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Testing for geographic scope and scale effects with choice modelling: Application to the Great Barrier Reef

John Rolfe and Jill Windle

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About the authors

Professor John Rolfe is Director of the Centre for Environmental Management at CQ University.

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

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THE AUSTRALIAN NATIONAL UNIVERSITY
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Abstract:

The focus of this report is to report choice modelling experiments that have tested the consistency of values across differently scoped dimensions of an environmental asset. The case study involved the Great Barrier Reef (GBR) in Australia, where a key policy question is to identify if protection values for one part of the reef can be transferred to different sections and scaled from local case studies to the whole reef area without adjustment. The study involved 12 split-samples in three CM experiments to assess values for the whole GBR, a regional section of the GBR and a local reef area while controlling for variations across populations, the scope of the choice tasks, and survey formats.

The results demonstrate that issues of geographic scope and scale remain challenging in CM experiments. Contrary to expectations, the proportional values for different regions of the GBR remained consistent when geographic scope and scale increased, while absolute values declined. This was despite substantial efforts in designing and presenting the surveys to define the amenity of interest to respondents. The results indicate that it is difficult to identify single unit values for an environmental amenity that can be easily transferred and extrapolated across geographic regions and scales. However, there may be good theoretical reasons why marginal values for specific areas of interest in the GBR have much higher protection values, which then decline as larger and more general areas are considered.

1. Introduction

Tests of validity for stated preference valuations have been associated with the need to demonstrate that willingness to pay is sensitive to varying dimensions of the tradeoffs on offer. With the contingent valuation (CV) method, insensitivity to smaller and larger tradeoffs became known as part-whole bias (Mitchell and Carson 1989) or scope insensitivity (Arrow et al. 1993), and has generated heated and divergent views about the usefulness of the technique (Schulze et al. 1998). Since the NOAA panel recommended a scope test become integral to the application of CV experiments, there have been a number of studies that passed the test; failed the test or had mixed results (Bateman et al. 2004; Heberlein et al. 2005; Czajkowski and Hanley 2009).

The development of the choice modelling (CM) technique, also known as choice experiments, has been stimulated in part by its built-in tests of scope sensitivity (Hanley et al. 1998). In CM, the use of attributes to represent choice dimensions means the amenity of interest can be framed within a pool of substitutes, while variation in attribute levels means that respondents are automatically aware that different amounts are available (Rolfe et al. 2000). If respondents to a choice experiment do not distinguish between different amounts of each attribute on offer, the result is non-significance of the variable in the subsequent model. Not only did CM frame the tradeoffs more intently for respondents, but it allowed more forensic insights into where choice insensitivity may be located. For example, studies into serial non-participation (e.g. von Haefen et al. 2005) and attribute non-attendance (e.g. Campbell et al. 2008, Scarpa et al. 2009) identify groups of respondents who ignore variations in all or some of the attributes.

While the development of the CM technique has improved the framing and identification of internal scope effects, wider scope issues still remain. Some choice experiments (e.g. van Bueren and Bennett 2004) identify much higher values for environmental attributes when they are framed in different contexts, such as with regional tradeoffs rather than national ones. Similarly, a number of reviews of benefit transfer applications involving stated preference techniques (e.g. Brouwer 2000, Bergland et al. 2002, Rolfe and Bennett 2006) have noted that tests of convergent validity between experiments are difficult to satisfy even when there are only modest differences between source and target sites. This suggests that the way that values change when there are variations in the dimensions of the good to be valued are still not always well understood.

The focus of this report is CM experiments that have tested the consistency of values across differently scoped dimensions of an environmental asset. The case study involved the Great Barrier Reef (GBR) in Australia, where a key policy question is to identify if protection values for one part of the reef can be transferred to different sections and scaled from local case studies to the whole reef area without adjustment. The study involved 12 split-samples in three CM experiments to assess values for the whole GBR, a regional section of the GBR and a local reef area while controlling for variations across populations, the scope of the choice tasks, and survey formats. The report is structured as follows. In the next section, theoretical issues underpinning scope sensitivity are discussed and the different issues to be tested in this study are developed. The case study details are presented in Section 3 followed by the results in Section 4. Discussions and conclusions follow in the final section.

2. Background literature and defining the issues

The scope test employed in CV experiments often confounds both changes in the quantity of the good on offer and the dimensions of the tradeoffs. Here these issues are defined more precisely to clarify the concepts involved. The scope of a good involved in a stated preference experiment refers to the dimensions used to define the good and the tradeoffs involved, the scale refers to the quantities involved, and the framing to the context in which the choices are made. Scale and scope issues are often intertwined, because increasing amounts of an environmental good often involve both changes in the quantity (scale) and extent of the good (scope). In a CM experiment the key ways of varying the scope of the tradeoff to be considered are to vary the geographic setting of the tradeoffs (e.g. at local, regional, national or international levels), and through the choice and definition of attributes used in the choice sets. Changes in scale are generated through variation in the levels for each attribute.

Historically, insensitivity to scope and scale variations in CV experiments generated arguments that the choices made were not consistent with economic theory (Diamond and Hausman 1994). Arguments such as the embedding hypothesis (Kahneman and Knetsch 1992), the good cause dump (Harrison 1992), and the warm glow effect (Diamond and Hausman 1994) imply that any constructed markets are problematic because respondents will react to the opportunity to signal their support for a cause rather than tradeoff the quantities on offer.

Several theoretical arguments were offered to explain some insensitivity to variations in scale and scope dimensions. The theoretical argument relating to scale is that increasing amounts of an environmental asset are likely to be associated with diminishing marginal utility, implying that willingness to pay is not a linear function of the amount of the amenity on offer (Randall 1997). A second theoretical argument is that apparent insensitivity to scope can arise because of a sequencing effect (Randall and Hoehn 1996, Bateman and Brouwer 2006), where the value of an item changes according to whether it is offered first or alone, as against later in a long list of choices. Furthermore, a sub-additivity effect can be generated according to whether an amenity is framed by itself or within a group (Hanemann 1994, Randall 1997, Bateman et al. 1997).

A number of measurement and methodological issues can also generate apparent insensitivity to scale and scope variations. Insensitivity may be generated by poor design, inappropriate definition of contingent markets, or amenity mis-specification (Carson and Mitchell 1995), or may be mistakenly identified through inappropriate statistical analysis (Harrison 1992, Hanemann 1994). In other cases apparent variations may be caused by differences in the way the tradeoffs are framed through variations in complexity (Veitsten et al. 2004) or changes in policy settings (Pouta 2005, Czajkowski and Hanley 2009). Psychological factors such as 'affective scope' (liking the whole more than the part) and 'cognitive scope' (knowing more and thinking more about the whole than the part) may also explain variations (Heberlein et al. 2005). Other evidence has shown that scope sensitivity can vary according to the importance of the good with more important goods showing scope sensitivity and trivial goods not (Bateman et al. 2005).

