FINAL DRAFT

Valuing the Environmental Attributes of NSW Rivers*

Draft Report Prepared for the NSW Environment Protection Authority

by

Dr Jeff Bennett
Dr Mark Morrison

of

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Executive Summary

The Water Reforms process under way in New South Wales requires Water Management Committees for rivers across the State to provide advice to the government on appropriate water sharing arrangements. This advice is to be based on the environmental and social impacts of alternatives. Information on which to base this advice is scarce, particularly as it relates to the values held by the community for changes in the environmental conditions of rivers.

The aim of the research reported here is to provide Water Management Committees with information on the values held by the people of NSW for the environmental attributes of rivers.

A non-market valuation technique known as Choice Modelling has been used in the estimation process because the environmental values of rivers are not traded in markets.

The Choice Modelling application involved asking samples of people to choose between alternative future water management options. Each option was described in terms of the results achieved in a number of environmental attributes: water quality, riverside vegetation and wetland health, and the number of fish and fauna species present. A levy on water rates was also associated with each option. The choices made by respondents indicated the trade-offs respondents are willing to make to secure environmental improvements. With one of the attributes being monetary, values expressed in dollar willingness to pay form can be inferred from the choices made.

Five rivers were selected as “representative” of rivers across the State to be the subjects of the Choice Modelling process. These were the Bega, Clarence, Georges, Gwydir and Murrumbidgee Rivers. Samples of people living within the catchment were selected to take part. In addition, the values of people living outside the Gwydir and Murrumbidgee Rivers catchments were also estimated.

The value estimated for an increase of one per cent in the length of the river with healthy native vegetation and wetlands was in the order of one to two dollars per respondent.

For an additional fish species, the value estimated was, on average, around two to three dollars and for waterbird and other fauna species the average respondent was willing to pay approximately one to two dollars.

The water quality of rivers was proxied by the recreational opportunities that can be undertaken across the length of the river. For an improvement that would allow fishing (rather than just boating), respondents were willing to pay, on average, around $50. To take the water quality improvement up to the point where the river was swimmable throughout, an additional $35 (on average) would be paid.

Value estimate differences were found across rivers and between “within” and “outside” catchment respondents.

In order to “transfer” the values estimated from the five rivers for people living both within and outside the catchments to the other rivers across the State, a benefit transfer protocol was developed. The protocol took into account the differences observed in value estimates. The protocol was informed by a model of respondents’ river option choices that extended across all rivers and respondents. This allowed the differences between river regions and respondents to be identified.

The output of the benefit transfer protocol is a series of attribute value tables that each pertain to the rivers of a region of the State. Water Management Committees will be able to identify their region and hence the table of attribute values that relates to that region.

In order to assist the Water Management Committees further, a process for the aggregation of attribute values has also been developed. This process takes the per respondent single attribute value estimates and develops the total community value for water management proposals that involve improvements in multiple environmental attributes.

Two issues arise in this aggregation process.

First, two methods of aggregating across multiple attribute changes are described: the aggregation of the individual attribute values and the calculation of the "compensating surplus". The latter is only recommended when the changes involved are non-marginal.

The second issue involves complications that arise when estimating “outside” catchment values. The “outside” catchment values estimated for the environmental attributes are based on respondents’ preferences when only one river improvement is being undertaken across the State. Where multiple proposals across a number of rivers are being considered simultaneously, these single river value estimates may be inflated. The recommendation is to use value estimates generated in a parallel Choice Modelling exercise, that was conducted with a focus on rivers across the whole State, as upper bounds for the “outside” catchment value estimates.

The value estimates and the procedures developed to assist analysts with the use of these value estimates, break new ground in the preparation of information for natural resource management. The incorporation of this type of non-market value information – alongside value information relating to market impacts –will enable better decisions to be made regarding the future use of the State’s water resources.

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1. Goals of the Project

The aim of this report is to provide estimates of community values associated with the protection of riverine environments across the State. The value estimates presented are for the use of Water Management Committees (WMCs) in their formulation of advice to the NSW Government regarding the allocation of water between competing uses.

The "Water Reform" process being undertaken by the NSW Government as a component of the Council of Australian Government's reforms requires a "better balance in water use by a more explicit and careful sharing of water resources between the environment and water users" (Department of Land and Water Conservation 1998). To pursue this goal, WMCs have been established across the State to advise the government on appropriate water sharing arrangements.

The WMCs will find useful in the formulation of such advice information relating to the biophysical consequences of alternative water sharing arrangements. For instance, predictions of the impacts on the number of fish species present in a river and the quantities of irrigated crops harvested given increased allocations of water to agriculture would be relevant.

However, biophysical predictions alone give no indication of the relative values of alternative water sharing regimes. Hence, in order to consider the impact on the community of changes such as might occur in fish species numbers and tonnes of crops harvested, the values held by the community for these changes must also be established.

The value generated to society from marketed goods like irrigated crops can be readily estimated with reference to market data. However, many of the goods that are produced by the allocation of water for environmental protection are not marketed. The values enjoyed by society from these environmental goods must be estimated using non-market valuation techniques. Such techniques involve a sample of the people who will enjoy the environmental values under consideration being asked about their preferences, in the format of a structured questionnaire. The non-market valuation technique selected for the application reported here is known as Choice Modelling.

