The Value of Improved Environmental Health in Rivers

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Abstract

The purpose of the study reported in this paper is to develop and implement economic tools to guide river health policy formulation and investment priorities. Approximately 32 per cent of Victoria's rivers are in poor to very poor condition while only 21 per cent are in good to excellent condition. To address this situation, current government targets include delivering significant improvements in river health by 2010, and ensuring maximum improvement in river health for the community's investment. To facilitate these investment choices, the estimation of values associated with improvements in river health arising from projects and policy initiatives in monetary terms is useful. That enables the use of benefit cost analysis to assess the viability of investment options. The non-market valuation technique known as Choice Modelling was used to generate such estimates for a selection of Victorian Rivers including the Goulburn, Gellibrand and Moorabool Rivers. Choice Modelling involves samples of the population being asked to make choices between alternative future resource management outcomes. The choices people make allow inferences to be drawn regarding the amount they are willing to pay for improvements in specific aspects of river health. Monetary values were estimated for four attributes of environmental improvement: the percentage of pre-settlement fish species and populations; the percentage of the river's length with healthy vegetation on both banks; the number of native waterbird and animal species with sustainable populations; and the percentage of the river suitable for primary contact recreation without threat to public health. The valuation exercise was conducted across both rural and urban populations to determine the impact of respondent location on values held. By estimating values for a range of environmental attributes across a range of rivers for a range of different groups of people, the study provides a data base that can be used for 'benefit transfer'. This is the process whereby values estimated in one context can be transferred to other related contexts thus reducing the costs of assembling information relevant to river health investment choices.

1 Introduction

The Victorian Department of Sustainability and the Environment is undertaking a project to estimate the *benefits* associated with improvements in river health. This information will be used in Benefit-Cost Analysis (BCA) for the assessment and prioritisation of investments in river health.

BCA, where the potential outcomes (benefits) of a project and the sacrifices (costs) which it entails are compared in monetary terms, is the most widely used framework for the economic evaluation of public projects. Challenges in applying BCA are the treatment of benefits and costs that are not valued in markets and predicting the behaviour of natural resources with and without the project. These challenges are pertinent for river management projects, where costs can be readily determined but most of the potential benefits are not valued in markets and may be difficult to predict the impact of a river health improvement project.

Non-market valuation (NMV) techniques are designed to yield value estimates in monetary units that are consistent with the principles of welfare economics that underpin BCA. ‘Stated preference’ techniques, a key type of NMV technique, estimate *Implicit Prices* by asking people to state their preference or willingness to pay for, in this case, improved condition of river health.

The Contingent Valuation Method (CVM) is perhaps the most widely known ‘stated preference’ technique. In a CVM application, respondents are asked to reveal their Willingness To Pay (WTP) in a structured questionnaire. The CVM is extremely flexible in its application and has thus been applied in a wide variety of non-market valuation contexts. It can be used to estimate the value associated with moving from the ‘status quo’ situation to one in which a range of environmental attributes are improved.

The Choice Modelling (CM) approach to non-market valuation is a development of the CVM where respondents to a questionnaire are asked to select between an array of alternative future resource allocation scenarios. Each scenario is described in terms of a set of non-marketed ‘attributes’ or characteristics and a monetary cost. For example, a CM application may provide estimates of the value of increased stream side vegetation, enhanced biodiversity, improved water quality, more recreational opportunities, etc. By combining these individual estimates, the values associated with changing from the ‘status quo’ situation to many different alternative situations can be estimated.

URS Australia was commissioned to undertake a trial of CM to estimate the benefits associated with improvements in the environmental health of rivers in the Goulburn Broken and Corangamite catchments. Readers are referred to the full report for this study (URS 2006) for more detail. Specific objectives were to:

- Define a set of river health attributes that captures the outcomes of management activities that are of interest to the relevant communities; and
- establish the communities’ valuations of those attributes in a form that is appropriate for use in BCA.

An additional consideration of the project is the ability to transfer the results or data from a valuation in one system to other similar systems - benefit transfer. Thus in the pilot study an objective was to categorise Victoria’s rivers to enable Benefit transfer (BT) has been developed as a way to limit the costs of estimating non-market values.

2 Methodology

2.1 Choice Modelling

CM is questionnaire-based and involves respondents being asked to make choices between alternative future resource management strategies (Bennett and Blamey 2001). Each alternative is described in terms of a set of environmental, social and monetary attributes. Different alternatives give rise to different levels being taken by the attributes.

Observing respondents’ choices across a fraction of the full factorial of potential combinations of attribute levels allows the CM analyst to estimate the amount of one attribute people are willing to give up to secure more of another. When one attribute is money, the trade-off across the attributes can be calibrated in monetary terms and is thus a marginal willingness to pay for the non-monetary attributes.

CM yields a functional relationship between marginal values and the levels of the attributes and the socio-demographic characteristics of the respondents. Hence, unlike CVM that produces only a single value estimate per sample of respondents, CM is capable of yielding an array of value estimates across the spectrum of resource management options under consideration.

CM has the same flexibility as CVM and hence has the potential for wide application, including the estimation of both use and non-use values. CM appears to be less prone to some of the biases that are claimed to limit the application of CVM. However, the complexity of questioning involved in a CM questionnaire places greater strain on the cognitive capacities of respondents. Furthermore, the computational requirement of CM are more sophisticated than those of CVM.

CM is a comparatively new technique and has been less widely applied than CVM. However, the rate at which it is being applied is growing at a faster rate than CVM. The initial concerns about CM as an 'unknown' quantity have now been dispelled and the technique is demonstrating its capacity both in Australia and internationally – particularly in the UK and Europe.

Applications in Australia have focused on the estimation of the benefits of land and water restoration (van Bueren and Bennett 2004), wetland and remnant vegetation protection (Whitten and Bennett 2004) and river health improvements (Morrison and Bennett 2004). Major studies have been commissioned by the NSW EPA and others to investigate the extent of environmental benefits generated from environmental flows.

2.2 Representative Rivers and Sample Populations

A sample of rivers was selected to act as 'representatives' of biophysically defined classes of rivers across the state. This is necessary in order to determine the nature and extent of differences in values held for different types of rivers. A sequence of sub-samples of the Victorian population was chosen to reflect potential differences in values held due to preference difference across the state. The selections made were targeted at the creation of a database of river health improvement value estimates that could be used in BT applications (Rolfe and Bennett 2006).

2.3 Selection of rivers

In discussions with DSE staff, the rivers of Victoria were classified according to a number of factors: regulated/unregulated, flow characteristics, location (urban/peri-urban/rural) and size. The purpose of this classification was to facilitate benefit transfer – allowing the results for representative rivers to be extended to rivers of similar classification.

