$100	☐

Figure 2. Example multiple and single attribute choice sets

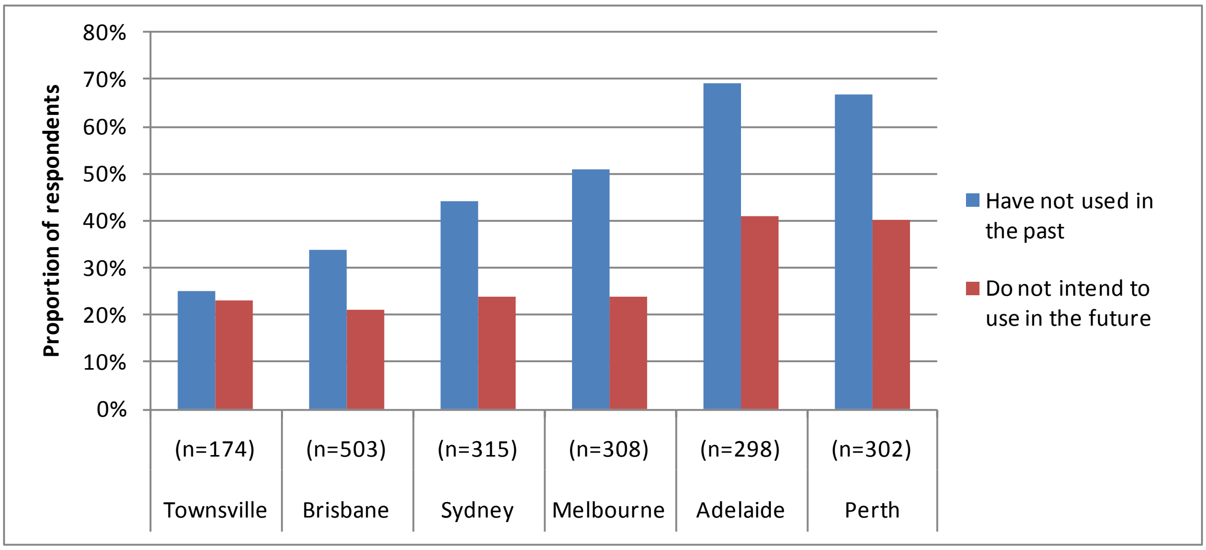
