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Developing a benefit transfer database for environmental values in Queensland

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Abstract

Policy makers are often interested in transferring estimates of environmental values made in one situation to related circumstances. The benefit transfer process is typically reliant on the availability of a number of source studies which have appropriate levels of reliability and relevance to the issue of interest. However, the limited number of non-market valuation studies to draw on for source values currently limits the benefit transfer process. In this paper, an alternative approach to benefit transfer is outlined where a series of valuation studies were specifically performed to build a reference data base of values for benefit transfer purposes. The choice modelling technique was used to estimate community values for protecting soil, water and vegetation stocks in Queensland, Australia, where both state and regional populations were surveyed to generate value estimates in a variety of contexts. The results provide a database where government and natural resource management agencies can access generic estimates of environmental values.

Keywords: benefit transfer, environmental valuation, choice modelling

1. Introduction

At a policy level, there are often requirements to assign monetary values to potential environmental impacts in cost-effective and timely ways (Wilson and Hoehn 2006). Most evaluations of development proposals or justifications of public investment in environmental protection require some assessment of the environmental costs or benefits to be incorporated into the assessment process. While specific valuation studies can be performed for each case study requirement, a more expedient option is to transfer values from previously conducted case studies. Benefit transfer (BT) is the process where non-market values gained from a 'source' study can be used in some way to predict economic values at a 'target' site (Desvousges et al. 1992). The process typically involves transferring values across time, space, populations, and sometimes from one type of environmental asset to another (Brower 2006, Rolfe 2006).

The three main ways of performing BT are the transfer of point estimates, the transfer of value functions and the performance of meta analysis (Bateman et al. 2002). With point estimates, it is normally a per-unit value for a particular attribute that is transferred with some adjustment for site differences, although sometimes a lump sum value estimate will be transferred (Rolfe 2006). With a benefit function transfer, the equation describing the valuation function at the original site is transferred to the second site with the ability to adjust for site and population variations (Brouwer 2006). A meta analysis can also be conducted to synthesis a series of past studies, and the results used as inputs to the BT process (Wilson and Hoehn 2006).

BT is generally not viewed by practitioners as being very reliable, although it appears to work better in some contexts than others for reasons that are not well understood (Bateman et al. 2002, Brouwer 2006). The technique started to be applied in the 1980s once there was a pool of non-market valuation studies available as source data sets. There has been a great deal of effort by practitioners in the 1990s and early 2000s to understand where sources of bias in the benefit transfer process might be generated, and to develop more accurate ways of performing non-market valuation studies and the benefit transfer process (Wilson and Hoehn 2006).

The use of benefit transfer is still limited for a number of reasons, including the limited number of available studies, the inconsistencies in the way that data has been collected and modeled, and the brevity of reporting in many academic publications (Loomis and Rosenberger 2006). Many studies are conducted and reported for specific purposes, with little consideration for subsequent use in benefit transfer applications. As a consequence, a number of study aspects such as the selection of relevant variables, attribute definition and the type of modeling conducted may not be conducive to further applications (Brouwer 2000, Wilson and Hoehn 2006).

An alternative to the 'random foraging' approach for suitable source studies for a benefit transfer exercise is to develop a specific data base of benefit transfer values for subsequent case study applications. Such an approach has potential benefits in that the design of the non-market valuation exercise and data collection is conducted specifically for the purpose of ensuring accurate benefit transfer, and that any necessary adjustment factors can be explicitly modeled (van Bueren and Bennett 2004). Previous attempts to develop a benefit transfer framework have been reported by Morrison and Bennett (2004) and van Bueren and Bennett (2004).

In this paper, the conduct of a series of non-market valuation exercises to develop a benefit transfer framework is reported. The valuations were conducted with the choice modeling technique, which employs stated preferences to identify community values for environmental tradeoffs. The case study application was the condition of natural resources in regional areas of Queensland, Australia. The remainder of this paper is structured as follows. An overview of benefit transfer and the choice modeling technique is provided in the next section. The design and application of the valuation exercises are reported in section three, followed by a presentation of the results in section four. The results are discussed and conclusions drawn in the final section.

2. Benefit transfer and the choice modeling technique

The challenge in benefit transfer is to estimate values from one or more source studies at acceptable levels of accuracy. There are two broad areas where biases and inaccuracies can develop out of a benefit transfer process (Rolfe 2006). The first is where a source study may have measurement errors, and any benefit transfer process may simply map those inaccuracies to another site (Brookshire and Neil 1992). The second is where differences between source and target sites create problems for reliability and validity. Loomis and Rosenberger (2006) categorise these differences into three groups: commodity aspects, market area aspects and welfare measure aspects, following the categorization of ideal transfer conditions suggested by Boyle and Bergstrom (1992).

Commodity aspects relate to differences between sites, where idealistic criteria suggest that source and target sites should be identical for valid benefit transfer (Boyle and Bergstrom 1992). A more realistic condition is that source and transfer sites should be similar across a number of key aspects (Rosenberger and Stanley 2006). Market area aspects relate to the similarities in demand for the source and target sites. This encompasses differences in the populations of relevance and the attitudes of respondents (Loomis and Rosenberger 2006) as well as policy and institutional contexts which might frame the valuation context (Rolfe 2006). Welfare measure aspects relate to differences that might emerge according to the type of analysis, including variations between willingness to pay (WTP) and willingness to accept (WTA) constructs, differences in the models applied, collection measures and the estimation of benefits (Loomis and Rosenberger 2006).