For the purposes of the pilot phase, the following rivers were selected:

1. Goulburn River (large lowland regulated river - irrigation)
2. Moorabool River (large peri-urban regulated river)
3. Gellibrand River (large unregulated coastal river.

2.4 Sample populations

The values people hold for changes in the health of Victorian rivers are likely to be heterogeneous not only because of different biophysical characteristics of those rivers. Differences will also arise because of differences between people. To capture information about differences in personal preference, the respondents selected to answer the CM questionnaire must be representative of the diversity within the overall population. One potential aspect of this diversity is respondents' physical location. Living close to a river, for instance, may give rise to differing perceptions and hence preferences for the river. To capture that element of diversity, a population sampling strategy was developed to provide representation of urban and rural groups and people living within a river's catchment and outside it.

With the overall budget for the pilot project in mind, six sub-samples were selected. These are set out in Table 1. The structure of the sampling strategy enables the detection of any value differences between urban and rural sub-populations and in-catchment and out-of-catchment sub-populations.

Table 1: Sampling Strategy

SUB POPULATION → **RIVER ↓**	**GOULBURN**	**MOORABOOL**	**GELLIBRAND**
Urban	Melbourne	Melbourne	
Rural in-catchment	Goulburn	Moorabool	Gellibrand
Rural out-of-catchment	Gellibrand		

Hence, values for river health improvements were estimated for the Goulburn River amongst people living out of the catchment in both the city (Melbourne) and a rural area (the Gellibrand catchment area). Values for the Moorabool were estimated for people living in Melbourne and in-catchment. Only in-catchment respondents were surveyed for the Gellibrand.

2.5 Questionnaire Design

Applying CM requires the development of a questionnaire in which respondents are presented with a sequence of choice sets that set out the alternative resource use options available.

To allow for comparisons of values across the six sub-samples, a generic form questionnaire was designed. This involved the initial establishment of a single questionnaire structure into which the specific details of the particular river of interest were inserted. Thus three specific questionnaires were developed that were the same apart from the specifics of the three rivers.

A key part of the initial design work involved the selection of river health attributes that are used to convey information to respondents about the outcomes of alternative management options. The attributes must be sufficiently generic to be common across all rivers involved in the study yet be sufficiently specific to convey to respondents appropriate information about each river. The selection of attributes was based around a two-phase process. The first phase involved the gathering of information about river health outcomes from river managers and scientists. The second used focus groups of potential respondents to the survey to determine the suitability of attributes in conveying information. The next sub-sections details these two phases of the questionnaire design process.

2.6 Expert Opinion

An expert panel, consisting of representatives from environmental consulting, La Trobe University, Parks Victoria, DSE, Goulburn Broken CMA, Corangamite CMA and URS, defined an initial list of important river health attributes. These were then refined in discussions with experts, managers as well as by members of the public in discussions in focus groups, held in Melbourne, Meredith near Geelong, and in the Trawool near Seymour.

The four river health attributes selected were:

Native fish*:* A healthy river will have an abundant and self-sustaining population of native fish. The population of native fish will be related to both the number of species that are present and the numbers of fish of each species. A useful measure of the population is to express it as a percentage of the estimated size of the population pre-European settlement.

Healthy river-side zone: A healthy river-side zone has more than 60 per cent of the ground cover as native species and the vegetation belt on each side of the river is more than about 1.5 times as wide as the channel. More than 50 per cent of the river's wetlands and billabongs are well-connected to the river and are in good condition with regard to the naturalness and quantity of fringing vegetation. The measure used was the percentage of the river length with healthy native river-side vegetation on both banks.

Water quality: The quality of water can be indicated by the recreational opportunities that could be undertaken. Three levels were defined:

- passive recreation only (such as walking and picnicking), that is, contact with the water is not recommended;
- secondary contact only, such as boating or other activities that give minimal contact with the water; and
- primary contact, direct contact or immersion in the water are possible without threat to public health, that is, swimming and paddling are possible.

It is noted that the activity does not have to be physically possible, merely that the quality of the water would permit it. To reduce attribute complexity, only the percentage of the river suitable for primary contact measure was used.

Sustainable populations of native waterbirds and riverine fauna: The emphasis in this attribute is that the observed populations of native birds and animals (such as, platypus and gliders) are sustainable, that is, the observed populations are not casual 'visitors'. Sustainable populations of migratory waterbirds that use the river are regular, long-term visitors. The measure used was the Number of species of native waterbirds and riverine fauna with sustainable populations.

The levels of each attribute applicable for each river were then determined by staff of the relevant Catchment Management Authority. Conditions were considered over a twenty year time period, with and without management interventions. The levels used in the final questionnaire are detailed in Table 3.

The levels of each attribute were set in the context of what could be achieved in practice for each river, through management initiatives. In other words, they were not the same for all rivers and reflected the likely potential for improvement in each case. In general they were based on the best estimates of the experts – quantitative evidence from formal studies was seldom available.

2.7 Focus groups

Selection and description of attributes, and the design and content of the questionnaires and information booklets were refined through a sequence of focus groups designed to reflect the understanding of river health issues by members of the general public. Focus group meetings were held in URS offices in Melbourne (relating to the out-of-catchment sample for the Moorabool River), Meredith Community Hall near Geelong (relating to the in-catchment sample for the Moorabool River), and in the Trawool Resort near Seymour (relating to the in-catchment sample for the Goulburn River below Lake Eildon).

The attributes needed to be meaningful to the respondents in the choice modelling survey. Environmental attributes that are outside the experience of respondents (such as highly technical measures) are unlikely to encourage reliable responses.

URS recruited participants in the Melbourne focus group, using the ‘friend of a friend’ approach, while CMA staff and other community contacts, in conjunction with the consultants, were used to select the regional focus groups. Recruitment methods ensured that the groups were as representative as possible of the communities in question in terms of a range of socio-economic descriptors such as age, gender, income level, occupation and level of education. For privacy reasons the details cannot be included in this report.

Focus group meetings were held in the evenings, and were of about 90 minutes duration and involved the inducement of refreshments and a payment of $50 per participant.

We targeted 10 participants for each focus group and hoped to achieve eight attendees. For Melbourne there were 9 participants, Trawool attracted 11 participants, Meredith attracted 12 participants.

The sessions were recorded to audio CD as well as to computer based notes. The volume of information received was substantial and only a brief summary is provided here of the main points emerging from each meeting. The points focus on majority views of participant - as is to be expected, not all participants agreed on every point.