Issues of scope and scale are very relevant to the assessment of protection values for major biodiversity systems or ecological assets such as the GBR in Australia. To provide useful information into policy settings, values need to be available for varying quantities of environmental protection across different geographic scopes. Evidence from CM experiments is mixed about whether single point values for key assets (attributes) can be estimated and then simply extrapolated to different contexts and quantities, or whether issues of geographic scope and scale will affect the results. Van Bueren and Bennett (2004) found that values from surveys framed in a regional context exceeded those framed at a national context. In contrast, Rolfe and Windle (2008) found no significant WTP differences between state and regional contexts and Rolfe et al. (2006) found that WTP estimates were similar between catchment level and sub-catchment level valuations. The study outlined in this report tests these issues in more detail for the GBR by valuing protection measures for a single ecosystem and dividing it into geographical parts at regional and local levels to repeat the tests.

The GBR is a large complex system of over 2,800 reefs that extend over 2,300 kilometres in a World Heritage Area of 35 million hectares. While its size and extraordinary biological diversity make it very unique, it is challenging to identify how protection values can be adjusted from the whole GBR down to the local case study level. Economic theory would suggest that the whole GBR should be valued more highly than a regional part or a smaller local area, because it includes more species, more biodiversity and more people can use and enjoy it. Here the variations in geographic scope are associated with changes in the scale (quantity) of the tradeoffs on offer, potentially confounding tests for the separate effects. Key tests are to determine whether values for changes in quantity (scale tests) are independent of variations in geographic scope.

A number of factors may potentially confound tests between geographic scope and scale effects. People may consider different substitutes as the set of resource possibilities expands (Pate and Loomis, 1997; Rolfe et al. 2002; Hanley et al. 2003; Bateman et al. 2006). A local population may feel more connectivity and more responsible for their local assets (Rolfe and Bennett 2002; Hanley et al. 2003; Bateman et al. 2005), and may have more awareness and knowledge of them compared with a more distant population (Sunderland and Walsh 1985; Pate and Loomis, 1997). Regional or local case studies may generate a type of queuing effect, where respondents empathise with the case study and use it to signal their values for the whole asset. As geographic scope changes, responses may vary between different attributes that describe a choice set, or between choice experiments that are structured in different ways. Each of these factors may lead to lower unit values for larger scoped goods.

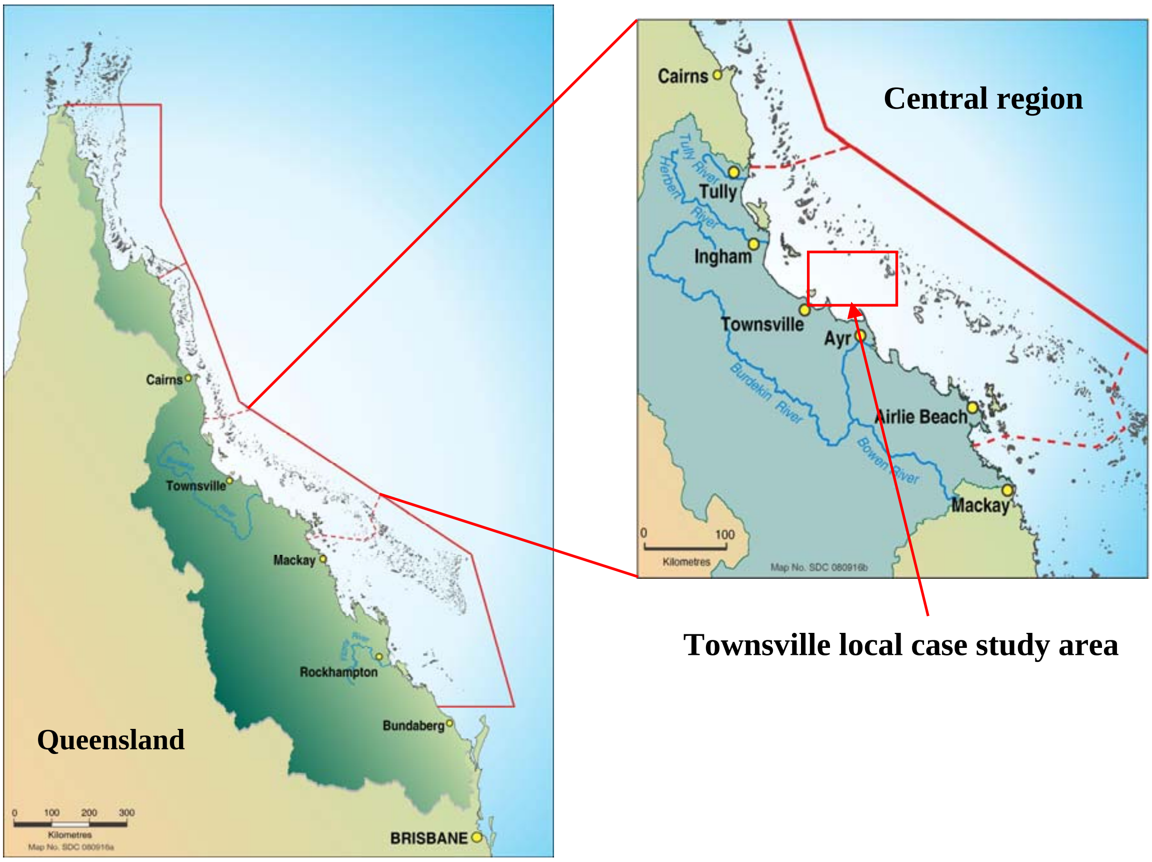
The research outlined in this report examines key two aspects of values for the GBR where there may be some sensitivity to geographic scope. The first issue tested examines the degree of value sensitivity across three levels of scope. The *a priori* expectation is that values for improvements in GBR condition will increase as the level of scope increases from a local case study through to the whole GBR, and that unit values will be consistent. The second issue to be tested is whether value sensitivity to scope issues varies across two populations. In this case study one population is drawn from a city adjacent to the GBR, where higher levels of knowledge and use are expected, and the other from a more distant location. The *a priori* expectation is that respondents from the local population will display more scope sensitivity than those from outside the GBR area.