2. An Introduction to Choice Modelling

Choice Modelling (CM) has its origins in psychology, market research and transport economics. Its primary applications have been in the prediction of market shares for newly developed products. For instance, a firm considering the introduction of a new breakfast cereal could use CM to predict its likely impact as a competitor against established products. In the transport field, the technique is used to forecast the sharing of traffic on a particular route between alternative transport modes if a new service was introduced.

The method adopts a perspective on products that involves goods as "bundles" of attributes or characteristics. Each individual product can therefore be pictured as a bundle of these attributes supplied at particular levels. Hence, the good milk is considered as a bundle of attributes including volume, price, fat content and packaging type. A specific product may therefore be a one litre plastic container of low fat milk retailing for $2.

In a marketing application, milk consumers would be presented with a sequence of questions in which they would be asked to select their preferred milk product from a range of alternatives. The questions in the sequence differ because the alternative milk products offered are altered. Whilst all the differing products are described using the same product attributes, the “levels” (eg plastic or cardboard container; full cream or low fat) of the attributes are varied so that a good cross section of all the possible combinations of attribute levels are evaluated by respondents[1].

By analysing the choices people make in relation to the levels of the attributes and their socio-economic characteristics, the market researcher can understand the importance of each attribute as a component of demand. This in turn enables the prediction of market shares for established and new products. Furthermore, by comparing the way respondents are willing to give up one product attribute in order to achieve more of another it is possible to estimate the relative values of the attributes. If one of the attributes involved in the trade-off process is product price, a monetary value for the individual attributes can be estimated. Finally, by comparing alternative products, it is possible to use the model to estimate how much extra (or less) respondents would be willing to pay for one product over another.

The capacity for CM to be used to investigate the prospects of products that have yet to be released onto the market made it of interest to environmental economists. Their interest was also focused on goods that were not available in the market – the environmental goods that are not bought and sold in markets. The development of CM as a technique for non-market environmental valuation followed[2].

The type of environmental CM exercise that has been developed involves respondents being asked to select their preferred alternative from a range of potential, future resource management policies. Each policy outcome is described in terms of a set of attributes. The alternatives differ, according to an experimental design, in terms of the levels of the attributes in each. For instance, a CM application centred on the estimation of values associated with the protection of an endangered species may include policy alternatives characterised by:

- Number of the species remaining
- Health rating
- Levy on income tax (as a payment to secure the alternative)

The levels for the health attribute may be:

- excellent
- good
- poor

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[1] This is done using an experimental design involving the selection of an orthogonal fraction of the full factorial of combinations.

[2] See Bennett and Blamey (2001) for a more complete expose of environmental choice modelling.

Other attributes may be depicted using numerical levels.

Similar to the marketing application described above, the choices made by respondents in an environmental valuation CM questionnaire can be analysed to show the impact of each attribute and respondents' socio-economic characteristics on choice. This analysis can then be used to develop the same type of valuation outputs as produced by their market research counterparts.

"Market shares" can be estimated. In the environmental application these are the percentages of public support particular policy options could be expected to generate.

The values of individual attributes can be estimated. When estimated using the monetary attribute these are known as "implicit prices". They show the amount respondents are willing to pay to achieve an increase in the level of an environmental attribute, given that all other factors remain unchanged.

Finally, if the choices presented to respondents are structured appropriately, monetary estimates of the change in welfare experienced by respondents as a result of a change in policy away from a base case can be determined. These estimates are compatible with the theoretical underpinning of benefit cost analysis and can therefore be incorporated into economic assessments of potential policy changes.

Applications of CM as a tool of environmental valuation in Australia cover a range of issues. Studies have been undertaken to estimate the value of improved wetland conditions in the Macquarie Marshes and Gwydir Wetlands in NSW (Morrison, Bennett and Blamey 1999). Remnant vegetation protection in Queensland, NSW and Victoria has been the focus of work by Blamey, Rolfe and Bennett (2000) and Lockwood and Carberry (1998). Whitten and Bennett (2001) have used CM to quantify the trade-offs between alternative land use management strategies in the Upper South East of South Australia and the Murrumbidgee River Floodplain in NSW. As a component of the National Land and Water Resources Audit, van Bueren and Bennett (2001) undertook a nation wide survey that used CM as a method for estimating the values held by Australians for land and water degradation.

3. Choice Modelling and the Process of Benefit Transfer

A specific weakness of non-market environmental valuation, including the application of CM, is its cost. Because an application involves the surveying of a sample of the population, it is expensive relative to the type of "desk-top" valuation exercise that can be done for marketed goods.

For many policy decisions involving environmental impacts, the costs of undertaking a CM application are simply not warranted. To deal with this type of situation, Benefit Transfer (BT) has developed. Under BT, value estimates that have been developed for other cases ("source" estimates) are used to inform decisions where an environmental valuation exercise is not warranted given the scale of the proposed changes or cannot be afforded in terms of either time or money (the "target" case). For instance, estimates of wetland protection values developed for the Macquarie Marshes are used to evaluate policy initiatives in the Gwydir Wetlands.