The Meredith (Moorabool) participants thought that the questionnaire was biased in favour of the environment and that the information in the booklet was inaccurate and simply went along with the standard CCMA/DSE “rhetoric”. They thought that the main problem for the catchment was the excessive quantity of water extracted for urban use (Geelong and Ballarat), at the expense of stock and domestic users. They didn’t like the symbol approach to defining attributes and their levels. Despite all this they did have an interest in environmental issues. They were intent on pursuing details of river management regimes.

The Melbourne (Moorabool) participants thought that there wasn’t enough information, didn’t know why they should be bothered with the Moorabool, generally liked the symbol approach to defining attribute levels, and wanted some measure of the Moorabool’s problems relative to other rivers in Victoria.

The *Trawool (Goulburn) participants* thought that we should use the Upper King Parrot Creek as the target river, were generally interested in environmental outcomes, and thought that too much information was provided for the average person. They liked the symbol approach to defining levels of attributes and were intent on pursuing details of river management regimes.

In general, the groups were comfortable with the selection of attributes and were willing to leave the definition of levels of attributes to the experts. They did not feel that there was overlap between the attributes and understood that they were selected to represent easily understood measures of the benefits that healthy rivers provide. The final versions of the questionnaires and information booklets took account of all the feedback from the Focus Groups, where appropriate.

2.8 Experimental design

With the river health attributes selected and the range of values over which they can vary for each of the rivers involved in the study determined, the next step in the design of the questionnaire is putting the attribute levels together to form the choice sets. This is achieved through the use of an experimental design.

CM relies on an analysis of the choices respondents make between an array of potential resource management options. The choice information is only useful if the options presented cover the full range of possible combinations of attribute levels. Because there are so many possible combinations (the 'full factorial'), it is impossible to present them all to respondents and so a fraction of the full factorial needs to be selected. An experimental design provides this fraction.

In choosing an experimental design, a trade-off is made between the completeness of the fraction used and the cognitive burden imposed on the respondent. The more complete the fraction, the more choice observations are generated but the greater is the number of choice sets faced by each respondent. Because the attributes selected for this study were found to be largely independent of each other in the minds of focus group respondents, a 'main effects' experimental design was selected. This permits the analysis of choices made in terms of the levels of each of the attributes. It does not allow for the estimation of interdependent effects, specifically the cross product terms of pairs of attributes. Such main effects experimental designs in cases where independence between attributes can be assured have the capacity to explain at least 80 per cent of the potential choices made by respondents.

The experimental design selected involves 54 alternative river management outcomes being created. Each alternative involves the five attributes taking on one of the three different levels. These choice alternatives are then sorted into pairs. Each pair of alternatives, along with an alternative that represents the 'status quo' or 'do nothing new' river management option, goes to make one choice set. Two of the 27 choice sets so established were dropped from the experimental design because they involved logical inconsistencies in the combinations of levels across alternatives. For instance, where one alternative involves attribute levels that are in every case superior to the other then the inclusion of the pair in a choice set will not force respondents to make a trade-off across the pair – one alternative is said to 'dominate' over the other. Inclusion of that pair of alternatives in a choice set does not provide information that is useful in the development of a model of choice.

The remaining 25 choice sets were divided into five 'blocks' of five pairs each. This blocking process is necessary in order to reduce the cognitive burden of respondents. The task of answering five choice set questions was found in the focus groups (and in the literature) to be a sufficient burden. However, it means that five respondents are required in order to secure one response across the complete fraction of the full factorial. It also means that for each river, five versions of the questionnaire must be designed, with the variation across the questionnaires being derived from the experimental design. Hence, for each river, five versions of the questionnaire each differing only in terms of the levels taken by the attributes in the non-status-quo options were developed. For this study, a total of 15 questionnaire versions was therefore required.

2.9 Communications

Various strategies were developed to ensure that the questionnaires communicated the method requirements adequately to the respondents. These strategies are particularly important in the context of a mail-out-mail-back survey as is required for this project due to the wide dispersion of survey respondents. The overall design of the questionnaire benefited from previous work in the context of NSW Rivers (Morrison and Bennett 2004) and the River Murray (Bennett and Gillespie 2005).

The questionnaire was split into two pamphlets: one that was entitled “Information Booklet” and the other “A survey of your views”. All questions were contained in the second booklet thus enabling respondents to retain the information booklet that provided information on the river and its management. The information booklet cover featured a map of the river catchment while the survey booklet cover included photographs of the river.

A feature of the questionnaire was its use of symbols to communicate attribute levels in the choice sets. Hence, instead of using numbers to tell respondents the percentage of pre-settlement fish species and population levels that would occur under each option, a symbol, similar to the star system used to characterise hotels, was used. Multiple fish icons represented differing fish attribute levels and a key to this symbolic representation was provided in the information booklet. An example of a key is provided in Figure 1.

A disadvantage of using the symbol approach is that, unless part-symbols are used, the relationship between the number of symbols and the numerical level of the attributes is not linear. For the example in Figure 1 the simple correlation coefficient for a zero intercept is 97 per cent. It was considered that the advantage in terms of simplicity outweighed the disadvantage in terms of non-linearity.

Native fish

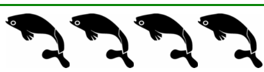
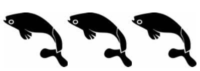
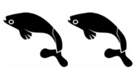
Score	Percentage of pre-settlement species and population levels
	30
	20
	10
	5

Figure 1: Symbol Key

The location of the key in the information booklet meant that respondents could answer the questionnaire in the ‘survey’ booklet whilst referring to the key without the need for continual page turning.

Information concerning the rivers was sourced from Victorian CMA waterway managers. The difficult balance between detail, complexity and ‘user-friendliness’ was struck through the testing of the questionnaire in the focus group sessions. Respondents who were not satisfied with the level of detail provided in the information booklet were referred to relevant web sites and to the local Catchment Management Authority.

The survey booklet began with details of survey purpose and requirements. Initial questions focused on visitation and interest levels. The choice set questions were prefaced by explanations of their rationale and the task involved. Framing statements regarding respondents’ budget constraints were included:

When deciding on the options you prefer, keep in mind your available income and all other things you have to spend money on.

A version of 'cheap talk' script was also included. Cheap talk script is designed to induce respondents to answer the essentially hypothetical questions that constitute the choice sets in an honest, well-considered manner:

IMPORTANT NOTE: Even though the options you are being asked to consider are hypothetical, your answers will provide information that is very important to improving the management of the Gellibrand River. Please consider the options carefully and make your choices as if they were real.