A number of methodological issues are also tested as part of the experiments. The first of these is to determine whether sensitivity to geographic scope is consistent across different ways of depicting the tradeoffs in a choice experiment. Two separate experiments have been applied for the GBR case study to test this. The second methodological issue is to identify whether ways of defining and presenting differently scoped tradeoffs in choice experiments that increase respondent awareness of the issues will generate more consistent results. The *a* *priori* expectation is that respondents will better distinguish between varying scope tradeoffs when they are contained within the same experiment. The third methodological issue is to identify whether sensitivity to scope issues varies by attributes within a CM experiment when different ways of defining the attributes are used.

3. The choice modelling case study

The research project outlined in this report was designed to explore the effects of geographic scope on the valuation of the GBR. Three levels of scope were used for comparison; the whole GBR, a regional section of the GBR (the central region, extending from Airlie Beach in the South to Tully in the North and including the famous tourist destination, the Whitsunday Islands) and a local section, focused around Townsville (Figure 1). The regional section represents about one-quarter of the total asset, and reflects current management boundaries.

Figure 1. Great Barrier Reef



Source: Great Barrier Reef Marine Park Authority

Three separate experiments were developed to allow the range of tests of interest to be conducted. The first experiment involved a single attribute to describe the health of the GBR, but included uncertainty as a primary attribute as well as the use of labelled alternatives in each choice set. The labels described the management option that would be applied to achieve the predicted environmental improvements. Two versions of the survey were developed to reflect variations across whole and regional scope and scale levels, and were collected in both population centres. Each respondent completed six choice sets.

The second experiment involved the same design but incorporated both whole GBR choice sets and regional GBR choice sets in the same survey. Details in the introduction were framed in terms of the whole GBR and respondents were advised that they would receive both whole and regional choice tasks. A total of six choice set tasks were maintained, with three whole and three regional sets in each survey. There were two versions of the survey; one where the three whole choice sets were presented first and the second where the three regional choice sets were presented first.

The third experiment focused on a multiple attribute version of the survey that was developed for the whole GBR and the regional and local case studies. Instead of describing the condition of the GBR with a single all-encompassing attribute, it was disaggregated into three component attributes:

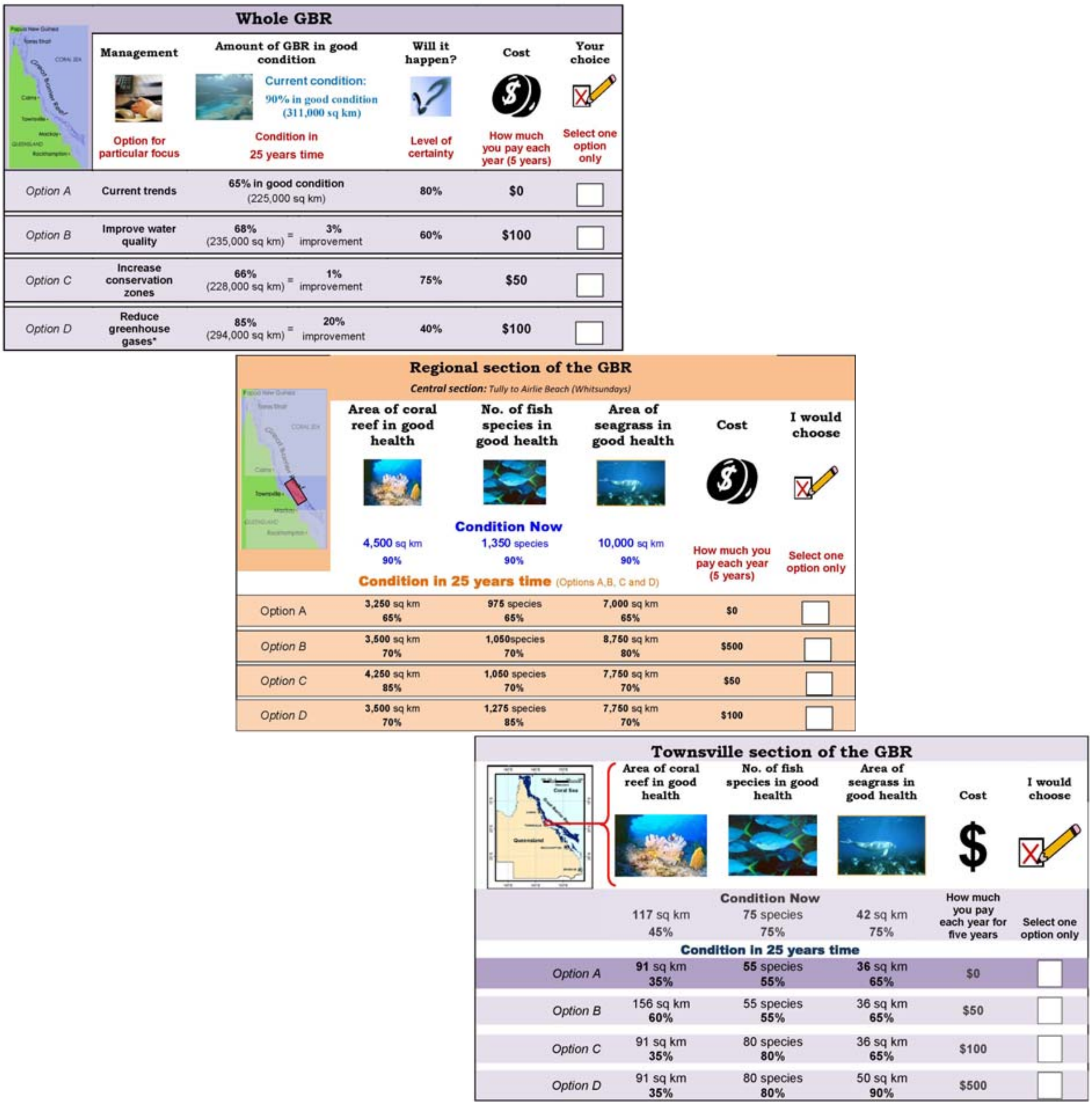
- Area of coral reef in good health
- No of fish species in good health
- Area of seagrass in good health

Examples of the differently scoped and designed choice sets used in the three experiments is provided in Figure 2. The first alternative in all surveys 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. The other alternatives provided scenarios where protection of the GBR could be improved through additional investment. The attribute descriptions and levels are presented in Table 1.

