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Valuing environmental improvements in the Great Barrier Reef: Ecological and preference heterogeneity in local area case studies

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Abstract:

The focus of this report is to test if protection values at a particular GBR site may be easily transferred to other case studies of interest in the region. The research involved valuing three local case studies in the GBR and testing how values were consistent across site and population characteristics. The sites were chosen to reflect substantial heterogeneity in extent, ecological composition and condition, while values were assessed for both local and distant populations.

The results are encouraging, indicating that although significant heterogeneity was identified with the mixed logit models, values were robust to various site and population differences. No significant difference in protection values between the three local case studies could be identified, and there was no significant difference in values between the local population and the Brisbane population. However, some evidence for distance effects was identified for the Brisbane population, with closer sites valued more highly. As well, potential losses were valued more highly (in absolute terms) than potential gains. The implication of these results is that protection values are likely to be higher for closer reef areas with risks of losses than these with opportunities for improvements.

Keywords: Choice modelling, benefit transfer, population effects, Great Barrier Reef, willingness-to-pay, willingness-to-accept.

1. Introduction

Managers of major ecological assets often require information about public conservation values to assess options for management changes. Ecosystems are rarely uniform, so a key issue is the extent to which preservation values are sensitive to the heterogeneity in natural systems and condition, as well as across various population groups that hold protection values. These issues can be demonstrated with the Great Barrier Reef in Australia. This is the largest coral reef ecosystem in the world (approximately 35 million hectares), that has significant variation in terms of biodiversity, condition and threats that vary over time at different locations (Furnas, 2003; GBRMPA 2009). The length of the GBR system (over 2,000 kilometres) means that it is adjacent to a number of coastal cities and communities, while its iconic status makes its protection relevant to a number of Australian and international communities.

At a policy level it would be particularly useful to understand if protection values at a particular GBR site may be easily transferred to other case studies of interest in the region, a process known as benefit transfer. Opportunities for benefit transfer of protection values for the GBR are currently very limited because of the small pool of relevant economic valuation studies. The focus of most valuation studies within the region has been on recreation activities (e.g. Carr and Mendelsohn 2003; Kragt et al. 2009; Prayaga et al. 2010). There is a smaller pool of studies that report non-use values for protection of the GBR. In the absence of any more accurate or recent studies, Oxford Economics (2009) combined and extrapolated the results of Hundloe et al. (1987) and Windle and Rolfe (2005) to develop estimates of non-use values for the GBR. As the source studies were dated and narrowly focused, their application for benefit transfer is questionable.

Benefit transfer is attractive because it means that results from a small number of targeted studies may potentially be transferred to other sites of interest, providing a cost effective means of extending economic analysis (Hanley et al. 2006). However, there are a number of questions about the validity and accuracy of benefit transfer applications, with concerns that large transfer errors may make limit the usefulness of results (Rosenberger and Stanley 2006; Rolfe 2006; Johnston and Rosenberger 2010). To address this, there has been substantial interest in the benefit transfer literature about the extent to which environmental values are sensitive to both site and population differences (Brouwer 2000, Rolfe and Bennett 2006, Johnston and Rosenberger 2010). Value functions that can be systematically related to variations in site and population characteristics are more suitable for transfer to other case study applications (Rolfe 2006).

Value estimates and benefit transfers may be sensitive to a number of factors that characterise small local case studies. There may be large variations in the natural quantity and quality of the resource stocks. As well there may differences in the current condition of the stock, the extent of threats that are faced, and the future condition of the stock. Scenarios may differ according to current and future conditions of the resource and whether there may be gains or losses involved. Values may vary across populations, not only because of demographic variations, but also because of distance effects and varying levels of knowledge, concern and responsibility.

The focus of this case study is to systematically test if differences between sites and populations are confounded with distance effects and methodological variations. This involves three important tests to determine if benefit transfer is possible when site characteristics differ, the amount of losses and gains involved vary, and when the characteristics of the relevant population differ. The research reported in this paper involved valuing three local case studies in the GBR and testing how values were consistent across site and population characteristics. The sites were chosen to reflect substantial heterogeneity in extent, ecological composition and condition, while values were assessed for both local and distant populations.

2. Background literature

The influence of heterogeneity in site characteristics on both use and non-use values has been extensively canvassed in the benefits transfer literature (e.g. Brouwer 2000; Rolfe and Bennett 2006; Johnston and Rosenberger 2010). While many benefit transfer tests have focused on whether the values for a source site can be transferred to a target site, the variations in sites have meant that many comparisons have also tested the extent to which heterogeneity can be present before benefit transfer becomes problematic. Two important advances in valuation and benefit transfer have helped to accommodate site heterogeneity (Rolfe 2006). First, the development of valuation techniques such as choice modelling (CM) help to define and value sites in terms of their environmental characteristics or attributes, allowing protection values to be decomposed (Louviere et al. 2000; Hanley et al. 2001; Bennett and Blamey 2001). Second, the trend in benefit transfer from assigning lump values towards transferring benefit functions allows values for target sites to be adjusted according to the levels of site characteristics (Rosenberger and Stanley 2006; Rolfe and Bennett 2006). These same advances also allow variations in population characteristics and values to be accommodated.