This text involves the explicit recognition of the potential for respondents to misrepresent their preferences, either inadvertently by not taking the time to think through what their preferences are or strategically in an effort to distort the results of the survey in favour of their preferred outcome.

One choice set was presented on each double page of the survey booklet. Options were individually numbered to avoid confusion. Outcomes were framed in the time period of 20 years into the future. The status quo option appeared as Option 1 in every choice set. A 'not sure' response was included along with the three choice options in each set. Follow up questions on the choice set sought to identify 'protest' responses whereby respondents always chose the status quo as a protest against the ways in which the choice set questions were asked or framed (for instance, the payment vehicle) rather than as an established preference. The final section of the questionnaire focused on respondents' socio-economic details.

3 Survey Logistics

3.1 Sampling

Six sub-samples of 1,000 respondents were drawn at random on the basis of address postcodes for the geographic location required from a database of the Australian population. Three sub-samples were drawn from the Melbourne population, two from the Gellibrand catchment area and one from the Moorabool catchment area. Each sub-sample was randomly split five ways for the distribution of the five versions of each questionnaire.

3.2 Survey

The survey involved a three-stage process. Initially, a letter of invitation was dispatched to the selected respondents. The aim of this letter was to generate interest in the survey and also to 'clean' the sample of respondents who were no longer at the address selected, or were unwilling to respond for any reason. The second stage involved the dispatch of the two pamphlets together with a covering letter and a reply paid envelope to be used for returning the completed questionnaire. Finally, a reminder postcard was posted to respondents who had not already returned completed questionnaires.

The main mail out of the pamphlets took place in mid November 2005. This meant that the survey process began to encroach on the pre-Christmas period, a time when it is very difficult to divert respondents' attention from end of year activities. Because of this problematic timing, an experimental re-mail of questionnaires to non-respondents was carried out in February in an attempt to increase the response rate achieved.

3.3 The Sample

The response rates and respondent socio-economic characteristics of the six sub-samples are set out in Table 2. In total, 806 valid responses were recorded. This represents a response rate of 13 per cent of the original 6,000 respondents selected. However, when the sample size is adjusted for the incorrect addresses and deceased persons detected after the first invitation letter was sent, the average response rate rises to 17 per cent.

Response rates were generally better in the in-catchment sub-samples, reaching 20 per cent for the Goulburn, and lower in the out-of-catchment sub-samples, both urban and rural, where they ranged from 15-17 per cent.

The material consequence of the low response rates is that, on average, each block of each questionnaire was answered by 32 respondents. This just meets the sample size required for statistical inference to be based on the laws of large numbers. Despite this, careful analysis of sample representation is required before extrapolating the results to the population each sub-sample represents.

A conservative approach that avoids this potential problem is to extrapolate the results only to the percentage of the population represented by the response rate, viz. 17 percent of the population overall, with the remaining 83 per cent assumed to hold zero willingness to pay for improvement in river health. *This approach avoids the consequences of any self-selection bias evident in the sample.*

The 'conservative' approach is likely to significantly underestimate the aggregate willingness to pay. Based on follow-up interviews with non-respondents Morrison (2000, page 227) assumed that at least 30 per cent of non-respondents are likely to have similar preferences to the survey sample[1]. Applying this assumption would justify extrapolating results to 34 per cent of the population for this study.

Table 2: Sub-Sample Demographic Characteristics

River		**MOORABOOL**		**GELLIBRAND**	**GOULBURN**			**ALL**
Population		Local	Melb	Local	Gellibrand	Local	Melb	
Sample size		1000	1000	1000	1000	1000	1000	6000
Respondents:		152	117	147	125	165	100	806
Revised sample*		852	684	828	807	818	667	4656
Adjusted response rate (%)		**18%**	**17%**	**18%**	**15%**	**20%**	**15%**	**17%**
Kids	NK	9%	5%	3%	7%	7%	5%	6%
	Yes	84%	68%	82%	78%	76%	75%	77%
	No	8%	27%	16%	15%	16%	20%	17%
Gender	NK	8%	6%	1%	6%	8%	5%	6%
	M	55%	57%	52%	59%	61%	61%	57%
	F	38%	37%	47%	34%	32%	34%	37%
Age	Mean	52.6	53.1	49.2	55.0	54.5	51.0	52.6
Educ	Mean	11.9	13.4	12.7	12.7	12.6	13.6	13.0
Income	Mean	$2,255	$2,650	$1,902	$1,795	$1,836	$2,652	$2,142

*Response rate adjusted for wrong addresses and deceased persons.

[1] A more recent study (van Bueren and Bennett 2004, page 15) assumed that at least 25 per cent of non-respondents are likely to have similar preferences to the survey sample, based on follow-up interviews of non-respondents. They adjusted their initial response rate (16 per cent – similar to that for the current study) to justify extrapolating the survey results to 37 per cent of the population.

4 Results

4.1 Understanding preferences

To understand the preferences and hence values revealed by respondents in the survey, models are required that relate respondents' choices to their characteristics and the choice settings they faced. The fundamental idea behind choice modeling is thus to observe respondents' trade-offs between non-market and monetary outcomes of the various options. Their willingness to make those trade-offs provide the necessary information to estimate their willingness to pay for better environmental outcomes.

In this section, the procedures used to model respondents' choices are detailed first. In the second part, the models derived from the six sub-samples data are set out. Finally, the validity of the models as accurate representations of respondents' choice behaviour is assessed.

4.2 Modelling procedures

The CM approach to environmental valuation requires the estimation of models that explain respondents' selections of their preferred option in each choice set in terms of the levels of the choice attributes and the respondents' socio-economic characteristics. Choice probability is modeled as a function of attribute level and factors such as respondent age, income, gender etc. Different assumptions regarding the error term in the models require differing model formulations. To avoid breaches of the assumption that the addition of an irrelevant option into the choice sets makes no difference to the probability of choice, a nested choice model is used in this analysis.

A nested model assumes that respondents approach the choice process in a step-wise fashion. In the models reported here, this process involves an initial choice between the status quo option and the change options and a second choice between the two change options. The first level choice is explained by the respondents' socio-economic characteristics and the second by the levels of the attributes. In addition an alternative specific constant (ASC) that is applied as 'one' to the two change options and 'zero' to the status quo option is included in the model to capture the effects of omitted unidentified variables.

Because the respondents' socio-economic characteristics are the same for all of the choices they make, it is necessary to interact the ASC with the socio-economic variables to avoid non-singularities in the determining matrix.