A key challenge in the experiment was to depict the changes in terms that were meaningful to respondents. After working through focus groups the environmental attributes in each of the experiments were presented in both percentage and absolute terms. Respondents needed the absolute levels to be able to identify the quantities involved, but many preferred the presentation of percentage changes to understand the relative changes involved. Absolute values for the area of Reef and Seagrass in the regional GBR survey were estimated to be 25% of those for the whole survey, while estimates for the number of different Fish species remained the same. Attribute levels for the local case study reflected the situation in this small section of the GBR.

The future base percentage levels were the same for all three attributes in both the whole and regional surveys. Based on the predictions of Wolanski and De'ath (2005), Lough (2007) and Garnaut (2008), they were set at 65% being in good condition, down from approximately 90% in current times (GBRMPA 2009; Wolanski and De'ath 2005). Levels in the local case study were more specific, and the future base was set at 35% for the condition of the reef AIMS (2009); 55% for fish (Bell and Galzin 1984; Jones et al. 2004; AIMS 2009) and 65% for seagrass (Udy et al. 1999; Rasheed et al. 2007).

Figure 2. Example single (whole) and multiple attribute (regional and local) choice sets



Three D-efficient experimental designs, each containing 12 choice sets, were created using the NGENE software. The first was used for the whole and regional surveys in experiments one and two. The second was used for the whole and regional scoped multiple attribute profiles, and the third for the locally scoped multiple attribute survey. To avoid respondent fatigue, the designs were blocked into two versions so that each respondent was assigned a random block of six choice sets. For the second experiment the 12 choice set design was blocked into four versions, with each respondent receiving a random three blocks from the whole GBR design and another three blocks from the regional GBR design.

Responses were collected in Townsville, a regional centre within the GBR catchment area, and Brisbane, the State capital located outside the GBR catchment area. Surveys were collected in both a paper-based and web-based modes, with the former collected to provide a check on the accuracy of the online responses. The effects of collection mode were tested for in the Brisbane population, but little significant difference could be identified, supporting the results of Olsen (2009).

Table 1. Attribute levels[1] for choice alternatives

Attribute	Description		Base/ Option levels		
			Whole	**Regional[1]**	**Local[2]**
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%**/66%, 68%, 70%, 72%, 75%,76%, 80%, 85%		
		Sq km	**225,000** /228,000 to 294,000	**56,250** /57,000, 73,500	
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		**$0/**$50, $200, $500
Reef	Area of coral reef in good health	%	**65%/** 70%, 80%, 85%		**35%/**45%, 55%, 60%
		Sq km	**13,000**/ 14,000, 16,000, 17,000	**3,250** /3,500, 4,000, 4,250	**91/** 117, 143, 156
Fish	No of fish species in good health	%	**65%** /70%, 80%, 85%		**55%/**65%, 75%, 80%
		No of species	**975 /**1050, 1200, 1275		**55 /**65, 75, 80
Seagrass	Area of seagrass in good health	%	**65%** /70%, 80%, 85%		**65%/**75%, 85%, 90%
		Sq km	**28,000** 31,000, 35,000, 38,000	**7,000** /7,750, 8,750, 9,500	**36** /42, 48,50

[1] All absolute levels for regional attributes were calculated at 25% of the whole levels
[2] The total area (100%) of Reef (260 sq km) was 5% of the total regional area (5000sq km); Fish were 7% of the regional (and whole) total of 1500 species and Seagrass was 0.5% of the regional total of 11,000 sq km.

3.1 Respondent characteristics

A total of 2111 surveys were collected across the three survey formats and from two population groups in the 12 split-sample experiments (Table 2). The whole and regional surveys were collected between August and December 2009 and the local surveys were collected between January and March 2010.

Table 2. Survey collection details

	Single attribute (single scope format)		**Single attribute (mixed scope format)**		**Multiple attributes**			**Total**
	Whole	Regional	Whole/ regional	Regional / whole	Whole	Regional	Local	
Townsville	90	93			91	93	144	**511**
Brisbane	257	255	210	212	258	249	159	**1600**
Total	**347**	**348**	**210**	**212**	**349**	**342**	**303**	**2111**

The paper-based surveys yielded a high response rate of over 85% in both population samples. An approximate response rate of 68% was estimated for the whole and regional internet surveys, and 27% for the local internet surveys. The difference in response rates was largely due to different providers being contracted to perform the surveys. The socio-demographic characteristics of survey respondents were reasonably well aligned with those of the population (Table 3), apart from education levels which were higher for the sample than the population and some imbalance in the age categories for both samples in the paper-based survey.

Table 3. Respondent characteristics

		Brisbane		Townsville	
		Sample	Population[1]	Sample	Population[1]
Gender	Female	53%	50%	55%	50%
Children	Have children	66%	n/a	70%	na
Average age	Online respondents	43 years	43 years	41 years	41 years
Age category	Paper based respondents				
	18-29 years	15%	24%	20%	27%
	30-45 years	29%	31%	29%	31%
	46-65 years	34%	30%	40%	28%
	66-89 years	22%	16%	11%	14%
Education	Post school qualification	62%	56%	58%	45%
	Tertiary degree	35%	24%	34%	15%
Income	less than $499 per week	18%	17%	16%	17%
	$500 – $799 per week	21%	18%	18%	18%
	$800 – $1199 per week	22%	21%	19%	22%
	$1200 – $1999 per week	27%	24%	30%	25%
	$2000 or more per week	13%	21%	17%	18%

[1] Australian Bureau of Statistics 2006 Census

4. Results

It was expected that the local population (Townsville) would have more recreation use of the GBR than the distant population (Brisbane), and that there may be some variation in attitudes towards the GBR between the population groups. Survey results confirmed both expectations (Table 4). Recreational use of the GBR is much higher in Townsville than Brisbane, with the main difference being in the frequency of use generally, and for fishing[1] in particular. There are slightly smaller differences between populations in plans for future usage, with 72% of the Brisbane population and 79% of the Townsville population planning to make at least one visit in the next five years. A higher proportion of Brisbane respondents thought the condition of the GBR had declined in the last 10 years compared with Townsville respondents.

Each of the surveys contained a range of the questions designed to explore respondents' attitudes to:

- different reasons for supporting protection of the GBR (included a range of use and non-use options),
- the importance of different areas in the GBR to protect,
- the importance of different potential actions that could reduce pressures on the GBR,
- their knowledge of issues relating to the GBR, and
- the actual survey and the choice selection process.

[1] It was difficult to accurately assess recreational fishing use, as there was a high rate of missing values (mv) in the paper-based survey, with 55% and 37% in the Brisbane and Townsville surveys respectively.