Despite the advances in benefit transfer, a number of issues remain unresolved. First, the evidence about the appropriateness and success of benefit transfer remains mixed, with large variations in transfer errors identified across different studies and targets (Brouwer 2000; Rolfe and Bennett 2010). This means that the extent to which values can be validly transferred between coral reef case studies where different populations are involved and substantial site heterogeneity exist is currently unclear.

The second issue relates to the way that respondents handle site heterogeneity issues when there are varying levels of knowledge and familiarity with sites. For example, a local population is likely to be much more familiar with a local site than a distant population, and may respond to choices in different ways. It is possible that choice complexity is lower for local populations because of familiarity with the issues, hence influencing selection behaviour and use of simplifying heuristics in valuation experiments (Dhar 1997; Swait and Adamowicz 2001; Dhar and Simpson 2003; Hensher 2008; Bateman et al. 2009). Unfamiliarity may also be associated with greater frequency of serial non-participation (van Haefen et al. 2005), increased selection of the status quo option (Boxall et al. 2009), or increased variability in choice selection (DeShazo and Fermo 2002).

The third issue relates to population differences where proximity to the asset may vary. Population differences are normally accommodated with the use of benefit transfer functions that include parameters for socio-demographic factors. However, distance effects may become important where there are variations in the proximity of populations to environmental assets. It is generally assumed that as distance from the resource of interest increases, the values for improvements in environmental condition, per person or household will decrease

(Pate and Loomis 1997; Hanley et al. 2003; Bateman et al. 2006). The importance of distance decay has been examined in stated preference experiments using the contingent valuation (CV) or CM techniques (e.g. 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), although it is often hard to apportion between them (Bateman and Langford 1997). It is likely that use values should decline with distance (Hanley et al. 2003), with more uncertain impacts on non-use values (Bateman et al. 2006).

The fourth issue is that it is unclear how values may vary when case studies have different initial conditions and varying prospects for improvement. Benefit transfer functions are designed to account for natural differences in ecological assets, such as different areas and compositions of coral reef systems that exist between sites. However sites may also vary by condition, reflecting the outcomes of human uses and pressures on assets, and in terms of the level of improvement that is available. In some cases future changes may be negative or positive. There is some evidence that values differ when there are variations in the starting conditions (Caussade et al. 2005), the ranges of possible changes (Dellert et al. 2009, Caussade et al. 2005, Hensher 2006), and whether changes are negative or positive (Horowitz and Connell 2002).

To address these issues, four key research questions were explored in this study. The first was focused on whether the values that local populations had for protection of their local GBR area was consistent. The *a priori* expectation was that there would be a difference in local values for improvements in the condition of local GBR case studies, resulting from the heterogeneity in both sites and populations. This was tested by performing three separate case studies of GBR sites with three different local population groups.

The second research question was designed to determine whether local populations had different values to distant populations because local populations were more familiar with, and had different uses of the case studies of interest. This was tested for each of the three case study sites by comparing the way that local populations and a more distant state capital (Brisbane) population constructed their preferences and ultimately values for the protection of each site. The *a priori* expectations were that local populations would have higher use values, would express more certainty and make less use of heuristics in their selection of protection of alternatives compared to the distant Brisbane population.

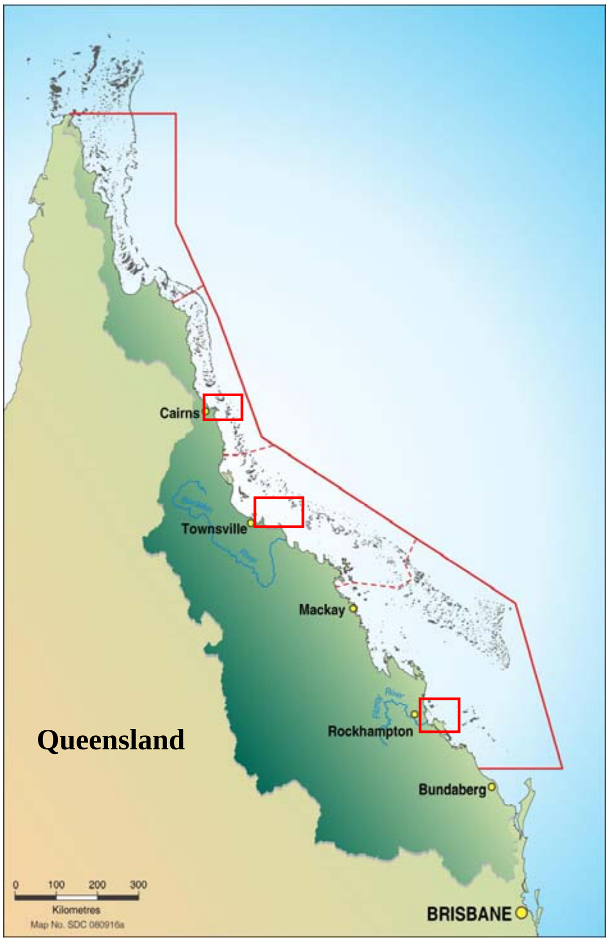
The third research question focused on the difference in values associated with distance effects. This was tested by comparing the values that the distant Brisbane community had for each of the GBR sites where they were approximately 700, 1,200 and 1,700 kilometres away respectively. The *a priori* expectation was that there would be evidence of distance decay associated with a decline in use values.