Benefit transfer is especially well suited to the task of providing environmental value estimates for rivers across NSW. The individual estimation of values for the large number of catchments in NSW would be prohibitively expensive, yet the process of allocating water is being undertaken across the whole State.

The approach taken in this study was to divide the catchments of NSW into five "geographic regions". One catchment from within each region was selected, and the environmental values of the rivers in these "representative" catchments were estimated in five separate CM applications.

After consultation with river ecologists and policy advisers, regions and "representative rivers" were selected. The rivers selected for analysis (along with their region of location) were:

- Bega River (southern, coastal)
- Clarence River (northern, coastal)
- Georges River (urban)
- Murrumbidgee River (southern, inland)
- Gwydir River (northern, inland)[3].

The WMCs for the catchments that were not the subject of the CM applications could then determine the region into which their particular catchments falls, and use the process of BT to derive environmental value estimates for their own catchment on the basis of the representative river estimates.

Choice Modeling is particularly well suited to the task of providing "source" estimates for this type of BT exercise. This is because the technique allows the values that people have for river protection to be divided up into the contribution made by its component attributes (Morrison and Bennett 2000, van Bueren and Bennett 2001). The technique provides estimates of the per unit value of the environmental attributes of the river. Hence, the values of many different proposed changes in environmental condition can be estimated by "reconstituting" the river attributes according to the specific case under consideration. The changes in the environment proposed for one river are unlikely to be the same as in other rivers. CM results provide the flexibility to estimate values for many different proposals on the basis of one application.

Another feature of CM is that its applications allow for differences in socio-demographic characteristics to be taken into account when transferring value estimates. For instance, if the "source" river has a catchment population that has, on average, higher levels of income than the "target" river catchment population, these differences can be taken into account if it is found that environmental values are influenced by income.

[3] In the initial stages of the research, the Narran River was included as a representative of western rivers. However, after consultation with the WMC for the Narran, it was decided to omit it from the analysis because of complications caused by its source being located in Queensland and its very small within-catchment population. The omission of rivers from the western region means that this study's results will have only limited application in that region.

The BT process is somewhat complicated by the impact of respondent location. The value placed on a river's environmental protection is likely to be different for a person who lives in the river's catchment compared to someone who lives at some distance from the river. In other words, value estimates from a "source" study – even after adjustment for differences in attribute levels and socio-economic characteristics of respondents – may not simply be extrapolated across a wider population. To account for this, values must be estimated for catchment residents and the broader population of NSW.

Thus when undertaking a BT exercise on the basis of CM results, it is possible to allow for both differences in the extent of the environmental change proposed, and the characteristics of the population. Undertaking separate studies of how values vary according to the location of respondents enables the aggregation of the survey results to the full population of people who gain benefits from the environmental protection of a river.

A final advantage of using this approach results from the use in this project of five separate catchments. With such an extensive data set collected from the five different catchments, it has been possible to develop an overall model that shows how value estimates change with the characteristics of a catchment eg inland/coastal, north/south. This model is described in Appendix F.

4. Project Structure in Summary

To allow the development of a set of environmental value estimates for the rivers of NSW that would allow the comprehensive use of the benefit transfer process, seven separate Choice Modelling surveys were undertaken. The following table summarises the structure of the study.

Table 1: Study structure

Representative River	*Within Catchment sample*	*Outside Catchment sample*
Bega	✔	
Murrumbidgee	✔	✔
Georges	✔	
Clarence	✔	
Gwydir	✔	✔

5. Review of the Questionnaires

Five separate questionnaires were designed around the five "representative" rivers for the within catchment surveys. In order to ensure the comparability of results from each survey, the questionnaires used were structurally identical. Differences between the questionnaires related to divergent biophysical characteristics of the rivers only. Maintaining the questionnaire structure across the samples enables the statistical testing for differences between the attribute values estimated for each river and its local population. These tests enable the detection of differences in attribute values that are due to differences in the biophysical features of the rivers and socio-economic characteristics of the local residents.

The outside catchment questionnaires were designed to parallel their respective within catchment questionnaires. This again was to ensure comparability of results across the questionnaire versions.

The questionnaires were developed through a process of consultation with experts, community consultation and peer review.

Initially, the same experts that were consulted about the choice of catchments, were asked about appropriate attributes for measuring river health. Then, through the use of focus groups, members of the community were consulted about what they saw as being the important attributes of river health. Encouragingly there was a lot of congruence between the views of the experts and members of the community.

Details of the attribute determination process are provided in Appendix A to this report.

Once these attributes were defined, a draft questionnaire was developed. The questionnaire was then tested in a series of focus groups. In total, five focus groups were held (two in Chatswood, one in Liverpool, one in Yass and one in Wagga Wagga).

After the questionnaires were developed, they were then peer reviewed by two experts, one experienced in ecology, the other in survey design. Drafts of the questionnaires were provided to the relevant WMC and feedback was incorporated into the designs.

