Non market values for improved NRM outcomes in Queensland

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Research Report 2 in the non-market valuation component of AGSIP Project #13

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This report represents the provisional findings of the AGSIP #13 research project "Economics and Natural Resource Management in Queensland".

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Executive summary

1. All Regional NRM groups in Queensland have developed NRM plans that outline and prioritise targets and actions to achieve better NRM outcomes. Achieving these outcomes will involve costs and benefits at both the public and private level, which means some kind of tradeoff between them will have to be made. The aim of this research project is to assess some of the public benefits associated with improved NRM outcomes across Queensland.

2. The results will provide information to help NRM groups apply economic tools and analysis when determining their priorities for different projects and NRM outcomes in their region. Having information about the benefits associated with better NRM outcomes, means they can then be compared with the associated costs. Applying a cost-benefit assessment will provide NRM groups with additional information that can be used to help determine priorities for their limited investment options.

3. Three choice modelling valuation surveys were conducted in Queensland in 2005 to assess the values that different population groups hold for improved NRM outcomes in different regional areas. The valuation exercise focused on improvements in soil condition, healthy waterways and healthy vegetation.

4. Careful attention was paid to the design of the different surveys. The design was developed and pre-tested at different community focus groups. The design process has been described in Windle (2005).

5. Surveys were conducted in four separate locations: Brisbane, Toowoomba, Mackay and Rockhampton. Households were selected at random, using a drop-off/pick up collection technique. The response rates were high and ranged from 50% in Brisbane and Toowoomba to over 70% in Rockhampton. A total of 1314 surveys were collected from the four locations between October and December 2005.

6. A range of information was collected in the choice modelling surveys, including details of respondents' values and preferences and also information about their opinions and attitudes to NRM issues.

7. Values for environmental assets and services can be categorized into "use" and "non-use" values. Respondents indicated that they rated non-use values for the relevant attributes as more important than use values.

8. A range of socio-demographic characteristics were found to influence choice selection in different choice models. However, the influence of these factors was not consistent and they are not a useful explanator of value preferences.

9. There were three main survey designs and nine separate survey samples which meant a range of models were developed. This provided a robust data set from which a comprehensive assessment of values for NRM outcomes could be determined.

10. Details of the three surveys and target population samples are outlined in the two tables below.

Table 1.1 Details of population samples for each survey

Population sample	Brisbane	Toowoomba	Mackay	Rockhampton
Regional survey	✓	✓	✓	✓
Statewide survey	✓	✓	✓	
Fitzroy longitudinal survey	✓			✓

Table 1.2 Survey details

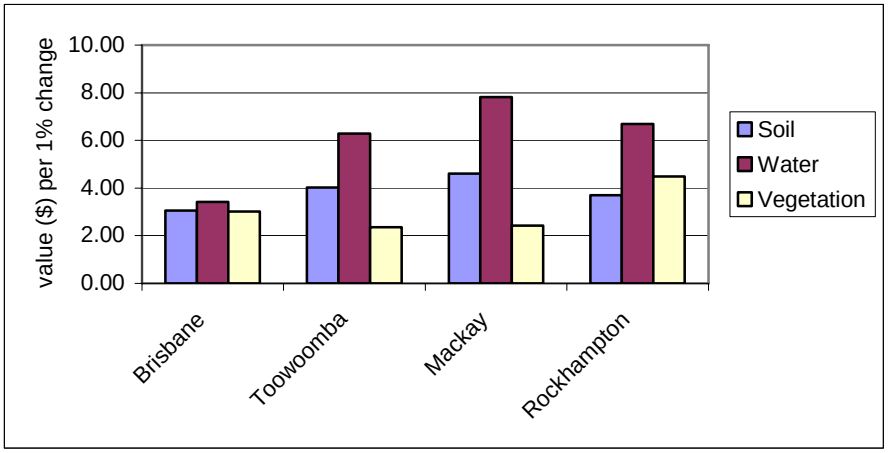
Survey	Region/catchment area	Population sampled	NRM improvements	Comment
Regional survey Four separate regional surveys	S.E. Queensland Murray Darling Mackay Whitsunday Fitzroy	Brisbane Toowoomba Mackay Rockhampton	Soil Water Vegetation	Each population sample completed a survey specific to their region
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 receive the same survey
Fitzroy longitudinal survey One regional survey	Fitzroy	Brisbane Rockhampton	Water Vegetation	Both populations completed the same survey

Regional survey

11. The regional survey assessed values that local residents held for their own region. This involved an assessment of:
    - Brisbane household values for improved NRM outcomes in the South East Queensland region;
    - Toowoomba household values for improved NRM outcomes in the Murray Darling region;
    - Mackay household values for improved NRM outcomes in the Mackay Whitsunday region; and
    - Rockhampton household values for improved NRM outcomes in the Fitzroy region.

12. Marginal values (the value of a one unit change) for different regional NRM improvements are outlined in the following diagram.

Figure 5.3 Marginal values for improvements in NRM outcomes



13. Overall, when all regional samples were combined the following values were calculated:
    - A 1% improvement in **soil condition** was valued at **$3.72** per household;
    - A 1% improvement in healthy **vegetation** was valued at **$2.88** per household; and
    - A 1% improvement in healthy **waterways** was valued at **$5.80** per household.

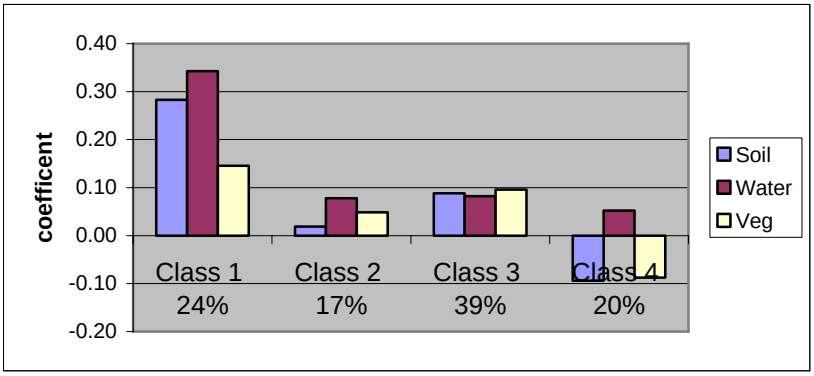
14. The values from the combined regional samples are robust and are not significantly different from values determined in the separate regional models (apart from Brisbane household values for healthy waterways in South East Queensland).

15. In the regional surveys, respondents' preferences can be classified into four distinct classes that are not location specific:
    Class 1: Respondents with very strong values for all attributes, especially soil and water;
    Class 2: Respondents without very strong preferences, but with a distinct preference for the different attributes. Improvements in healthy waterways were most preferred, then healthy vegetation and then good soil condition;
    Class 3: Respondents with stronger preferences than the second class, but no real preference between attributes; and
    Class 4: Respondents with positive values for improvements in healthy waterways, but negative values for soil and vegetation improvements.

The highest proportion of respondents was in Class 3 (39%).

The classes are summarised below

Figure 5.2 Coefficient values for attributes by different respondent classes



Statewide survey

16. The statewide survey assessed the values that residents in Brisbane, Toowoomba and Mackay held for improved NRM outcomes in different regions but within a statewide context. Four regions were considered:
    - Murray Darling;
    - South East Queensland;
    - Great Barrier Reef – Coastal; and
    - Great Barrier Reef – Inland.

17. Respondents in the statewide survey appeared to be using cues to help process information and assist in choice selection. Selection was not necessarily based on improvements in specific attributes.

18. In a statewide context, there was little statistical difference between marginal values for environmental resources across regions and populations. Most of the difference lay in lower values in Brisbane for healthy waterways in South East Queensland.

19. When populations and regions were grouped together (statewide and regional models) there was no significant difference between the marginal values for different resource improvements.

Fitzroy longitudinal survey

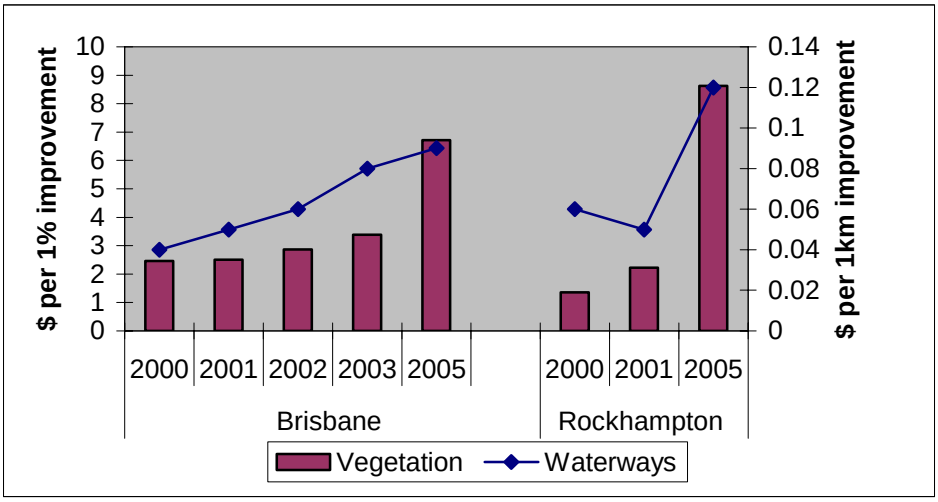
20. The Fitzroy longitudinal survey assessed the values that residents in Brisbane and Rockhampton held for improved NRM outcomes in the Fitzroy Basin. This repeated a survey that had been conducted over a number of years and provides valuable information on how values may change over time. Three environmental and one social attribute were considered:
    - healthy vegetation;
    - healthy waterways;
    - people leaving country areas; and
    - health of the river estuary.

21. There was no difference between Brisbane (remote population) and Rockhampton (local population) respondents' marginal values for changes in the attributes outlined above, apart from values for the health of the river estuary.

22. There has been a sharp increase in values of both Brisbane and Rockhampton households for healthy vegetation in the Fitzroy in recent years.

23. Since 2001, the marginal values of Brisbane and Rockhampton households for improvements in healthy waterways in the Fitzroy have been statistically consistent. However, there does appear to be an upward trend in values as the following diagram suggests.

Figure 7.5 Values for healthy waterways and vegetation in the Fitzroy over time



Overall results

24. The marginal values from the regional and statewide surveys are summarised in the following table.

	Soil	Water	Vegetation
Regional surveys	value of each 1% improvement		
Brisbane – South East Queensland	$3.05	$3.42	$3.01
Toowoomba – Murray Darling	$4.02	$6.28	$2.35
Mackay – Mackay Whitsunday	$4.60	$7.82	$2.42
Rockhampton - Fitzroy	$3.70	$6.69	$4.48
All populations combined			
Statewide survey	$4.64	$6.62	$4.54
Regional survey	$3.72	$5.80	$2.88

25. One of the most important results from a technical perspective is that the results have shown that marginal values remain the same when the valuation context changes.
    a. **Values remain the same when the valuation is framed in terms of a single region or as multiple regions within a statewide context**. For example, the marginal values for the all combined population samples in the statewide model are the same as regional specific models.

b. **Values remain the same when the region being valued is described in very specific or very general terms**. For example, the marginal values (all population samples) for the GBR – Coast and GBR – Inland in the statewide model were the same as Mackay values for the Mackay Whitsunday region and Rockhampton values for the Fitzroy in the regional models.
c. **Values for healthy waterways remain consistent when collected over time**, **but not for vegetation condition**. For example, marginal values of Brisbane and Rockhampton respondents for improvements in the health of waterways in the Fitzroy Basin have remained consistent over the last few years, although some upward trend is apparent. Values for healthy vegetation have shown a sharp increase in recent years.

26. One of the aims of the AGSIP #13 project is to generate some indicative values for better NRM outcomes in Queensland catchments that can be subsequently adopted by different regional groups. The survey results indicate that there are significant differences in the preferences and opinions of respondents in different locations, but little difference in their marginal values for different NRM outcomes. The underlying differences in value are not location specific (see point 15 above). The marginal values outlined in point 13 above are robust enough to be transferred and applied in other regions of Queensland. However, before these values are extrapolated there are various issues to consider. These are outlined in the third report which provides a practical guide on how these results may be used and applied.

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Acknowledgements

I gratefully acknowledge the contribution of Associate Professor John Rolfe who provided the experimental design for all the surveys. He also provided valuable comments and feedback in the survey design process, and in reviewing the final report.

1. Introduction

The National Action Plan for Salinity and Water Quality (NAP) was designed to provide improved natural resource management (NRM) outcomes by better targeting resources and solutions at the regional level. As part of the process, regional NRM groups have developed NRM plans that identify three tiers of targets (aspirational targets, achievable resource condition targets and management action targets) aimed at protecting and enhancing catchment resource conditions and assets. These targets have been developed through a process of engagement with a wide range of stakeholders, largely drawn from within each region. While the nomination of these targets and actions often involved some internal assessment of their net desirability, there is no guarantee that the targets and actions that have been nominated are agreed to, or are in the best interests of, all members of society. Achieving better NRM outcomes will involve costs and benefits at both the public and private level, which means that some kind of tradeoff between them will have to be made.

To support the NRM plans, each group has a Regional Investment Strategy (RIS) which outlines priority areas for funding allocation. In developing the RIS the regional groups must provide evidence that the social and economic impacts of the proposed management action targets have been considered. These checks are important to ensure that chosen targets do not have large hidden costs, or adversely impact on one particular section of the community. To adequately assess the tradeoffs, it is important that the costs and benefits that accrue to different sectors of the community can be identified and assessed.

The AGSIP #13 project has been funded under the NAP State-level Investment Program – Agriculture (AGSIP), and aims to provide resource economics support for NRM managers to assist in the assessment of the costs and benefits of achieving improved NRM outcomes. One component of AGSIP #13 is aimed at identifying the on-farm costs to landholders (private costs) of changing management practices to achieve better NRM outcomes. Another component of the project is to assess the public preferences and values for these improved NRM outcomes (public benefits) in different regions of Queensland. This report focuses on the latter.

Economists generally assess the dollar value of goods and services by their market value. For market goods, people can indicate their "willingness-to-pay" for something by accepting or rejecting the market price. The benefits of environmental services or better NRM outcomes are hard to assess, because there is no market in which their price is revealed. In the absence of market-based information, there are a range of specialized non-market valuation techniques that can be applied to make such assessments.

In this report the results of three separate non-market valuation surveys are reported. The main aim of the surveys was to assess community values (public benefits) for improved NRM outcomes across Queensland and to determine if priorities vary across different regional communities. An assessment was also made of the extent to which community values for NRM outcomes may vary over time. The results will provide information to help regional NRM groups determine priorities for different NRM outcomes in their regions.

The process of designing these surveys has been outlined in Windle (2005). A third report will follow that will provide a more practical application of these results.

1.1 Research plan

Four regional catchment areas were chosen to provide a broad cross-section of the NRM regions in Queensland and the main population centres in these regions were used as population samples for the different surveys.

- South East Queensland (Brisbane)
- The Murray Darling (Toowoomba)
- Mackay Whitsunday (Mackay)
- Fitzroy Basin (Rockhampton)

There were three main survey designs and nine separate survey samples (Table 1.1).

Table 1.1 Details of population samples for each survey

Population sample	Brisbane	Toowoomba	Mackay	Rockhampton
Regional survey	✓	✓	✓	✓
Statewide survey	✓	✓	✓	
Fitzroy longitudinal survey	✓			✓

The **regional survey** focused on assessing community preferences in a specific regional context. Values for improvements in **soil, water** and **vegetation** condition were assessed. Four separate surveys were conducted in four separate regions (Table 1.2).

Table 1.2 Survey details

Survey	Region/catchment area	Population sampled	NRM improvements	Comment
Regional survey Four separate regional surveys	S.E. Queensland Murray Darling Mackay Whitsunday Fitzroy	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 receive the same survey
Fitzroy longitudinal survey One regional survey	Fitzroy	Brisbane Rockhampton	Water Vegetation	Both populations completed the same survey

* Resource condition details from the Mackay Whitsunday and Fitzroy regional surveys were used to represent the GBR - coastal and GBR - inland areas respectively. Full details are provided in Windle (2005).

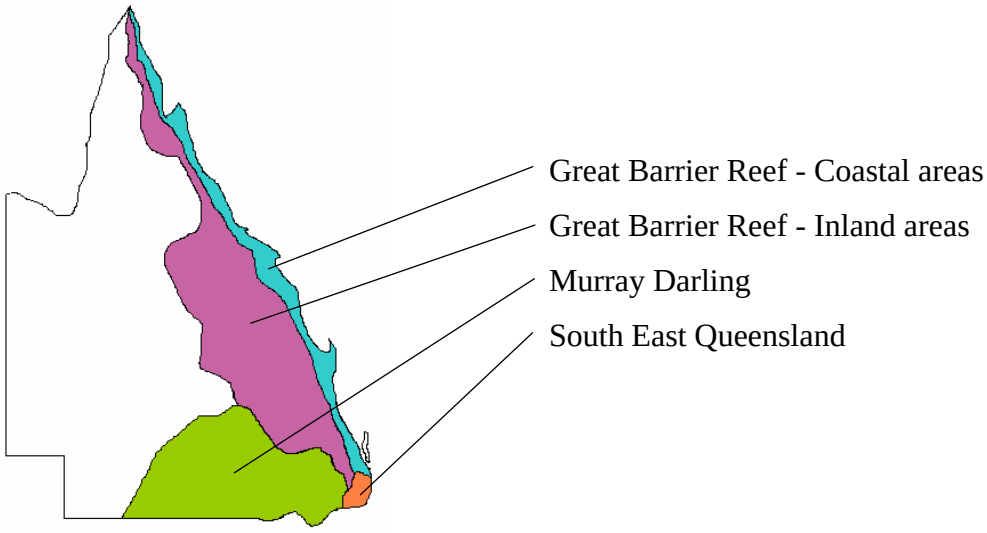
The results of the regional survey provide an indication of the difference in values for NRM outcomes in different regions, based on the following:

a. **Brisbane** households' values for improvements in the **South East Queensland** region;

b. **Toowoomba** households' values for improvements in the **Murray Darling** region;
c. **Mackay** households' values for improvements in the **Mackay Whitsunday** region; and
d. **Rockhampton** households' values for improvements in the **Fitzroy** region.