The fourth research question was designed to determine whether protection values varied by heterogeneity in the choice experiment tradeoffs associated with the initial condition and the potential changes in condition. This was tested by comparing how values for each of the case study sites were influenced by the levels of the base condition and the potential changes from the base that were presented in the choice alternatives. Each of the case studies involved different current conditions and varying possible increases and decreases in condition in the future.

3. The choice modelling case study

Protection values were assessed for three case study sites in the GBR that were close to regional population centres in Cairns, Townsville and the Capricorn coast[1]. The study sites were drawn from the northern, central and southern regions of the marine park. Values from two population samples were assessed for each site; the local population and Brisbane, the more distant State capital outside the GBR area (Figure 1). Each of the sites were relatively well known and associated with a large regional centre so that respondents in Brisbane would have some familiarity with the location and area, even if they had never visited the site. There were similar pressures on the GBR at all three sites, relating to increasing coastal residential development; tourism and recreational use and water quality issues from agriculture (GBRMPA 2009).

Figure 1. Local case study areas



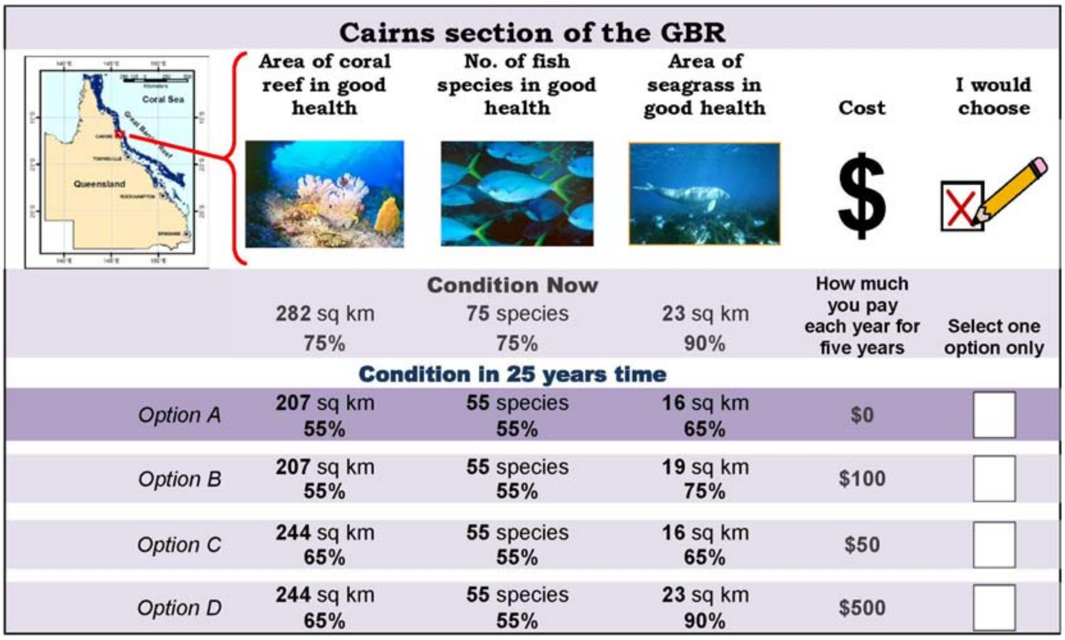
The same survey design was used in all population samples with the valuation scenario being described in terms of a cost attribute and three environmental attributes:

- Area of coral reef in good health (REEF)
- No of fish species in good health (FISH)
- Area of seagrass in good health (SEAGRASS)

[1] The Capricorn Coast has a broader population base than the other sites, and Rockhampton, the major urban centre is 40 km inland from the coast.

The choice experiment involved a sample of households being asked to consider different scenarios for the condition of the GBR case study in 25 years time. An example of a choice set used in the study is provided in Figure 2. In all three surveys, the first alternative was a constant base depicting the amount of each attribute expected to be in good condition in 25 years time under current policy settings and with no additional investment. The other alternatives provided scenarios where protection of the GBR could be improved through additional investment.

Figure 2. Example choice set for the Cairns case study area



The future base varied in each case study to reflect the different environmental assets and condition at each site. The levels for the three other alternatives also varied across case studies and included a mixture of gains and losses in relation to the current level (see Table 1 for details). To minimise the number of varying factors, the range in levels from the base to the highest level of improvement was held constant (at a total increase of 25%) across all three attributes, at all the three sites. The base, current and alternative levels for FISH were the same in each case study, enabling a direct comparison of values across case study areas. Information about current levels was included in each choice set (Figure 2) and was included as one of the levels in each alternative.