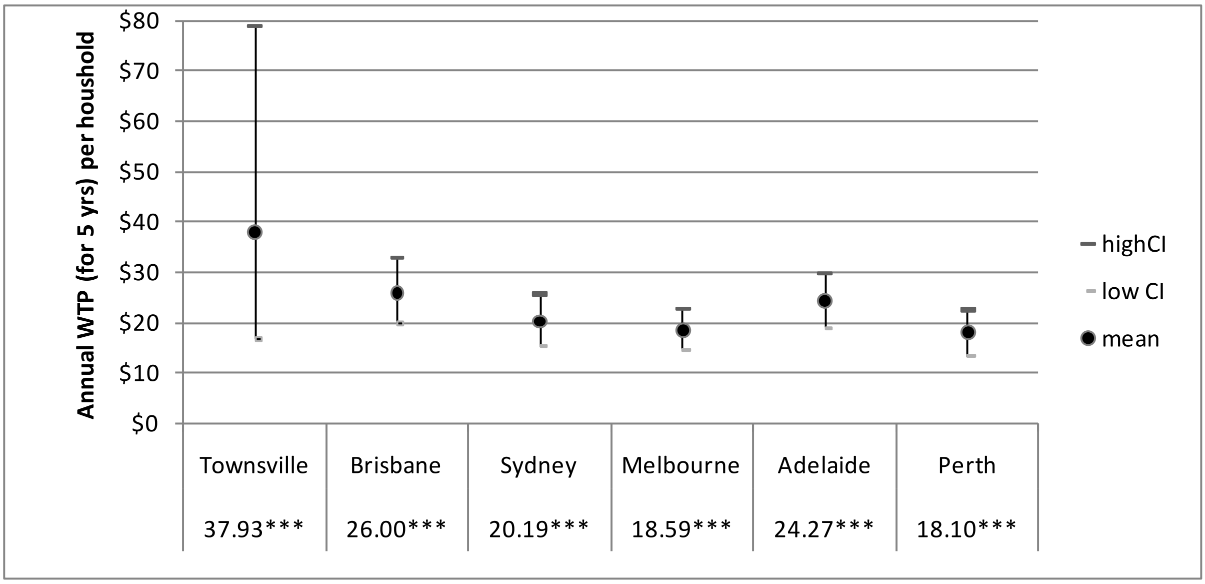
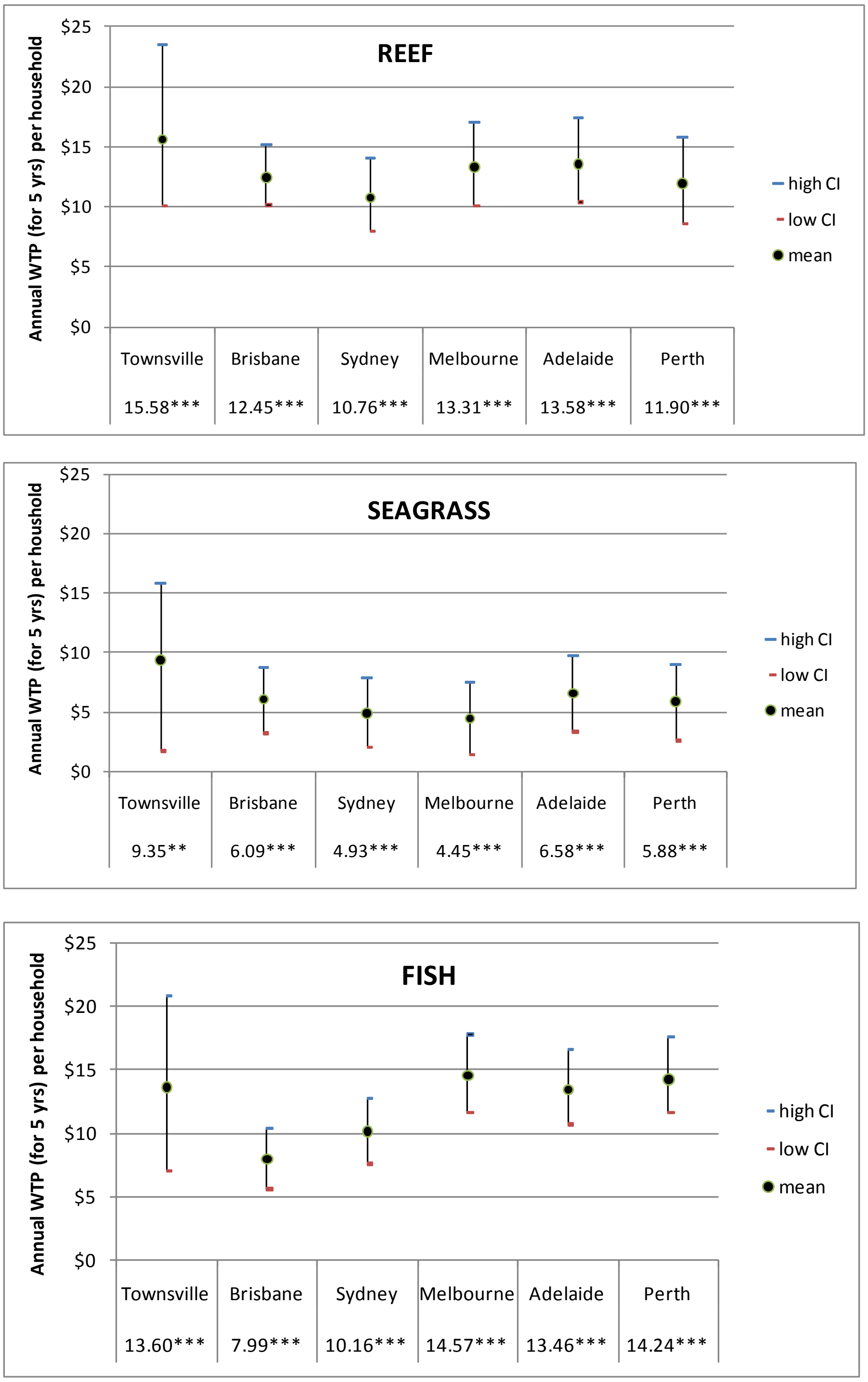