The **statewide survey** focused on values for the same NRM outcomes in different regions, but was framed in a statewide context. Respondents were asked to indicate their preferences for improvements in **soil, water** and **vegetation** condition in different regions across the State (Table 1.2). In this survey, four regional areas were included in the one survey (Figure 1.1). Two of the regions in this survey were the same (including resource condition details) as those in the regional survey – South East Queensland and the Murray Darling. The other two regions, Great Barrier Reef - Coastal areas and Great Barrier Reef – Inland areas were more broadly defined, but resource condition information was based on the Mackay Whitsunday and Fitzroy regions respectively.

Figure 1.1 Four regional classifications in the statewide survey



In the statewide survey, household values from **Brisbane, Toowoomba** and **Mackay** populations were assessed for regional improvements across the state. The results provide an indication of how values for NRM improvements in a specific region may change when different regions are considered in a statewide context.

The **Fitzroy longitudinal survey** had three main components.

1. An assessment of how the values for one region may vary between the local residents and those in a remote location. **Rockhampton** and **Brisbane** household values were assessed for NRM improvements in the Fitzroy.
2. The same survey had been conducted in previous years so the results provide an indication of how values may have changed over time.

3. The survey included a social impact tradeoff and the results provide an indication of how values for NRM improvements may change given a different valuation context.

This report is structured as follows. In the next section a brief overview is provided of non-market valuation techniques and why the choice modelling technique was selected. The third section provides a brief outline of the survey collection details and the main demographic details for the different populations sampled. In section four, an overview of respondents' opinions and attitudes gathered in the different surveys is presented. The results from the first, second and third surveys are presented in sections five, six and seven. In the last section, the results from the three surveys are combined and the elicited values for NRM outcomes across the state are discussed.

2. Non-market valuation

Economists have developed what is known as non-market valuation techniques that can be used to assess environmental values. These techniques can generally be grouped as surrogate market or revealed preference approaches and simulated/hypothetical market or stated preference approaches. In revealed preference techniques, such as the travel cost method or the hedonic pricing method, an alternative (surrogate) market is used to provide information about value. For example, the value of a sea view may be assessed by the premiums on house prices with such a view (hedonic pricing). Another example might be assessing the value of a National Park by using the costs people incur in visiting a particular park (travel costs) to indicate the value they have. Revealed preference techniques are able to assess what economists refer to as "use" values. However, values for environmental assets and services can be classified into two distinct categories; "use" and "non-use" values. Non-use values refer to the values people hold for an environmental good without actually using it. For example, many people value the Great Barrier Reef even though they might never go there and do not actually use it. Non-use values have been shown to be very important components of value for environmental assets and for some assets non-use values may be more important than use value.

Distinguishing values into use and non-use categories has important implications because it means that the benefits from improved NRM outcomes in a particular region will accrue to people living outside that region, as well as those living within the region. This in turn implies that any estimation of the values (public benefits) of improved NRM outcomes will have to include an assessment of values held by both local and remote communities.

The second group of valuation techniques, stated preference methods, are required to assess non-use values (use values can also be determined). In the absence of a surrogate market, a hypothetical market is created in which people are asked to state their preferences. There are two principal stated preference valuation techniques; the contingent valuation method and choice modelling (also known as choice experiments and conjoint analysis). The contingent valuation method has been the most commonly applied stated preference technique, and has been subject to considerable scrutiny and debate about the various aspects of the methodology. However, a legal precedent was set when non-use values, assessed using the contingent valuation method, were included in the damage assessment of the Exxon Valdez oil spill in Alaska in 1989.

Community values for environmental improvements will typically include both use and non-use values. While some use values can be assessed from market data, a stated preference technique is the appropriate valuation tool for estimating non-use values. Both the contingent valuation method and choice modelling valuation techniques can be applied in a questionnaire format in which details of the simulated market are presented. In this study, choice modelling was selected in preference to the contingent valuation method because it has the ability to disaggregate environmental improvements into underlying attributes, such as improvements in soil condition, water quality and vegetation condition. Being able to value components of NRM improvements is likely to be more useful to NRM groups than providing overall values of improvements.

2.1 The choice modelling valuation technique

A choice modelling valuation exercise is delivered in a questionnaire survey, and involves asking survey respondents to make a series of choices about alternative options for environmental management. In the questionnaire respondents are presented with a series of choice sets, with each set including a number of profiles describing the alternatives on offer. One of the profiles describes a current or future status quo option, and remains constant between the choice sets. The other profiles vary, so that respondents are being asked to make a series of similar, but different choices.

The profiles are made up of a number of attributes that describe the environmental issue in question. For example, profiles about improved NRM outcomes might be described in terms of the health of the waterways, the amount of healthy vegetation in the region, and the proportion of soil in good condition. To generate differences between profiles, these attributes are allowed to vary across a number of different levels (e.g. 30%, 40% or 50% of healthy vegetation). These profiles then represent different options for improved NRM outcomes.

The choice information is analysed using a logistic regression model. The probability that a respondent would choose a particular option can be related to the levels of each attribute making up the profile (and the alternative profiles on offer), the socio-economic characteristics of the respondent, and their opinions and attitudes about related issues.

3. Survey collection and respondent characteristics

The results in this report are based on nine separate choice modelling surveys that were collected from four separate populations 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 collection technique A total of 1314 surveys were collected, with response rates of approximately 50% or higher[1]. Details are provided in Table 3.1.

Table 3.1 Survey response details

	Survey version	Returned completed	Approx response rate
Brisbane			50%
	Regional – S.E. Queensland	180	
	Statewide	171	
	Fitzroy - longitudinal	122	
Toowoomba			50%
	Regional – Murray Darling	162	
	Statewide	140	
Mackay			61%
	Regional – Mackay Whitsunday	154	
	Statewide	141	
Rockhampton			72%
	Regional – Fitzroy	147	
	Fitzroy - longitudinal	97	
	Total	**1314**	

There was a similar spread of respondent characteristics across population samples (henceforth referred to as populations) in terms of age and gender, but differences in other characteristics. In terms of age, education and income, the sample population was broadly similar to that of the wider population (see Table 3.2 for details).

The average age of all respondents was 42 (ranging from 15 to 89) and the majority had dependent children. Much of the difference between populations came from Toowoomba, 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 organization. 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.

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

Table 3.2 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 [a b]	*43 yrs*	*44 yrs*	*42 yrs*	*45 yrs*
Gender (% female)	56%	54%	51%	50%
Have dependent children***	72%	59%	80%	77%
Education * **				
Have non-school qualification	46.9%	56%	42.7%	46%
ABS 2001 Census [a]	*46%*	*43%*	*40%*	*41%*
Annual income (pre tax) * **				
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*****	19%	34%	33%	23%

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

[b] 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.

*** significant difference between population samples at the 1% level[2]

[2] To test for differences across locations, the results were cross-tabulated and a chi squared test for significance was applied. The same test was used in all results presented in this report.

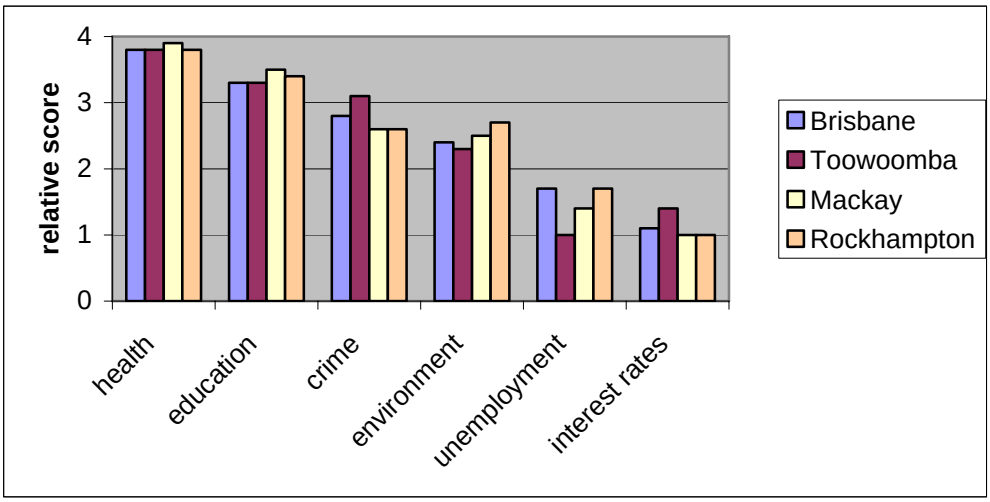
4. Survey results – respondents' opinions and attitudes

There are several types of information collected in a choice modelling survey. The main section collects information on respondents' preferences for different levels of the environmental attributes. Additional information is collected about respondents' opinions and attitude, as well as demographic data, which can be used to assess the influence these factors may have on choice selection. These details are presented in this section and are based on responses in both the regional and statewide surveys.

4.1 Opinions on environmental issues

At the start of the survey, respondents were provided with a list of broad issues and asked to rank them in order of importance. This acted as a warm-up question and provided an indication of the relative importance of environmental issues. In all populations, health issues were rated most highly, with education second. Environmental issues rated either third or fourth (Figure 4.1). There was a significant difference across the populations with a higher proportion of respondents in Rockhampton rating the environment first or second in importance and the lowest proportion in Toowoomba.

Figure 4.1 Relative importance of different social/economic concerns



Respondents were also asked a range of questions to assess their environmental opinions with a number of differences revealed across the populations (Table 4.1).

- The majority of respondents in all populations thought that the condition of the environment had declined over the last 10 years.
- Only 15% of all respondents thought that environmental condition had improved.
- The majority of respondents in all populations favoured equally both environmental and development outcomes.
- In all populations, a higher proportion of respondents favoured the environment more than development.
- Significantly more respondents in Toowoomba and Mackay favoured development than in other populations.

Table 4.1 General environmental opinions

	Brisbane	Toow'mba	Mackay	Rockh'ton
	% supporting the statement			
Change in environmental condition				
Think environmental condition **declined** over last 10 years (%)	52%	58%	56%	60%
Think environmental condition **improved** over last 10 years (%)	15%	14%	15%	15%
Attitude to environmental/development projects* **				
Favour **development** more than environment	6%	16%	12%	6%
Favour **environment** more than development	42%	24%	30%	38%
Favour environment and development **equally**	52%	60%	59%	57%
Environmental knowledge * **				
Self rating of knowledge of land and water issues from 1 (low) to 10 (high) **mean score**	5.1	4.9	5.6	5.4

*** significant difference between populations at the 1% level

Respondents were asked to rate their knowledge of issues addressed in the survey. There was a significant difference across populations with Mackay having the highest mean score and Toowoomba the lowest (Table 4.1).

4.2 Attitudes to use and non-use values for land and water resources

Another set of questions were asked to assess respondents' attitudes to the importance of different use and non-use values of our land and water resources. These questions were asked in the first part of the survey, before further information had been provided and before the choice sets had been considered. Economists generally separate values for environmental goods into use and non-use values. Some people may value land and water resources because they can go there and "use" them i.e. for recreational purposes. However, many people might value these resources even though they may never directly use them. In other words, they derive indirect benefit or non-use value. Non-use values can be separated into *existence, option, bequest* and *quasi-option* values.

- **Existence value** - Some people might value something simply because it exists, e.g. a particular species such as the platypus.
- **Option value** - Some people might not currently use an environment resource such as a particular river, but may want to retain the possibility of

being able to do so at a future date, i.e. they want to keep their options open.

- **Bequest value** refers to the value associated with being able to pass something on to the next generation, e.g. knowing that future generations will have the same opportunity to visit a beautiful place or river.
- **Quasi-option value** relates to the concept of uncertainty and refers to the value of waiting to gather further information about environmental impacts of certain actions, given the current level of uncertainty.

Respondents were asked to rate certain questions that were used as indicators of use and non-use values, on a scale from 1 (most) to 5 (least) important. Details of the questions and the mean scores (lower scores represent higher ratings) are presented in Table 4.2. The percentages of respondents rating the different values most highly (with a score of 1 or 2) are presented in Figure 4.2.

Table 4.2 Mean score ratings for use and non-use values for the GBR

	Brisbane	Toow'mba	Mackay	Rockh'ton
Use value **				
I want to use them for recreation	2.8	2.6	3.1	3.0
Option value* **				
I may want to use them in the future	2.6	1.9	2.6	2.5
Bequest value* **				
We should protect them for future generations	1.8	1.5	1.5	1.7
Existence value				
We need to protect plants, birds and water life	1.7	1.7	1.6	1.7
Quasi-option value				
We should be careful because the impacts of current practices may be poorly understood	2.2	2.1	2.2	2.1

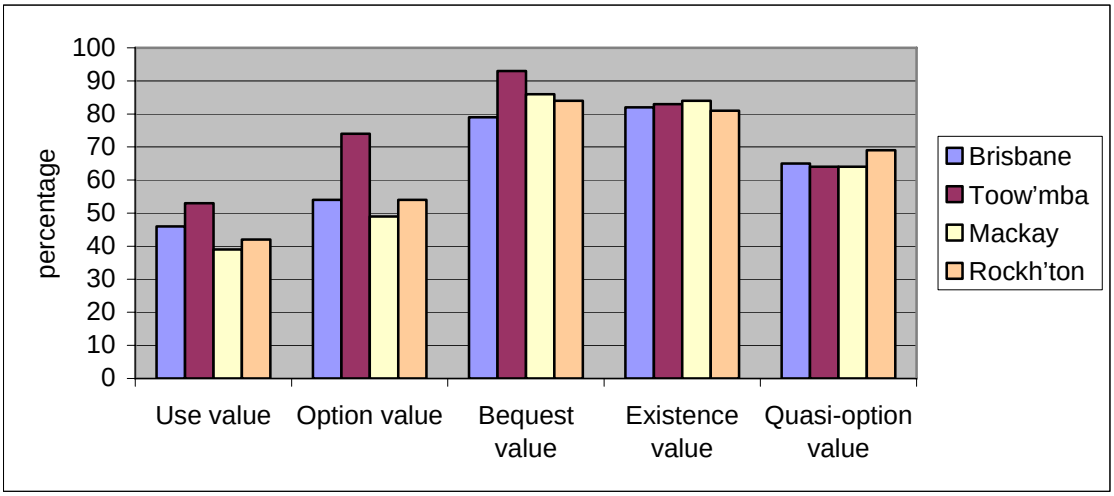
*** significant difference between populations at the 1% level; ** significant at the 5% level

In all populations, mean rating scores were highest, implying relative values were the lowest for **use values**.

In relation to **non-use values**, the results indicate the following:

- **Non-use** values were rated more highly than **use** values.
- **Existence** and **bequest values** were either first of second, in terms of mean importance rating, in all populations.
- In all populations, **quasi-option values** were rated third in terms of mean importance rating, with higher ratings than use and option values (except Toowoomba where option values were rated more highly than quasi-option values).
- **Option values** received the second lowest ranking (ahead of use values) in all communities except Toowoomba.

Figure 4.2 Percentage of respondents scoring values with a "1" or"2"



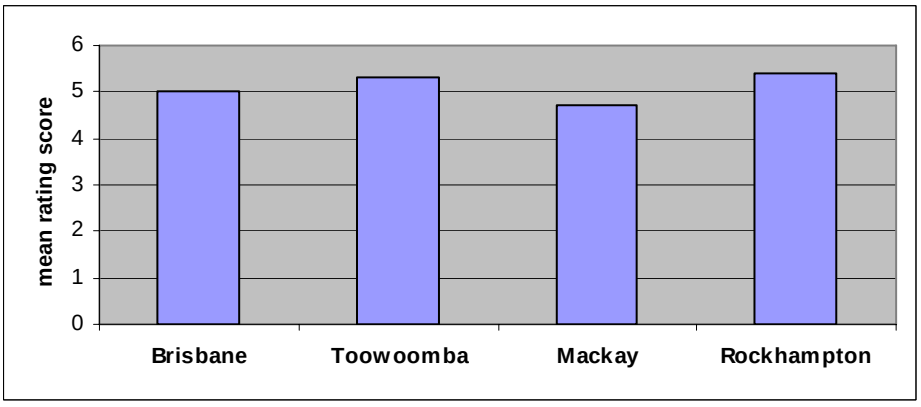
These results are particularly noteworthy because they highlight the importance of non-use values in all populations, and suggest more importance is placed on non-use than use values in each of the communities. It is likely that relatively lower score for option values means that these were interpreted more as use than non-use values.