Table 1. Attribute levels and case study details

Level	Cairns	Townsville	Capricorn coast
Total area (% of whole GBR)	1515 sq km (<0.05%)	9700 sq km (approx 3%)	2425 sq km (<1%)
REEF: Total area	376 sq km	260 sq km	27 sq km
Current level (in good health)	75% (282 sq km)	45% (117 sq km)	85% (23 sq km)
Future base (Status quo)	55%; (207 sq km)	35% (91 sq km)	60% (16 sq km)
Option levels (change from current level	55%, 65%, **75%,** 80% (2 losses; 1 gain)	35%, **45%,** 55%. 60% (1 loss; 2 gains)	60%, 70%, 80%. **85%** (3 losses)
FISH: Total no of species	100	100	100

Current level (in good health)	75% (75 species)	75% (75 species)	75% (75 species)
Base (Status quo)	55% (55 species)	55% (55 species)	55% (55 species)
Option levels (current level underlined)	55%, 65%, **75%**, 80% (2 losses; 1 gain)	55%, 65%, **75%**, 80% (2 losses; 1 gain)	55%, 65%, **75%**, 80% (2 losses; 1 gain)
SEAGRASS: Total area	25 sq km	56 sq km	7 sq km
Current level (in good health)	90% (23 sq km)	75% (42 sq km)	70% (5 sq km)
Base (Status quo)	65% (16 sq km)	65% (36 sq km)	50% (3 sq km)
Option levels (current level underlined)	65%, 75%, 85%, **90%** (3 losses)	65%, **75%**, 85%, 90% (1 loss; 2 gains)	50%, 60%, **70%**, 75% (1 loss; 1 gain)

The attribute levels for each case study were based on current trends and pressures, with a summary of the relevant literature used provided in Appendix One. The Cairns site had the smallest overall area but it had the largest area of REEF and the highest level for the current condition for SEAGRASS. The Townsville site had the largest overall area, the highest area of SEAGRASS, and the lowest current condition of REEF. The Capricorn coast site had the smallest area of REEF and SEAGRASS, but the best current condition of REEF.

All attribute values were presented in the survey in both percentage and absolute terms to help communicate the relevant information to respondents. In the interests of brevity all results reported in this paper have been analysed with the percentage terms only. The implications of using the two different measures for analysis are reported elsewhere.

A separate D-efficient experimental design for 12 choice sets was created for each case study. To avoid respondent fatigue, the designs were blocked into two versions so that each respondent was assigned a random block of six choice sets.

3.1 Respondent characteristics

The surveys were collected through the use of internet panels between January and March 2010. In the Cairns case study, 72 surveys were collected from households in Cairns and 160 from households in Brisbane. In the Townsville case study, 144 surveys were collected from households in Townsville and 159 from households in Brisbane. In the Capricorn coast case study, 73 surveys were collected from households in Rockhampton and other towns in the region and 160 from households in Brisbane. 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 in all samples, and the prevalence of female respondents.

Table 2. Respondent characteristics

		Cairns		Townsville		Rockhampton[1]		Brisbane	
		Sample	**Popul[2]**	**Sample**	**Popul[1]**	**Sample**	**Popul[1]**	**Sample**	**Popul[1]**
Gender	Female	63%	50%	62%	50%	58%	50%	57%	50%
Children	Have children	67%	na	70%	na	74%	na	62%	n/a
Age	Average (yrs)	43yrs	41 yrs	41 yrs	41 yrs	41 yrs	41 yrs	43 yrs	43 yrs
Education	Post school qualification	57%	34%	64%	45%	58%	28%	65%	56%
	Tertiary degree	27%	10%	31%	15%	30%	9%	39%	24%
Income per week	less than $499	16%	18%	10%	17%	12%	26%	16%	17%
	$500 – $799	19%	21%	19%	18%	21%	21%	17%	18%

$800 – $1199	30%	23%	21%	22%	22%	22%	22%	21%
$1200 – $1999	28%	24%	35%	25%	33%	17%	28%	24%
$2000 or more	7%	15%	15%	18%	12%	14%	16%	21%

[1] Several communities were included in the Capricorn coast survey, with over 40% living in Rockhampton

[2] Australian Bureau of Statistics 2006 Census

4. Results and tests

It is possible that responses to the choice scenarios between the local and distant population samples were influenced by variations in usage patterns and attitudes. Tests showed that there was no evidence to suggest that attitudes or knowledge of their local GBR area between the different communities may have influenced preferences, but there were some differences in usage across local population groups (Table 3). There was a significant difference[2] in recreation use (both for fishing and other recreational use) between communities, with higher levels in Cairns and lower levels in Townsville. Intended future use was similar across sites for the local population with 16-19% of respondents indicating that they never intended to visit the GBR in the next five years. There was no significant difference in opinions between local population about the condition of their local sites or in their knowledge of local GBR issues (Table 3).