A sample questionnaire is provided in Appendix B to this report. The questionnaires used for this project contain several elements. These include:

- background information about the catchment,
- a scenario description (ie explaining why people should have to pay for improving river health and what this will achieve),
- a series of choice sets to answer, and
- debrief questions.

These are now discussed in greater detail.

Each of the questionnaires had a fold out cover. On the front of the cover was a map, so that respondents would know the make up and boundaries of the catchments. The fold out cover also contained: (1) some basic catchment facts, (2) a description of agricultural activity in the catchment, and (3) a summary of the attributes used to describe the environmental condition of the river.

On the first page of the questionnaire, respondents were asked several simple questions about their past and potential experience of the river. They were asked whether they had heard of the river in question, visited it, and planned to visit it in the future. It is a feature of questionnaire design to start with several very simple questions.

Next, the issue of declining river health was introduced. Respondents were told that there had been declines in the attributes of river health (the number of native fish species, the amount of healthy riverside vegetation and wetlands, the number of water bird and other fauna species, and recreational opportunities). They were also told that various factors had contributed to this decline.

Respondents were then told that there were various ways of improving the quality of the river. Four of these methods that were pertinent to the catchment under consideration were then described (eg use of sewage treatment plants, buffer strips, engineering works etc) and photographs were included of each. The environmental management methods described were:

- Improvements to sewage treatment plants
- Construction work to reduce erosion
- Improving water use efficiency
- Fencing to protect riverside vegetation
- Control of weeds
- Control of feral species
- Construction work to reduce stormwater pollution
- Informing the community

An explanation was then given of how the improvement of river health would affect the respondent. It was explained that such projects are costly, and that a possibility for funding the projects is for the State Government to collect a one-off levy on water rates for all households in the catchment during 2001. Respondents were also told that the size of the levy would depend on which projects were chosen.

At this point it was felt necessary to assess whether respondents found this survey scenario believable. Thus three Likert scale (ie 1-strong agree, 5-strongly disagree) questions were asked. Respondents were asked the extent to which they agree or disagree with the following statements:

- A river improvement levy is a good idea
- I thought the projects described about would lead to improved river quality
- I don’t trust the government to make the increase in water rates one-off

Next the choice sets were introduced. Respondents were told that they were going to be presented with a number of options to evaluate, that had been grouped into sets of three. In each set, Option A represented the current situation, and the other two options represented improvements to river health. Respondents were asked to choose their preferred option from each set. In total, respondents were presented with five such questions.

Before answering the choice sets, respondents were told that some of the outcomes in the options may seem strange, but that these depend on the combination of projects chosen. They were also reminded to remember their available income and all the other things that they have to spend money on.

An example of a choice set is shown in Figure 1 below.

After answering the choice sets, a series of debrief and classification questions were asked. These aimed to identify respondents who might be protesting against the payment vehicle (Question 11), whether the information in the questionnaire was sufficient, understandable and unbiased (Question 12), whether respondents found answering the choice sets confusing (Question 12), and standard socio-demographic and attitudinal indicators (Questions 13-20).

The ecological information used in the questionnaires was gathered through an extensive literature review. This review relied heavily on information provided by NSW Fisheries, the NSW Environment Protection Authority, NSW Department of Land and Water Conservation, NSW National Parks and Wildlife Service and the Healthy Rivers Commission.

Information on fish species was drawn from information supplied by NSW Fisheries. Information on fauna species was based on data from the Wildlife Atlas at NSW National Parks and Wildlife Service. The recreational opportunities data were derived from water quality data sources in the NSW Department of Land and Water Conservation. Information on vegetation was derived from a range of sources[4].

Figure 1: A choice set from the Bega River questionnaire
(see over)

[4] Research assistance in the collection of ecological data was provided by Adrian Butler and Tiffany Mason, who are both environmental science graduates from Charles Sturt University. Assistance in interpretation of fauna data was provided by Dr Andrew Fisher, Environmental Studies Unit, Charles Sturt University.

Question 10: Carefully consider each of the following three options for the Bega River. Suppose Options A, J and K were the ONLY ones available, which one would you choose?

	Levy on water rates (one-off) $	Recreational uses	Healthy riverside vegetation and wetlands	Native fish	Waterbi other fa
Option A (Current situation)	no extra cost	✓Picnics ✓Boating ✗ Fishing ✗ Swimming	Along 30% of river	15 native species present	48 speci present
Option J	$200	✓Picnics ✓Boating ✓Fishing ✗ Swimming	Along 40% of river	21native species present	59 speci present
Option K	$200	✓Picnics ✓Boating ✓Fishing ✓Swimming	Along 60% of river	21 native species present	59 speci present

Which of these options would you choose

☐ I would choose Option A

☐ I would choose Option J

☐ I would choose Option K

☐ Not sure

6. Survey Logistics and Sample Characteristics

As summarised in Table 1, questionnaires were delivered to seven different samples in this project. For each of the five catchments, a sample was selected from within the catchment. For two of the catchments (Gwydir and Murrumbidgee), a sample was also selected from outside the catchment.