Key Finding 4.1: In all populations, non-use values were rated as more important than use values.

4.3 Attitudes to natural resource management

Respondents were asked three questions about natural resource management. First they were asked about how well they thought the Queensland Government was managing our environmental resources. All populations, apart from Mackay, respondents rated government performance as on or just above average, with a mean rating score of over 5 (range of 1(low) to 10 (high)) (see Figure 4.3).

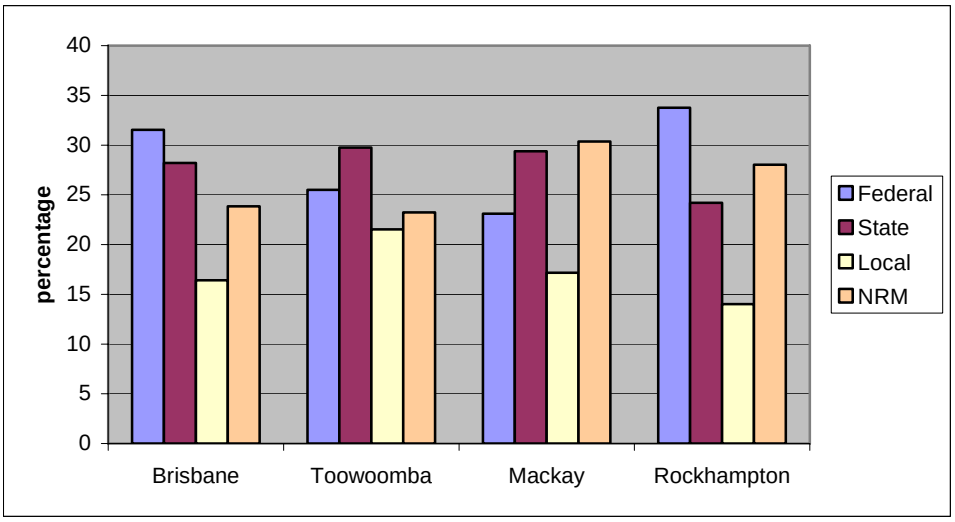
Figure 4.3 Qld Govt performance in managing environmental resources



To probe the issue of governance further, respondents were then asked who they thought should have the main responsibility for identifying and allocating funding to projects that improve environmental outcomes. Preferences were somewhat mixed (Figure 4.4), with the following points to note:

- In all populations, local government was the least preferred option;
- In Brisbane and Rockhampton, the federal government was the most preferred option;
- In Toowoomba, the state government was the most preferred; and
- In Mackay, the regional NRM groups were preferred, just ahead of the state government.

Figure 4.4 Preferred institutional governance for NRM[a]



[a] Percentage of responses (some respondents indicated more than one preference)

Comments provided by respondents on this issue typically mentioned that all these groups should be responsible and should work together. Several respondents thought that issues were best identified at the local level, with funding managed more at a higher Federal or State level. A few respondents suggested that environmental groups should also be involved.

Several comments were made about the need for experts and common sense in the decision making process

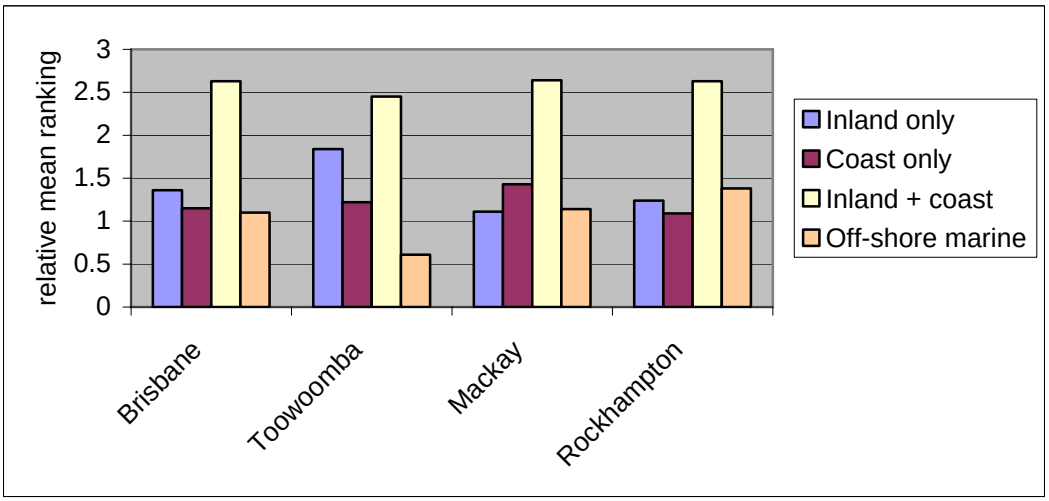
> "An unbiased selection of all parties chaired by someone with brains and common sense."

Key Finding 4.2: There was support for all levels of government to be responsible for NRM issues, with approximately equivalent support for federal and state government responsibility, less support for NRM groups and least support for local government.

Respondents were then asked about the spatial considerations of NRM improvements and whether they had a preference for impacts in inland and/or coastal areas. In this

question, respondents were asked to rank NRM improvements in four geographic alternatives in order of importance. There was a significant difference in the mean ranking scores in all populations.

Figure 4.5 The geographical/spatial importance of NRM improvements



- In all populations, impacts in both "**inland and coastal** areas" was the most preferred option.
- Respondents were not overly concerned about the impacts in **marine** areas, and Rockhampton was the only population where this was not rated as the least preferred option. However, respondents may have considered any improvements on shore would also benefit off-shore areas.
- In all population, apart from Mackay, improvements in **inland** areas only were preferred to improvements in **coastal** areas only.

4.4 Attitudes and responses to the choice selection questions

The other range of questions in the survey gathered information about respondents' attitudes and responses to the choice sets and choice selection (Table 4.3).

Even though there were statistical differences between populations, all respondents had a broadly similar attitude to choice selection.

- The majority of respondents (over 60%) were either **very confident** or **reasonably confident** that they had made the correct choices.

This means that although the choice selection process was not simple, most people felt they were able to make an informed choice. The inclusion of the status quo option is important in this respect as it provides a back-up option for some respondents who may be undecided or unsure. It is also a viable option for respondents who prefer the attribute levels offered in the option.

- A similar proportion of respondents (over 60%) reported that they **understood the information** in the survey.

- Approximately a third felt they **needed more information**[3]. In Rockhampton, this proportion was higher at 45%.
- A similar proportion (higher in Toowoomba and lower in Rockhampton) indicated they found the choice questions **confusing**.

Table 4.3 Attitudes and responses to the choice selection questions

	Brisbane	Toow'mba	Mackay	Rockh'ton
Very/reasonably **confident** with choices ***	72%	61%	68%	70%
Understood the information in the survey *** *Agree/strongly agree*	72%	60%	67%	68%
Needed **more information**** *Agree/strongly agree*	34%	27%	34%	45%
Found the choice questions **confusing** *Agree/strongly agree*	33%	39%	37%	36%
Selected all **status quo** options	19%	19%	14%	14%
Had an attribute **preference****	42%	35%	54%	52%

*** significant differences between populations at the 1% level

Respondents who had always chosen the **status quo** option were probed for their reasons – the three main reasons were:

- first, the respondent supported making environmental improvements but felt it should be funded from the taxes they already pay;
- second, the respondent supported making environmental improvements but could not afford to pay for it; and
- third, the respondent did not trust the government would spend the money as stated.

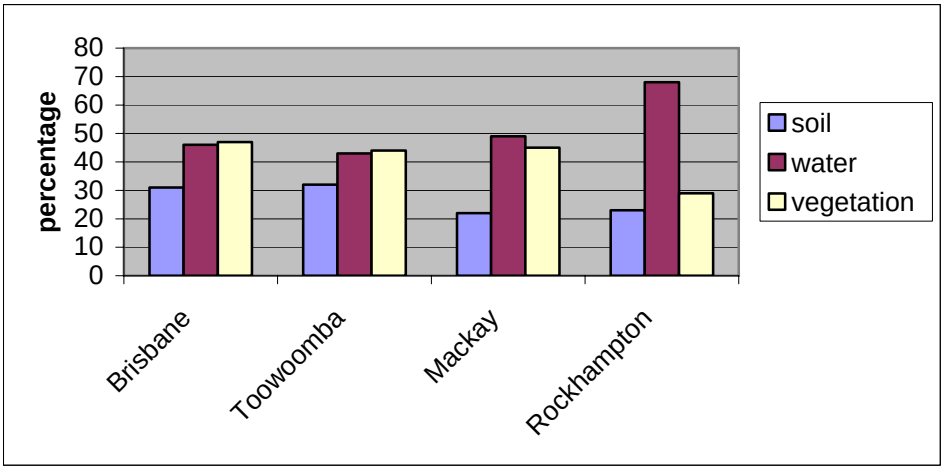
There was a significant difference between populations in terms of whether respondents had a **preference** for the different attributes.

- Over 50% of respondents in Mackay and Rockhampton had an attribute preference.
- Only 35% had a preference in Toowoomba and 42% in Brisbane.

While there was no difference in preferences for improvements in soil and vegetation condition across the populations, there was for healthy waterways, with a much higher proportion rating it first in Rockhampton (Figure 4.6). In Brisbane and Toowoomba, preferences for healthy waterways and vegetation were very similar. In all populations, soil condition was the least preferred attribute.

[3] There is always a trade-off in presenting information in choice modeling surveys and it is an issue that was pre-tested in the focus groups. Too much information can put some respondents off, but clearly this result indicates that more information could have been provided, even though website references were given. Providing additional information in a separate brochure that respondents can read if they choose, maybe a more viable option.

Figure 4.6 Percentage of respondents rating attribute as first preference



Key Finding 4.3: The majority of respondents understood the information in the questionnaire and were confident that they had made the right choice selections.

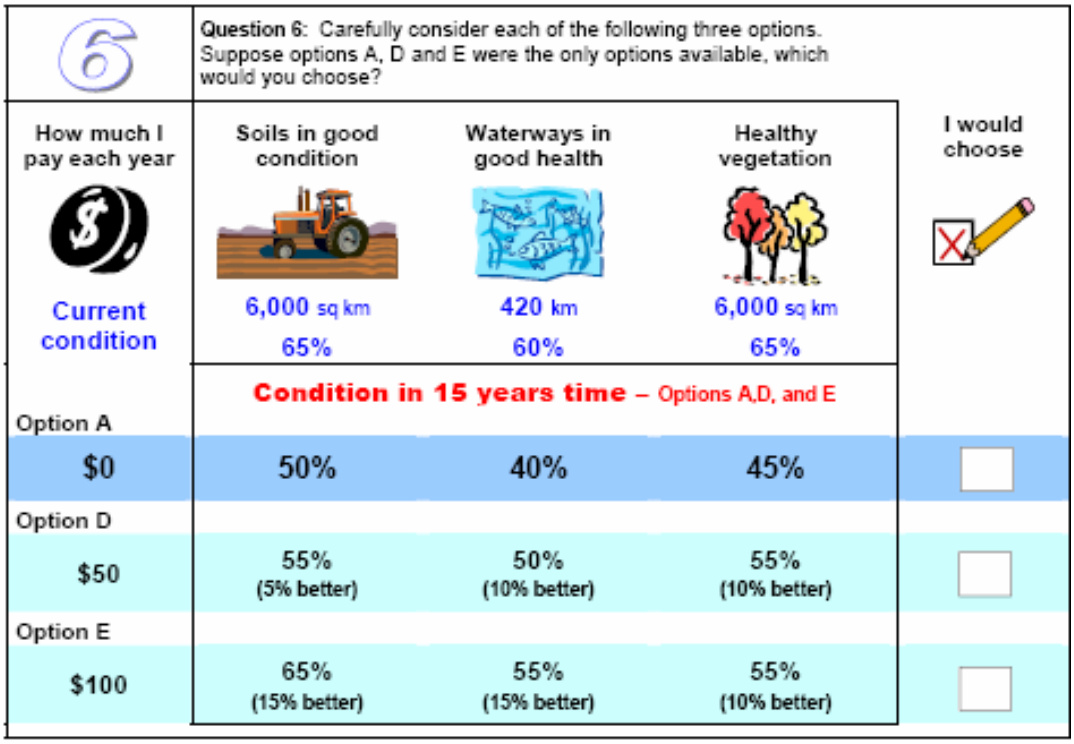
The results of the choice selection questions are now analysed in detail in the following sections.

5. Choice modelling results for the regional surveys

5.1 Choice set design

In the regional surveys, respondents were presented with six choice sets, each with a status quo option and two other alternative options. An example choice set is presented in Figure 5.1. Full details of how the choice modelling survey was developed and designed are provided in Windle (2005).

Figure 5.1 Example choice set for the regional model



Respondents were provided with information about the current condition of the soil, water and vegetation resources in their region, both in absolute and percentage terms. The first option, Option A, henceforth referred to as the **status quo option,** was the same in each choice set. It describes the situation that might be expected in 15 years time (future base). In the two other choice alternatives, Options B and C in the diagram above, the profiles were described in terms of attribute with reduced levels of degradation. These are referred to as **improvement options.** Attribute levels in each alternative varied, but all represented improvements (reduced degradation) from the status quo option. Respondents were being asked to make a choice between the status quo option (which costs nothing) and two improvement options which have an associated cost and which offer different levels of each attribute. In effect, respondents are being asked if they were willing-to-pay for environmental improvements. There were six choice sets in each survey.

The different attribute levels for the different regions are outlined in Table 5.1. The fourth cost attribute was the same for each region. The base (status quo) was $0 and the three levels were $20, $50, and $100. These were annual payments to be made over a period of 15 years.

Table 5.1 Future base and attribute levels in the different regions

	Soils in good condition	Waterways in good health	Healthy Vegetation
South East Queensland			
Area: 23,000 sq km			
River length: 2,000 km			
Current level	60%	55%	45%
Future base level	45%	35%	25%
Attribute levels	50%, 55%, 60%	40%, 45%, 50%	30%, 35%, 40%
Murray Darling			
Area: 314,000 sq km			
River length: 20,000 km			
Current level	65%	60%	45%
Future base level	50%	40%	25%
Attribute levels	55%, 60%, 65%	45%, 50%, 55%	30%, 35%, 40%
Mackay Whitsunday			
Area: 9,000 sq km			
River length: 700 km			
Current level	65%	60%	65%
Future base level	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 level	65%	50%	45%
Future base level	50%	30%	25%
Attribute levels	55%, 60%, 65%	35%, 40%, 45%	30%, 35%, 40%

Note: The values are based on information derived from information provided in the National Land and Water Audit. Full details are provided in Windle (2005).

The status quo option outlined the future base levels and all attribute levels in the improvement options represent an improvement from the status quo levels. This means that respondents could select the status quo option for one of two reasons. They might not wish to pay the cost of an improvement option, and/or they might prefer the levels outlined in the status quo. If they were willing to pay for an environmental improvement, then they could select one of the improvement options.

An experimental design is used to select the choice profiles that will be presented to respondents, where each choice set represents a profile of different attribute levels. In these surveys, there are a large number of combinations or profiles that could be presented to respondents. As it is only possible to present a selection of profiles, an experimental design process was used to select the profiles, and then partition them into blocks for presentation to survey respondents in different versions of the survey.

In the regional model, there were six choice sets in each survey and four versions of the survey. This meant 24 different choice profiles would be completed.

The choice information was analysed using a logistic regression model (using the ©LIMDEP software program). The probability that a respondent would choose a particular option can be related to the levels of each attribute making up the profile of each option on offer, the socio-economic characteristics of the respondents, and their attitudinal responses. The logistic regression function can be used to generate probabilities of choice, and subsequent estimates of value differences between different choice profiles.

The results from the multinomial logistical (MNL) regression models are presented in three separate sections:

- presentation of the basic MNL models for the different populations;
- a classification of respondents' preferences into four distinct classes; and
- details of the marginal values for improvements in NRM outcomes.

5.2 MNL models for the different populations

There are a range of different statistical models that could be developed from the available data, which in turn affects the range of information analysed and interpreted. One of the first decisions is to decide which variables to include in the model. On the one hand, increasing the number of variables will generally increase the explanatory power of the model, but on the other, it makes model presentation more dense and complex, and harder for the reader to intuitively interpret. One option would be to simply include some basic socio-demographic variables together with the data from the choice sets. However, such models would have lower explanatory power, and they would not include valuable information on respondents' attitudes and opinions that has been presented in the section above.

In addition to the four attributes used to describe the choice sets, the models developed for this report incorporate four different groups of variables

- socio-demographic (Table 3.2)[4];
- environmental opinions (Table 4.1);
- attitudes to choice selection (Table 4.3); and
- land and water resource use and non-use values (Table 4.2).

In all, a total of 21 variables were included in the model, which makes it difficult to present them in a clear and meaningful manner. In general, the model interpretation focuses on two important factors; whether a particular variable is statistically significant and whether the coefficient is positive or negative. A positive coefficient means that respondents were more likely to choose an improvement alternative in the choice sets, while a negative coefficient means that respondents were more likely to choose the status quo option. The model details presented below will outline this information, while full model details are provided in the Appendix. Details of the variables used in the models are presented in Table 5.2. MNL models for each population are presented in Table 5.3/Appendix 1

[4] Income was not included in the models as there were many missing values, which would have meant the complete response would have been discarded. Excluding income as a variable meant that the preferences of these respondents could be included in the model. Separate models were run that included the income variable and the relative significance is reported.