There were no significant differences (Pearson's chi squared crosstab at the 5% level) in the responses to these attitudinal questions between the whole and regional surveys in either population, and very limited differences with responses for the local survey, particularly in the Brisbane sample. Respondents rated the important of their own direct use less highly than for the whole and regional surveys. These results indicate that while differences in use of the GBR by the two population groups may generate variations in values across geographic scopes, other differences between the population groups appear to be very limited.

Table 4. Past and future use of the Great Barrier Reef

	Brisbane respondents (n=1600)			Townsville respondents (n=511)		
	Whole (n= 725)	**Regional (n= 716)**	**Local (n=159)**	**Whole (n=181)**	**Regional (n=186)**	**Local (n=144)**
Recreational fishing use	55% mv in paper survey (n=192)	53% mv in paper survey (n=180)		37% mv in paper survey (n=367)	30% mv in paper survey (n=186)	
Never	79%	84%	84%	37%	34%	64%
Once	7%	5%	8%	15%	9%	8%
More than once	14%	11%	8%	48%	57%	28%
Other recreational use						
Never	34%	41%	53%	24%	26%	37%
Once	26%	25%	18%	17%	19%	15%
More than once	40%	33%	29%	59%	55%	48%
Future recreational use						
Never	21%	26%	38%	23%	22%	19%
At least once in next 5 years	54%	48%	37%	37%	33%	22%
At least once next yr	25%	26%	25%	40%	45%	59v
Change in condition of the GBR in past 10 years						
Declined	68%	61%	47%	50%	50%	39%
Improved	2%	3%	6%	3%	6%	5%
Stayed the same	16%	16%	11%	27%	26%	29%
Not sure	14%	20%	36%	20%	18%	27%

A number of mixed logit (ML) models were developed to explore the sensitivity of responses to geographic scope and scale effects. Other model variables not previously included in Table 1 are explained in Table 5.

Table 5. 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
CZ…	Prefix to denote management option: Increase conservation zones
GG…	Prefix to denote management option: Reduce greenhouse gases
AGE	Age in years. Only categorical details were collected in the paper survey. 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 3 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 against the base or status quo alternative. Only the ASCs were randomised which meant that all single and multiple attributes were treated in a uniform manner as non-random parameters. Models have been estimated both with the GBR attributes in percentage and absolute terms, but for brevity only the results of the percentage formats are displayed. Part-worths from both alternative formats of the GBR CONDITION variable are shown in the appropriate results tables.

4.1 Scope sensitivity in a single GBR attribute survey design

The model results indicate that internal scope tests are being satisfied for each population group in both survey versions, with significant coefficients for the attributes (Table 6). There was no significant difference in serial non-participation in either population. In Brisbane, 15% of respondents in both the whole and regional surveys always selected the status quo option. In Townsville, a higher proportion always selected the status quo option in the whole survey (25%) compared with the regional (16%).

Table 6. Mixed logit models for a single GBR attribute format (Experiment 1)

	Brisbane				Townsville			
	Whole GBR		Regional GBR		Whole GBR		Regional GBR	
	Coefficient	*St. Err*	*Coefficient*	*St. Err*	*Coefficient*	*St. Err*	*Coefficient*	*St. Err*
Random parameters in utility functions								
ASC_WQ	-3.062***	1.108	-2.647***	0.858	-11.040***	2.875	-4.551**	2.080
ASC_CZ	-2.902***	1.072	-2.649***	0.830	-11.272***	2.894	-5.794***	2.083
ASC_GG	-5.345***	1.225	-3.885***	0.987	-13.945***	3.528	-4.557*	2.334
Derived standard deviations of parameter distributions								
ASC_WQ	2.255***	0.228	2.052***	0.210	3.524***	0.560	2.784***	0.405
ASC_CZ	2.172***	0.200	1.996***	0.178	3.111***	0.365	2.863***	0.332
ASC_GG	3.308***	0.347	3.099***	0.317	5.290***	0.840	3.408***	0.498
Non Random parameters in utility functions								
COST	-0.006***	0.000	-0.007***	0.000	-0.005***	0.001	-0.003***	0.001
GBR CONDITION (%)	0.164***	0.017	0.160***	0.017	0.179***	0.044	0.055	0.035
CERTAINTY	0.016***	0.005	0.023***	0.005	0.013	0.014	0.023*	0.012
AGE	-0.008	0.009	0.006	0.008	-0.089***	0.026	-0.053***	0.019
GENDER	-0.501***	0.271	-0.996***	0.238	0.216	0.661	0.492	0.539
CHILDREN	-0.187	0.215	-0.599**	0.266	-2.166**	0.917	-0.706*	0.375
EDUCATION	-0.286***	0.121	-0.048	0.109	-0.776**	0.304	-0.644**	0.266
INCOME	-0.1E-05***	0.4E-06	-0.9E-06***	0.4E-06	-0.2E-05*	0.1E-05	-0.2E-06	0.7E-06
Model statistics								
No of Observations	1500		1488		522		558	
Log L	-1577		-1564		-484		-564	
Finite sample: AIC	2.122		2.121		1.908		2.074	
Info. Criterion: BIC	2.171		2.171		2.021		2.181	
McFadden R-sqrd	0.242		0.242		0.332		0.271	
Chi Sqrd	1004		998		480		419	

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

The results provide mixed evidence about geographic scope and scale effects. Log likelihood ratio tests indicate that there is no significant difference between the Brisbane whole and regional level models, but there was between the Townsville whole and regional models. The WTP estimates (Table 7) and Poe et al. (2005) tests confirm that values for percentage changes held by the Brisbane population are similar across the two scope levels, while values for absolute changes are different. This is contrary to expectations in that there is little difference in values between the regional and the whole GBR, and unit values are not uniform. In the Townsville survey the insignificant GBR CONDITION attribute in the regional GBR survey makes the test inconclusive. The similarities and differences in values between the two population groups are reported elsewhere and are not discussed further in this report.