To implement this research design, seven samples of 900 respondents were drawn from "Australia on Disk", a listing of people based on the White Pages telephone directory. For the five "within catchment" samples, respondents were selected at random on the basis of postcodes relating to the corresponding river catchments. For two of the catchments (Gwydir and Murrumbidgee) further samples of 900 respondents were drawn from "outside" of these catchments across the whole State.

A four stage surveying process was employed. First, an introductory letter advising those drawn in the sample that they would shortly be receiving a questionnaire was dispatched. Those receiving the letter were given the option of withdrawal. As well as heightening the significance of the survey, this preliminary letter was designed to filter out names and/or addresses from the sample that were redundant – such as people who had moved, were incapable of answering or who were deceased. The effective sample size was reduced to account for these sample frame inadequacies.

The second stage of the survey involved the mailing of the questionnaire with an accompanying letter and a reply paid envelope.

A reminder card comprised the third stage and a re-mail of the questionnaire to those yet to respond completed the process[5].

The useable response rates for the all of the surveys is shown in Table 2. The overall response rate was 37.8%, ranging from 28.7% to 45.9%. For the within catchment samples, the response rate averaged 40%. This response rate compares favourably with other mail surveys of this genre (Mitchell and Carson 1989).

Table 2: Survey response rates

	Bega	*Clarence*	*Georges*	*Gwy-within*	*Gwy-outside*	*Murr-within*	*Murr-outside*	*Overall*
Useable responses	336	346	210	307	228	278	255	1960
Successfully delivered	732	763	731	752	751	719	703	5181
Response rate	45.9%	45.3%	28.7%	40.8%	30.4%	38.7%	36.3%	37.8%

The socio-demographic characteristics of the survey samples are shown in Table 3.

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[5] Barbara Davis and Associates and National Mailing and Marketing Pty Ltd were tasked with the sample selection and co-ordination of the survey.

Table 3: Socio-demographics of the survey samples

	Clarence	*Bega*	*Georges*	*Murr-within*	*Murr-outside*	*Gwy-Within*	*Gwy-outside*
Age (yrs)	55.9	52.6	51.1	50.5	52.9	51. 5	52.4
Sex (% female)	41%	41%	30%	45%	39%	34%	36%
Children	87%	83%	89%	84%	85%	85%	80%
Education#	3.9	4.3	4.1	4.1	4.3	4.1	4.3
Income	$32,256	$38,899	$46,069	$50,548	$50,251	$43,517	$47,989

1-never went to school, 6-tertiary degree

7. Values for the Environmental Attributes of NSW Rivers

The objective of this project is to estimate the values of environmental attributes of rivers. These attribute value estimates will be of use to WMCs in their considerations of alternative water sharing arrangements. Technically, these estimates (also known as *implicit prices*) are appropriate for use in cost-benefit analysis where benefit estimates resulting from incremental changes in river attributes are required.

To estimate these values, the choice data collected in the surveys were analysed statistically. In essence, the analysis involves searching for relationships between the levels of the attributes used to describe the outcomes of alternative river management strategies and the probability that respondents will choose a strategy. At the same time, the statistical process used looks for relationships between the choices respondents made and their socio-demographic characteristics (eg age, income, sex).

From the relationships between choices made and the levels of the attributes and respondents' characteristics identified, attribute values can be estimated. The attribute values estimated for each of the rivers covered in this study are presented in Tables 4 to 8 and in Figures 2 to 6. Technical details of how these estimates are derived are provided in Appendix C.

Table 4: Vegetation attribute value estimates

River/sample	**Value per one percent increase in the length of the river with healthy native vegetation and wetlands ($)**
Within catchment sample	
Bega	2.32
Clarence	2.02
Georges	1.51
Murrumbidgee	1.45
Gwydir	1.49
Outside catchment sample	
Murrumbidgee	2.17
Gwydir	2.01

Table 5: Fish attribute value estimates

River/sample	Value per unit increase in the number of native fish species present ($)
Within catchment sample	
Bega	7.37
Clarence	0.08*
Georges	2.11
Murrumbidgee	2.58
Gwydir	2.36
Outside catchment sample	
Murrumbidgee	3.81
Gwydir	3.43

* insignificant coefficients in model at the 5 percent level.

Table 6: Waterbird and other fauna attribute value estimates

River/sample	Value per unit of an increase in the number of waterbird and other fauna species present ($)
Within catchment sample	
Bega	0.92
Clarence	1.86
Georges	0.67*
Murrumbidgee	1.59
Gwydir	2.36
Outside catchment sample	
Murrumbidgee	1.80
Gwydir	0.55*

* insignificant coefficients in model at the 5 percent level.