Because of the relatively high proportions of respondents who refused to answer some of the socio-economic characteristics questions – particularly the income question – an approach was developed to ensure that these respondents were included in the estimation of the choice sets rather than being dropped as 'missing data'. Where missing data were recorded, the variable was coded at the average value of all respondents who had provided an answer. These cases were signaled in the data set by the addition of a further variable – a dummy that was scored as one when the data were otherwise missing and zero otherwise. The estimation of the dummy variable parameter allows an understanding of any systematic difference in the way respondents who did not reveal their socio-economic characteristic answer the choice questions.

The variables used in the choice models are listed in Table 3.

Table 3: Independent Variables for the Choice Models

Variable Name	Description	Levels/ unit: Goulburn	Levels/ unit: Gellibrand	Levels/ unit: Moorabool
ASC (change)	Alternative Specific constant	0 for status quo option otherwise 1	0 for status quo option otherwise 1	0 for status quo option otherwise 1
Cost	Compulsory one-off payment to trust fund	$0, 20, 50, 200	$0, 20, 50, 200	$0, 20, 50, 200
Fish	Percentage of pre-settlement species and population levels	5, 10, 20, 30	15, 20, 30, 45	5, 10, 20, 30
Vegetation	Percentage of river's length with healthy native vegetation on both banks	50, 60, 70, 80	12, 18, 28, 40	25, 35, 45, 55
Birds	Number of native waterbirds and animal species with sustainable populations	35, 45, 55, 65	3, 5, 7, 9	5, 10, 12, 15
Water quality	Percent of the river suitable for primary contact recreation without threat to public health	70, 80, 90, 100	60, 70, 80, 90	20, 30, 40, 55
Age × ASC	Age × ASC	Years		
Inc × ASC	Household income × ASC	$ per fortnight		
Ed × ASC	Years at school × ASC	Years		
Gen × ASC	Gender dummy	1 for male otherwise 0		
Kids × ASC	Children dummy	1 for has children otherwise 0		
No age dummy × ASC	Missing age	1 if no age reported otherwise 0		
No inc dummy × ASC	Missing income	1 if no income reported otherwise 0		
No ed dummy × ASC	Missing years at school	1 if no education reported otherwise 0		
IV	Inclusive value	Indicates the significance of the nesting structure		

4.3 Estimated choice models

Choice models were fitted for each of the six sub-samples surveyed. The modeling was performed using the Stata econometric software. Linear additive utility functions were estimated using a nested logit model. The coefficients of the independent variables and their statistical significance are reported in Table 4.

Table 4: Estimated Choice Models

	Moorabool/ In-catchment ($)	Moorabool/ Melbourne ($)	Gellibrand/ In-catchment ($)	Goulburn/ Gellibrand ($)	Goulburn/ In-catchment ($)	Goulburn/ Melbourne ($)
ASC (change)	0.698	5.570	-0.654	6.736	6.011	2.679
Cost	-.011*	-0.013*	-0.011*	-0.008*	-0.009*	0.011*
Fish	0.056*	0.068*	0.025*	0.046*	0.041*	0.049*
Vegetation	0.063*	0.068*	0.033*	0.038*	0.033*	0.061*
Birds	0.250*	0.232*	0.198*	0.025*	0.037*	0.037*
Water qual.	0.001	0.004	-0.001	-0.005	0.020*	0.018*
Age x ASC	0.000	-0.011	-0.016	-0.010	-0.035*	0.003
Inc x ASC	0.500*	0.216	0.214*	0.161	-0.153	0.312*
Ed x ASC	0.135*	-0.106	0.199*	0.061	0.096*	0.179*
Gen x ASC	-0.360	0.057	0.264	-0.031	0.672*	-0.055
Kids X ASC	-1.242*	-0.514	-0.365	-0.203	0.181	-0.881*
No age dum x ASC	0.282	0.597	-0.027	0.106	-0.567*	0.064
No inc dum x ASC	-1.507*	-1.041*	-2.23*	-1.614*	-0.835*	-0.879*
No ed dum x ASC	0.462	-0.559	-0.392	0.909*	1.279*	17.953
IV	0.381	0.319	0.38	0.32*	0.576	0.42*

* Significant at the five per cent level. Differences may arise due to rounding.

4.3.1 Model validity

The choice models estimated for the six sub-samples demonstrate remarkable consistency. In all cases, the cost, fish, vegetation and birds attributes are highly significant in explaining respondents' choice behaviour and have the *a priori* expected signs. That is, increasing fish species and populations, increasing areas of riverside vegetation and more native waterbirds and animals increase respondents' well being.

This means that respondents made choices with reference to the levels of the attributes in each option. Put simply, the respondents did not answer the choice set questions randomly.

The water quality attribute was significant only for the Goulburn River in-catchment and Melbourne sub-samples. This indicates that water quality in the Moorabool and Gellibrand were not important to respondents in their choices of preferred river futures. Water quality in the Goulburn however was important to both local respondents and to Melbourne respondents. Respondents in the Gellibrand catchment did not consider Goulburn River water quality as important.

In all six models, the alternative specific constant (ASC) was not significantly different from zero. There was no inherent preponderance for respondents to select the change options over the status quo. Because the ASC acts to 'collect' the impacts of relevant but unobserved explanatory variables, its insignificance gives confidence in the model specification.

Furthermore, the inclusive value in all models is significantly different from one indicating that the nesting structure of the model is effective.

The significance of the socio-economic variables in explaining choice behaviour is also instructive in terms of model validity. Consistency with *a priori* expectations regarding the effects of factors such as income and educational status strengthens the model's validity claims.

In four of the six models, respondent income is a significant variable and is positively signed. In other words, river health is confirmed as a 'normal good' in so far as income and value are positively correlated. Similarly, the number of years spent at school and the values held are also positively correlated, as would be expected *a priori.* In two of the six models, the age variable is significant and negatively signed indicating that younger respondents are more likely to choose environmentally improving options than older respondents.

A consistent finding across all six models is that respondents who chose not to reveal their income were less likely to support river health improvement options.

The strength of these findings indicate that the models estimated are robust and hence can be used with confidence to estimate values associated with river health improvements.

4.4 Implicit prices

The models detailed in Section 4.3 are the basis of the value estimation process. IPs are detailed for each attribute in each of the sub-samples. As defined earlier, IPs are the amount, on average, that respondents are willing to pay to enjoy an increase of one unit in a river health attribute. Recall that these amounts are per household rather than per individual as the survey respondents were asked to answer on behalf of their household. They can be interpreted as marginal values or marginal willingness to pay for the attributes and are displayed in Table 5.