Practitioners have developed a number of approaches to minimizing issues of potential bias and improving the benefit transfer process (Wilson and Hoehn 2006). One key approach has been to use benefit transfer functions, where environmental values are expressed as a function of a number of site, population and other characteristics. A key advantage of this approach is that values can be adjusted for variations in site and population characteristics between source and target applications (Boyle and Bergstrom 1992, Loomis 1992, Desvousgas et al. 1992, Kirchoff et al. 1997). The development of stated preference techniques such as choice modeling (CM) have facilitated the use of benefit transfer functions because CM can provide value functions that include both site and population characteristics (Rolfe 2006). Another advantage of using CM is that a range of attributes can be valued in a single questionnaire, which can reduce the cost of collecting source data.

There have been some exploratory attempts to use CM to develop specific databases for benefit transfer. Morrison and Bennett (2004) report the conduct of a series of CM exercises on valuing river health in New South Wales, Australia, and the subsequent estimation of a pooled model that summarized value estimates. The pooled model demonstrated that while values were dependent on river attributes and the socio-economic characteristics of respondents, they were also influenced by whether respondents lived inside or outside catchments. However, the study may have minimized some scope and scale issues by focusing on only one river catchment at a time, and it is unclear how accurate it would be to aggregate values up to a state level where a number of river catchments would be involved.

Van Bueren and Bennett (2004) report a more explicit attempt to include scope and scale issues in a valuation study of protecting endangered species, countryside aesthetics, waterway health and country communities in Australia. They did this by conducting surveys at both national and regional levels and engaging both national and regional populations. Their results demonstrated significantly higher values at regional compared to national levels, leading to suggestions that benefit transfer between national and regional applications would need to be adjusted by scalar factors. While these arguments for scalar adjustments are similar to the calibration proposals of Smith et al. (1999), it is not clear why the scalar factors should be so high (up to 26 times), and how values might vary between regional and state levels.

The purpose of the research reported in this paper was to build on these earlier case studies to develop a state and regional level model of values for natural resource management which could then be accessed for benefit transfer purposes. The focus of the research was to frame the state and regional tradeoffs more consistently by identifying how regional variations contributed to state-level outcomes. Designing the valuation exercise within a benefit transfer framework meant it was possible to control the survey instrument, sampling and modelling components so that they remained the same across each single valuation exercise. That left four key issues that needed to be explored:

- site differences;
- population differences;
- scope differences; and
- scale differences.

The manner is which the survey was designed to address these issues is reported in the next section.

3. Research and survey design

In Australia, the primary source of Federal and State funding for natural resource management issues is provided through the National Heritage Trust and the National Action Plan for Salinity and Water Quality. Funding is delivered at the regional level through natural resource management (NRM) groups; all of whom have government accredited NRM plans that outline and prioritise targets and actions. In all Queensland regions, priority investments are specifically directed towards improving the condition of soil, water and vegetation resource stocks. These are the environmental issues of most concern to resource managers and where there will be the most demand for economic valuations. Consequently, these three environmental attributes were the central focus of the valuation surveys. The valuation or policy scenario was framed in the context of funding for the National Action Plan for Salinity and Water Quality running out in 2007. Further funding would be required to ensure improvements in natural resource management in the State. This made it realistic to apply a WTP elicitation format. The valuation exercise was designed to provide NRM groups and other stakeholders with a template of community values for soil, water and vegetation resources that could then be drawn on to evaluate investment priorities.

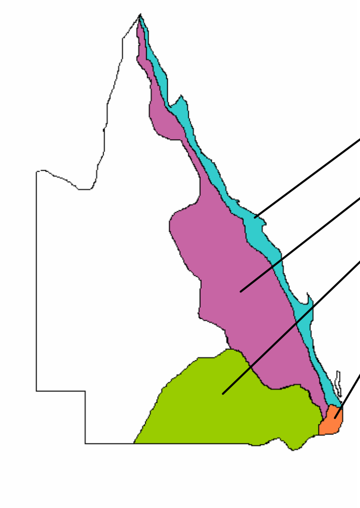
Two separate evaluation surveys were designed for the research project. The regional survey focused on a single region or catchment area. The other, statewide survey was designed as a composite of regional areas rather than the more commonly applied aggregation, i.e. several regional areas were included in the one survey (applying a labelled choice format). The main challenge was to select a small number of broadly defined regional areas which would include a cross section of resource management issues within the state. As the survey would be completed by a range of residents across the State, it was important that the selected regions would be readily recognised and that respondents would easily comprehend the associated resource management issues.

There were several broad regional distinctions which spanned both inputs (land management practices) and outputs (environmental impacts). These included:

- catchments that drain into the Great Barrier Reef (GBR) versus those that do not;
- inland areas versus coastal areas of GBR catchments;
- large catchments versus small catchment areas;
- catchments where grazing is the dominant land use and those where sugarcane dominates:
- the importance of coastal and/or GBR tourism; and
- the importance of residential development.

There were two regions that were well known by most residents in Queensland: South East Queensland (the area surrounding Brisbane, the capital city) and the Murray Darling Basin (part of the largest river system in Australia). In addition, residents were generally familiar with the coastal region adjacent to the GBR. The only other region that most residents were likely to relate to in terms of the importance of NRM issues was inland areas of catchments that drain into the GBR. Any further distinction within the State would probably not have been immediately meaningful for survey respondents. These four broad regional classifications were used in the statewide survey (Figure 1).

Figure 1. Four regional classifications in the statewide survey



To match these four regional classifications, four specific catchment areas were selected for use in the regional survey. The main population centres in these regions were used as population samples for the different surveys. The broad characteristics of these catchment areas are outlined in Table 1. Survey details for the regional and statewide surveys are presented in Table 2.