Table 7: Water quality attribute value estimates (1)

River/sample	Value of increasing water quality from boatable to fishable across the whole river ($)
Within catchment sample	
Bega	53.16
Clarence	47.92
Georges	48.23
Murrumbidgee	53.43
Gwydir	51.31
Outside catchment sample	
Murrumbidgee	30.50
Gwydir	29.19

Table 8: Water quality attribute value estimates (2)

River/sample	Value of increasing water quality from fishable to swimmable across the whole river ($)
Within catchment sample	
Bega	50.14
Clarence	24.73
Georges	27.28
Murrumbidgee	20.35
Gwydir	60.21
Outside catchment sample	
Murrumbidgee	60.68
Gwydir	30.35

Figure 2: Attribute Value Estimates - Vegetation (within catchment samples)

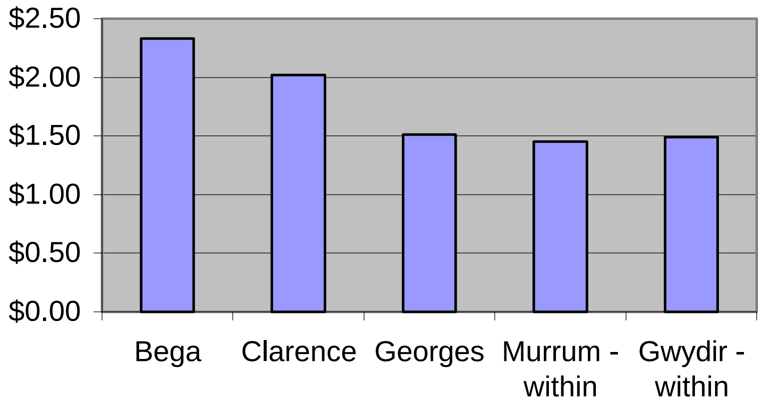
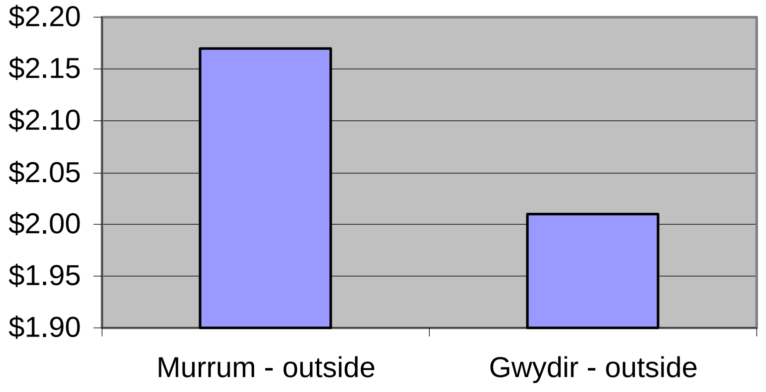


Figure 3: Attribute Value Estimates - Vegetation (outside catchment samples)



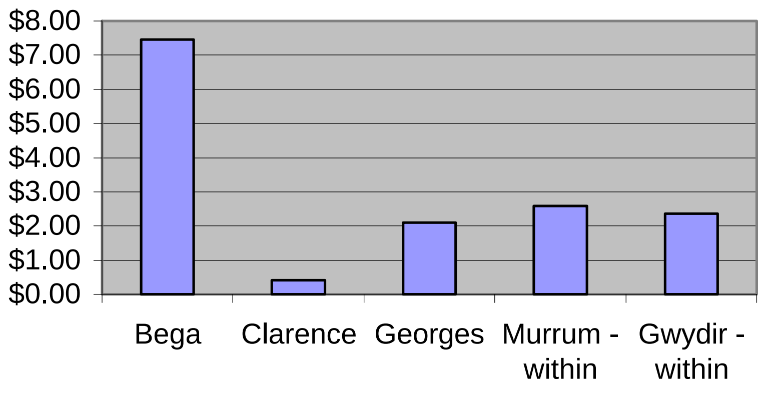


Figure 4: Attribute Value Estimates - Fish species (within catchment samples)

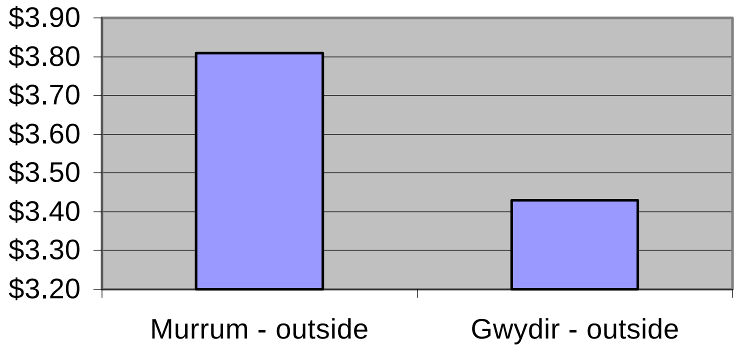


Figure 5: Attribute Value Estimates - Fish species (outside of catchment samples)

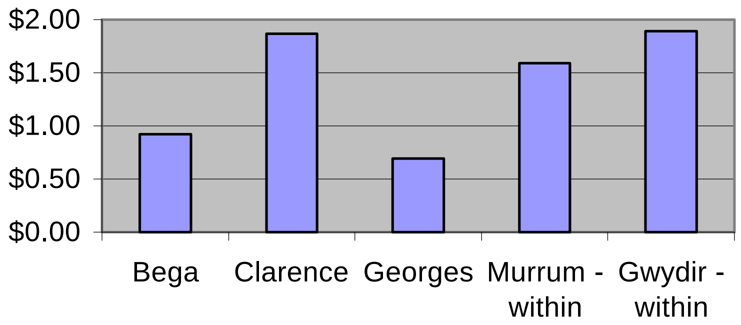


Figure 6: Attribute Value Estimates - Waterbirds and other fauna (within catchment samples)