Table 5: Implicit Prices and their 95 per cent Confidence Intervals ($)

	Moorabool/ In-catchment ($)	**Moorabool/ Melbourne ($)**	**Gellibrand/ In-catchment ($)**	**Goulburn/ Gellibrand ($)**	**Goulburn/ In-catchment ($)**	**Goulburn/ Melbourne ($)**
Fish	4.95* (3.02-6.87)	5.34* (3.30-7.38)	2.19* (0.92-3.46)	5.56* (2.97-8.14)	4.39* (2.59-6.10)	4.47* (2.40-6.55)
Vegetation	5.56* (3.73-7.38)	5.33* (3.43-7.23)	2.91* (1.51-4.31)	4.65* (2.36-6.94)	3.56* (1.94-5.19)	5.53* (3.35-7.70)
Birds	22.07* (14.41-25.41)	18.19* (10.98-25.41)	17.33* (9.16-25.5)	3.04* (0.82-5.27)	3.90* (2.19-5.6)	3.35* (1.52-5.19)
Water quality	0.09 (-0.99-1.18)	0.34 (-0.76-1.44)	-0.05 (-1.45-1.35)	-0.59 (-2.57-1.38)	2.12* (0.60-3.63)	1.64* (-0.08-3.35)

* Significant at the five per cent level. Differences may arise due to rounding.

Only the in-catchment respondents and Melbourne respondents were willing to pay for water quality improvements in the Goulburn River. That amount for both sub-samples was in the order of $2 for a one per cent increase in the length of the river suitable for primary contact recreation. The water quality IPs were not significant for the other samples. It should be recalled that recreation was employed as a surrogate measure of water quality and it may be necessary to refine this attribute in future work. It is possible that respondents associated other attributes with water quality. Future work would need to ensure that respondents were clear about the relationship between recreation and water quality. Adding a question to test whether or not they visited the river in question may resolve any problems with this attribute.

Fish health was consistently valued by respondents at around $5 for a one per cent increase in species and population levels. Gellibrand in-catchment respondents were willing to pay $2 for more native fish in their river.

Willingness to pay for improvements in riverside vegetation was also significantly different from zero and ranged between $3 and $6. This value was for an additional per cent of the river's length with healthy vegetation on both banks.

Waterbird and animal species were of less interest in the Goulburn River than in either the Moorabool or Gellibrand but implicit prices were consistently significantly different from zero in all sub-samples. Moorabool in-catchment respondents were willing to pay over $20 for each additional native species of waterbird and animal that could be re-introduced into the riverine area. In contrast, the marginal value expressed by Gellibrand catchment resident respondents for Goulburn River species was around $3. A possible reason for these differences is that the attribute was starting from a low base for the Moorabool, with potential for significant improvement compared with the Goulburn.

4.5 Testing differences

In the previous section, it was established that apart from water quality, the implicit prices for all the environmental attributes for all three rivers were significantly different from zero. In other words, respondents to the choice modeling survey demonstrated that additional units of environmental health attributes were valuable to them. The water quality attribute of river condition was only valuable for the Goulburn River for local and Melbourne respondents. In this section, differences between implicit prices across rivers and sub-samples are analysed. Such differences are important in determining the process to be used for benefit transfer. If differences in implicit prices are detected across either rivers or respondent sample, then those differences must be incorporated into the benefit transfer process.

The analysis presented in this section draws on the implicit price estimates and their associated 95 per cent confidence intervals presented in Table 5

4.5.1 Native Fish

The fish attribute's implicit price was significantly different from zero across all rivers and samples. The estimated values ranged from $2.19 (Gellibrand River) to $5.56 (Goulburn River/Gellibrand sample). However, the 95 per cent confidence intervals for these estimates ($0.95 – $3.46 and $2.97 – $8.14 (respectively) overlap. Hence it cannot be concluded that there is any statistically significant difference between the two. The intermediate implicit value estimates for the other rivers and samples are consistent with this finding. It must therefore be concluded that the people surveyed do not differentiate between the value of improvements in the number of fish species and population levels across the rivers considered.

4.5.2 Riverside vegetation

While all the implicit prices estimated in this study were significantly different from zero, they ranged from $2.91 (Gellibrand River) to $5.56 (Moorabool/Local sample). The confidence intervals on these bounds of the estimated value range overlapped ($1.51 - $4.31 and $3.73 – $7.38) indicating that no significant difference existed across rivers and samples. The conclusion therefore is that respondents did not differentiate between rivers in terms of the values they held for improvements in the extent of healthy riverside vegetation.

4.5.3 Native waterbirds and animals

All implicit prices for the birds attribute were significantly different from zero indicating that respondents in all sub-samples value improvements in species numbers and population sizes of native waterbirds and animals. Two 'clusters' of value estimates emerge: one for the Goulburn River samples and another for the Gellibrand and Moorabool Rivers. No significant differences arise between the sub-samples asked to value the Goulburn River. The range of estimates for the Goulburn is from $3.04 (Gellibrand sample) to $3.90 (local sample) but the confidence intervals for these estimates overlap ($0.82 - $5.27 and $2.19 - $5.60). Hence, respondent location makes no difference to preferences for protecting native waterbirds and animals on the Goulburn. However, there are significant differences between these Goulburn River estimates and those for the Gellibrand and Moorabool. These estimates range from $17.33 (Gellibrand sample) through to $22.07 (Moorabool/local sample). Confidence interval overlaps indicate no significant difference across this cluster of estimates ($9.16 – $25.50 and $14.41 - $29.72 respectively).

These results indicate that respondent location is not important in determining values for the birds attribute but there are differences due to the type of river under consideration. Why such differences have been observed is conjectural however it is worth noting that the levels of the bird attribute is different across the two 'clusters': in the Goulburn, the range taken by the bird attribute was 35 to 65 species whilst for the Moorabool it was 5 to 15 and for the Gellibrand it was 3 to 9. The lower values estimated for the Goulburn may therefore be a reflection of respondents' diminishing marginal values.

4.5.4 Water quality

The implicit price for the water quality attribute was significantly different from zero only for the Goulburn River local and Melbourne samples. This does not translate into a significant difference between these value estimates and those estimated for the other rivers/samples. All estimates are positively signed and range from $0.05 (Gellibrand) to $2.21 (Goulburn/local sample) however these range extremes have overlapping confidence intervals ($-1.45 - $1.35 and $0.60 - $3.63 respectively).

5 Application to Management and Policy

The values estimated in this study provide river managers and policy makers with information on the values held by people for the non-marketed benefits associated with alternative river management strategies that is directly comparable to the monetary values associated with marketed benefits.