For the Brisbane population there was limited variation in past use and little variation in intentions of future use of the three case study areas, but significantly lower levels of past and future use compared to the local populations. Brisbane people tended to have the highest use for the Capricorn coast (the closest site), with use of the Cairns area (the most distant site) higher than Townsville. This is likely to be because Cairns is the more popular tourist destination and there is little difference in flight access and cost between these two centres. Across the three experiments Brisbane respondents did not rate differently in terms of the self rated knowledge of respondents on GBR issues, or about the extent to which condition of the GBR is changing (Table 3).

Table 3. Respondents' usage, attitudes and knowledge of the GBR

Population	**Cairns**	**Townsville**	**Rock'ton + others**	**Brisbane**		
Site	**Cairns**	**Townsville**	**Capricorn coast**	**Cairns**	**Townsville**	**Capricorn coast**
Past use: Recreational fishing						
Never	49%	64%	52%	89%	84%	86%
Once only	12%	8%	7%	6%	8%	4%
More than once	39%	28%	41%	5%	8%	11%
Past use: Other recreation						
Never	17%	37%	22%	48%	53%	43%
Once only	7%	15%	10%	25%	18%	26%
More than once	76%	48%	68%	27%	29%	31%
Future use (next 5 years)						
Never	18%	19%	16%	33%	38%	31%
At least once next year	65%	58%	59%	28%	25%	26%
At least once next 5 years	17%	22%	25%	39%	37%	43%
Condition of the GBR over past 10 years						
Declined	50%	39%	45%	46%	47%	40%
Improved	13%	5%	7%	7%	6%	5%
Stayed the same	19%	29%	27%	14%	11%	19%

[2] All references to significant differences relate to Pearson's chi squared crosstabs at the 5% level.

Uncertain	18%	27%	21%	33%	36%	36%
Knowledge of GBR issues: **Average score** from 1=no knowledge to 10=extensive knowledge	5.9	5.4	5.8	5.2	5.4	5.4

Mixed logit (ML) models were developed to identify the response patterns and test the different research questions. Details of the attribute descriptions and levels are presented in Table 1, with other model variables explained in Table 4. In all models presented in this section, the socio demographic variables were modelled against the base or status quo alternative. Only the ASC associated with the status quo alternative was randomised.

Table 4. Model variables

Main variables	**Description**
ASC	Alternative specific constant
SQ…	Prefix to denote status quo (current situation) alternative
AGE	Age in years.
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 3 for details). The mid point of each category was used for analysis with an additional 25% added to the last category.

The first hypothesis to be tested is to determine whether there is a significant difference in improvement values held by the three local population samples for the relevant case study site. The relevant ML models are presented in Table 5.

Table 5. Local community preferences for their local case study area

	Cairns			**Townsville**			**Capricorn coast**		
	Coefficient	*St Error*	WTP[1]	*Coefficient*	*St Error*	WTP	*Coefficient*	*St Error*	WTP
Random parameters in utility functions									
ASC_SQ	-15.267	9.809		-2.694	5.206		1.064	7.567	
Derived standard deviations of parameter distributions									
ASC_SQ	8.759***	2.444		7.378***	1.419		7.395***	1.980	
Non Random parameters in utility functions									
COST	-0.002***	0.000		-0.003***	0.000		-0.003**	0.000	
REEF	0.028***	0.010	$12.72	0.040***	0.009	$11.75	0.025***	0.013	$8.06
FISH	0.036***	0.011	$16.33	0.040***	0.009	$11.89	0.042***	0.014	$13.36
SEAGRASS	0.023***	0.007	$10.53	0.023	0.005	$6.88	0.026***	0.006	$8.36
AGE	0.299**	0.145		0.005	0.065		0.080	0.088	
GENDER	0.143	2.779		-2.373	1.463		-2.377	1.728	
CHILDREN	2.785	3.027		1.401	1.754		-3.229	2.089	
EDUCATION	-1.436	1.173		0.333	0.691		-0.023	0.838	
INCOME	0.2E-05	0.2E-05		-0.9E-06	0.2E-05		-0.2E-05	0.3E-05	
Model statistics									
No of Obs	432			864			438		
Log L	-428			-885			-447		
AIC	2.035			2.074			2.094		
BIC	2.138			2.134			2.195		
McFadden R-sqd	0.285			0.261			0.263		
Chi Sqrd	341			626			320		

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

[1] Household values for a 1% improvement over a five year period

All three models are highly significant (high chi-squared values) and have similar levels of performance as measured by the AIC and BIC values. There are some small differences in the explanatory power of the different socio-demographic variables. There was no significant difference in the incidence of serial non-participation across sites with 21%, 17% and 14% of respondents always selecting the status quo option in Cairns, Townsville and the Capricorn Coast samples respectively.