Figure 7: Attribute Value Estimates - Waterbirds and other fauna (outside of catchment samples)

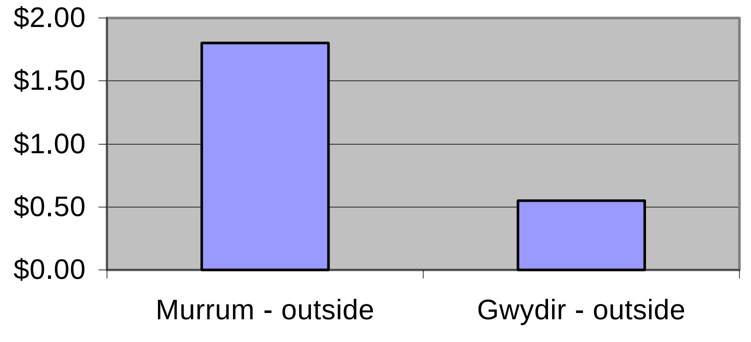


Figure 8: Attribute Value Estimates - Boatable to Fishable (within catchment samples)

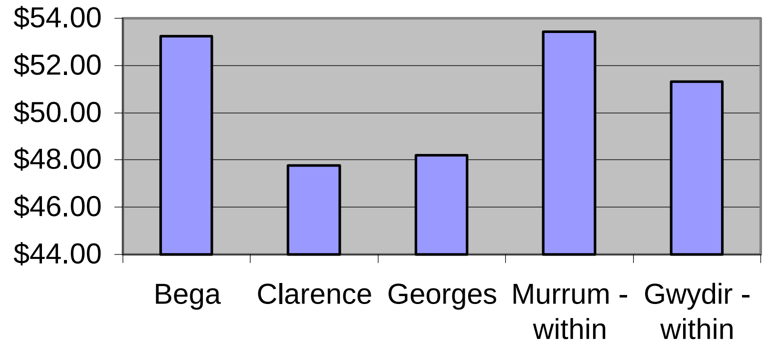


Figure 9: Attribute Value Estimates - Boatable to Fishable (outside of catchment samples)

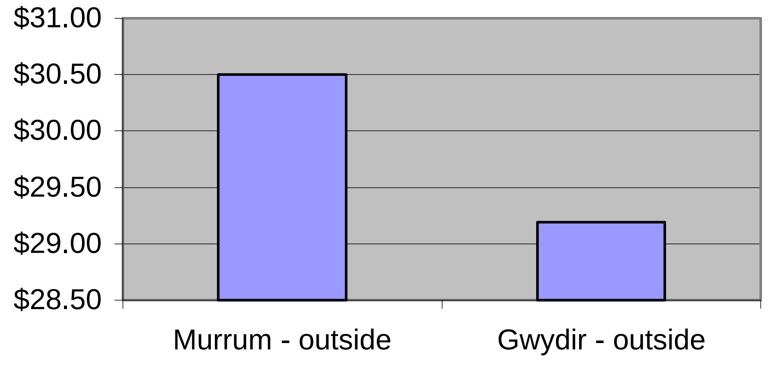


Figure 10: Attribute Value Estimates - Fishable to Swimmable (within catchment samples)

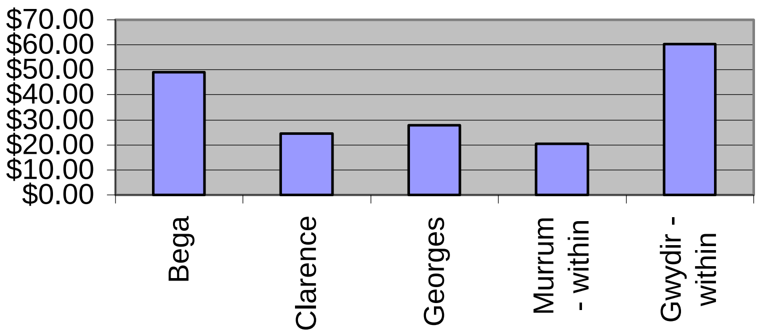
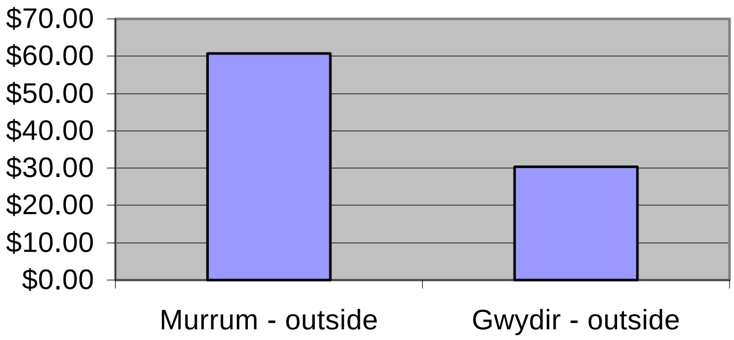


Figure 11: Attribute Value Estimates - Fishable to Swimmable (outside of catchment samples)



The reliability and accuracy of the estimates displayed can be judged in a number of ways. First, the strength of the statistical models that underpin the estimates provides a means of assessing the validity of the analysis. The models estimated for this study are able to explain an exceptionally large proportion of the total variability displayed in the raw data. That is, the models are extremely good at explaining the choice behaviour of the respondents.