For instance, a proposal to re-allocate flows that have been previously used in irrigated agriculture to augment environmental flows will lead to benefits in the form of improved environmental health and costs in terms of foregone agricultural profits. The estimates provided in this report can be used to inform the environmental flows side of the trade-off equation. The estimates for the Moorabool River have already been utilised within Melbourne Water Corporation's Business Case for the Salt Reduction Project at the Western Treatment Plant.

The process involved in using these estimates involves several stages.

Where the policy or management decision to be made involves one of the rivers included in this pilot phase study, the process requires an extrapolation of the estimates derived from the survey to the population. First, changes in the levels of the attributes must be forecast. This is a task for biophysical scientists expert in predicting river health outcomes. The question, "what will happen to fish species numbers over the next 20 years if this management strategy is implemented compared to what would happen if the existing management strategy was maintained?" Similar questions that relate to the other attributes must be answered. The difficulty and complexity of this task should not be under-estimated – the experts will frequently need to make judgments and assumptions based on their experience rather than on the outcomes of formal published research studies.

With the biophysical predictions completed, there are two ways to proceed. The first is to calculate the change in attribute levels with and without the proposed management strategy and to multiply that change by the per unit implicit prices. Summing across all attributes will yield the per household average value of the environmental health benefits associated with the change.

Extrapolating to the population requires the estimation of the populations that are represented by the sub-samples. Multiplying the average value from the survey by the number of households in each segment of the population yields the overall value of the change. Where differences in implicit prices have been observed across the sub-samples, the different implicit prices must be multiplied by the populations in the relevant sub-population. This multiplication process must be modified to reflect non-response rates. For instance, if the response rate was 20 per cent then a conservative approach is to extrapolate only to 20 per cent of the population.

Where the river management case of concern involves a river other than the ones considered in this pilot phase, the benefit transfer process is required. The analysis begins with a search for a river that has been the subject of a valuation exercise that has similar biophysical conditions to the case at hand. The three rivers studied in this pilot phase will be able to act as representatives for large inland rivers used for irrigation (the Goulburn), peri-urban rivers (the Moorabool) and coastal rivers (Gellibrand). For other river types in the state, reliance will have to be made on studies from further afield, including the NSW Rivers study (Morrison and Bennett 2004) until a more comprehensive study across all river types in the state is completed.

Benefit transfer then proceeds along the same lines as extrapolation except that further flexibility in terms of population socio-economic characteristics and attribute level adjustment may be required.

5.1.1 An example

A CMA is considering the viability of an investment in excluding stock from the riparian zone along a 30km stretch of a river. The investment would involve fencing and alternative stock watering facilities. The river under consideration is a large inland river.

Consultations with ecologists familiar with this river have led the CMA to form predictions of the changes in the four river condition attributes that would occur given the implementation of the stock exclusion investment:

- Percentage of pre-settlement native fish species and populations (ΔF):

  An increase of five per cent

- Percentage of the river's length with healthy native vegetation on both banks (ΔV):

  An increase of two per cent

- Number of native bird and animal species with sustainable populations (ΔB):

  An increase of one species

- Percentage of the river suitable for primary contact recreation (ΔR):

  No change

Estimating the per household value for these anticipated changes involves multiplying the per unit implicit prices (IP) for each attribute by the number of units of change:

$$\text{Value / household} = \Delta F \times IP_F + \Delta V \times IP_V + \Delta B \times IP_B + \Delta R \times IP_R$$

The implicit price estimates to be used depend on the type of river under consideration and the population of relevance. In this case, the estimates for the Goulburn River are relevant (large inland river) and implicit prices have been estimated for three different sub-populations (Table 6).

Table 6: Example Implicit Prices for a Large Inland River (Goulburn)

Implicit prices per household ($)	In catchment	Rural Out-of catchment	Melbourne
Fish	4.39	5.56	4.47
Vegetation	3.56	4.65	5.53
Birds	3.90	3.04	3.35
Water quality	2.12	0*	1.64

* not significantly different from zero

Hence, per household values can be estimated for in-catchment residents, rural out-of catchment residents and Melbourne residents. Substituting these implicit price estimates into the value equation yields:

Value / household (in catchment) = 5 × 4.39 + 2 × 3.56 + 1 × 3.90 + 0 × 2.12

= $32.97

Value / household (rural out-of catchment) = 5 × 5.56 + 2 × 4.65 + 1 × 3.04 + 0 × 0

= $40.14

Value / household (Melbourne) = 5 × 4.47 + 2 × 5.53+ 1 × 3.35 + 0 × 1.64

= $36.76

The next step in the estimation process involves the extrapolation of the per household values to the relevant populations. This requires estimates of the populations involved. ABS data[2] indicate the population of Victoria stands at around 4.9m with Melbourne comprising around 3.5m of this figure. This leaves 1.4m as the regional population. Using 2.2 people per household yields household population estimates of 2.2m for Victoria, 1.6m for Melbourne and 0.6m regional. If the in-catchment population for the river of interest is 50,000 then the out of catchment regional population is 0.55m.

Extrapolation across the whole of these sub-populations is unwise given that the IP estimates relate only to the proportion of the sample that responded to the questionnaire. Hence, extrapolation at its most conservative involves multiplication of the sub-populations by the survey response rate:

Extrapolated value = Population × sample response rate × household value

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[2] http://www.abs.gov.au/Ausstats/abs@.nsf/Lookup/56D4546CBA3D58E2CA256E5400711592

For this case:

In-catchment value = 50,000 × 0.2 × 32.97

= $329,700

Regional out-of catchment value = 550,000 × 0.15 × 40.14

= $3,311,550

Melbourne value = 1.6m × 0.15 × 36.76

= $8,822,400

In total across the state, the environmental health improvements generated by the proposed riparian zone fencing project is estimated at around $12.5m. The logic of benefit cost analysis therefore suggests that if the cost of the fencing initiative is less than $12.5 m (taking into account all costs including the financial costs of fencing material and labour as well as any lost profits from changed land use arrangements caused by the project) then the project should be undertaken.

6 Summary and Conclusions

River management in Victoria presents decision makers with a set of complex issues that involve trade-offs between competing uses. Information on which to base sound river management decisions should include details of the relationships between alternative uses and the biophysical condition of rivers. For instance, decision makers should be aware of the consequences for attributes of river condition (such as native fish species numbers, the health of riverside vegetation, native waterbird and animal species numbers, and water quality) of various river management strategies (such as permitting more extraction, excluding stock from river banks, increasing the cap on extractions, etc.).