Table 7. Value estimates for a single GBR attribute and the certainty of outcomes

	Brisbane		Townsville	
GBR CONDITION	Whole	Regional	Whole	Regional
Mean WTP (per 1%)	$26.29***	$23.71***	$36.51***	$16.41 ns
Confidence intervals	$20-$33	$19-$30	$16-$76	$0-$64
Mean WTP (per 100 sq km)	$0.75***	$2.80***	$0.10***	$1.97 ns
Confidence intervals	$0.57-$0.95	$2.20-$3.46	$0.04-$0.22	$0-$6.96
CERTAINTY				
Mean WTP (per 1%)	$2.50	$3.34	$2.70	$6.73
Confidence intervals	$1-$4	$2-$5	$0-$7	$0-$12

*** Significant at the 1% level; ns= not significant

4.2 Scope sensitivity in a mixed scope survey design

It is possible that CM respondents focus too intently on the experiment they are presented with, downplaying other substitutes and ignoring wider scale and scope issues. The effect of an issue assuming first place in the queue is that values for each issue in turn assume primary importance, generating apparent scope and scale inconsistencies. To test this, the second experiment involved split samples with both the whole GBR choice sets and regional GBR choice sets in the same survey.

There was no significant difference between the split samples in serial non-participation, with 12% in the survey where the whole sets were presented first and 13% in the survey where the regional sets were presented first. For the analysis the whole set responses were grouped together and the regional responses were grouped together (Table 8). The statistical fit of the two models is slightly different and generally lower than the other surveys (AIC and BIC values), possibly because of the additional choice burdens place on respondents to address the differently scoped tasks.

A log likelihood ratio test indicates that there is no significant difference between the two models, while a Poe et al. (2005) procedure indicates that there is no significant difference in the different scope estimates for either GBR CONDITION or CERTAINTY. There is also no significant different between the WTP estimates elicited for Brisbane respondents in the single attribute/ single scope format (Experiment 1) and the mixed scope format (Experiment 2). While contrary to expectations, these results indicate that it is not the presentation of choice tasks that is driving apparent insensitivity to geographic scope and scale.

Table 8. Mixed logit models for a mixed scope survey format (Experiment 2)

	Whole GBR (3a) (mixed scope format)		WTP	Regional GBR (3b) (mixed scope format)		WTP
	Coefficient	*St. Err*		*Coefficient*	*St. Err*	
Random parameters in utility functions						
ASC_WQ	-0.909	0.595		-0.829	0.610	
ASC_CZ	-0.915	0.570		-0.494	0.583	
ASC_GG	-1.335*	0.704		-2.173***	0.740	
Derived standard deviations of parameter distributions						
ASC_WQ	0.621***	0.137		0.793***	0.133	
ASC_CZ	0.517***	0.144		0.594***	0.136	
ASC_GG	1.039***	0.158		1.671***	0.194	
Non Random parameters in utility functions						
COST	-0.004***	0.000		-0.005***	0.000	
GBR CONDITION (%)	0.089***	0.013	$20.71	0.110***	0.014	$22.26
CERTAINTY	0.015	0.005	$3.41	0.001	0.005	$0.23
AGE	-0.005	0.005		-0.005	0.005	
GENDER	-0.422***	0.147		-0.281	0.150	
CHILDREN	0.111	0.165		0.265	0.166	
EDUCATION	-0.086	0.060		-0.072	0.061	
INCOME	-0.9E-07	0.2E-06		-0.9E-07	0.2E-06	
Model statistics						
No of Observations	1263			1263		
Log L	-1600			-1562		
Finite sample: AIC	2.556			2.496		
Info. Criterion: BIC	2.612			2.553		
McFadden R-sqrd	0.0863			0.1079		
Chi Sqrd	302			377		

4.3 Scope sensitivity in a multiple GBR attribute survey design

To identify more clearly where geographic scope and scale effects were being generated, the third experiment was developed with two major changes from the first experiment. First, a local case study of the GBR (within the regional case study) was added to identify if the pattern of value estimates was consistent between whole, regional and local frames. Second, the single GBR CONDITION attribute was replaced with three component attributes (REEF, FISH and SEAGRASS), and the UNCERTAINTY attribute and policy labels were dropped. This allowed a more forensic examination of where value changes were concentrated. It also provided an opportunity to control for scope and scale differences. While two of the variables (REEF and SEAGRASS) increased in scale and scope together, the other variable (FISH) maintained a consistent scale across the three levels of geographic scope.

There was no significant difference in serial non-participation at the different levels of scope in either population sample, with 14%, 17% and 15% of respondents in the whole, regional and local surveys respectively always selecting the status quo option in Brisbane and 15%, 16% and 17% respectively always selecting the status quo option in Townsville. Results of the multiple attribute survey are presented in Table 9. All models are significant (high chi-squared values) and 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. The randomised ASC parameter is not significant in any of the three Brisbane models, indicating there are no unexplained effects influencing the selection of the status quo alternative. However, the parameter was significant in the Townsville models, perhaps indicating that the local population were more discriminating in their choices.

Table 9. Mixed logit models for a multiple attribute survey format

	Brisbane			Townsville		
	Whole GBR (1a)	Regional GBR (1b)	Local GBR (1c)	Whole GBR (1a)	Regional GBR (1b)	Local GBR (1c)
	Coefficient	*Coefficient*	*Coefficient*	*Coefficient*	*Coefficient*	*Coefficient*
Random parameters in utility functions						
ASC_SQ	1.207	-4.694	2.055	-17.913**	4.837	-2.694
Derived standard deviations of parameter distributions						
ASC_SQ	6.027***	8.025***	7.522***	6.907***	6.365***	7.378***
Non Random parameters in utility functions						
COST	-0.004***	-0.005***	-0.002***	-0.003***	-0.003***	-0.003***
REEF (%)	0.053***	0.051***	0.026***	0.045***	0.018**	0.040***
FISH (%)	0.034***	0.048***	0.038***	0.039***	0.028***	0.040***
SEAGRASS (%)	0.026***	0.026***	0.013**	0.027**	0.015	0.023
AGE	0.009	0.066	-0.033	0.162**	-0.004	0.005
GENDER	-0.739	0.480	-0.015	3.567*	-0.369	-2.373
CHILDREN	-0.505	-0.126	-0.163	2.971	-4.168*	1.401
EDUCATION	-0.261	0.040	-0.927*	-1.632*	-0.258	0.333
INCOME	-0.3E-05***	-0.5E-05**	-0.2E-05	-0.4E-05	-0.2E-05	-0.9E-06
Model statistics						
No of Observations	1500	1464	954	522	534	864
Log L	-1548	-1387	-1000	-556	-569	-885
Finite sample: AIC	2.078	1.909	2.119	2.174	2.174	2.074
Info. Criterion: BIC	2.117	1.949	2.175	2.262	2.261	2.134
McFadden R-sqrd	0.256	0.317	0.244	0.232	0.231	0.261
Chi Sqrd	1064	1286	645	335	342	626

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

Consistent with the first experiment, log-likelihood ratio tests indicate that there is no significant difference between the whole and regional models for either the Brisbane or Townsville populations. There is also no significant difference between the whole and local or regional and local models for the Townsville population sample. However, there is a significant difference between the whole and local and, regional and local for the Brisbane population.