Table 5.2 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

Table 5.3 Regional MNL models

Population	ALL		Brisbane South East Queensland		Toowoomba Murray Darling		Mackay Mackay Whitsunday		Rockhampton Fitzroy	
Region	**Combined**									
Cost	–	***	–	***	–	***	–	***	–	***
Soil	+	***	+	***	+	***	+	***	+	***
Water	+	***	+	***	+	***	+	***	+	***
Vegetation	+	***	+	***	+	***	+	***	+	***
ASC	–	***	–	***	–	***	–	***	–	***
Socio-demographic variables										
Age	+		+		+		–		–	
Gender	–	***	–	***	–	***	–	***	+	***
Children	–	***	+		–	***	–	***	–	***
Education	+	***	+	*	+	***	+	***	+	*
Environmental opinions										
Env condition	–		+		+		–		–	
Env favour	+	***	+	***	+	***	–		+	***
Env knowledge	–		–	**	+		–	***	+	
Choice selection variables										
Confidence	–	***	–		–		–		–	***
Preference	+	***	+	***	+	***	+	***	+	***
Understand	–	**	–	***	–		+	**	–	
More info	+		–		+		+	***	+	
Confused	–	*	+	*	–	**	–	***	+	
Land and water values										
Use	–		+		–	***	+	**	+	
Option	–	***	–	**	+		–	***	–	***
Bequest	+	***	+	***	–		+	***	+	**
Existence	–		–	*	+	***	–		–	***
Quasi option	+	***	+		+		+	***	+	***
Model statistics										
Log Likelihood	-3246.92		-914.14		-790.85		-683.16		-682.48	
Adj Rho sqrd	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 the same models were run with income included as an additional variable it was positive in Brisbane and negative in the other populations but only significant in Toowoomba and Mackay. The negative association meant people with higher incomes were less likely to prefer an improvement option.

The models presented above are robust and all have strong explanatory power (high adjusted Rho-squared values). As expected, the cost attribute in all models is significant and negative, meaning higher cost levels were not preferred. However, the ASC constants were all significant, indicating there were factors other than those outlined in the models that were influencing choice selection. The negative sign meant these unexplained factors were influencing respondents to select the status quo option.

Environmental attributes

- All three environmental attributes were positive and significant in all models. This meant higher levels of improvement in the condition of **soil, water and vegetation** resources were preferred.
- For all populations coefficient values for **water** were higher than those for soil and vegetation. This meant that preferences for improvements in the health of waterways were stronger than those for improvements in soil and vegetation condition.
- Preferences for improvements in **waterway** health were strongest in Mackay and weakest in Brisbane.
- Preferences for improvements in **soil** condition were also strongest in Mackay, but weakest in Rockhampton.
- Preferences for improvements in **vegetation** condition were stronger in Rockhampton and Brisbane than in Toowoomba and Mackay.

Socio-demographic variables

- **Age** was not a significant indicator of preferences in any population.
- **Gender** was significant in all models, but did not have a consistent influence. In Rockhampton, it was positive which meant that women were more likely to select an improvement option than men. In the other populations it was negative which meant that women preferred the status quo option. The overall impact (ALL model) was negative.
- Having **dependent children** was a significant influence in all populations apart from Brisbane. The influence was negative which meant that respondents without children were more likely to prefer the status quo option.
- **Education** was significant and positive in all populations. Respondents with higher levels of education were more likely to prefer the improvement options.
- **Income** (a variable included in separate model runs) was only a significant influence on choice in the Toowoomba and Mackay samples. People with higher incomes were less likely to select an improvement.

Environmental attitudes variables

- **Environmental condition**: The influence of these opinions was not a significant indicator of preferences.
- **Favoured the environment**: People who favoured the environment more frequently than development were more likely to select an improvement option. This was a significant influence in all populations apart from Mackay.
- **Environmental knowledge**: This was a significant influence on preferences in Brisbane and Mackay, but not in the other populations. People who rated their knowledge of NRM issues more highly were less likely to select an improvement option.

Choice selection variables

- **Confidence** was only a significant influence on choice in Rockhampton, where the **less confident** people were that they had made the right choices, the more likely they were to select the status quo option.

- **Preference** was positive and significant in all populations. This meant that respondents who could articulate a clear preference between the attributes tended to prefer the improvement options.
- The **understood, more information** and **confused** variables had a mixed influence and significance in the different populations.
- Respondents who **understood** the information in the survey were more likely to select the status quo option in Mackay, whereas in Brisbane they were more likely to select an improvement. Overall, the influence was significant and negative.
- **More information** was only significant in Mackay where respondents who wanted more information preferred the status quo option.
- **Confused** had a negative influence in two populations where respondents who found the choice sets confusing were more likely to select the status quo option. The opposite was true in Brisbane. Overall, it was significant and negative.

Land and water resource values

These variables refer to the use and non-use values that were rated in the early part of the survey (Table 4.2). The influence for **use, option, bequest, existence** and **quasi-option** values varied in terms of significance and influence in the different populations. Overall,

- Respondents with a high rating for **use values** were less likely to select an improvement in Toowoomba and more likely in Mackay. Overall, there was not a significant influence.
- **Option value** was always negative and significant in all populations apart from Toowoomba. Respondents with a high rating for option values were more likely to select the status quo option.
- **Bequest value** was always positive and significant in all populations apart from Toowoomba. Respondents with a high rating for option values were more likely to select an improvement option.
- The influence of **existence value** was varied in terms of significance and influence. Respondents with high ratings for existence values were more likely to select an improvement option in Toowoomba and less likely in Brisbane and Rockhampton. Overall the variable was not significant.
- In Mackay and Rockhampton, respondents with high ratings for **quasi option values** preferred the improvement options.

The models show that respondents preferred options that involved lower costs and larger environmental improvements.

Key Finding 5.1: Age was not a significant influence on preferences and choice selection but education, whether people had dependent children and gender were all significant influences.

Key Finding 5.2: Overall, people who were less confident that they had made the correct choice selection and people who did not understand the information in the survey were more likely to select the status quo option.

Key Finding 5.3: Overall, respondents' opinions about non-use value ratings for bequest and quasi-option values had a significant influence on preferences. Both were positive explanatory variables of environmental values.

5.3 MNL latent class models for all respondents combined

Information about the different variables presented above has focused on their relative significance and influence these had on the choice of improvement alternatives in the choice sets. The results highlighted the preference heterogeneity amongst respondents in different populations. It would also be useful to examine preference heterogeneity across all respondents to determine if there are certain preferences that are not location specific. Latent class models can be used for this purpose.

Latent class models are a mechanism to test if the respondents to the choice surveys can be classified into particular groups according to their choice behaviour. The models provide a different way of categorising respondents' preferences, instead of defining them in terms of population and other factors (as reported in the models above). Since a number of groups can be estimated and no restrictions are placed on membership probabilities, latent class models allow for a wider range of preference heterogeneity.

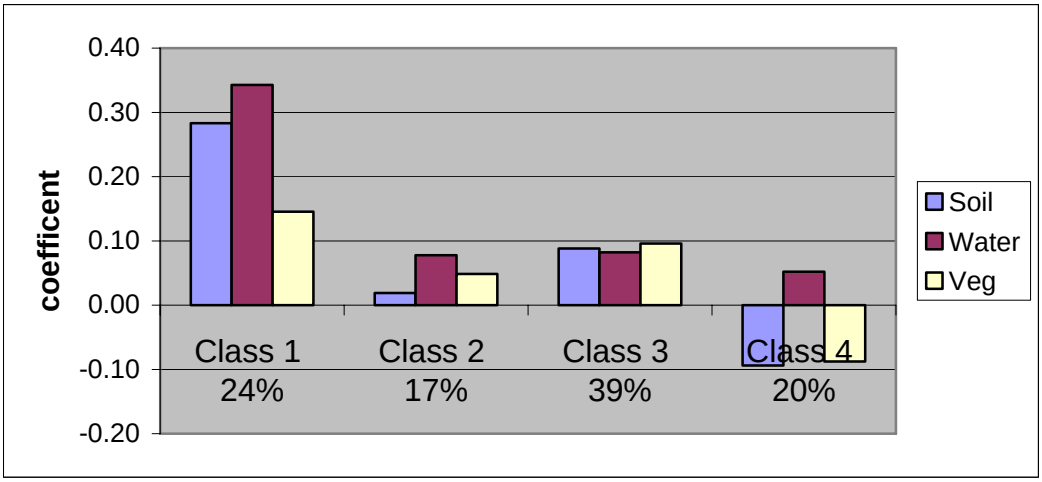
For this data set, latent class models were estimated, with results presented in Table 5.4 and Figure 5.2 below. The data from the different population groups was pooled to facilitate the modelling. It was possible to run a model that identified four distinct classes of respondents (cost was held as a fixed variable). The model had high explanatory power, with all attribute coefficients being highly significant (Table 5.4).

Table 5.4 Latent class models for all respondents combined

	Class 1	**Class 2**	**Class 3**	**Class 4**
	coefficient	coefficient	coefficient	coefficient
Cost	-0.02	-0.02	-0.02	-0.02
Soil	0.28	0.02	0.09	-0.09
Water	0.34	0.08	0.08	0.05
Vegetation	0.15	0.05	0.10	-0.09
Probability of being in the class	24%	17%	39%	20%
Log L	-3147.402			
Rsq adj	0.25238			
Observations	3840			
Significance	All values and probabilities were significant at the 1% level, apart from soil in Class 2 which was significant at 10%			

The coefficient values for the different attributes in the different classes are presented in Figure 5.2.

Figure 5.2 Coefficient values for attributes by different respondent classes



The characteristics of the different classes can be described as follows:

Class 1 (24% probability)

- strong preferences for all attributes;
- strongest preferences for healthy waterways; and
- very strong preferences also for good soil condition.

Class 2 (17% probability)

- not very strong preferences generally;
- small preferences for healthy waterways; and
- limited preferences for healthy vegetation but stronger than those for soil in good condition.

Class 3 (39% probability)

- the class with the largest proportion of respondents;
- not very strong preferences but higher than Class 2; and
- not a big distinction in preferences, but strongest for healthy vegetation and soil condition preferred over healthy waterways.

Class 4 (20% probability)

- healthy waterways is the only attribute with positive values; and
- no interest in soil or vegetation.

Overall, preferences for healthy waterways were dominant, but in the class with the highest proportion of respondents (Class 3), preferences for soil and vegetation were equally strong. Approximately a quarter of respondents (Class 1) valued both soil and water very highly. It might be expected that these respondents in this class were more likely to reside in the rural/regional locations. However, there was no significant difference between populations in the proportion of respondents represented in each class, apart from Class 4, where a significantly (at the 10% level) lower proportion of Brisbane and Mackay respondents being represented in this class than in Toowoomba and Rockhampton (see Table 5.5 for details).

Table 5.5 Proportion of respondents in each class from different populations

	Brisbane	Toowoomba	Mackay	Rockhampton
Class 1	28%	22%	34%	28%
Class 2	12%	11%	11%	9%
Class 3	41%	44%	38%	38%
Class 4	17%	24%	14%	23%
Unexplained	2%	-	3%	2%
Total	100%	101%	100%	100%

These results are important because they suggest that a lot of the heterogeneity between respondents and populations can be classified in terms of overall preferences for different attributes. In other words, the same preference classes exist in each population and a similar proportion of respondents from each population are represented in the different classes.

Key Finding 5.4: The type of preferences across all respondents can be classified into four distinct groups that are not location specific. Those with very strong values for all attributes, especially soil and water; those with preferences for water, then vegetation and then soil; those with no real preference between attributes; and those with positive values for water but negative values for soil and vegetation.

5.4 Marginal values for improvements in environmental condition

In analysing MNL models, most interest usually lies in finding the difference in value between the status quo option and other specific options that are policy relevant. This was the focus of attention in section 5.2 above. As well as these estimates of value, the models can also be used to generate estimates of marginal value changes for each attribute. These marginal value changes provide a useful way of summarising the community tradeoffs in value terms. **Marginal values provide an indication of the value to respondents of each one-unit change in the provision of a single attribute.**

Marginal values are estimated from the MNL 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 estimated marginal values are directly comparable between models, and are presented in Figure 5.3 with full details presented in Table 5.6.

Figure 5.3 Marginal values for improvements in NRM outcomes

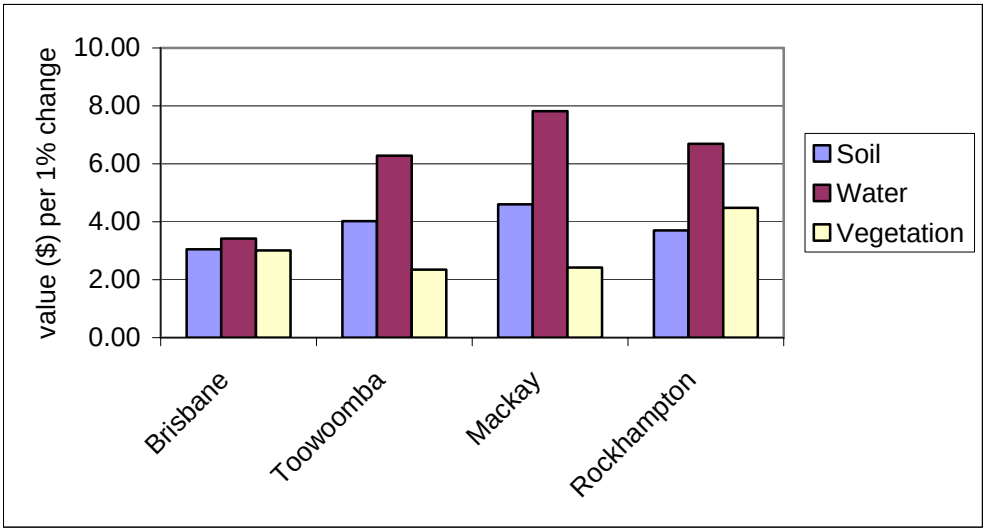


Table 5.6 Marginal values and confidence intervals for regional models

	Soil	Water	Vegetation
	$ value of each 1% improvement		
Brisbane – S.E. Queensland			
Marginal Value	**3.05**	**3.42**	**3.01**
Confidence intervals	(1.79 – 4.59)	(2.26 – 4.88)	(1.77 – 4.40)
Toowoomba – Murray Darling			
Marginal Value	**4.02**	**6.28**	**2.35**
Confidence intervals	(2.51 – 5.91)	(4.77 – 8.80)	(0.94 – 4.01)
Mackay – Mackay Whitsunday			
Marginal Value	**4.60**	**7.82**	**2.42**
Confidence intervals	(2.87 – 6.75)	(5.84 – 10.88)	(0.86 – 4.37)
Rockhampton - Fitzroy			
Marginal Value	**3.70**	**6.69**	**4.48**
Confidence intervals	(1.96 – 6.23)	(4.70 – 10.01)	(2.53 – 7.18)
All combined			
Marginal Value	**3.72**	**5.80**	**2.88**
Confidence intervals	(2.94 – 4.57)	(4.98 – 6.88)	(2.10 – 3.71)

There was some variation in values for the different attributes across populations, with the widest range in values for healthy waterways. In Brisbane, values for the soil, water and vegetation attributes were very similar, while in the regional locations there was a clear distinction in the values for different attributes. Values for healthy waterways were the highest. Soil condition was valued more highly than vegetation in Toowoomba and Mackay and the other way round in Rockhampton. This is somewhat surprising because in all regions there was a higher percentage of soil in good condition compared with vegetation in good condition, apart from the Mackay

Whitsunday region where the proportion was the same (Table 5.1). In addition, there was a higher proportion of respondents who had a specific preference for the different attributes, who ranked healthy vegetation ahead of soil condition (Figure 4.6). This meant that marginal willingness-to-pay values were not being dominated by respondents with preconceived preferences.

When the responses are grouped, the variation in values across populations evens out. Values were highest for healthy waterways than for good soil condition, and values for healthy vegetation were third (Table 5.6).

Soil in good condition

- Overall, respondents (households) valued a 1% improvement in the area of soil in good condition at **$3.72**. This was an annual amount for a period of 15 years and represents a present value of **$38.61**[5]**.**
- Household values for soil condition ranged from **$3.05** in Brisbane for a 1% improvement in South East Queensland to **$4.60** in Mackay for a 1% improvement in the Mackay/Whitsunday region.

Waterways in good health

- Overall, respondents (households) valued a 1% improvement in the length waterways in good health at **$5.80**. This was an annual amount for a period of 15 years and represents a present value of **$60.20.**
- Household values for healthy waterways ranged from **$3.42** in Brisbane for a 1% improvement in South East Queensland to **$7.82** in Mackay for a 1% improvement in the Mackay/Whitsunday region.

Healthy vegetation

- Overall, respondents (households) valued a 1% improvement in the area of healthy vegetation at **$2.88**. This was an annual amount for a period of 15 years and represents a present value of **$29.89.**
- Household values for healthy vegetation ranged from **$3.01** in Brisbane for a 1% improvement in South East Queensland to **$4.48** in Rockhampton for a 1% improvement in the Fitzroy region.