Log Likelihood Ratio tests indicate that there is no significant difference between any of the three models. The WTP estimates (Table 5) also show a strong similarity and a Poe et al. (2005) procedure, (which calculates the proportion of differences greater than zero) confirms there is no significant difference between the estimates for REEF, FISH or SEAGRASS across the three population samples. The values for FISH are the highest of the three attributes, in all samples, suggesting that use values, possibly associated with recreational fishing, may be driving preferences. These results provide strong evidence at the local case study level that protection values are consistent, despite the heterogeneity between local site and populations.

The second hypothesis was that local populations would have different values to distant populations because local populations were more familiar with, and had different uses of the case studies of interest. This was tested by comparing the protection values for each case study of each local population centre (Table 5) against those held by the distant Brisbane population (Table 6). The WTP estimates are presented in Tables 5 and 6 respectively and a Poe et al. (2005) procedure indicates that there is no significant difference between the values of Brisbane and local populations, for any of the attributes at any of the sites apart from one. The values for FISH are significantly lower for the Brisbane population in Cairns compared with the local population. These results indicate that the hypothesis that values would be higher for local populations cannot be verified, indicating instead that it is appropriate for benefit transfer of values between local case studies and the Brisbane population.

There are some indications of increased variability in the choices of the Brisbane respondents compared to the local respondents. The significance of the standard deviations suggests there is strong heterogeneity in these effects in all three case studies, and there is some variation in the significance of the socio-demographic variables and the alternative specific constants (ASCs). However, there was no significant difference in the incident of serial non-participation across sites (or between population groups) with levels of 21%, 16% and 15% recorded in Cairns, the Capricorn Coast and Townsville respectively.

The third hypothesis was that there would be evidence of distance decay in the values of the Brisbane population for the three case study sites. To test this, log-likelihood ratio tests were used to identify significant differences between models, while the Poe et al. (2005) procedure was used to test for differences between part-worth's for individual attributes. The Log Likelihood Ratio test indicates that there was no significant difference between the Townsville and Capricorn Coast models, a marginal difference (at the 1% level) between the Townsville and Cairns models, and a significant difference between the Cairns and Capricorn Coast models.

Table 6. Brisbane community preferences for the local case study areas

	Cairns			**Townsville**			**Capricorn coast**		
	Coefficient	*St Error*	*WTP*	*Coefficient*	*St Error*	*WTP*	*Coefficient*	*St Error*	*WTP*
Random parameters in utility functions									

ASC_SQ	-12.006**	5.801		2.055	4.439		16.588***	6.328	
Derived standard deviations of parameter distributions									
ASC_SQ	6.412***	1.035		7.522***	1.340		15.461***	4.385	
Non Random parameters in utility functions									
COST	-0.004***	0.000		-0.002***	0.000		-0.003***	0.000	
REEF	0.020***	0.006	$5.74	0.026***	0.009	$10.78	0.040***	0.009	$14.70
FISH	0.030***	0.007	$8.31	0.038***	0.008	$15.55	0.044***	0.010	$16.22
SEAGRASS	0.028***	0.005	$8.00	0.013**	0.005	$5.18	0.024***	0.004	$9.05
AGE	0.112**	0.053		-0.033	0.052		-0.045	0.059	
GENDER	0.621	1.204		-0.015	1.163		-9.433***	2.769	
CHILDREN	2.159	1.456		-0.163	1.321		-1.685	1.727	
EDUCATION	0.498	0.519		-0.927*	0.560		-0.617	0.653	
INCOME	-0.3E-05**	0.1E-05		-0.2E-05	0.2E-05		-0.7 E-05**	0.3E-05	
Model Statistics									
No of Obs	960			954			960		
Log L	-959			-1000			-927		
AIC	2.021			2.119			1.955		
BIC	2.077			2.175			2.011		
McFaddon R-sq	0.279			0.244			0.303		
Chi Sqrd	744			645			807		