Figure 3. Proportion of past and future "non-users" of the GBR



*** significant at 1%;

Figure 4. WTP estimates for a 1% improvement in GBR condition



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

Figure 5. WTP estimates for a 1% improvement in reef, fish and seagrass health

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

Table 2. 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	Data was collected in a five category format for gross annual income. The following midpoints were applied in the model analysis: $13,000; $33,800; $52,000; $83,200; $130,000
QUEENSLAND	Live in Queensland = 1, Interstate = 0
LEVEL OF FUTURE USE	Coded from 0 = no future visits planned to 5 = plan to visit more than once in the next year
LOGDISTANCE	Log of distance (kms) from city of residence to the GBR

Table 3. Mixed logit models for the single GBR attribute survey

	Townsville	Brisbane	Sydney	Melbourne	Adelaide	Perth
Random parameters in utility functions						
WQ_ASC	-9.69***	-3.74***	-1.17	0.62	-3.22**	-1.78
CZ_ASC	-10.41***	-3.73***	-0.94	1.47	-3.25**	-1.65
GG_ASC	-12.62***	-5.92***	-2.01*	-0.84	-4.70***	-2.78*
Derived standard deviations of parameter distributions						
WQ_ASC	2.89***	2.19***	1.95***	2.42***	2.27***	2.21***
CZ_ASC	3.95***	2.28***	1.58***	2.25***	1.92***	2.02***
GG_ASC	5.25***	3.15***	2.78***	4.04***	3.39***	3.13***
Non Random parameters in utility functions						
COST	-0.01***	-0.01***	-0.01***	-0.01***	-0.01***	-0.01***
GBR CONDITION	0.19***	0.16***	0.13***	0.18***	0.18***	0.14***
CERTAINTY	0.01	0.02***	0.01**	0.02***	0.02***	0.02***
Non random parameters in utility function of the No Control (Status Quo) option						
AGE	-0.07***	-0.01	0.01	0.01	-0.01	-0.01
GENDER	-0.35	-0.52*	0.28	1.10***	-0.60*	0.54*
CHILDREN	-1.68**	-0.38*	-0.04	0.36	0.56	-0.08
EDUCATION	-0.72***	-0.33***	-0.14	-0.29*	-0.78***	-0.41***
INCOME	-0.1-E05	-0.1-E05***	-0.1-E05***	-0.1-E06	-0.1-E05***	-0.1-E05**
Model statistics						
Observations	522	1500	954	924	888	906
Log L	-487	-1580	-1059	-910	-914	-956
AIC	1.92	2.12	2.25	2.00	2.09	2.14
McFadden R-sqrd	0.33	0.24	0.20	0.29	0.26	0.24
Chi Sqrd	473	999	528	741	635	599

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

Table 4. Mixed logit models for the multiple attribute survey

	Townsville	Brisbane	Sydney	Melbourne	Adelaide	Perth
Random parameters in utility functions						
SQ_ASC	-17.553*	0.603	-2.149	4.434	4.526	2.474
Derived standard deviations of parameter distributions						
SQ_ASC	6.814***	6.086***	6.257***	5.992***	7.847***	7.565***
Non Random parameters in utility functions						
COST	-0.003***	-0.004***	-0.004***	-0.005***	-0.005***	-0.004***
REEF	0.045***	0.053***	0.044***	0.055***	0.065***	0.053***
FISH	0.039***	0.034***	0.031***	0.052***	0.065***	0.064***
SEAGRASS	0.027**	0.026***	0.013*	0.025***	0.032***	0.026***
Non random parameters in utility function of the No Control (Status Quo) option						
AGE	0.166*	0.011	0.023	-0.046	0.011	-0.038
GENDER	3.605*	-0.624	-0.877	-0.912	-1.879	-1.691
CHILDREN	3.113	-0.754	-0.005	-1.335	-0.226	0.888
EDUCATION	-1.729	-0.156	0.189	0.367	-1.332*	-0.985
INCOME	0.4-E05	-0.3-E05**	0.3-E05*	-0.4-E05**	0.4-E05	0.1-E05
Model statistics						
Observations	522	1506	936	924	900	906
Log L	-556	-1550	-870	-886	-798	-845
AIC	2.17	2.07	1.88	1.94	1.80	1.89
McFadden R-sqrd	0.23	0.26	0.33	0.31	0.36	0.33
Chi Sqrd	335	1076	855	790	302	823

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

Table 5. A comparison of WTP values for a 1% improvement across survey formats

	Single attribute format	Aggregated multiple attribute format
Townsville	$37.93	$38.54
Brisbane	$26.00	$26.53
Sydney	$20.19	$25.85
Melbourne	$18.59	$32.32
Adelaide	$24.27	$33.62
Perth	$18.10	$32.01

Table 6. Single attribute WTP estimates for user and non-users groups across locations

	Townsville	Brisbane	Sydney	Melbourne	Adelaide	Perth
All respondents						
No of observations	522	1500	954	924	888	906
WTP_ GBR CONDITION	$37.93***	$26.00***	$20.19***	$18.59***	$24.27***	$18.10***
Current users						
No of observations	378	534	102	90	66	84
WTP_ GBR CONDITION	$32.09***	$18.29***	ns	ns	$17.26*	ns
Future users						
No of observations	396	1182	738	684	564	528
WTP_ GBR CONDITION	$35.18***	$24.87***	$20.46***	$15.95***	$27.25***	$19.31***
Non users						
No of observations	54	120	126	180	240	288
WTP_ GBR CONDITION	ns	$46.49**	$16.04***	$21.29***	$16.14***	$12.14***
Proportion: current/all WTP	0.85	0.70	-	-	0.71	-
Proportion: future/all WTP	0.93	0.96	1.01	0.86	1.12	1.07
Proportion: non user/all WTP	-	1.79	0.79	1.15	0.67	0.67

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

Table 7. RPL Pooled model for the single GBR attribute survey

	Pooled model
Random parameters in utility functions	
WQ_ASC	-4.243***
CZ_ASC	-4.076***
GG_ASC	-5.543***
Derived standard deviations of parameter distributions	
WQ_ASC	2.234***
CZ_ASC	2.105***
GG_ASC	3.446***
Non-random parameters in utility functions	
COST	-0.007***
GBR CONDITION	0.158***
CERTAINTY	0.019***
Non random parameters in utility function of the No Control (Status Quo) option	
AGE	-0.006
GENDER	-0.057
CHILDREN	-0.026
EDUCATION	-0.349***
INCOME	-6.0-E06***
QUEENSLAND	-0.583***
FUTURE USE	-0.268***
LOGDISTANCE	-0.179***
Model statistics	
Observations	5724
Log L	-5947
AIC	2.10
McFadden R-sqrd	0.24
Chi Sqrd	3842

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