Although log likelihood ratio tests have shown that all the models for each population group are significantly different, the confidence intervals for the soil and vegetation attributes overlap. This suggests that while there was some variation in the factors that influence these values, there was no underlying difference in the values held across communities. However, the confidence intervals in values for healthy waterways in Brisbane and Mackay do **not** overlap, suggesting there were real differences in values. The confidence intervals for the grouped models are much closer, indicating a convergence in mean values for broader community models.

Further analysis can determine whether the differences in marginal values are statistically significant. The marginal values are calculated from a set of 1000 parameters for each model. Differences between marginal values can be calculated by taking one vector of parameters from another. Following a Poe et al. (2001) procedure, this process is repeated 100 times by randomly reordering one vector of

[5] A 5% discount rate was used to calculate all present values reported here and later in the document.

parameters. The 95% confidence interval is approximated by identifying the proportion of differences that fall below zero. The results of these tests are presented in Appendix 4, and reveal the following:

There was a significant difference in the separate regional models between:

- values for **waterways** in South East Queensland and each of the other three regions; and
- values for **vegetation** in the Murray Darling and the Fitzroy.

There was NO significant difference in the separate regional models between:

- values for **soil** condition in any of the regions;
- between values for **any attributes** between the Fitzroy and Mackay Whitsunday regions; and
- values for **any attributes** between the all-combined model and the separate regional models (apart from waterways in South East Queensland).

Key finding 5.5: Overall, respondents (households) valued a 1% improvement in the area of soil in good condition at $3.72. This was an annual amount for a period of 15 years and represents a present value of $38.61. Values ranged from ranged from $3.05 in Brisbane for a 1% improvement in South East Queensland to $4.60 in Mackay for a 1% improvement in the Mackay/Whitsunday region.

Key finding 5.6: Overall, respondents (households) valued a 1% improvement in the length waterways in good health at $5.80. This was an annual amount for a period of 15 years and represents a present value of $60.20. Values ranged from $3.42 in Brisbane for a 1% improvement in South East Queensland to $7.82 in Mackay for a 1% improvement in the Mackay/Whitsunday region.

Key finding 5.7: Overall, respondents (households) valued a 1% improvement in the area of healthy vegetation at $2.88. This was an annual amount for a period of 15 years and represents a present value of $29.89. Values ranged from $3.01 in Brisbane for a 1% improvement in South East Queensland to $4.48 in Rockhampton for a 1% improvement in the Fitzroy region.

Key Finding 5.8: Values were highest for healthy waterways in all populations.

Key Finding 5.9: Values for healthy waterways were higher in the regional populations compared with Brisbane, the capital city.

6. Choice modelling results for the statewide survey

6.1 Choice set design

In the statewide surveys, respondents were presented with six choice sets, each with a status quo option and four other alternative options. In this survey, the alternatives were labeled and each option or choice profile related to a particular region within the state. An example choice set is presented in Figure 6.1.

Figure 6.1 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

Each attribute in each option is described in terms of the expected levels (the 15 year projection or future base levels) and the alternatives or options. These represent the **improvement** options. The **status quo** option is also included in each choice set. Presenting this quantity of information in a single choice set requires careful consideration of a number of design issues. A number of community focus groups were held to assist with survey development and pre-testing. Details are provided in Windle (2005).

Details for South East Queensland and the Murray Darling regions remained the same as in the regional models. However, in the statewide model two broad regions were included, Great Barrier Reef – Coastal and Great Barrier Reef – Inland. While these regions were described in very broad terms, the associated attribute levels were the same as those used in the regional models (Table 5.1). Values from the Mackay/Whitsunday region were used to represent GBR-Coastal and the Fitzroy data was used to represent the GBR-Inland.

The experimental design for the statewide model was more elaborate than the one for the regional model. In the state model, a total of 78 different choice sets were developed to represent the choices on offer. These were blocked into 13 groups or versions of the survey and each respondent was offered six choice sets in a survey.

The choice modelling results for this survey are analysed using the same methods as for the regional methods. The basic MNL models for the different populations are presented in the next section and then the marginal values for improvements in NRM outcomes in the different parts of the state are outlined and discussed.

6.2 General MNL models for the different populations

There were some tradeoffs involved in deciding which variable to include in the models. As there are four regions to describe, it makes the inclusion of a large number of variables even more complex than with the regional models. The regional models (Table 5.3) have highlighted the influence that different attitudinal variables may have on preferences and choice selection. In this section, the variables used in the models are limited to the basic socio-demographic characteristics. The main MNL models are outlined in Table 6.1 with full details presented in Appendix 2. The variables have been described in Table 5.2. The additional variable, "population" was included in the "All combined" model to determine if the location of the population sample had any influence on choice selection. Log likelihood ratio tests indicated that the models from all three sampled populations were significantly different from each other.

All models are significant with chi-squared values greater than the test statistic and provide the following information.

- The attributes are all highly significant and signed as expected.
- All ASC coefficient values are significant which means that factors other than those used in the model, were influencing choice selection. This would be expected, given the heterogeneity of preferences and the limited number of variables used in the models.
- **Population** was a significant influence on the choice of regions (ALL model). It was a positive influence on the selection of all regions apart from South East Queensland. This meant the less centralised populations of Toowoomba and more so Mackay, preferred improvements in the three regional/rural regions, but were less likely to select improvements in the South East Queensland region.
- There was variation in both the significance and relative influence of the socio-demographic variables. This variation occurred within and across populations.
- Overall, **age** was not a significant influence, but could be either negative (Mackay) or positive (Toowoomba).
- **Gender** could have either a negative or positive influence on choice, but overall it was a significant (negative) influence on the choice of all regions. Being negative meant that women did not prefer these options.
- When significant, **dependent children** had a negative influence (those without children did not prefer these options). Overall, it was a significant influence on the choice of the inland regions (GBR – Inland and Murray Darling).
- **Education** was always positive (people with higher levels of education preferred these options), and overall it was a significant influence on the choice of all regions.

- **Income** could have a negative or positive influence, but overall it had a positive influence in the selection of the two Great Barrier Reef regions (GBR – Coastal and GBR – Inland).

Table 6.1 Multinomial logit model for the statewide survey

	ALL combined		BRISBANE		TOOWOOMBA		MACKAY	
COST	– ve	***	– ve	***	– ve	***	– ve	***
SOIL	+ ve	***	+ ve	***	+ ve	**	+ ve	**
WATER	+ ve	***	+ ve	***	+ ve	***	+ ve	***
VEG	+ ve	***	+ ve	***	+ ve	*	+ ve	*
Murray Darling								
ASC-MD	– ve	***	– ve	***	– ve	***	– ve	***
AGE	+ ve		+ ve		+ ve		+ ve	
GENDER	– ve	***	– ve	**	– ve	***	+ ve	**
CHILDREN	– ve	***	– ve		– ve	*	– ve	
EDUCATION	+ ve	***	+ ve	**	+ ve	***	+ ve	***
INCOME	+ ve		+ ve		+ ve		– ve	
POPULATION	+ ve	***						
Great Barrier Reef - Coastal								
ASC-GBR	– ve	***	– ve	***	– ve		– ve	
AGE	+ ve		+ ve		+ ve		– ve	
GENDER	– ve	**	– ve	**	– ve		+ ve	
CHILDREN	– ve		– ve	**	+ ve		– ve	*
EDUCATION	+ ve	***	+ ve	**	+ ve	*	+ ve	***
INCOME	+ ve	**	+ ve	*	– ve	**	+ ve	
POPULATION	+ ve	***						
South East Queensland								
ASCSEQ	– ve	*	– ve	***	– ve		+ ve	
AGE	+ ve		+ ve		+ ve	*	– ve	**
GENDER	– ve	***	– ve		– ve	***	– ve	
CHILDREN	– ve		– ve	***	+ ve		– ve	
EDUCATION	+ ve	***	+ ve		+ ve	***	+ ve	
INCOME	+ ve		+ ve	***	– ve	***	– ve	*
POPULATION	– ve	***						
Great Barrier Reef - Inland								
ASC-GBRI	– ve	***	– ve	***	– ve	**	– ve	***
AGE	+ ve		+ ve		+ ve		– ve	***
GENDER	– ve	***	– ve		– ve	***	– ve	***
CHILDREN	– ve	***	– ve	***	– ve		– ve	*
EDUCATION	+ ve	***	+ ve		+ ve	**	+ ve	***
INCOME	+ ve	***	+ ve	***	– ve		+ ve	
POPULATION	+ ve	***						
Model statistics								
Log Likelihood	-3413.716		-1222.041		-1069.557		-1069.557	
Adj R sqrd	0.05647		0.08187		0.08337		0.08337	
Chi sqrd (dof)	396.230 (28)		152.716 (24)		123.172 (24)		100.036 (24)	
Observations	2256		834		690		732	

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

Key Finding 6.1: Population location was a significant explanator of preferences for improvements in different regions. Respondents in the more regional/rural locations of Toowoomba and more so in Mackay, preferred improvements in the three rural regions. They were less likely to select improvements in the South East Queensland region.

Key Finding 6.2: Overall, the socio-demographic variables had an inconsistent influence on choice selection. Education was the variable that was the most consistent explanator of preferences.

In the "All combined" model presented in Table 6.1, the location of respondents is a significant influence of the selection of improvements in particular regions. The results indicate that the more rural populations preferred improvements in the more rural regions, and not in South East Queensland. However, it does not tell us which regions were being preferred by which community. The key question here is whether people prefer improvements in their own region compared with improvements in other parts of the state. On the other hand, respondents may think it is better to fund improvements in regions where there is the most pressure on our resources, e.g. South East Queensland and possibly the Murray Darling[6]. Other respondents may have preferences for improvements in regions that will reduce the impact of land-based activities on the Great Barrier Reef.

One way of determining which regions were most preferred in each choice set, is to conduct statistical cross-tabulations for regional selection in each of the six choice sets. The computational residual, i.e. the difference between the expected and actual count, provides an indication of the strength of preferences. Details are presented in Table 6.2 and indicate the following:

- In **Brisbane,** a higher proportional of respondents (than statistically expected) selected the **South East Queensland** option. They preferred improvements in their own region and did not particularly avoid selecting any other region.
- In Toowoomba, the results were less definitive. Preferences for their local **Murray Darling** region were strongest, but many respondents also favoured the **status quo** option. There was also a strong preference **not** to select the **GBR – Coast** region.
- In **Mackay**, the strongest preferences were to select the **GBR – Coastal** region (of which their local region was representative). To a lesser extent, improvements in the **GBR – Inland** region were also favoured. The strongest aversion was for improvements in **South East Queensland**.

These results are important because they confirm what people might intuitively think, that within a statewide context, people value their own region more highly than others.

[6] The importance of improvements in the Murray Darling region was mentioned in the focus groups as it was seen as the "bread basket" of Queensland.

Table 6.2 Cross-tabulation residual between expected and actual count*

	Murray Darling	GBR Coast	S.E Queensland	GBR Inland	Status Quo
Brisbane					
Choice set 1	-5.1	-6.7	20.4	-8.6	0.1
Choice set 2	-4.5	-5.6	10.5	-0.5	0.1
Choice set 3	-9.2	-9.0	21.5	-2.9	-0.3
Choice set 4	-6.6	-5.1	14.2	-1.4	-1.1
Choice set 5	-11.3	-6.5	19.3	-1.1	-0.3
Choice set 6	-8.3	-2.7	13.0	-0.3	-1.7
Toowoomba					
Choice set 1	15.3	-17.0	-2.5	-4.9	9.1
Choice set 2	6.5	-12.0	6.4	-5.5	4.6
Choice set 3	9.9	-7.7	-3.9	-5.7	7.4
Choice set 4	10.5	-8.4	3.5	-12.7	7.0
Choice set 5	18.9	-10.4	-6.3	-11.1	8.9
Choice set 6	13.4	-13.0	1.7	-9.6	7.5
Mackay					
Choice set 1	-10.2	23.7	-17.9	13.5	-9.2
Choice set 2	-2.0	17.6	-16.9	6.0	-4.6
Choice set 3	-0.7	16.7	-17.5	8.7	-7.1
Choice set 4	-3.9	13.4	-17.7	14.1	-5.9
Choice set 5	-7.7	17.0	-12.9	12.2	-8.6
Choice set 6	-5.1	15.7	-14.7	9.9	-5.7

* In each choice set there was a significant correlation (at 1% level of significance) between sample population and choice selection

Key Finding 6.3: Respondents in Brisbane were focused on improvements in their own region and did not care too much about other regions.

Key Finding 6.4: Respondents in Toowoomba were most likely to prefer improvements in their own region but many selected the status quo option. There was a strong aversion for improvements in GBR – Coastal region.

Key Finding 6.5: Respondents in Mackay valued improvements in their own GBR – coastal region, but also in GBR – Inland areas. They were not interested in improvements in South East Queensland.

6.3 MNL models with separate regional attribute values

Whereas the models in Table 6.1 linked regional selection with socio-demographic variables, the models outlined in Table 6.3 provide information about the preferences for environmental improvements in the four regions.

Table 6.3 Multinomial logit models for regional improvements within a statewide context

	All respondents		Brisbane		Toowoomba		Mackay	
	Coefficient	S.Error	Coefficient	S.Error	Coefficient	S.Error	Coefficient	S.Error
Socio-economic variables influencing selection of the status quo option								
Age	-0.0017	0.0043	-0.0066	0.0067	-0.0178	0.0112	0.0063	0.0079
Gender	0.3468 ***	0.1013	0.3373 **	0.1692	0.6670 ***	0.1814	-0.0643	0.1947
Children	0.3934 ***	0.1292	0.8785 ***	0.2444	0.2162	0.2287	0.5036 **	0.2514
Education	-0.2070 ***	0.0479	-0.1874 **	0.0792	-0.4042 ***	0.0989	-0.3063 ***	0.0913
Income	-0.1156 ***	0.0377	-0.2307 ***	0.0589	0.2303 **	0.0974	-0.0062	0.0677
Murray Darling								
ASC - MD	-2.1228 ***	0.4068	-3.1694 ***	0.7752	-1.2670 *	0.6883	-2.2827 ***	0.8105
MD - Cost	-0.0063 ***	0.0018	-0.0073 **	0.0034	-0.0049 *	0.0027	-0.0081 **	0.0035
MD - Soil	0.0333 **	0.0141	0.0538 *	0.0276	0.0193	0.0214	0.0460 *	0.0278
MD - Water	0.0587 ***	0.0141	0.0733 ***	0.0276	0.0327	0.0214	0.1067 ***	0.0286
MD - Veg	0.0314 **	0.0141	0.0382	0.0276	0.0341	0.0215	0.0345	0.0279
Great Barrier Reef - Coastal								
ASC - GBRC	-1.6832 ***	0.3734	-2.6261 ***	0.6560	-2.7400 ***	0.7705	-0.0304	0.6389
GBRC - Cost	-0.0071 ***	0.0016	-0.0073 **	0.0029	-0.0027	0.0034	-0.0099 ***	0.0025
GBRC - Soil	0.0226 *	0.0129	0.0180	0.0229	0.0806 ***	0.0285	0.0029	0.0198
GBRC - Water	0.0537 ***	0.0127	0.0602 ***	0.0229	0.0552 **	0.0274	0.0525 ***	0.0196
GBRC - Veg	0.0301 **	0.0129	0.0719 ***	0.0232	0.0128	0.0279	0.0110	0.0198
South East Queensland								
ASC - SEQ	-1.6424 ***	0.3793	-1.9489 ***	0.6050	-1.0342	0.7040	-1.7143 **	0.8028
SEQ - Cost	-0.0086 ***	0.0017	-0.0079 ***	0.0024	-0.0109 ***	0.0030	-0.0069 *	0.0039
SEQ - Soil	0.0310 **	0.0133	0.0419 **	0.0196	-0.0031	0.0240	0.0581 *	0.0313
SEQ - Water	0.0397 ***	0.0131	0.0392 **	0.0191	0.0626 ***	0.0239	0.0188	0.0314
SEQ - Veg	0.0362 ***	0.0130	0.0603 ***	0.0191	0.0071	0.0235	0.0202	0.0308
Great Barrier Reef - Inland								
ASC - GBRI	-2.1382 ***	0.3878	-2.9572 ***	0.6720	-2.3063 ***	0.7884	-0.9713	0.6594
GBRI - Cost	-0.0063 ***	0.0018	-0.0099 ***	0.0032	-0.0055	0.0038	-0.0039	0.0028
GBRI - Soil	0.0491 ***	0.0141	0.0732 ***	0.0245	0.0405	0.0301	0.0395 *	0.0216
GBRI - Water	0.0391 ***	0.0140	0.0746 ***	0.0245	0.0158	0.0297	0.0211	0.0216
GBRI - Veg	0.0327 **	0.0141	0.0297	0.0245	0.0459	0.0301	0.0335	0.0215
Model statistics								
No of observ	2664		996		840		828	
Log L	-3498.96		-1230.32		-1026.85		-1078.66	
Adj R sqed	0.0337		0.0765		0.0669		0.0765	
Chi sqred (dof = 1)	225.75		136.16		88.97		81.83	

Note: This model distinguishes between respondents' values on a regional basis. In some locations only a relatively small number of respondents may have provided information about a particular region. This in effect is "thinning" the data and it is likely that a lot more attributes will not be significant.