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

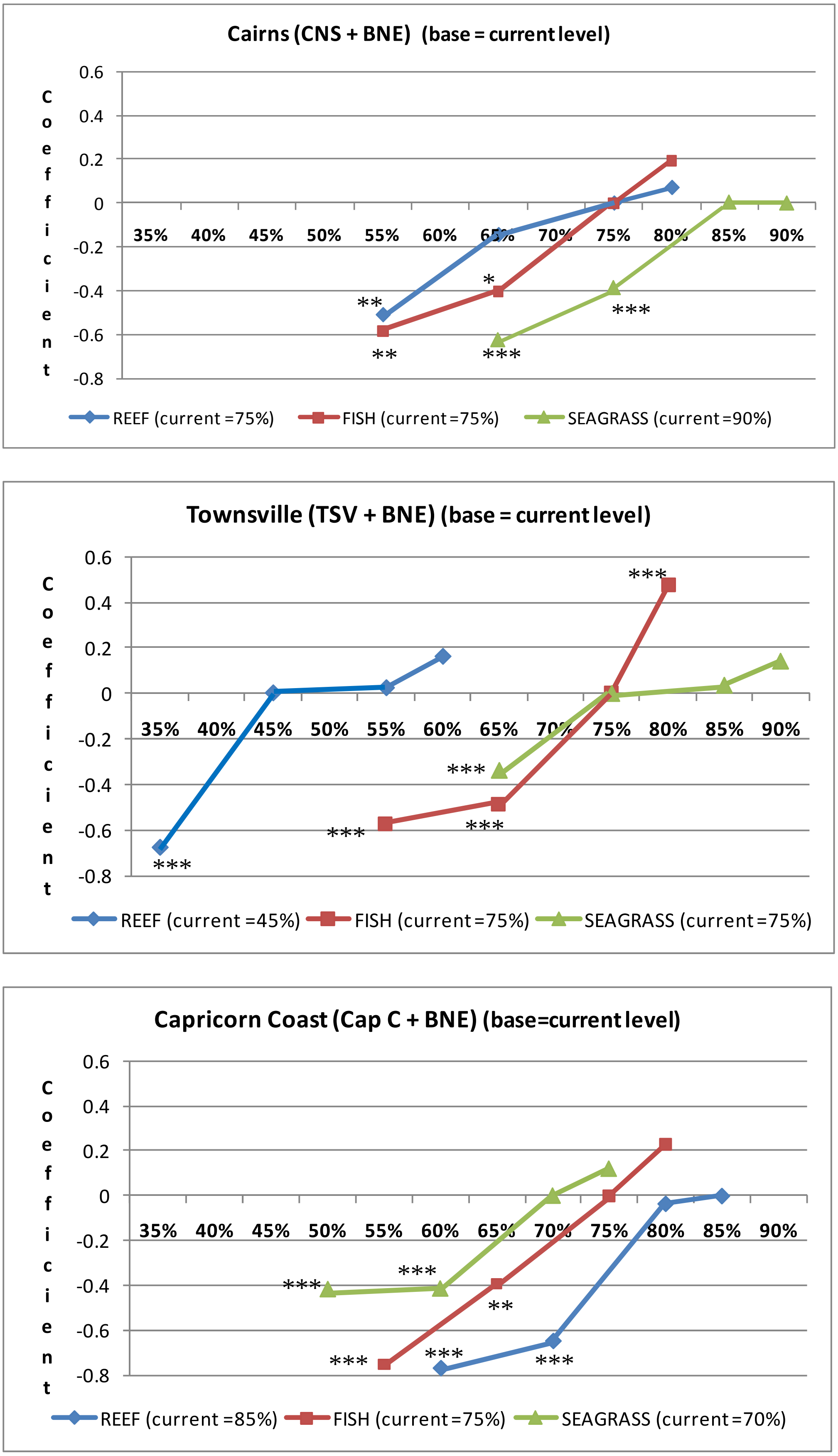
Significant differences in estimates of part-worth's were identified for the REEF attribute between the Capricorn Coast and Cairns (Poe statistic=0.006), a significant difference for FISH between Cairns and Townsville (Poe statistic=0.979) and between the Capricorn Coast and Cairns (Poe statistic=0.023). These differences between case study values suggest that there may be some influence of distance decay, focused on values for REEF and FISH between Cairns, the most distant location and Capricorn Coast, the closest location. Values for these two attributes are more likely to be associated with use values than seagrass, but additional model tests to include patterns of recreation behaviour did not generate any significant results.

When the WTP values are summed for all three attributes, to represent the broader GBR ecosystem, the total WTP per Brisbane household for a 1% improvement in GBR condition is $22.05 in Cairns, $31.51 in Townsville and $39.97in the Capricorn coast. The values for Cairns and Townsville are 55% and 79% respectively of that for the Capricorn coast. While there is strong evidence that distance decay is affecting preferences, there appears to be a non-linear relationship with values declining by 20% in the first 700 km (from the Capricorn coast to Townsville) and by 45% in the next 350 km (from Townsville to Cairns).

The fourth research question was designed to determine whether protection values varied because of differences in the status quo and the potential gains and losses involved. For this test the two population samples for each case study were pooled and the attribute levels were modelled separately using the current level as the base or reference level. The results for the ML models for each case study are presented in graphic form in Figure 3[3]. The four levels involved in each attribute (Table 1) are plotted on the graphs, with the coefficient for current condition set at zero in each case study. The variation on the horizontal axis shows the different levels used, while the variation above and below the horizontal axis represents the gains and losses from the current situation.

[3] Full model details are available from the authors upon request.