Table 1. Main characteristics of the four regional catchments

	Murray Darling	South East Queensland	Mackay Whitsunday[1]	Fitzroy Basin[2]
Main town	Toowoomba	Brisbane	Mackay	Rockhampton
Main land use	Agriculture Western grazing	Urban development	Sugarcane (cropping)	Cattle grazing
Catchment size	Large	Small	Small	Large
Catchment outlet	Not Queensland	Not Great Barrier Reef (GBR)	GBR High risk	GBR Low risk
Tourism	Some - not important	Important – coastal tourism	Very important. Some coastal but mainly GBR tourism	Low importance - coastal + GBR tourism
Residential development	Some growth	Very important	Growing	Recent growth

1. Information from this catchment was used to represent the broader GBR – Coastal classification

2. Information from this catchment was used to represent the broader GBR – Inland classification

Table 2. Survey details

Survey	Region/catchment area	Population sampled	Environmental attributes	Comment
Regional survey Four separate regional surveys	S.E. Queensland Murray Darling Mackay Whitsunday Fitzroy Basin	Brisbane Toowoomba Mackay Rockhampton	Soil Water Vegetation	Each population sample completed a survey specific to their region
Statewide survey Four regional areas included in one survey	S.E Queensland Murray Darling GBR – Coastal areas GBR – Inland areas	Brisbane Toowoomba Mackay	Soil Water Vegetation	All populations completed the same survey

Four attributes were used to describe the choice scenario in each region; three environmental attributes (soil water and vegetation) and a cost attribute. The way in which a cost attribute is presented in a CM survey, e.g. an increase in rates, is known as the payment vehicle. In order to avoid any payment vehicle bias, several potential payment options were described. Payments would be made on an annual basis for a 15 year period and the attribute had three levels ($20, $50, $100). The status quo option was presented in terms of a fifteen year future base with a decline in resource condition. Choice alternatives offered improvements from that base. Full details of the attribute levels are outlined in Table 3 and example choice sets are presented in Appendix 1a and 1b.

Two experimental designs were developed for the surveys. In the regional model, each choice set had two alternatives plus a no choice or status quo option. There were six choice sets in each survey and four versions of the survey. This meant 24 different choice profiles would be completed. In the state model, each choice set had four alternatives plus a no choice or status quo option. There were six choice sets in each survey and 13 versions of the survey. This meant 78 different choice sets would be completed.

The valuation exercise was designed, where possible, to minimise potential differences between source sites and potential target sites. Market area aspects, welfare measure aspects and most commodity aspects, (Loomis and Rosenberger 2006) were all similar across each of the single valuation surveys. For example, the welfare measure and, policy and institutional context were the same for all surveys and would be applicable in a range of potential transfers situations (within the State). Some differences, such as site and population differences, could not be minimised, and in this case the valuation exercise was designed to identify their significance. A comparison of the results from the regional and statewide surveys would determine if there were significant value differences:

1. across different regional contexts and catchments (site and population differences – regional models);
2. across different regional populations (population differences – statewide models);
3. when the valuation scenario was presented in a regional or statewide context (scope differences – regional and statewide models); and
4. when presented with very large or smaller catchment areas (scale differences – regional and statewide models).

Table 3. Current condition, future base and attribute levels

	Soils in good condition	Waterways in good health	Healthy Vegetation
Murray Darling			
Area: 314,000 sq km			
River length: 20,000 km			
Current condition	***65%***	***60%***	***45%***
Base level in 15yrs	50%	40%	25%
Attribute levels	55%, 60%, 65%	45%, 50%, 55%	30%, 35%, 40%
South East Queensland			
Area: 23,000 sq km			
River length: 2,000 km			
Current condition	***60%***	***55%***	***45%***
Base level in 15yrs	45%	35%	25%
Attribute levels	50%, 55%, 60%	40%, 45%, 50%	30%, 35%, 40%
Mackay Whitsunday			
Area: 9,000 sq km			
River length: 700 km			
Current condition	**65%**	**60%**	**65%**
Base level in 15yrs	50%	40%	45%
Attribute levels	55%, 60%, 65%	45%, 50%, 55%	50%, 55%, 60%
Fitzroy Basin			
Area: 143,000 sq km			
River length: 15,000 km			
Current condition	***65%***	***50%***	***45%***
Base level in 15yrs	50%	30%	25%
Attribute levels	55%, 60%, 65%	35%, 40%, 45%	30%, 35%, 40%
GBR-coast[1]			
Area: 90,000 sq km			
River length: 7,000 km			
Current condition	***65%***	***60%***	***65%***
Base level in 15yrs	50%	40%	45%
Attribute levels	55%, 60%, 65%	45%, 50%, 55%	50%, 55%, 60%
GBR-inland[2]			
Area: 430,000 sq km			
River length: 34,000 km			
Current condition	***65%***	***50%***	***45%***
Base level in 15yrs	50%	30%	25%
Attribute levels	55%, 60%, 65%	35%, 40%, 45%	30%, 35%, 40%

[1] The area and rivers were estimated to be approximately 10 times larger than Mackay Whitsunday (MW) region. The MW values were used to represent this region.
[2] The area was estimated to be approximately three times the size of the Fitzroy Basin. The river length was adjusted to 8% of the area in line with the other regions. The Fitzroy Basin values were used to represent this region.

3.1 Survey collection and respondent characteristics

All surveys were collected between October and December 2005. Households were selected at random based on a cluster sampling technique and surveys were collected using a drop-off/pick-up format. A total of 1095 surveys were collected, with response rates of approximately 50% or higher[1]. Details are provided in Table 4.