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

In this model the socio-demographic variables are associated with the status quo option and have the same influence as was described for the models in Table 6.1. Men and people with dependent children are more likely to select the status quo option and people with higher education levels and higher incomes are less likely to select this option.

The models outlined in Table 6.3 above highlight the fact that many of the attributes are not significant, particularly in the Toowoomba and Mackay populations, where even the cost attribute is not always significant. Model fits, as shown by the adjusted rho-squared statistic, were also weak. One of the main reasons is the limited data set for each sample population, especially if relatively few respondents select a particular regional option. However, it does also suggest that some respondents were not basing their selection in terms of cost (which would be expected), or in terms of improvements in particular attributes. The choice sets in the statewide model were quite complex and contained a lot of information for respondents to process. Some respondents may have used other "cues" or strategies to help determine their preferences.

Evidence presented in Table 6.2 suggests that respondents were either selecting or avoiding specific options. In other words, they were using the "label" as a "cue" to assist selection. Another possible method respondents could have used to help process all the information was to count the overall amount of improvement on offer in each option. This method would have been made easier by the choice set design, which simply presented the alternatives in terms of a "% better" (Figure 6.1).[7]

The more complex nature of the choice selection process in the statewide survey compared with the regional survey is highlighted in the Toowoomba population sample. Chi squared cross tabulations revealed a significant difference (at the 1% level) between the responses for the regional and statewide survey, with a higher proportion of respondents in the latter group who;

- did not **understand** the information in the survey;
- felt they needed **more information**;
- were **confused** by the choice set questions;
- were not sure if they had an attribute **preference**;
- were less **confident** they had made the correct choice; and
- were more likely to select the **status quo** option.

In Mackay, respondents did not appear to have the same difficulty with the statewide survey as there was no significant difference (at the 5% level) in respondents' answers to any of the questions outlined above. In the Brisbane sample, there was some difference in answers to these questions between the two surveys, but not as marked as in Toowoomba. A higher proportion of respondents (significant at the 5% level) in the statewide survey:

- did not **understand** the information
- were **confused** by the choice set questions; and
- were less **confident** they had made the correct choice.

To make it easier to compare respondents' preferences for environmental improvements in the different regions, marginal values have been calculated and these are presented in Table 6.4. These values can in turn be compared with those elicited in the regional models (Table 5.6) to assess whether values vary according to the survey

[7] This format was used after persistent probing at focus groups. It was the format that respondents felt they could best assimilate the complex amount of information. However, it did make "counting" the overall improvements relatively easy and it was mentioned as a strategy used in the last focus group.

format and valuation context. It might be expected that values would be higher when respondents are being asked to consider one particular region than if they are asked to consider several regions in a statewide context. This is because in the statewide context respondents are likely to be more aware of their budget restraints as there is more than one region that might need additional funding to provide NRM improvements.

To make an exact comparison between the marginal values for the state and regional models, it would have been necessary to use the same variables in each model. However, to use the same 17 variables (in addition to the four attributes) for each regional option would have produced models with over 70 variables, which was too large for the software to calculate confidence intervals. Instead, marginal values and confidence intervals were calculated from the smaller models presented in Table 6.3. Full details of the confidence intervals are outlined in Appendix 3.

Table 6.4 Marginal values for state and regional models

	Soil	Water	Vegetation
	$ value of each 1% improvement		
Brisbane – South East Queensland			
State - marginal values	**5.34****	**4.99****	**7.69*****
Regional - marginal values	**3.05*****	**3.42*****	**3.01*****
Toowoomba – Murray Darling			
State - marginal values	**3.92 ns**	**6.64 ns**	**6.92 ns**
Regional marginal values	**4.02*****	**6.28*****	**2.35*****
Mackay – Mackay Whitsunday			
State - marginal values for GBR - coastal	**0.29 ns**	**5.33*****	**1.11 ns**
Regional marginal values	**4.60*****	**7.82*****	**2.42*****
Rockhampton - Fitzroy			
No state sample from Rockhampton	-	-	-
Regional marginal values	**3.70*****	**6.69*****	**4.48*****
All combined			
State - marginal value	**4.64*****	**6.62*****	**4.54*****
State –with regional variables [a]	**4.65*****	**6.74*****	**3.68*****
Regional - marginal value	**3.72*****	**5.80*****	**2.88*****

[a] Marginal values were calculated although the models were too large to calculate confidence intervals.

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

There are several points to note:

- Developing models where the attributes are specified for each region highlights the heterogeneity in values, with some of the attributes not significant and a very wide range in confidence intervals (Appendix 3). However, information is based on a limited range of responses.
- In **Brisbane,** respondents are focused on their own region (see Table 6.2) and this was reinforced in the state model where values for the South East Queensland become even greater than they were in the regional model.

However, when considering state level issues, respondents valued healthy vegetation and soil condition more highly than healthy waterways, whereas in the regional model values for waterways were the highest.

- In **Toowoomba**, considering statewide issues had the opposite effect and none of the attributes were significant for the Murray Darling. However, respondents may have had difficulty deciding where their preferences lay and often favoured the status quo option, as outlined in Table 6.2. In Toowoomba, the only attribute that was significant (where cost was also significant) was healthy waterways in South East Queensland (Table 6.3).
- In **Mackay**, healthy waterways was the only attribute for the GBR – Coastal region that was significant in the statewide model, and this was not valued as highly as it had been in the regional model. In the latter case, where the region being valued was specifically identified as the Mackay Whitsunday area, which may explain the higher values.

Overall, it would appear that there maybe a capital city/regional split in terms of the relative importance of improvements in soil, water and vegetation condition when these issues are presented in statewide context than in a regional context. In Brisbane values for NRM outcomes are higher in the statewide valuation context compared with the regional specific context. However, this is not true for the other regional population centres. To test whether there is a statistical difference in marginal values a Poe et al. (2001) procedure (Section 5.4) can be applied.

In the statewide models there are three comparisons that can be made.

1. Values from the all-combined statewide model (Table 6.1/ Appendix 2) can be compared with the all-combined regional model (Table 5.3/ Appendix 1).
2. The limited data set for the statewide model means that a comparison between statewide and regional values for a specific population and specific region can only be used to compare Brisbane values for South East Queensland (Table 6.3) with the Brisbane /South East Queensland region model (Table 5.3/ Appendix 1). Most attributes were not significant in Toowoomba and Mackay for their local regions and the Rockhampton population was not surveyed.
3. Values from the all combined statewide model for each region (Table 6.1/ Appendix 2) can be compared with the location specific regional models (Table 5.3/ Appendix 1).

The results of all comparisons are presented in Appendix 4. In the first comparison:

- There was **no difference** in marginal values for **any attributes** in the statewide model compared with the all-combined regional model.

In the second comparison:

- There was n**o difference** in the values of Brisbane households for good soil condition or healthy **waterways** between the statewide and regional models.
- There was a **difference** in the values of Brisbane households for healthy **vegetation** between the statewide and regional models.

The third comparison provides further information about contextual influences on value formation. Two of the regions in the statewide model, GBR – Coastal and GBR – Inland were described in general terms but applied the same attribute levels as for

the Mackay Whitsunday region and Fitzroy region in the regional surveys. When all sample populations were combined there was sufficient data to calculate robust values for attribute improvements in each region and these can be compared with the regional specific values from the regional surveys. Results indicate there are no significant differences between values between the combined populations statewide model and regional specific models for improvements in soil, water or vegetation condition in any of the four regions (see Appendix 4 for details). This means that:

- the values Mackay respondents had for improvements in the Mackay Whitsunday region were the same as statewide values for improvements in a region generally termed as "Great Barrier Reef – Coastal"; and
- the values Rockhampton respondents had for improvements in the Fitzroy region were the same as statewide values for improvements in a region generally termed as "Great Barrier Reef – Inland".

Overall, these results indicate that while there appears to be some difference in values for the three environmental resources in different regions, most differences are not statistically significant.

Key Finding 6.6: Distinguishing values for the environmental resources for each region (within a statewide context) highlights preference heterogeneity.

Key Finding 6.7: Respondents in the statewide survey appeared to be using cues to help process information and assist in choice selection. Selection was not necessarily based on improvements in specific attributes.

Key Finding 6.8: Respondents in Toowoomba found the statewide survey more complicated than the regional survey[8]. As a result, more respondents selected the status quo option.

Key Finding 6.9: There was little statistical difference between marginal values for environmental resources across regions and populations. Most of the difference lay in lower values in Brisbane for healthy waterways in South East Queensland.

Key Finding 6.10: When populations and regions were grouped together (statewide and regional models) there was no significant difference between the marginal values for different resources.

Key Finding 6.11: The values Mackay respondents had for improvements in the Mackay Whitsunday region were the same as statewide values for improvements in a region generally termed as "Great Barrier Reef – Coastal".

Key Finding 6.12: The values Rockhampton respondents had for improvements in the Fitzroy region were the same as statewide values for improvements in a region generally termed as "Great Barrier Reef – Inland".

[8] On average Toowoomba respondents were younger and better educated than the other locations (Table 3.2)

7. **Choice modelling results for the Fitzroy – a longitudinal study**

The third choice modelling survey had a different focus from the regional and statewide surveys. In this case, a survey had already been developed and had been conducted with different population samples in 2000, 2001, 2002 and 2003. Conducting the same survey in 2005 would provide the fifth set of choice data and an indication of how values may have changed over time. Whereas the regional and statewide surveys had been framed in terms of the National Action Plan and the need for better NRM outcomes, this survey was framed in terms of water resource development (irrigation). The choice scenario was described in terms of the tradeoff between allocating more water for development which would have economic benefits, but may also have negative environmental impacts.

One of the main differences between this survey design and the regional and statewide surveys was the inclusion of an additional social attribute. It was termed "people leaving country areas each year" and was designed to represent the employment benefits associated with development options. This presented respondents with a more realistic policy scenario where further water resource development may result in environmental losses, but would provide employment benefits. The choice profiles were more realistic as they presented options for environmental improvements but these included tradeoffs in terms or reduced employment opportunities which might mean people would have to leave country areas to find employment elsewhere.

Although the attributes used in each year of the survey have not always been the same, two of the environmental attributes (healthy waterways and healthy vegetation) have remained constant. Values elicited for these attributes in this survey are directly comparable with the results from the regional model for the Fitzroy, outlined in Section 5. Results for this survey will provide information about how values may have changed over time in the different populations sampled. Survey details for each year are outlined in Table 7.1.

Table 7.1 Details of all Fitzroy surveys

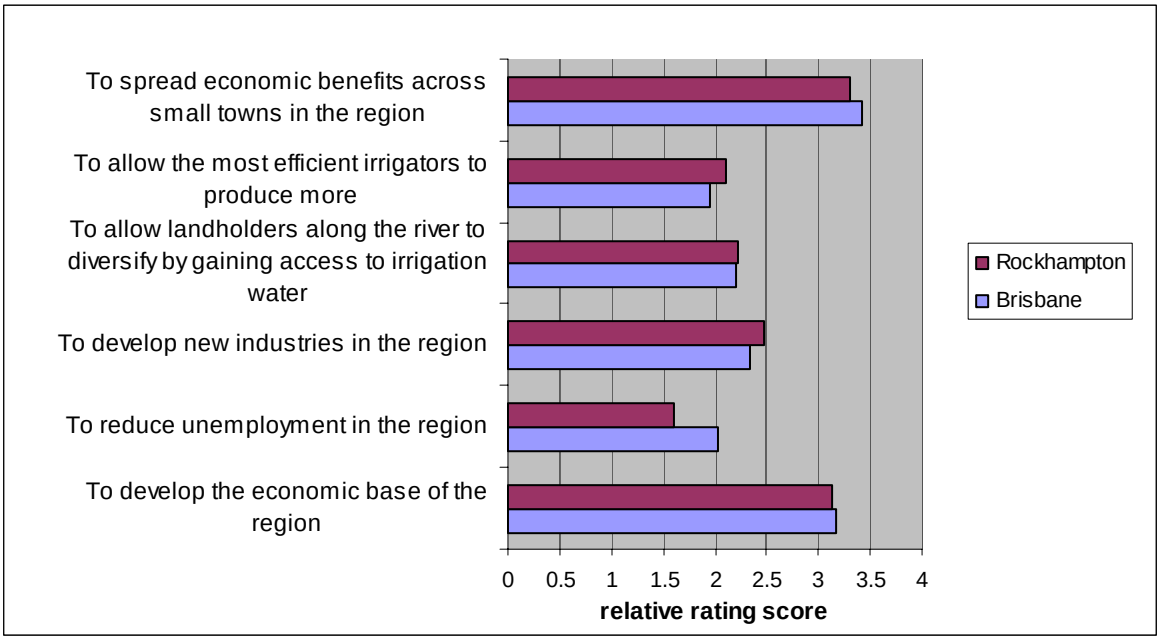
Year	Attributes valued	Survey sample	References
2000	Healthy vegetation Healthy waterways People leaving country areas Water reserve	Emerald Rockhampton Brisbane	Loch et al. 2002 Rolfe et al. 2002 Rolfe and Windle 2005
2001	Healthy vegetation Healthy waterways Protection of Aboriginal cultural heritage sites Water reserve	Rockhampton Rocky Aboriginal Brisbane	Rolfe and Windle 2003 Windle and Rolfe 2003
2002	Healthy vegetation Healthy waterways People leaving country areas Water reserve	Brisbane	Rolfe and Bennett 2003
2003	Healthy vegetation Healthy waterways Protection of Aboriginal cultural heritage sites River estuary	Brisbane	Windle and Rolfe 2005

Year	Attributes valued	Survey sample	References
2005	Healthy vegetation Healthy waterways People leaving country areas River estuary	Brisbane Rockhampton	

7. 1 Results from the 2005 survey

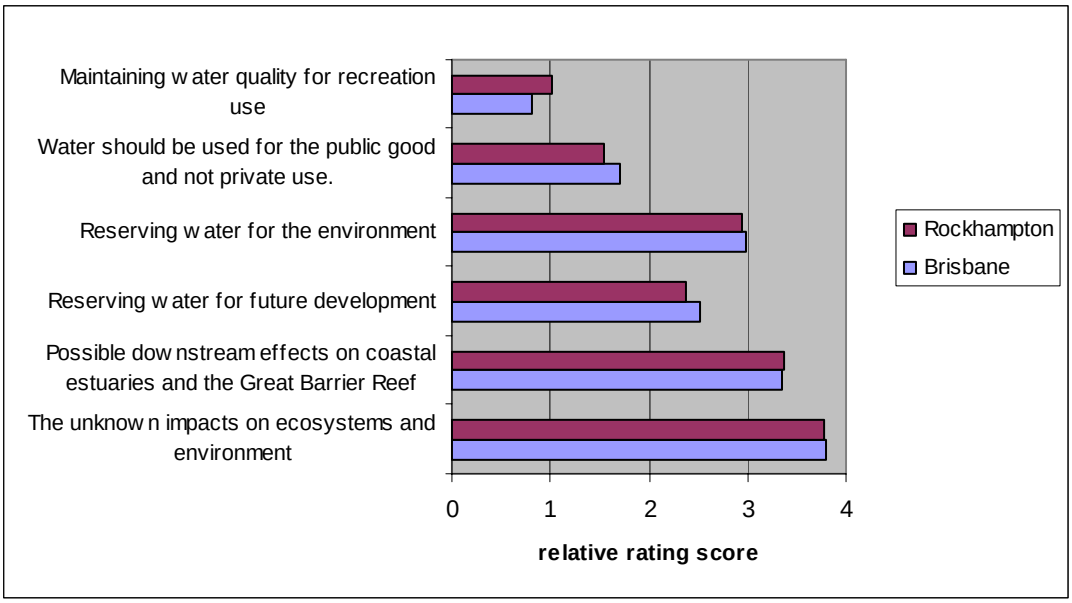
In the warm up questions in the first part of the survey, respondents were provided with reasons why allocating more water for irrigation may be a good idea and asked to rank them from 1(most) to 6 (least) important. It was the broader and the more equitable reasons that had the highest relative ranking scores (Figure 7.1).

Figure 7.1 Relative ranking scores for allocating more water of irrigation



A similar question was then asked about rating reasons for not allocating more water to development (Figure 7.2).

Figure 7.2 Relative ranking scores for NOT allocating more water of irrigation



The interesting result here is that the reasons rated most highly are those that most closely align with non-use, quasi-option values (Section 4.2). In other words, respondents are favouring a risk adverse strategy to "reserve water for the environment" because of the uncertainty surrounding the full nature of the environmental impacts of further water resource development. This uncertainly extends to the impacts on the Great Barrier Reef. Recreational use values had the lowest rating, even for Rockhampton respondents who were at the mouth of the Fitzroy river.

An example choice set is presented in Figure 7.3.

Figure 7.3 Example choice set for the Fitzroy longitudinal survey

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	Healthy vegetation	Waterways in good health	People leaving country areas every year	River estuary in good health	I would choose
Current condition	45%	2800 km	30 people	75%	
Condition in fifteen years time – Options A,B, and C					
Option A					
$0	25%	1500 km	0 people	65%	☐
Option B					
$50	40%	1500 km	5 people	75%	☐
Option C					
$50	25%	1800 km	25 people	70%	☐

The attribute details and levels used in this survey are outlined in Table 7.2. The other variables have been described in Table 5.2.