More detailed tests are available by comparing the marginal values for the different attributes (Table 10). There is very little difference in WTP estimates for percentage changes (per household, per year for a five-year period) for the three main attributes across populations and levels of scope, with all confidence intervals overlapping. Conversely, there is a large difference in absolute values across the three geographic scopes, even for FISH where scale was held constant.

The Poe et al. (2005) procedure was used to test for differences in WTP for percentage changes, with results indicating that in the Brisbane sample:

- there is a significant difference (5%) between the WTP estimates for REEF between the whole and regional levels of scope (Poe statistic of 0.041) but not between either of these and the local level estimate.
- there is a significant difference (5%) between the WTP estimates for FISH between the whole and local levels of scope (Poe statistic of 0.010), but not between either of these and the regional level estimate.
- there is no significant difference between the WTP estimates for SEAGRASS at any level of scope

In the Townsville sample, there is no significant difference between the estimates for FISH and SEAGRASS but there is for REEF at the 5% level (Poe statistic of 0.015) between the whole and regional levels.

Table 10. WTP estimates and scope sensitivity in the multiple attribute survey

	Brisbane				Townsville			
	Reef	Fish	Seagrass	SUM	Reef	Fish	Seagrass	SUM
Whole GBR								
Mean WTP (per 1%)	$12.45	$8.00	$6.10	$26.55	$15.58	$13.61	$9.37	$38.56
Confidence intervals	$10-$15	$6-$10	$3-$9		$10-$23	$7-$21	$2-$15	
Mean WTP (per sq km/species)	$0.06	$0.53	$0.01		$0.08	$0.90	$0.02	
Confidence intervals	5¢-7¢	37¢-70¢	1¢-2¢		5¢ 12¢	79¢-101¢	0¢-3¢	
Regional GBR								
Mean WTP (per 1%)	$9.67	$9.09	$5.00	$23.76	$6.44	$9.68	$5.22	$21.34
Confidence intervals	$8-$12	$7-$11	$2-$7		$0-$12	$4-$17	$0-$12	
Mean WTP (per sq km/species)	$0.19	$0.60	$0.04		$0.13	$0.64	$0.05	
Confidence intervals	15¢-23¢	47¢-75¢	2¢-6¢		1¢-24¢	20¢-115¢	0¢-10¢	
Local GBR								
Mean WTP (per 1%)	$10.78	$15.55	$5.18	$31.51	$11.75	$11.89	$6.88	$30.52
Confidence intervals	$4-$17	$10-$22	$1-$9		$7-$16	$7-$17	$4-$10	
Mean WTP (per sq km/species)	$4.27	$15.79	$9.44		$4.63	$12.15	$12.29	
Confidence intervals	$2-$7	$10-$22	$3-$16		$3-$6	$8-$17	$7-$18	

These results indicate little sensitivity to geographic scope and scale changes. For the FISH attribute, where levels did not change between whole GBR and regional GBR frames, but then had much smaller numbers in the local case study, the scope effects varied. Per unit values remained constant between whole and regional frames but were much higher for the local case study, indicating that the key issue was insensitivity to changes in scale across split sample experiments. For the REEF and SEAGRASS attributes, where attribute levels increased across local, regional and whole GBR frames, the per unit values increased while the proportional values remained constant. Per unit values are highest for the local GBR frame where smaller absolute levels were involved.

When the values per 1% improvement of the three GBR attributes are summed to provide an estimate of the complete GBR ecosystem, there is no significant difference (Poe et al. 2005 procedure) in the Brisbane summed values for the whole ($26.55), regional ($23.76) or local ($31.51) models, nor for the Townsville summed values for the whole ($38.56), regional ($21.34) or local ($30.52) models. There are minor differences in the level of insensitivity to scope in the two populations, with the summed values highest for the local level in Brisbane and the whole GBR in Townsville.

5. Discussion and conclusions

The results of the twelve split-sample experiments reported in this report demonstrate that issues of geographic scope and scale remain challenging in CM experiments. Although economic theory predicts that values for larger and more inclusive goods should be higher than for smaller and less inclusive ones, the results of the experiments reported here consistently confirm that proportional values remain consistent when geographic scope and scale is increased, while absolute values decline. This is despite substantial efforts in designing and presenting the surveys to define the amenity of interest to respondents. The results indicate that it is difficult to identify single unit values for an environmental amenity that can be easily transferred and extrapolated across geographic regions and scales.

The results indicate that values remain dependent on the context in which they are framed. There may be two methodological reasons that help to explain why. First, in the experiments that were conducted, the payment levels were held constant across the split-samples, even when scope and scale changed. It is possible that payment amounts carried implicit signals about the level of environmental improvements that were available, explaining why support levels remained so consistent. This is an important issue to test in the future. Second, it is unclear how respondents interpreted and used the dual presentation of environmental attributes in percentage and actual changes. It is possible that a focus on percentage changes only may have contributed to the apparent insensitivity.

There may also be some theoretical reasons why values should vary across geographical scope and scale. In a marginal framework, the presentation of the local case study may have simply led respondents to consider these as the first issues to prioritise. In this case, the lower per unit values for increasing the geographic scope to regional and then the whole GBR simply reflects the diminishing marginal utility of increasing the amounts to be protected. The values should be interpreted as marginal values for changes at discrete levels of geographic scope, not as average values to be extrapolated out of context in a benefit transfer application. In policy setting, this suggests that while whole GBR scope values are appropriate to use for general protection issues, the values for immediate issues in the forefront of community attention may be better reflected by those from the local case study level.

In a similar manner, the iconic nature of the environmental asset may have limited the ability of respondents to consider parts of the whole GBR as independent units. Instead, the responses reflect an underlying desire to protect the whole of the iconic resource, either as a series of regions or local areas. Respondents may have simply treated the smaller geographic areas as representative of their preferences for the whole GBR to be protected, hence explaining why the total value of changes per percentage of change was relatively uniform across the different geographic case studies.

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References

Australian Institute of Marine Science (AIMS) 2009 *AIMS Research – Reef monitoring*. Online resource: http://data.aims.gov.au/waReefPage/servallreefs,(accessed September 2009). Australian Institute of Marine Science, Townsville.