Table 4. Survey response details

	Survey version	Returned completed	Approx response rate
Brisbane	Regional – S.E. Queensland	180	50%
	Statewide	171	
Toowoomba	Regional – Murray Darling	162	50%
	Statewide	140	
Mackay	Regional – Mackay Whitsunday	154	61%
	Statewide	141	
Rockhampton	Regional – Fitzroy Basin	147	72%
	Total	**1095**	

There was a similar spread in the age and gender of respondents across population samples, but differences in other characteristics. In terms of age, education and income, the sample population was broadly similar to that of the wider population (Table 5).

Table 5. Socio-demographic characteristics of respondents

	Brisbane	Toow'mba	Mackay	Rockh'ton
Average age	42 yrs	37 yrs	43 yrs	47 yrs
(Range)	(17-89)	(18-82)	(15-81)	(19-86)
ABS 2001 Census [1 2]	*43 yrs*	*44 yrs*	*42 yrs*	*45 yrs*
Gender (% female)	56%	54%	51%	50%
Have **dependent children**[3]	72%	59%	80%	77%
Education[3]				
Have non-school qualification	46.9%	56%	42.7%	46%
ABS 2001 Census [1]	*46%*	*43%*	*40%*	*41%*
Annual income (pre tax)[3]				
Missing values	13%	23%	14%	10%
Less than $70,000	77%	80%	60%	72%
ABS 2001 Census	*63%*	*72%*	*66%*	*71%*
Member of an **environmental organisation**	7%	6%	9%	7%
Family associated with **farming industry**[3]	19%	34%	33%	23%

[1] The ABS figures were calculated on the same age range as in the sample.

[2] T-tests were conducted to compare the sample data with ABS figures. There was only a significant difference between the ABS and sample age in Toowoomba.

[3] Population samples were cross-tabulated and there were significant differences (chi squared test) at the 1% level.

[1] Response rates varied within a location (e.g. from 49% to 80% in Mackay), according to suburb and collector.

Much of the difference between populations came from the Toowoomba sample, where the population sample was younger, less likely to have dependent children, better educated, and with lower income levels than in other populations (although a higher proportion did not report their income).

Only a small percentage of respondents were members of an environmental organisation. In contrast, a third of respondents in Toowoomba and Mackay, and a fifth in Brisbane and Rockhampton, were associated with the farming industry. This meant that more respondents were likely to be influenced by their association with the farming industry than would be influenced by their association with an environmental organisation.

4. Results

To analyse the results, multinomial logit models were developed using LIMDEP software. In the regional survey, four separate models were developed for each catchment area and then all samples were combined to provide a pooled model. A description of the variables used in the models is presented in Appendix 2 and full model details are presented in Appendix 3. In the statewide survey, three separate models were developed, one for each population sample and they were then combined in a pooled model (Appendix 4).

The valuation exercise was designed to elicit values for different environmental attributes and so interest in the applicability of the results for benefit transfer lay in a comparison of point estimates rather than value functions. Marginal values were estimated from the models by taking the ratio of each attribute coefficient and the cost coefficient. A Krinsky and Robb (1986) procedure was used to draw a vector of 1000 sets of parameters for each model and calculate the 95% confidence intervals. The results are presented in Table 6.

A key test for benefit transfer was to test if the models generated similar values for the same environmental improvements. Differences between marginal values were calculated by taking one vector of parameters from another. Following a Poe et al. (2001) procedure, this process was repeated 100 times by randomly reordering one vector of parameters. The 95% confidence interval was approximated by identifying the proportion of differences that fell below zero. A summary of the results is presented in Appendix 5. Exploring the differences or similarities in marginal values meant an assessment could be made of where values might be specific to a particular set of circumstances and where they may be applied more broadly in a benefit transfer. The valuation exercise was designed to determine the importance of differences in population and site, population, scope and scale. Each is examined below.

Table 6. Marginal values and 95% confidence intervals for the different models

	Soil	Water	Vegetation
	$ value of each 1% improvement		
Brisbane – South East Queensland			
Regional model	**3.05**	**3.42**	**3.01**
	(1.79 – 4.59)	(2.26 – 4.88)	(1.77 – 4.40)
Statewide model[1]	**5.34**	**4.99**	**7.69**
	(0.68 – 17.4)	(0.55 – 16.93)	(3.19 – 21.03)
Toowoomba – Murray Darling			
Regional model	**4.02**	**6.28**	**2.35**
	(2.51 – 5.91)	(4.77 – 8.80)	(0.94 – 4.01)
Mackay – Mackay Whitsunday			
Regional model	**4.60**	**7.82**	**2.42**
	(2.87 – 6.75)	(5.84 – 10.88)	(0.86 – 4.37)
Rockhampton – Fitzroy Basin			
Regional model	**3.70**	**6.69**	**4.48**
	(1.96 – 6.23)	(4.70 – 10.01)	(2.53 – 7.18)
Pooled models			
Regional model	**3.72**	**5.80**	**2.88**
	(2.94 – 4.57)	(4.98 – 6.88)	(2.10 – 3.71)
Statewide model[1]	**4.64**	**6.62**	**4.54**
	(2.64 – 7.09)	(4.68 – 9.43)	(2.66 – 7.03)

[1] Full details of the underlying models are presented in Windle and Rolfe (2006: Table 6.3).