Table 7.2 Attribute description and levels for current survey

Attribute name	Description	Levels
Cost	Amount that households would pay in extra rates (or rent) each year to fund improvements	**Future Base:** $0 **Choice set levels** **$**10, $20, $50, $100
Healthy vegetation	% of healthy vegetation remaining in floodplains	**Future Base:** 25% **Choice set levels:** 25%, 30%, 35%, 40%
Healthy waterways	Kilometres of waterways in catchment remaining in good health	**Future Base:** 1500km **Choice set levels:** 1500km, 1800km, 2100km, 2400km
People leaving country areas	No of people leaving country areas each year	**Future Base:** 0 **Choice set levels:** 0, 5, 10, 15 people
River estuary	% of river estuary in good health	**Future Base:** 65% **Choice set levels:** 50%, 55%, 60%, 65%, 70%,75%, 80%, 85%

This survey was collected at the same time and in the same format as the other two surveys. There were eight choice sets in each questionnaire and eight versions of the survey which meant a total of 64 different choice sets were completed. In this case, 122 completed surveys were collected in Brisbane and 97 in Rockhampton (see Table 3.1), meaning a total of 976 and 776 choice sets were completed in Brisbane and Rockhampton respectively.

Multinomial logit models were calculated in the same way as outlined in the two sections above. The MNL models were statistically robust with all attributes significant and signed as expected (Table 7.3).

These models can be read in the same way as those discussed in earlier sections. The ASC constant values are not significant which meant that variables used in the models are sufficient in describing the influences on choice selection. In the Brisbane model the ASC is weakly significant indicating there were some other factors influencing choice selection. The main point to note is that all the socio-demographic variables were significant influences on choice selection in Rockhampton whereas none of them are significant in the Brisbane model. Overall, those who were less confident that they had made the right choice selection and those that did not understand the information in the survey were less likely to select an improvement option.

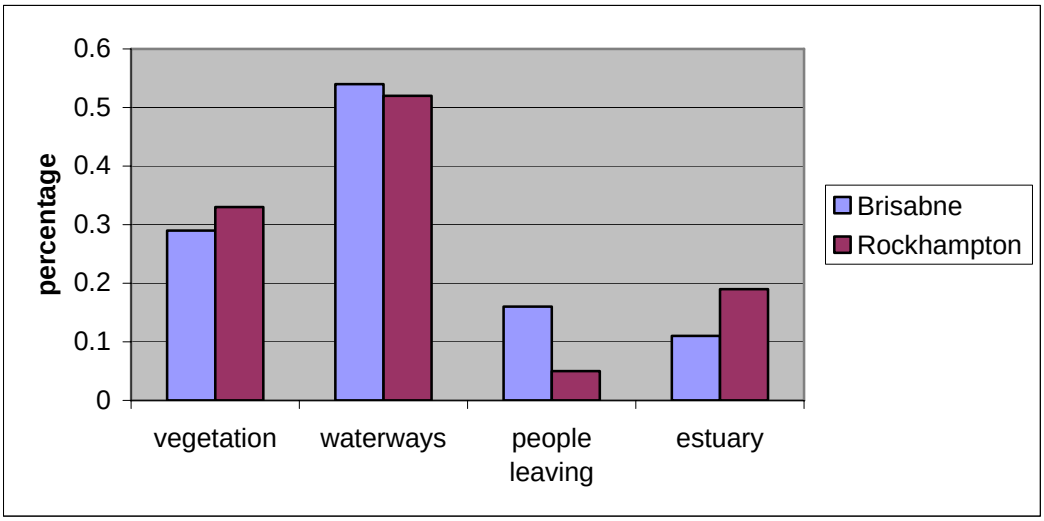
Those who had a preference for the different attributes were more likely to select an improvement option. The majority of those with preferences considered healthy waterways as the most important attribute, with healthy vegetation coming second (Figure 7.4).

Table 7.3 MNL models for the Fitzroy longitudinal survey

	All combined		Brisbane		Rockhampton	
	Coefficient	S.Err	Coefficient	S.Err	Coefficient	S.Err
Cost	-0.0088 ***	0.0011	-0.0087 ***	0.0015	-0.0094 ***	0.0017
Vegetation	0.0663 ***	0.0065	0.0586 ***	0.0087	0.0812 ***	0.0104
Waterways	0.0009 ***	0.0001	0.0008 ***	0.0002	0.0011 ***	0.0002
People Leaving	-0.0250 ***	0.0044	-0.0306 ***	0.0059	-0.0219 ***	0.0069
Estuary	0.0287 ***	0.0036	0.0177 ***	0.0048	0.0463 ***	0.0059
ASC	-0.7482	0.5021	-1.2230 *	0.6711	-1.2757	0.9651
Age	0.0053	0.0055	-0.0005	0.0078	0.0269 **	0.0111
Gender	0.1900	0.1425	-0.2225	0.1808	1.3140 ***	0.2928
Children	0.0293	0.1770	-0.3152	0.2655	1.0199 ***	0.3009
Education	0.2027 ***	0.0641	0.0870	0.0908	1.1417 ***	0.1662
Env condition	-0.2003 **	0.0875	-0.2360 **	0.1115	0.1147	0.1839
Env favour	0.3125 **	0.1271	0.3956 **	0.1614	-0.5959 *	0.3072
Confidence	-0.1549 *	0.0886	-0.0085	0.1191	-0.5595 ***	0.1660
Preference	0.7926 ***	0.0763	0.8655 ***	0.0975	0.5810 ***	0.1500
Understood	-0.1584 **	0.0655	-0.1257	0.0912	-0.5418 ***	0.1319
More Info	0.0712	0.0813	0.3529 ***	0.1162	-0.1995	0.1453
Confused	0.0335	0.0757	0.0877	0.1013	-0.2159	0.1440
Model statistics						
log likelihood	-1437.941		-824.0146		-539.3527	
Adj R sqrd	0.16071		0.13936		0.27750	
Observations	1568		880		688	

*** significant at 1%; ** significant at 5%; *significant at 10%
Note: If "Income" was included as a variable it was significant in the Rockhampton but not the Brisbane model.

Figure 7.4 Percentage of respondents with a preference, rating attributes first



For Brisbane respondents, people leaving country areas was more important than the health of the river estuary, whereas the opposite was true for Rockhampton respondents.

Alternative choice levels in this survey included the status quo level, which was not the case in the regional and statewide models. This resulted in a lower proportion of

respondents always selecting the status quo option in this survey – 12% and 6% for Brisbane and Rockhampton respectively in this survey, compared with 19% and 14% (Table 4.3) in the other surveys. This would suggest that in the other surveys, some respondents did select the status quo option because they preferred the levels on offer and not just because there was no associated cost.

The marginal values calculated from this model are presented in Table 7.4.

Table 7.4 Marginal values for environmental and social attributes

	All combined	Brisbane	Rockhampton
		$ values for a one unit change	
Vegetation			
Marginal values (%)	**7.56**	**6.72**	**8.62**
(confidence intervals)	(5.67 – 10.48)	(4.40 – 10.40)	(5.97 – 13.37)
Waterways			
Marginal values (km)	**0.10**	**0.09**	**0.12**
(confidence intervals)	(0.07 - 0.15)	(0.06 - 0.15)	(0.07 - 0.20)
People Leaving			
Marginal values (people)	**-2.85**	**-3.51**	**-2.33**
(confidence intervals)	(-4.27 to -1.79)	(-5.79 to -2.00)	(-4.57 to -0.88)
Estuary			
Marginal values (%)	**3.27**	**2.04**	**4.92**
(confidence intervals)	(2.39 – 4.59)	(0.94 – 3.53)	(3.23 – 7.73)

The results from the Brisbane and Rockhampton models are very consistent and the confidence intervals for all the attribute values are overlapping. Although log likelihood ratio tests indicate there is a significant difference between the two population samples. However, tests using the Poe et al. (2001) procedure (Section 5.4) indicate that there is no significant difference between Brisbane and Rockhampton households' marginal values for any of the attributes apart from those for the river estuary (Appendix 4). This implies that, in general, local communities do not have higher values for their own region compared with the values held by a remote community for the same region. However, in a statewide context, local communities may have stronger preferences for their own region compared with a remote community (Table 6.2).

The results indicate that:

- Overall, households value a 1% improvement in healthy vegetation in the Fitzroy Basin at **$7.56,** ranging from **$6.72** in Brisbane to **$8.62** in Rockhampton**.** This represents an annual payment for 15 years which has a present value of **$78.47** per household.
- Overall, households value a one kilometre improvement in healthy waterways in the Fitzroy Basin at **$0.10**, ranging from **$0.09** in Brisbane to **$0.12** in Rockhampton**.** This represents an annual payment for 15 years which has a present value of **$1.04** per household.
- Overall, households are willing-to-pay **$2.85** to avoid one person having to leave a country area in the Fitzroy Basin, ranging from **$3.51** in Brisbane to **$2.33** in Rockhampton**.** This represents an annual payment for 15 years which has a present value of **$29.58** per household.

- Overall, households value a 1% improvement in the health of the Fitzroy estuary at **$3.27** ranging from **$2.04** in Brisbane to **$4.92** in Rockhampton**.** This represents an annual payment for 15 years which has a present value of **$33.94** per household.

Key Finding 7.1: There was no difference between Brisbane and Rockhampton households' marginal values for any of the environmental or social attributes, apart from values for the health of the river estuary.

7. 2 A comparison of values from the different populations over time

In the analysis outlined in the sections above, two types of comparisons have been made about respondents' values. One has compared complete models for different populations and the other has compared marginal values for different environmental resources in different populations. From an economic perspective the two comparisons are quite different. The complete model provides an estimation of respondents' "utility" or "welfare" (value) function and includes all the factors outlined in the models. It is possible that values for a particular attribute maybe dependent on the other attributes in the valuation scenario, and the marginal values between attributes may cancel out in a value function. It is also possible that differences in population characteristics may compensate for differences in marginal values in a value function.

One way of determining whether there is a difference between two models or value functions is to conduct a log likelihood ratio test which compares the difference between the log likelihood of two separate models and that for a combined model. Such a test indicates that Rockhampton and Brisbane had different values for the Fitzroy in the 2005 longitudinal survey. This is perhaps not surprising as it might be expected that local residents have higher values for their own region than people outside the region. However, in some of the previous Fitzroy surveys log likelihood tests have shown no difference between household values in Brisbane and Rockhampton for environmental improvements in the Fitzroy. Tests have shown (results are reported in the references provided in Table 7.1) that in **2000** values were not the same for Rockhampton and Brisbane, but they were the same in **2001**.

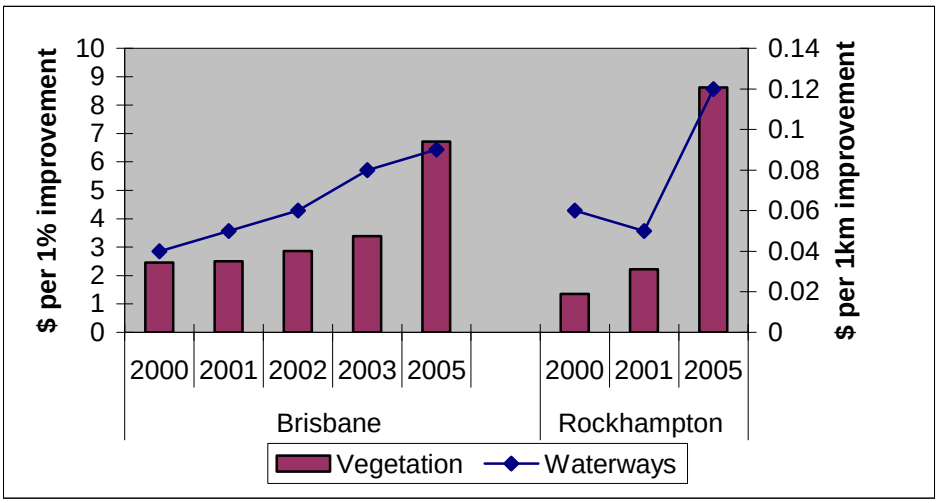
The other comparison of values is to compare the marginal values for separate attributes. The same Poe et al. (2001) procedure to determine differences in marginal values can be applied to examine the changes in values over the six year survey period. The marginal values for healthy vegetation and waterways elicited in the different surveys are outlined in Table 7.5.

Table 7.5 A longitudinal comparison of marginal values

Year of survey	Population sample	Healthy vegetation ($ values for a 1% improvement)	Healthy waterways ($ values for a 1km improvement)
2000	Brisbane	**$2.46** (1.75-3.27)	**$0.04** (0.01-0.06)
	Rockhampton	**$1.36** (0.44-2.34)	**$0.06** (0.02-0.09)
2001	Brisbane	**$2.51** (1.26-4.71)	**$0.05** (0.00-0.12)
	Rockhampton	**$2.22** (1.25-3.50)	**$0.05** (0.01-0.10)
2002	Brisbane	**$2.87** (1.01-5.25)	**$0.06** (0.01-0.11)
2003	Brisbane	**$3.39** (2.16 - 5.10)	**$0.08** (0.05 - 0.13)
2005	Brisbane	**6.72** (4.40 – 10.40)	**0.09** (0.06 - 0.15)
	Rockhampton	**8.62** (5.97 – 13.37)	**0.12** (0.07 - 0.20)

Full details of the marginal values for all the attributes in the different surveys are presented in Appendix 5 and results of the Poe tests are presented in Appendix 4. The results indicate that the values for healthy waterways have generally remained consistent over time. Although there appears to be a steady increase in marginal values, there is no significant difference between them since 2001. On the other hand, the values for healthy vegetation were more consistent in the earlier years (2000-2003) but have shown a significant increase in 2005 (Figure 7.5).

Figure 7.5 Values for healthy waterways and vegetation in the Fitzroy over time



Key Finding 7.2: Since 2001, the marginal values of Brisbane and Rockhampton households for improvements in waterways in the Fitzroy have been quite consistent., although mean values are showing some upwards trend.

Key Finding 7.3: The marginal values of Brisbane and Rockhampton households for improvements in healthy vegetation in the Fitzroy have shown a sharp increase since 2003.

8. Summary of results

The results of the three surveys presented above contain a large amount of detailed information that might not be readily assimilated. In particular, some of the more technical results will only be immediately relevant to NRM managers with some background in economic valuation. However, there are other more general results on community attitudes that will be relevant to a wider range of NRM managers. There are five main sources of information that should be useful to different NRM groups and managers across the state.

1. Section 4 presents valuable information about community opinions and attitudes to NRM issues in Brisbane, Toowoomba, Mackay and Rockhampton.
2. The specific case studies provide information about how respondents' values and preferences may be influenced by their opinions and socio-demographic characteristics.
3. Detailed information is provided on household values (in dollar terms) for improvements in soil, water and vegetation condition. These values can be used to estimate the public benefits of achieving particular targets outlined in the NRM plans.
4. The non-market valuation methodology provides NRM managers with information about how "use" and in particular, "non-use" values for NRM improvements may be assessed.
5. Some information is presented and further references are provided about a broader range of community values for environmental and social impacts associated with water resource development in the Fitzroy Basin (Table 7.1). These results are from a longitudinal study where information has been collected over a number of years.

The calculated values for NRM improvements include two components of value; use and non-use values. Indeed, there are indications that non-use values are more important than use values. This finding has two important implications. First, it means that people hold significant values for NRM improvements in a particular region, even when they do not reside within that region. This means the public benefits of improvements within a region extend to residents across the state. The second implication is that any estimation of value of NRM improvements will need to account for non-use values, which in turn implies that stated preference valuation techniques will need to be applied.

Assessing the tradeoffs between public and private costs and benefits is important. In this report information has been presented about assessing values for public benefits. However, non-market valuation surveys are not cheap and take time to complete, and collecting original or primary data will not always be a feasible or affordable option. If there is no data on the public benefits for resource condition improvements in one specific region, then one option would be to apply and adapt data and information that already exists about another region. This is known as benefit transfer and describes a process where values from an existing data source or study site/region can be transferred to a target site/region.

The intention in this study is to develop a set of indicative values that can be used for benefit transfer and applied in all regions of Queensland. To do this, a range of

surveys were conducted in different regions and in different contexts to estimate the extent to which it might be realistic for values collected in one region to be applied in another region.

There are two measures of value that can be calculated from the different models outlined above. The first is marginal value, which is an estimate for a one unit change in each specific attribute. Focusing on estimates of marginal value implies that the values for the associated NRM improvements are independent of the context in which they were elicited. The second measure of value assumes that the valuation context does matter and for example, the values for an improvement in soil condition are influenced by the fact that respondents were comparing it with improvements in waterway and vegetation health. In this case, estimates can be made of what economists refer to as a value function. A value function would include all the parameters outlined in the MNL models presented above.

In the first regional survey, all the regional models were significantly different from each other, which indicates that the overall value function for regional respondents cannot not be transferred across regions. However, one of the important finding from this survey was that respondents' preferences and values could be categorised into four distinct classes that were not population specific (Table 5.2). The four classes were:

Class 1: Respondents with very strong values for all attributes, especially soil and water;

Class 2: Respondents without very strong preferences, but with a distinct preference for the different attributes. Improvements in healthy waterways were most preferred, then healthy vegetation and then good soil condition;

Class 3: Respondents with stronger preferences than the second class, but no real preference between attributes; and

Class 4: Respondents with positive values for improvements in healthy waterways, but negative values for soil and vegetation improvements.