Figure 3. Coefficient values for attribute level changes from the current level



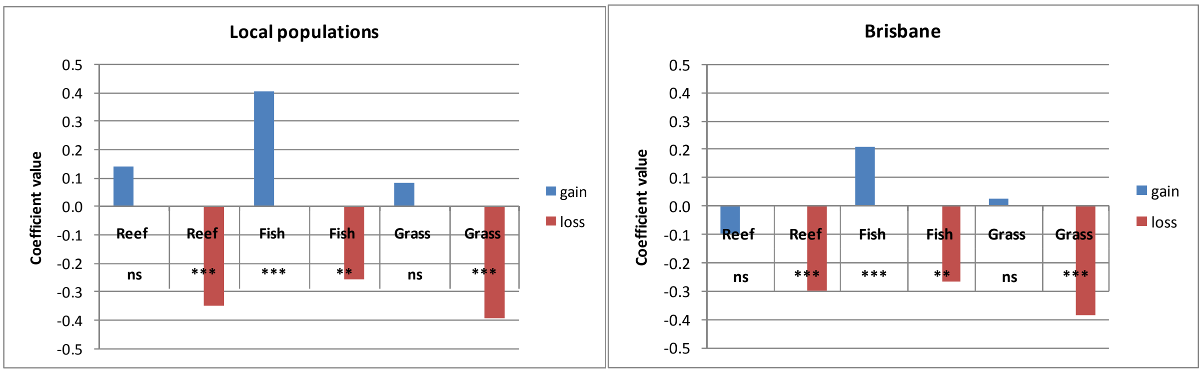
*** significant at 1%; ** significant at 5%; * significant at 10%

It is not possible to make a direct comparison of the coefficient levels between these models due to potential differences in scale parameters, but the general trends can be compared. The results indicate that in all cases, preferences for losses are negative and preferences for gains are positive. Apart from the gain from the current level of 75% to 80% for FISH in Townsville, none of the gains above the current level are significant. However, all losses are significant, apart from a decline from 75% to 65% in REEF in Cairns. For the two attributes where there were significant differences of the status quo base in the case studies (REEF in Cairns and SEAGRASS in Cains and the Capricorn Coast), no different in response pattern can be identified. This suggests that while levels of gains and losses involved appear to be significant, the differences in the status quo base were not.

To provide an overview of respondents' preferences for losses and gains across all three sites, a pooled model for each population group was developed where attribute level changes for each site were recoded into dummy variables and classified as either losses or gains[4]. In the pooled model for the local populations, dummy variables were included for the different local population groups. None were significant, confirming the results of the first hypothesis. In the pooled model for Brisbane, dummy variables for the site were included, but none could be identified as significant.

The significance and strength of preferences from the pooled population models are presented in Figure 4. All losses are significant, are valued negatively and the strength of preferences are similar across the local and Brisbane pooled models. The only gain that is significant is for FISH in the Townville case study. To make a direct comparison across the two pooled models, WTP estimates were calculated (Table 7). The value estimate for FISH gains is much lower for Brisbane respondents ($76.76) and only half that for local respondents ($143.58). This would suggest that use values, particularly use for recreational fishing, do drive preference differences.

Figure 4 Preferences for gains and losses in pooled models across sites



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

Table 7. Value estimates for gains and losses across population groups

	Brisbane		Local		Significant
Reef – gain	-$36.07		$49.79		Ns
Reef – loss		-$110.54		-$123.55	***
Fish – gain	$76.76		$143.58		***
Fish – loss		-$97.56		-$90.80	**

[4] Full models available from the authors on request.

Seagrass – gain	$10.06		$28.96		Ns
Seagrass – loss		-$141.87		-$139.62	***

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

The value estimates for losses from current levels are similar across the two population groups, while the pattern of values for gains appears more varied. Design dimensions, in terms of the gains and losses presented in choice scenarios, appear to influence choice patterns and subsequent value estimates. For this case study the results suggest that protection values are going to be higher for sites that are in good condition with greater potential for future losses than for sites that are in poorer condition with limited potential for future declines.

5. Discussion and conclusions

This case study was designed to test whether heterogeneity within sites, populations and case studies would limit the potential application of benefit transfer of protection values. The results are encouraging, indicating that although significant heterogeneity was identified with the mixed logit models, values were robust to various site and population differences. No significant difference in protection values between the three local case studies could be identified, and there was no significant difference in values between the local population and the Brisbane population. There was little evidence of information or complexity differences between the populations, with no differences in serial non-participation across the studies.

Two areas of sensitivity were identified, consistent with a number of previous studies. Some evidence for distance effects could be found with the Brisbane population, with closer sites valued more highly. As well, potential losses were valued more highly (in absolute terms) than potential gains. This is consistent with the widely observed differences between willingness to accept and willingness to pay formats, and is possibly driven by some aversion to future losses. The implication of these results is that protection values are likely to be higher for reef areas with risks of losses than these with opportunities for improvements.

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Appendix 1

Table A1. References for attribute levels in the case study areas

	Reef	Fish	Seagrass
Cairns	AIMS (2009)	Bell and Galzin (1984); Jones *et al*. (2004); AIMS (2009)	Coles *et al*. (1993); Udy *et al.* (1999); Campbell *et al*. (2001); Rasheed *et al.* (2007)
Townsville	AIMS (2009)	Bell and Galzin (1984); Jones *et al*. (2004); AIMS (2009)	Udy *et al.* (1999); Rasheed *et al*. (2007)
Capricorn Coast	GBRMPA (2007)	Bell and Galzin (1984); Jones *et al*. (2004)	Udy *et al.* (1999); Rasheed *et al*. (2007)