4.1 Population and site differences

To determine if there were significant population and site differences, a comparison was made of the marginal values elicited in each of the four regional models. Three factors are considered. First, the confidence intervals overlap for all three attribute in all the four models (Table 6). The only exception is the confidence intervals for healthy waterways do not overlap for the Brisbane and Mackay models. Second, Poe et al. tests indicate that there was no significant difference between the marginal values in the different models (Appendix 5). The only exception was that the values Brisbane residents held for healthy waterways in South East Queensland were significantly different (lower) than each of the other three regional models. When all the responses were combined in a pooled model, the marginal values were the same as those determined from each of the separate regional models. The only significant differences were that Mackay residents had higher values for healthy waterways in their region and Brisbane respondents had lower values for waterways in their region[2]. The third consideration further reinforces the similarity in the different regional models as 'location' was not a significant variable if included in the pooled model (Appendix 3).

[2] It should be noted that at the time the survey was conducted there was not a critical water shortage in Brisbane as subsequently occurred.

4.2 Population differences

The similarity of results between the regional models suggests that different regional populations across regional centres hold similar values. This can be explored further by comparing the marginal values from each of the three regional samples in the statewide models. Again, there appears to be a large degree of consistency. Poe et al. tests indicate that values from the different population samples were all the same apart from Brisbane which had higher values for improvements in healthy vegetation compared with Toowoomba and Mackay (Appendix 5). When the responses were pooled, there was no significant difference between any values for improvements compared to each population sample model (Appendix 5), but the population sample was a significant influence on choice selection (Appendix 4).

4.3 Scope differences

Scope differences relate to the valuation context and whether values varied when valued in a regional context compared with the broader scope of the statewide valuation context. An accurate assessment of these differences requires an assessment of values from either the Brisbane or Toowoomba samples in the statewide model for improvements in South East Queensland and the Murray Darling respectively, compared with the relevant regional model[3]. Poe et al. tests indicate marginal values from the Brisbane statewide model were the same as those from the Brisbane regional model, for healthy soils and waterways but values were higher in the statewide model for healthy vegetation (Appendix 5).

A broader comparison using the pooled statewide model indicates there were no significant differences in the values for South East Queensland and the Brisbane regional model, or between the values for the Murray Darling and the Toowoomba regional model. Similarly, there were no differences in the values of the pooled statewide model compared with the pooled regional model.

4.4 Scale differences

There were two regional classifications in the statewide model that could be used to test scale differences. The GBR-Coastal classification was based on the Mackay Whitsunday region. It was described in a similar way, used the same resource condition levels, but was 10 times larger (Table 3). Similarly, the GBR-Inland classification was based on the Fitzroy Basin, but was three times larger.

Poe et al. tests reveal there were no significant differences in values elicited in the pooled statewide model for improvements in the GBR-Coastal classification and the values Mackay respondents had for improvements in the Mackay Whitsunday region in the regional model (Appendix 5). Similarly, values elicited in the pooled statewide model for improvements in the GBR-Inland classification were the same as values Rockhampton respondents held for improvements in the Fitzroy Basin region in the regional model. While these comparisons are not accurate tests of scale

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[3] There were insufficient responses to calculate significant marginal values for each regional classification from each sample in the statewide survey. The only sample where significant results were calculated was for Brisbane and South East Queensland.

differences, they do provide an indication that some similarities exist and that scale differences have only slight impacts on values.

4.5 Application

The valuation exercise was designed so the results would be applicable for use by NRM groups and other stakeholders, to improve their economic evaluation of priority investment projects. The similarity in results outlined above indicates that marginal values are quite robust and may be used for benefit transfer in a range of target sites in Queensland. Given that the values in the pooled regional models are mainly lower than in the separate regional models and the pooled statewide model, a conservative approach would be to use these values in a transfer to a target region. This would mean that across the State the following values could be applied:

- $3.70 for a 1% improvement in soil condition;
- $2.90 for a 1% improvement in healthy vegetation; and
- $5.80 for a 1% improvement in healthy waterways, with
  - a higher value of $7.80 needed in target sites in GBR coastal areas; and
  - a lower value of $3.40 in needed in target sites in South East Queensland.

5. Discussion and conclusion

While there is growing demand from policy makers and NRM managers for value estimates to help determine the benefits of achieving improved NRM outcomes, there is a shortage of relevant information. However, there are limited resources available to collect primary data and there is generally a lack of confidence in the reliability of the benefit transfer process. The valuation framework outlined in this paper was designed to overcome these problems by developing a database of value estimates that could be applied to a range of target site conditions at the state level. The framework involved five separate valuation surveys designed to collect a range of estimates that could account for differences in population, site, scope and scale while ensuring other factors such as the policy and institution context and survey design features remained constant. This would both address the need for more primary source data and improve the reliability of the benefit transfer process by limiting the potential differences between source and target site valuation characteristics.

The results suggest that in Queensland there is substantial consistency in community values for improvements in soil, water and vegetation condition across populations and across regions where different NRM issues are of concern. In particular, the results from the pooled models, produced value estimates which were not significantly different from the more specific regional model estimates. This means it would be appropriate to apply these more generic estimates in situations where a target site does not match one of the specific regional source sites.

Developing a combination of inter-related regional and statewide surveys has built on the earlier work of van Bueren and Bennett (2004) and Morrison and Bennett (2004) to develop a framework for benefit transfer valuation studies. There were relatively few differences in marginal values obtained from the various models in the valuation exercise outlined in this paper and the results are more consistent than these earlier studies. One difference between this study and the two earlier ones was the use of a labelled choice set format in the statewide survey which allowed the valuation scenario to be framed in terms of a composite of different regions. In contrast, the national and statewide surveys in the van Bueren and Bennett (2004) and Morrison and Bennett (2004) studies respectively, presented information at an aggregate level. While there are some advantages of using a labelled choice format, it does make the choice task more complex. There was some evidence that this had affected responses (more respondents favoured selection of the status quo option), in Toowoomba, but it was not the case for Brisbane or Mackay respondents (Windle and Rolfe 2006:34). The main disadvantage of using a labelled model in the statewide survey was the need for a greater number of survey responses in order to provide statistically robust results that would explain the preferences from each population sample for attribute changes in each regional classification.