Arrow, K. Solow, R. Portney, P. Leamer, R, Radner, R. and Schuman, H.1993 Report of the NOAA Panel on contingent valuation, *Federal Register* 58 (10): 4602–4614.

Bateman, I. and Brouwer, R. 2006 Consistency and construction in stated WTP for health risk reductions: A novel scope-sensitivity test. *Resource and Energy Economics* 28: 199–21.

Bateman, I., Cole, M., Cooper, P., Georgiou, S. Hadley, D. and Poe, G. 2004 On visible choice sets and scope sensitivity. *Journal of Environmental Economics and Management* 47: 71–93.

Bateman, I., Cooper, P. Georgiou, S., Navrud, S., Poe, G., Ready, R., Riera, P., Ryan, M. and Vossler, C. 2005 Economic valuation of policies for managing acidity in remote mountain lakes: Examining validity through scope sensitivity testing. *Aquatic Sciences* 67(3): 274-29.

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: 450-46.

Bateman, I., Munro, A., Rhodes, B., Starmer, C. and Sugden, R, 1997 Does part-whole bias exist? An experimental investigation, *The Economic Journal* 107**:** 322–332.

Bell, J. and Galzin, R. 1984 Influence of live coral cover on coral-reef fish communities. *Marine Ecology – Progress Series*, Vol.14: p265-274.

Bergland, O., Magnussen, K. and Navrud, S. 2002 Benefit transfer: testing for accuracy and reliability, in R. Florax, P. Nijkamp and K. Willis (eds) *Comparative Environmental Economic Assessment*, Edward Elgar, Cheltenham, U.K. and Northhampton, M.A. USA.

Brouwer, R. 2000 Environmental value transfer: state of the art and future prospects, *Ecological Economics*, 32: 137-152.

Campbell, D., W. G. Hutchinson, and R. Scarpa. 2008 Incorporating discontinuous preferences into the analysis of discrete choice experiments, *Environmental and Resource Economics*, 41:401-417.

Carson, R.T. and Mitchell, R. C. 1995 Sequencing and nesting in contingent valuation surveys, *Journal of Environmental Economics and Management* 28: 155–175.

Czajkowski, M. and Hanley, N. 2009 Using labels to investigate scope effects in stated preference methods, *Environmental and Resource Economics*, 44(4): 521-535.

Diamond, P.A and Hausman, J.A. 1994 Contingent valuation: is some number better than no number? *The Journal of Economic Perspectives*, 8 (4): 45-64.

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., Wright, R. and Adamowicz, W. 1998 Using choice experiments to value the environment: Design issues, current experience and future prospects, *Environmental Resource Economics*, 3-4: 413-428.

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

Hanemann, W.M. 1994 Valuing the environment through contingent valuation, *Journal of Economic Perspectives*, 8: 19–43.

Harrison, G.W. 1992 Valuing public goods with the contingent valuation method: A critique, *Journal of Environmental Economics and Management*, 23:3 (November), 248-257.

Heberlein, T.A., Wilson, M. A., Bishop, R.C. and Schaeffer, N.C. 2005 Rethinking the scope test as a criterion for validity in contingent valuation. *Journal of Environmental Economics and Management* 50: 1–22.

Jones, G., McCormick, M., Srinivasan, M. and Eagle, J. 2004 Coral decline threatens fish biodiversity in marine reserves. *Proceedings of the National Academy of Sciences*, Vol. 101(21): 8251-8253.

Kahneman, D. and Knetsch, J.L. 1992 Valuing public goods: the purchase of moral satisfaction, *Journal of Environmental Economics and Management* 22: 57–70.

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.

Mitchell, R.C. and Carson, R.T. 1989 Using Surveys to Value Public Goods: the Contingent Valuation Method, Resources for the Future, Washington, DC.

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.*

Pouta, E. 2005 Sensitivity to scope of environmental regulation in contingent valuation of forest cutting practices in Finland. Forest Policy and Economics 7:539-550.

Randall, A. 1997 The NOAA Panel Report: A New Beginning or the End of an Era?, *American Journal of Agricultural Economics*, 79:1489-1494.

Randall, A. and Hoehn, J.P. 1996 Embedding in market demand systems, *Journal of Environmental Economics and Management*, 30: 369-80.

Rasheed, M., Taylor, H., Coles, R. and McKenzie, L. 2007 *Coastal seagrass habitats at risk from human activity in the Great Barrier Reef world heritage area*. Queensland Department of Primary Industries and Fisheries, Cairns.

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

Rolfe, J. and Bennett, J. (eds) 2006 *Choice Modelling and the Transfer of Environmental Values*, Cheltenham, Edward Elgar.

Rolfe, J., Bennett, J. and Louviere, J. 2000 Choice modelling and its potential application to tropical rainforest preservation, *Ecological Economics*, 35: 289-302

Rolfe, J., Bennett, J. and Louviere, 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): 1-20.

Rolfe, J., Loch, A. and Bennett, J. 2006 Testing benefit transfer with water resources in Central Queensland, Australia, in Rolfe, J. and Bennett, J. (ed.) *Choice Modelling and the Transfer of Environmental Values*, Cheltenham, Edward Elgar.

Rolfe, J. and Windle, J. 2008 Testing for differences in benefit transfer values between state and regional frameworks *Australian Journal of Agricultural and Resource Economics,* 52(2):149-168.

Scarpa, R., Gilbride, T., Campbell, D. and Hensher, D. 2009 Modelling attribute non-attendance in choice experiments for rural landscape valuation, *European Review of Agricultural Economics*, 36: 151-174.

Schulze, W. D., McClelland, G., Lazo, J. and. Rowe, R. D. 1998 Embedding and calibration in measuring non-use values, *Resource and Energy Economics* 20: 163–178.

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

Udy, J., Dennison, W., Lee Long, W. and McKenzie, L. 1999 Responses of seagrass to nutrients in the Great Barrier Reef, Australia. *Marine Ecology – Progress Series,* Vol.185: p257-271.

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): 1-32.

Veitsten, K., Hoen, H., Navrud, S. and Strand, J. 2004 Scope insensitivity in contingent valuation of complex environmental amenities. *Journal of Environmental Economics and Management,* 73: 317-331.

Von Haefen, R.H., Massey, D.M. and Adamowicz, W.I. 2005 Serial Nonparticipation in Repeated Discrete Choice Models, *American Journal of Agricultural Economics*, 87(4): 1061-1076.

Wolanski, E. and De'ath, G. 2005) Predicting the impacts of present and future human land-use on the Great Barrier Reef, *Estuaries, Coastal and Shelf Science*, 64: 504-508.