Providing predictions of these consequences is the province of bio-physical scientists. However, such information may not be sufficient for good decision making. Information on the values that the community holds for the predicted outcomes of the alternative management strategies is also important. These values will include the benefits to be enjoyed by the community from extracting water from a river for agricultural or domestic purposes and the benefits of improving the condition of the river achieved by restoring water flows or investing in engineering or land management options. It is only with such value information that the trade-offs associated with particular strategies can be fully assessed. Estimating values associated with extractive values of water are comparatively straightforward because the goods and services so provided are bought and sold in markets. Estimating values associated with improving the environmental condition of rivers is more difficult because the goods and services so provided are not marketed. Ignoring these non-market values is likely to lead to biased decision making.

The goal of the study detailed in this paper was to provide decision makers with estimates of values arising from investments that will improve the environmental condition of rivers in the state of Victoria. The information provided will allow improved evaluations of decisions to allocate scarce resources to river management alternatives.

The Choice Modelling technique is used. Applying CM involves samples of people to be affected by proposed changes in river management being asked to choose between a range of alternative 'futures'. These alternatives are described in terms of their likely river condition outcomes and their cost to the respondent. Through an analysis of the trade-offs that people make in deciding their preferred alternatives, monetary values for unit increases in the environmental condition attributes can be estimated.

As a pilot study, three rivers were selected as the focus of the work reported here: the Gellibrand, Moorabool and Goulburn Rivers. Values were estimated for these rivers across respondents living within their catchments, in Melbourne and elsewhere in the State.

Models of the data provided by over 800 respondents were found to be statistically robust in terms of their overall capacity to predict respondents' choices. Estimates of respondents' willingness to pay for improved numbers of native fish species, length of river with healthy native vegetation, and numbers of native waterbirds and animals proved to be significantly different from zero showing that people do value the environmental condition of rivers. Differences in values between the Goulburn River and the other two rivers were detected for the numbers of waterbirds and animals. No value differences across differently located respondents could be detected although it was clear that differences in respondents' incomes age and education do influence their preferences for river condition attributes.

The picture for water quality is mixed. While significant values were detected for water quality improvements in the Goulburn River amongst locals and Melbourne respondents, values in other rivers were found to be insignificant. However, it is noted that primary contact recreation was used as a surrogate measure of water quality and in future work it may be necessary to distinguish between those who have actually visited the rivers versus those who have not – in order to test any confounding effects between recreation per se and water quality.

The main conclusions to be drawn from the study relate to the method and the results. Choice Modelling has been demonstrated to be capable of application in the context of the assessment of Victorian river condition. Furthermore, its application has been shown to be robust. The results derived from the application have direct and immediate use in the assessment of actual river health investments. The implicit price estimates provided are theoretically consistent with the principles of benefit cost analysis and so can be used in any benefit cost analysis of proposed river management options along with already established values for extractive uses of water. The consistency of implicit price estimates across rivers and samples of different populations indicates that there is potential to use the results obtained as sources for benefit transfer exercises. Put simply, the value estimates derived in this study will be useful not only in assessments of river management strategies in the Goulburn, Gellibrand and Moorabool Rivers but, with due care, will also be useful as indicators of values arising in similar rivers in Victoria.

As well as providing policy relevant results, the study, as a pilot, has delivered important lessons for the application of the technique to all river types in Victoria.

It was found that the sample frame used for the pilot included numerous people who had moved house or who were deceased. Alternative sampling frames need to be sourced or other sampling methods – such as geographically randomized drop-off-pick-up surveying – employed. Surveying over the Christmas period was detrimental to the response rate achieved and voiding that period – and other key holiday periods such as Easter and school holidays – is a key lesson of the pilot.

Measures to simplify the questionnaire format warrant investigation. Increased use of photographic material to give respondents quick and easy access to the relevant information is one possibility. The use of full colour photographs, particularly on the cover of the survey booklet would increase the visual attraction of the package delivered to respondents. More integration of the information booklet and the questionnaire itself is another possibility for improving the communication aspects of the questionnaire. It may be less daunting to respondents to use an information *sheet* rather than an information booklet.

The use of icons to represent the attribute levels in the choice sets is also worth re-assessing, particularly where there is no clear proportional relationship between the numbers of icons and the progression of the levels. Numeric representation is an alternative as is a combination of icons and numbers.

The levels selected for the attributes need to be consistent in the derivation across the rivers selected for analysis. A re-visiting of the scales used for the attributes would thus be advantageous as would the determination of the prospects for respondents to view attributes as being in some ways interrelated. Such interrelationships would mean that cross product terms (between attributes) would require estimation in the choice models derived from the data and such estimations are only valid if an appropriate experimental design has been used. The alternative is to ensure that respondents are adequately informed of the attributes not being interrelated.

One attribute warrants special mention: the payment vehicle. A one-off payment was specified in the pilot and this has implications for budget constrained respondents who whilst wishing to support river condition improvements may be unduly restricted in their choices compared to what they could do if payment was scheduled over a longer period.

This is the first study in Victoria to deal with the difficult-to-quantify ‘unpriced’ or ‘non-market’ values associated with improvements in river health. These values are often large in relation to market-based values for improvements and have commonly been ignored in other studies, or at best extrapolated from other States or countries. The omission of these values can lead to serious under-estimation of the returns to investment in river health.

If the study is extended to all river types in Victoria it will be possible to use the results of the study to assist in prioritising river management projects within and between catchments and regions.

In a policy context, it will be possible to quantify the economic benefits of the DSE Healthy Rivers program on a State-wide basis. The results can be incorporated in Benefit-Cost Analyses, providing support to funding applications for expansion of existing projects and programs, or to establishment of new projects and programs in river health.

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8 Bibliography

Bennett, J and R. Blamey (2001). *The Choice Modelling Approach to Environmental Valuation,* Edward Elgar, Cheltenham.

Morrison, M. (2000), ‘Aggregation Biases in Stated Preference Studies’, *Australian Economic Papers*, Vol. 39, pp. 215-230.

Morrison, M. and J. Bennett (2004). ‘Valuing New South Wales Rivers for use in Benefit Transfer’, *Australian Journal of Agricultural and Resource Economics*, 48(4): 591-612.

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

URS (2006), *The Value of Improved Environmental Health in Victorian Rivers: Results from the Pilot Phase*, Report prepared for the Victorian Department of Sustainability and Environment, Corangamite Catchment Management Authority, Goulburn Broken Catchment Management Authority, and Melbourne Water Corporation, Melbourne, Australia.

Van Bueren, M. and J. Bennett (2004). 'Toward the development of a transferable set of value estimates for environmental attributes', *Australian Journal of Agricultural and Resource Economics,* 48(1): 1-32.

Whitten, S. and J. Bennett (2005). 'Managing Wetlands for Private and Social Good', Edward Elgar, Cheltenham.