There was some evidence that the marginal values elicited in the statewide survey were higher than those from the regional surveys (Table 6), although there was no statistical difference between them. This was in contrast to the results of van Bueren and Bennett (2004) where values for national benefits were lower than for regional benefits. Insights from economic theory would also support the expectation for WTP estimates to be lower in the statewide models compared with regional models because of the availability of a wider range of substitutes. It is possible that when presented with a statewide valuation as a composite of regions, respondents elevated the relative importance of the environmental issues, which led some people to increase rather than decrease their WTP.

There was also some evidence that residents in the highly urbanised capital city have different values for environmental improvements than residents in more regionalised communities. Brisbane respondents had lower values for healthy waterways in their own catchment area and higher values for vegetation across the State. There were no differences in the values for good soil condition. Other studies have found no difference in values for environmental improvements between regional and city households (van Bueren and Bennett 2004; Rolfe and Windle 2006), but neither of these valuations assessed city household values for improvements in their own urban catchment.

The results of this study indicate that it is possible to design an evaluation exercise that will provide a database of locally determined value estimates that are broadly relevant and suitable for benefit transfer at the state level. This is an important finding because it helps to overcome some of the reliability issues generally associated with the benefit transfer process. Developing a database of values for future application provides more realistic and more reliable value estimates for benefit transfer than having to use other more limited source data. However, the environmental improvements outlined in the valuation surveys were described in very broad terms. This has the advantage of generating broad-based value estimates that may be applied in a wide range of circumstances, but the challenge is then to generate value estimates for more precisely defined resource condition improvements.

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Appendix 1. Example choice sets

Appendix 1a. Example choice set for the regional model

5	**Question 5:** Carefully consider each of the following three options. Suppose options A, B and C were the only options available, which would you choose?			
How much I pay each year	Soils in good condition	Waterways in good health	Healthy vegetation	I would choose
Current condition	6,000 sq km 65%	420 km 60%	6,000 sq km 65%	
	Condition in 15 years time – Options A,B, and C			
Option A				
$0	50%	40%	45%	☐
Option B				
$100	65% (15% better)	55% (15% better)	55% (10% better)	☐
Option C				
$50	55% (5% better)	55% (15% better)	60% (15% better)	☐

Appendix 1b. Example choice set for the statewide model

Qu 4. Carefully consider each of the following 5 options. Suppose these were the only options available, which would you choose?

Please indicate which option you prefer ☒ mark one box only

☐ I prefer this option	Murray Darling	
In 15 years time	Expected	Option
Soils in good condition	50% or 157,000 sq km	5% better
Waterways in good health	40% or 8,000 km	5% better
Healthy vegetation	25% or 78,500 sq km	10% better
How much I pay each year		$100

☐ I prefer this option	Great Barrier Reef – Coastal	
In 15 years time	Expected	Option
Soils in good condition	50% or 45,000 sq km	5% better
Waterways in good health	40% or 2,800 km	10% better
Healthy vegetation	45% or 40,500 sq km	5% better
How much I pay each year		$100

☐ I prefer this option	South East Queensland	
In 15 years time	Expected	Option
Soils in good condition	45% or 10,500 sq km	5% better
Waterways in good health	35% or 700 km	10% better
Healthy vegetation	25% or 6,000 sq km	5% better
How much I pay each year		$20

☐ I prefer this option	Great Barrier Reef – Inland	
In 15 years time	Expected	Option
Soils in good condition	50% or 215,000 sq km	15% better
Waterways in good health	30% or 10,200 km	10% better
Healthy vegetation	25% or 107,500 sq km	10% better
How much I pay each year		$50

☐ I prefer this option	Keep current situation	How much I pay each year		$0

Appendix 2. Description of the variables used in the MNL models

Variable	Description
Cost	The annual amount that households would pay to fund improvements over a 15 year period
Soil	Area of soil in good condition
Waterways	Kilometres of waterways in good health
Vegetation	Area of vegetation in good health
ASC	Alternate Specific Constant which reflects the influence of all other factors on choice of improvement options
Socio-demographic variables	
Age	Age of respondent (in years)
Gender	Male (1) Female (2)
Children	Has dependent children (1) Does not have dependent children (2)
Education	Education ranges from – primary education (1) to tertiary degree (5)
Income	Ranges from "under $6,000 (1) to "more than $100,000 (7)
Population	Brisbane = 1; Toowoomba = 2 ; Mackay = 3; Rockhampton = 4
Environmental opinions	
Env condition	Think environmental condition in last 10 years has "declined" (-1); "improved" (1); "stayed same/don't know" (0)
Env favour	In project proposals – "favour environment more often" (1); "favour development more often" (-1); "favour environmental and development equally" (0).
Env knowledge	Knowledge of the issues addressed in the survey. Self rating from 1 (low) to 10 (high)
Choice selection variables	
Confidence	Confidence that made the correct choice – from "very confident" (1) to "not very confident" (4)
Preference	Did respondent have a preference for the different attributes? Yes (1); No (-1); not sure (0)
Understood	Understood the information in the survey: "strongly agree" (1) to "strongly disagree" (5)
More Info	Needed more information than was provided: "strongly agree" (1) to "strongly disagree" (5)
Confused	Found answering the choice qus confusing: "strongly agree" (1) to "strongly disagree" (5)
GBR values variables: Reasons for supporting more environmental protection of the GBR	If ranked 1 or 2 (most) important (1); If ranked 3,4 or 5 (least) important (0)
Use	I want to use them for recreation
Option	I may want to use them in the future
Bequest	We should protect them for future generations
Existence	We need to protect plants, birds, and water life
Quasi option	We should be careful because the impacts of current practices may be poorly understood