These distinct classes of preferences were apparent in all regions and when all survey responses are combined the regional differences even-out and there is little difference in the marginal values across the regions and between the regional and all-combined models (Appendix 4).

1. There is no difference in the marginal values for **soil** and **vegetation** improvements between the all-combined model and the separate regional models.
2. There is no difference in the marginal values for good **soil condition** between any of the regional models.
3. The only difference in marginal values for **healthy vegetation** is between the Toowoomba and Rockhampton models.
4. Marginal values for **healthy waterways** in the Brisbane regional model are significantly lower than any of the regional models, or the all-combined model. Values are the same in the other three regions.

If there was a need to apply these values to another region not included in the survey there would be several options.

1. For a 1% improvement in **soil condition**, values could be transferred from one of the sampled regions that might have similar characteristics, or the value of **$3.72** for the all-combined model could be applied.
2. For a 1% improvement in healthy **vegetation**, values could be transferred from Brisbane or Mackay (if the target population had similar characteristics) otherwise it would be best to use the value of **$2.88** from the all-combined model.
3. For a 1% improvement in healthy **waterways**, values could be transferred from one of the sampled regions that might have similar characteristics, but not from Brisbane. The value of **$5.80** from the all-combined model could be applied. If the target region is part of South East Queensland, those values should apply.
4. Given that the values in the all-combined models are lower than in the separate regional models, a conservative approach would be to use these to transfer to a target region.

The results from the statewide survey provide three insights into values for NRM outcomes. First, they provide an indication of how values for a specific region may vary if the valuation context includes other regions in the state (as opposed to the first regional survey, where the focus was on a single region). Second, the results provide an indication of the values (mainly non-use) that residents outside a region may have for that region. Third, they provide an indication of how the way a region is described may affect respondents' values and preferences.

Results from the statewide model suggest that the combined regional results are the most robust values to apply from that survey. While marginal values from the statewide survey appear higher that the values from the all-combined regional models (Table 6.4), there are no statistical differences between the marginal values (Appendix 4). More specifically, there was no statistical difference between the all-combined statewide model values for a specific region, and the values elicited for the same region in the location specific regional models. The results imply that the context of the valuation survey (single region Vs statewide) does not significantly affect marginal values for improved NRM outcomes.

Brisbane was the only sample community where there was sufficient data to compare the same valuation context (statewide Vs single region) in a specific community. The results indicated there was no difference in marginal values for improved soil and water condition, but there was for vegetation (Appendix 4). In Brisbane, the values for a one percent increase in healthy vegetation in South East Queensland were significantly higher (more than double) when valued in a statewide context compared with the single region context. When presented with a wider frame of reference, respondents seemed to focus their attention more closely on vegetation improvements in their own region which increased the strength of preferences and values.

The third important result from the statewide model was that values for the regions GBR-Coast and GBR-Inland were the same as those determined in the location specific region models for the Mackay Whitsunday and Fitzroy regions respectively. The values for the latter had been used to represent the broad regions in the statewide model. This means that values do not vary if a region is described in broad or specific

terms, which in turn implies that values determined in one specific region, may be used as indicative values in another region that is broadly similar.

Results from the Fitzroy longitudinal survey suggest that:

1. Values for improvements in healthy waterways are stable over time. This would imply that the values elicited in this survey will be stable for a few years and will not quickly become outdated.
2. Values for healthy vegetation have risen sharply in recent years, and are an important issue for both local and remote populations.
3. Households in Brisbane have the same marginal values as local households in the region, for environmental improvements in the condition of waterways and vegetation resources in the Fitzroy Basin.

Although the choice models that explain respondents' value formation differ from each other, the comparison of marginal values indicates there is more similarity in values across regions and populations. This suggests that values assessed in one context may be transferred and applied to another situation (although it would always be more accurate to collect primary data for a particular location). A comparison of results from the three main surveys have highlighted that marginal values do not necessarily differ when the valuation context changes, making the values more robust for benefit transfer. This result will be of particular interest to economists who conduct non-market valuations and who need to consider the potential of survey data for benefit transfer. In particular, the results have shown that marginal values remain the same when:

1. The valuation context is framed in terms of a single region or as multiple regions within a statewide context;
2. The number and type of attributes vary; and
3. The region being valued is described in very specific or very general terms.

The results from these surveys have outlined a set of indicative marginal values for improved NRM outcomes. In order to apply these values to calculate estimates of the public benefits for a particular NRM improvement in a particular area, the household values outlined above need to be extrapolated to account for all households across the state who may value such improvements. There are a number of technical issues to consider in extrapolating and applying these results, which will be outlined and discussed in the third research report.

Overall, if there was a need to transfer values to another region and a conservative approach was adopted, it would be reasonable to apply the values from the all-combined regional model. However, as with the process of extrapolation, there are also a number of technical issues to consider in the process of benefit transfer, and these too will be discussed in the third research report.

All the key findings from the report are outlined below.

Key findings

Section 4 - Respondents' attitudes and opinions:

Key Finding 4.1: In all populations, non-use values were rated as more important than use values.

Key Finding 4.2: There was support for all levels of government to be responsible for NRM issues, with approximately equivalent support for federal and state government responsibility, less support for NRM groups and least support for local government.

Key Finding 4.3: The majority of respondents understood the information in the questionnaire and were confident that they had made the right choice selections.

Section 5 – Results from the regional survey:

Key Finding 5.1: Age was not a significant influence on preferences and choice selection but education, whether people had dependent children and gender were all significant influences.

Key Finding 5.2: Overall, people who were less confident that they had made the correct choice selection and people who did not understand the information in the survey were more likely to select the status quo option.

Key Finding 5.3: Overall, respondents' opinions about non-use value ratings for bequest and quasi-option values had a significant influence on preferences. Both were positive explanatory variables of environmental values.

Key Finding 5.4: The type of preferences across all respondents can be classified into four distinct groups that are not location specific. Those with very strong values for all attributes, especially soil and water; those with preferences for water, then vegetation and then soil; those with no real preference between attributes; and those with positive values for water but negative values for soil and vegetation.

Key finding 5.5: Overall, respondents (households) valued a 1% improvement in the area of soil in good condition at $3.72. This was an annual amount for a period of 15 years and represents a present value of $38.61. Values ranged from ranged from $3.05 in Brisbane for a 1% improvement in South East Queensland to $4.60 in Mackay for a 1% improvement in the Mackay/Whitsunday region.

Key finding 5.6: Overall, respondents (households) valued a 1% improvement in the length waterways in good health at $5.80. This was an annual amount for a period of 15 years and represents a present value of $60.20. Values ranged from $3.42 in Brisbane for a 1% improvement in South East Queensland to $7.82 in Mackay for a 1% improvement in the Mackay/Whitsunday region.

Key finding 5.7: Overall, respondents (households) valued a 1% improvement in the area of healthy vegetation at $2.88. This was an annual amount for a period of 15 years and represents a present value of $29.89. Values ranged from $3.01 in Brisbane

for a 1% improvement in South East Queensland to $4.48 in Rockhampton for a 1% improvement in the Fitzroy region.

Key Finding 5.8: Values were highest for healthy waterways in all populations.

Key Finding 5.9: Values for healthy waterways were higher in the regional populations compared with Brisbane, the capital city.

Section 6 – Results from the statewide survey:

Key Finding 6.1: Population location was a significant explanator of preferences for improvements in different regions. Respondents in the more regional/rural locations of Toowoomba and more so in Mackay, preferred improvements in the three rural regions. They were less likely to select improvements in the South East Queensland region.

Key Finding 6.2: Overall, the socio-demographic variables had an inconsistent influence on choice selection. Education was the variable that was the most consistent explanator of preferences

Key Finding 6.3: Respondents in Brisbane were focused on improvements in their own region and did not care too much about other regions.

Key Finding 6.4: Respondents in Toowoomba were most likely to prefer improvements in their own region but many selected the status quo option. There was a strong aversion for improvements in GBR – Coastal region.

Key Finding 6.5: Respondents in Mackay valued improvements in their own GBR – coastal region, but also in GBR – Inland areas. They were not interested in improvements in South East Queensland.

Key Finding 6.6: Distinguishing values for the environmental resources for each region (within a statewide context) highlights preference heterogeneity.

Key Finding 6.7: Respondents in the statewide survey appeared to be using cues to help process information and assist in choice selection. Selection was not necessarily based on improvements in specific attributes.

Key Finding 6.8: Respondents in Toowoomba found the statewide survey more complicated than the regional survey. As a result more respondents selected the status quo option.

Key Finding 6.9: There was little statistical difference between marginal values for environmental resources across regions and populations. Most of the difference lay in lower values in Brisbane for healthy waterways in South East Queensland.

Key Finding 6.10: When populations and regions were grouped together (statewide and regional models) there was no significant difference between the marginal values for different resources.

Key Finding 6.11: The values Mackay respondents had for improvements in the Mackay Whitsunday region were the same as statewide values for improvements in a region generally termed as “Great Barrier Reef – Coastal”.

Key Finding 6.12: The values Rockhampton respondents had for improvements in the Fitzroy region were the same as statewide values for improvements in a region generally termed as “Great Barrier Reef – Inland”.

Section 7 – Results from the Fitzroy longitudinal survey:

Key Finding 7.1: There was no difference between Brisbane and Rockhampton households’ marginal values for any of the environmental or social attributes, apart from values for the health of the river estuary.

Key Finding 7.2: Since 2001, the marginal values of Brisbane and Rockhampton households for improvements in waterways in the Fitzroy have been quite consistent, although mean values are showing some upwards trend.

Key Finding 7.3: The marginal values of Brisbane and Rockhampton households for improvements in healthy vegetation in the Fitzroy have shown a sharp increase since 2003.

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Appendices

Appendix 1. Regional multinomial logit models

Population	ALL		Brisbane		Toowoomba		Mackay		Rockhampton	
Region	Combined		S.E Queensland		Murray Darling		Mackay/Whitsunday		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;

Appendix 2. 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		ba 996 d 162		ba 840 d 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 3. Marginal values and confidence intervals for the statewide model calculated from Table 6.4.

	ALL	Brisbane	Toowoomba	Mackay
Murray Darling				
cost	***	**	*	**
soil	**5.29**** (1.05-12.43)	**7.39*** (-0.44-48.51)	**3.92 ns** (-13.29-31.88)	**5.65*** (-3.40-20.57)
water	**9.32***** (4.06-21.47)	**10.08***** (2.05-57.44)	**6.64 ns** (-15.21-40.19)	**13.09***** (4.14-56.84)
vegetation	**4.99**** (0.44-12.89)	**5.25 ns** (-2.60-36.37)	**6.92 ns** (-21.47-54.32)	**4.23 ns** (-3.13-25.98)
GBR - Coastal				
cost	***	**	ns	***
soil	**3.20*** (-0.48-7.75)	**2.47 ns** (-5.86-14.68)	**29.50***** (-262.70-278.77)	**0.29 ns** (-3.96-3.89)
water	**7.61***** (4.30-14.90)	**8.27***** (2.18-31.50)	**20.21**** (-201.17-174.29)	**5.33***** (1.30-10.58)
vegetation	**4.27**** (0.63-7.96)	**9.88***** (2.92-40.36)	**4.69ns** (-93.85-72.33)	**1.11 ns** (-3.04-4.61)
South East Queensland				
cost	***	***	***	*
soil	**3.61**** (0.82-7.03)	**5.34**** (0.68-17.4)	**-0.28ns** (-4.93-4.79)	**8.40*** (-36.63-78.78)
water	**4.62***** (1.66-8.31)	**4.99**** (0.55-16.93)	**5.72***** (1.46-13.24)	**2.73 ns** (-11.18-53.83)
vegetation	**4.22***** (1.32-7.06)	**7.69***** (3.19-21.03)	**0.65ns** (-4.70-5.46)	**2.92 ns** (-9.65-49.08)
GBR - Inland				
cost	***	***	ns	ns
soil	**7.80***** (3.47-19.40)	**7.39***** (2.43-25.10)	**7.41ns** (-32.45-37.01)	**10.04*** (-81.70-155.59)
water	**6.21***** (1.45-16.69)	**7.54***** (2.67-25.93)	**2.89ns** (-20.43-25.76)	**5.36 ns** (-32.31-114.48)
Vegetation	**5.19**** (1.16-15.87)	**3.00 ns** (-2.48-12.77)	**8.39ns** (-45.07-50.21)	**8.51 ns** (-69.86-143.41)
Model statistics				
Observations	2664	996	840	828
Log Likelihood	-3498.96	-1230.32	-1026.85	-1078.66
Adj R squared	0.0337	0.0765	0.0669	0.0765
Chi sqrd (dof =21)	225.75	136.16	88.97	81.83

Note: The large number of attributes that are not significant can be expected if a relatively small number of respondents provided information about a particular region.

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

Appendix 4. Similarities in marginal values at the 95% level of significance

		Vegetation	Waterways	Soil	
2005:					
Statewide – all	Regional – all	✓	✓	✓	
Regional					
Regional – all	South East Qld	✓	x	✓	
Regional – all	Murray Darling	✓	✓	✓	
Regional – all	Mackay Whitsunday	✓	✓	✓	
Regional – all	Fitzroy	✓	✓	✓	
South East Qld	Murray Darling	✓	x	✓	
South East Qld	Mackay Whitsunday	✓	x	✓	
South East Qld	Fitzroy	✓	x	✓	
Murray Darling	Mackay Whitsunday	✓	✓	✓	
Murray Darling	Fitzroy	✓	✓	✓	
Mky Whitsunday	Fitzroy	✓	✓	✓	
Statewide – all	**Regional**				
Murray Darling	Toow'ba for Murray D	✓	✓	✓	
GBR - Coast	Mackay for Mky/whit	✓	✓	✓	
South East Qld	Bne for S.E. Qld	✓	✓	✓	
GBR-Inland	Rockh'ton for Fitzroy	✓	✓	✓	
State - Brisbane				✓	
State – S.E. Qld	Regional S.E. Qld	x	✓	✓	

		Vegetation	Waterways	People leaving	Water reserve
2000: Fitzroy 1					
Brisbane	Emerald	✓	x	✓	✓
Brisbane	Rockhampton	x	✓	✓	✓
Emerald	Rockhampton	✓	✓	✓	✓
2001: Fitzroy 2					
Brisbane	Rock general	✓	✓		✓
Brisbane	Rock Aboriginal	x	✓		✓
Rock general	Rock Aboriginal	x	✓		✓
Rockhampton: Fitzroy 1,2 & 5					
2000	2001	✓	✓		✓
2005	2001	x	✓		
Brisbane: Fitzroy 1,2,3,4 & 5					
2000	2001	✓	✓		✓
2000	2002	✓	✓	✓	x
2000	2003	✓	x		
2000	2005	x	x		
2001	2002	✓	✓		✓
2001	2003	✓	✓		
2001	2005	x	✓		
2002	2003	✓	✓		
2002	2005	x	✓		**Estuary**
2003	2005	x	✓		
2005: Fitzroy 5 (longitudinal)					
Brisbane	Rockhampton	✓	✓	✓	x

Appendix 5. A longitudinal comparison of marginal values

Survey	Population	vegetation	waterways	Water reserve	River estuary	People leaving	Aboriginal culture
2000	Brisbane	**2.46** (1.75-3.27)	**0.04** (0.01-0.06)	**1.52** (0.22-2.81)		**-0.28** (-0.50 to -0.07)	
	Rockhampton	**1.36** (0.44-2.34)	**0.06** (0.02-0.09)	**1.43** not signif		**-0.29** (-0.58 to-0.02)	
	Emerald	**1.94** (1.16-2.83)	**0.07** (0.05-0.10)	**2.20** (0.71-3.71)		**-0.28** (-0.52 to-0.04)	
2001	Brisbane	**2.51** (1.26-4.71)	**0.05** (0.00-0.12)	**3.19** (1.79-5.32)			**-1.32** (-2.73 to -0.15)
	Rockhampton	**2.22** (1.25-3.50)	**0.05** (0.01-0.10)	**2.95** (1.93-4.35)			**-2.06** (-3.29 to -1.11)
	Rockhampton Aboriginal	**0.45** not signif	**0.06** (-0.01-0.14)	**3.86** (2.02-6.73)			**3.37** (1.80-6.21)
2002	Brisbane	**2.87** (1.01-5.25)	**0.06** (0.01-0.11)	**5.77** (3.20-8.85)		**-0.88** (-1.79 to -0.06)	
2003	Brisbane	**3.39** (2.16 - 5.10)	**0.08** (0.05 - 0.13)		**3.21** (2.07 - 4.72)		**-5.09** not signif
2005	Brisbane	**6.72** (4.40 – 10.40)	**0.09** (0.06 - 0.15)		**2.04** (0.94 – 3.53)	**-3.51** (-5.79 to -2.00)	
	Rockhampton	**8.62** (5.97 – 13.37)	**0.12** (0.07 - 0.20)		**4.92** (3.23 – 7.73)	**-2.33** (-4.57 to -0.88)	

Note: The same set of variables were not always used in the models to calculate the marginal value