Appendix 3. Regional multinomial logit models

Population Region	Pooled model All combined		Brisbane S.E Queensland		Toowoomba Murray Darling		Mackay Mackay/Whitsunday		Rockhampton Fitzroy	
	Coefficient	St Error	Coefficient	St Error	Coefficient	St Error	Coefficient	St Error	Coefficient	St Error
Cost	-0.0178 ***	0.0012	-0.0214 ***	0.0024	-0.0186 ***	0.0024	-0.0182 ***	0.0026	-0.0155 ***	0.0025
Soil	0.0663 ***	0.0070	0.0652 ***	0.0132	0.0746 ***	0.0141	0.0839 ***	0.0154	0.0575 ***	0.0147
Water	0.1032 ***	0.0064	0.0730 ***	0.0121	0.1167 ***	0.1167	0.1427 ***	0.0141	0.1038 ***	0.0139
Vegetation	0.0512 ***	0.0067	0.0642 ***	0.0130	0.0437 ***	0.0133	0.0441 ***	0.0146	0.0695 ***	0.0147
ASC	-0.7455 ***	0.0749	-0.9516 ***	0.1441	-0.8223 ***	0.1489	-0.6147 ***	0.1597	-0.7403 ***	0.1628
Socio-demographic variables										
Age	0.0008	0.0030	0.0073	0.0060	0.0039	0.0071	-0.0033	0.0075	-0.0116	0.0079
Gender	-0.2554 ***	0.0853	-0.6083 ***	0.1662	-0.5642 ***	0.1992	-0.9260 ***	0.2179	0.5829 ***	0.2110
Children	-0.6280 ***	0.1005	0.2639	0.1925	-1.3254 ***	0.2177	-1.0454 ***	0.2971	-0.7478 ***	0.2585
Education	0.2746 ***	0.0404	0.1541 *	0.0849	0.4457 ***	0.0947	0.3924 ***	0.0947	0.1741 *	0.0892
Environmental opinions										
Env condition	-0.0834	0.0621	0.1115	0.1272	0.0896	0.1413	-0.1279	0.1488	-0.0789	0.1447
Env favour	0.4094 ***	0.0736	0.7605 ***	0.1662	0.5813 ***	0.1603	-0.0210	0.1747	0.9614 ***	0.1911
Env knowledge	-0.0328	0.0244	-0.1108 **	0.0488	0.0445	0.0536	-0.2189 ***	0.0697	0.0587	0.0670
Choice selection variables										
Confidence	-0.2946 ***	0.0553	-0.1272	0.1116	-0.0174	0.1274	-0.2264	0.1436	-0.9050 ***	0.1317
Preference	0.5410 ***	0.0493	0.9243 ***	0.0983	0.4013 ***	0.1132	0.7600 ***	0.1303	0.3115 ***	0.1179
Understand	-0.0868 **	0.0420	-0.3129 ***	0.0776	-0.0601	0.0926	0.3411 **	0.1335	-0.0599	0.1120
More info	0.0379	0.0474	-0.1408	0.0969	0.1206	0.0984	0.3675 ***	0.1284	0.1627	0.1183
Confused	-0.0913 *	0.0482	0.1698 *	0.1002	-0.2284 **	0.1122	-0.3419 ***	0.1207	0.1539	0.1166
Land and water values variables										
Use	-0.1049	0.1032	0.0866	0.1933	-0.8129 ***	0.2528	0.6499 **	0.2568	0.3437	0.2635
Option	-0.3754 ***	0.1144	-0.4223 **	0.2110	0.1465	0.3018	-0.8124 ***	0.2868	-1.1272 ***	0.2889
Bequest	0.7605 ***	0.1396	1.0504 ***	0.2176	-0.6159	0.4635	1.1207 ***	0.4011	0.8009 **	0.4036
Existence	-0.1026	0.1404	-0.4926 *	0.2640	1.6826 ***	0.2888	-0.4598	0.3991	-1.5023 ***	0.3988
Quasi option	0.2642 ***	0.1012	0.2425	0.2099	0.1097	0.2211	0.8885 ***	0.2647	0.8820 ***	0.2549
Model statistics										
Log Likelihood	-3246.92		-914.14		-790.85		-683.16		-682.48	
Adj Rsq	0.15097		0.15007		0.19025		0.23324		0.19218	
Observations	3492		990		900		822		780	

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

Note: When 'Income' was included as a variable in the models it was only significant in the Toowoomba and Mackay samples and only at the 5% level. When regional 'location' was included as a variable in the pooled model it was not significant.

Appendix 4. Multinomial logit models for the statewide survey

	ALL		BRISBANE		TOOWOOMBA		MACKAY	
	Coefficient	S.Error	Coefficient	S.Error	Coefficient	S.Error	Coefficient	S.Error
All regions								
COST	-0.0073***	0.0009	-0.0081***	0.0015	-0.0064***	0.0016	-0.0074***	0.0015
SOIL	0.0334***	0.0068	0.0448***	0.0116	0.0306**	0.0127	0.0276**	0.0119
WATER	0.0489***	0.0068	0.0595***	0.0114	0.0445***	0.0126	0.0481***	0.0118
VEG	0.0335***	0.0068	0.0537***	0.0114	0.0232*	0.0128	0.0228*	0.0120
Murray Darling								
ASC-MD	-2.8651***	0.4483	-2.8042***	0.7350	-2.2914***	0.7190	-2.4449***	0.7718
AGE	0.0058	0.0060	0.0053	0.0098	0.0161	0.0139	0.0087	0.0111
GENDER	-0.3837***	0.1377	-0.6601**	0.2595	-0.7705***	0.2224	0.6314**	0.2764
CHILD	-0.6163***	0.1706	-0.5507	0.3545	-0.4928*	0.2817	-0.4977	0.3359
EDUCAT	0.3681***	0.0666	0.2693**	0.1184	0.4318***	0.1231	0.3659***	0.1263
INCOME	0.0815	0.0519	0.0948	0.0877	0.0143	0.1167	-0.0040	0.0972
POPULATION	0.2226***	0.0858						
Great Barrier Reef - Coastal								
ASC-GBRC	-2.9365***	0.4282	-2.4926***	0.6668	-1.0885	0.8059	-0.7852	0.6323
AGE	0.0063	0.0056	0.0047	0.0089	0.0056	0.0160	-0.0019	0.0091
GENDER	-0.3097**	0.1298	-0.5219**	0.2283	-0.1721	0.2631	0.0244	0.2195
CHILD	-0.2562	0.1640	-0.6632**	0.3155	0.1358	0.3333	-0.5058*	0.2796
EDUCAT	0.1884***	0.0620	0.2516**	0.1065	0.2600*	0.1404	0.2965***	0.1026
INCOME	0.1030**	0.0490	0.1432*	0.0787	-0.3162**	0.1433	0.0442	0.0772
POPULATION	0.4969***	0.0806						
South East Queensland								
ASC-SEQ	-0.8618*	0.4251	-2.5684***	0.6089	-1.0477	0.7305	0.4271	0.7881
AGE	0.0005	0.0056	0.0105	0.0079	0.0279*	0.0135	-0.0289**	0.0133
GENDER	-0.3435***	0.1308	-0.0864	0.1987	-0.8036***	0.2369	-0.1708	0.3034
CHILD	-0.2361	0.1670	-0.9222***	0.2807	0.2221	0.3010	-0.3449	0.3639
EDUCAT	0.2169***	0.0629	0.1272	0.0939	0.4933***	0.1266	0.2148	0.1451
INCOME	0.0407	0.0490	0.3227***	0.0711	-0.5612***	0.1294	-0.2010*	0.1078
POPULATION	-0.3961***	0.0849						
Great Barrier Reef - Inland								
ASC-GBRI	-2.7565***	0.4539	-2.4703***	0.6958	-1.8323**	0.8705	-0.7778***	0.6683
AGE	0.0008	0.0062	0.0018	0.0095	0.0142	0.0177	-0.0125***	0.0102
GENDER	-0.4656***	0.1394	-0.3462	0.2398	-0.7627***	0.2848	-0.1113***	0.2354
CHILD	-0.5758***	0.1721	-1.2891***	0.3175	-0.5354	0.3646	-0.5724*	0.2940
EDUCAT	0.1791***	0.0666	0.1556	0.1141	0.3020**	0.1536	0.3227***	0.1104
INCOME	0.1764***	0.0528	0.2833***	0.0840	-0.1554	0.1479	0.0549	0.0839
POPULATION	0.3669***	0.0865						
Model statistics								
No of obs	2664 bad 408		996 bad 162		840 bad 150		828 bad 96	
Log L	-3413.716		-1222.041		-1009.745		-1069.557	
Adj R sqrd	0.05647		0.08187		0.08142		0.08337	
Chi sqrd (dof)	396.230 (28)		152.716 (24)		123.172 (24)		100.036 (24)	

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

Appendix 5. Similarities in marginal values at the 95% level of significance

Model 1	Model 2	Vegetation	Waterways	Soil
Regional	**Regional**			
Pooled	South East Qld	✓	x	✓
Pooled	Murray Darling	✓	✓	✓
Pooled	Mackay Whitsunday	✓	x	✓
Pooled	Fitzroy Basin	✓	✓	✓
South East Qld	Murray Darling	✓	x	✓
South East Qld	Mackay Whitsunday	✓	x	✓
South East Qld	Fitzroy Basin	✓	x	✓
Murray Darling	Mackay Whitsunday	✓	✓	✓
Murray Darling	Fitzroy Basin	✓	✓	✓
Mackay Whitsunday	Fitzroy Basin	✓	✓	✓
Statewide	**Statewide**	✓	✓	✓
Pooled	Brisbane	✓	✓	✓
Pooled	Toowoomba	✓	✓	✓
Pooled	Mackay	✓	✓	✓
Brisbane	Toowoomba	x	✓	✓
Brisbane	Mackay	x	✓	✓
Toowoomba	Mackay	✓	✓	✓
Statewide – pooled	**Regional**			
All regions	Regional – pooled	✓	✓	✓
Murray Darling	Toowoomba for Murray D	✓	✓	✓
GBR - Coast	Mackay for Mky/whit	✓	✓	✓
South East Qld	Brisbane for S.E. Qld	✓	✓	✓
GBR-Inland	Rockhampton for Fitzroy B	✓	✓	✓
Statewide - Brisbane	**Regional - Brisbane**			
State – S.E. Qld	Regional S.E. Qld	x	✓	✓