In particular, the attributes used to describe the outcomes of river management strategies were consistently found to be significant in determining respondents' choices. Furthermore, the direction of the relationships between attribute levels and choices were as expected. For instance, it was consistently found that river management options that were more costly were less frequently chosen by respondents whilst options providing more species of fish were chosen more frequently.

Similarly, respondents' ages, their income and their attitudes to environmental issues had significant influences on choice behaviour and in directions that are predicted by theory. For instance, respondents with higher incomes were prepared to pay more for environmental improvements than respondents with lower income.

A further factor indicating the strength of the value estimates is the high response rate achieved in the surveys. The response rates achieved for the Bega and Clarence surveys were greater than 45 per cent, a remarkable rate compared to other Australian CM applications that have used a mail out mail back format. Even the two poorest response rate samples (Georges and Gwydir-outside) were well in excess of 25 per cent, a rate that is commonly accepted as reasonable for mail questionnaires of this level of complexity.

Notwithstanding these indicators of validity, there are numerous factors that need to be considered when deliberating on the confidence with which the attribute value estimates can be used. These factors will be discussed in the following sections.

8. Interpreting the Value Estimates

The units of measurement of the attribute value estimates displayed in Tables 4 to 8 are dollars per unit of each attribute. For instance, from the Bega River survey, the Fish Specie attribute value can be interpreted as:

On average, respondent households in the Bega Valley value the presence of an additional fish specie in the river at $7.37 per household.

The units used to measure the attributes are different for each attribute. Whilst the fish attribute value is per additional species, the vegetation attribute is per an additional percent of the river having healthy riverside vegetation and wetlands. In addition, the water quality (recreational opportunities) attribute has a different interpretation because, unlike the other attributes its unit of measurement was qualitative rather than quantitative. The water quality attribute is thus broken up into two "levels" – "boatable to fishable" and "fishable to swimmable". The attribute values associated with the first of these levels is the value, on average, that a respondent household holds for an improvement in the river's water quality from its current level "suitable for boating along its length" to the point where it is suitable for fishing along its length. For instance:

On average, each respondent household in the Clarence River sample values an improvement in river water quality that would make it safe for fishing along the length of the river at $47.92.

Furthermore:

To have the river water quality improved further so that it would be swimmable across its length, would be valued (on average) by the Clarence respondents at an additional $24.46 per household.

The use of qualitative, discrete levels for the water quality attribute requires further interpretation when a change occurs that lies between the defined levels. For example, if a management change causes an improvement in water quality from boatable to fishable from 40 percent of the river's length to 60 percent of its length, it is necessary to adjust the attribute value estimates because they are predicated on the improvement occurring over the entire length of the river. The adjustment required necessarily involves an assumption regarding the behaviour of value as less of the river is affected. The most straightforward assumption that can be made in this regard is that the relationship between value and length of the river affected is linear. In other words, if an extra 20 percent of the river is affected, the value associated with the improvement is 20/60 percent (ie 33%) of the value estimate for the whole river[6]. Using the Gwydir as an example:

On average, each respondent household in the Gwydir River sample values an improvement in river water quality that would make it safe for fishing ***along 66 percent*** *of the river at $25.65.*

Because the units of measurement are different across the attributes, the value estimates for the different attributes are not directly comparable. Hence the value estimates for the water quality attributes, swimming and fishing, may initially seem comparatively large. However, the differences may not be so great once differences in the units of measurement are taken into account.

For instance in some catchments, policy induced changes in the levels of the attributes that have comparatively small per unit may be substantial. As an example, a 20% increase in the coverage of healthy native riverside vegetation and wetlands may occur in some catchments. The relatively small per unit value could thus multiplied by a large amount of attribute change to yield the aggregate value of change. If each percent of vegetation coverage increase is estimated to be worth $2.02, as it is for the case of the Clarence River, then the aggregate value of the increase is $2.02 x 20 = $40.40 per respondent household. On the other hand, the water quality attribute levels involve change across the whole length of the river. The attribute value estimates in that case represent an already aggregated value of change. Hence consider the case, again of the Clarence, where the value of a river being made fishable rather than boatable across the whole river was estimated at $47.92. However, the policy under review may only affect five percent of the river. Thus, the value of the water quality improvement would be estimated at $47.92 x .05 = $2.40 per respondent household.

Comparisons are directly possible between the same attributes across different rivers and different samples. These results, detailed in Appendix D, indicate that:

- The estimates of attribute values related to the direct use of rivers (swimming and fishing) tend to be larger for the within catchment respondents than those estimated for the comparable outside catchment sample.
- The estimates of values associated more with the ecological condition of the rivers (the so-called existence values associated with vegetation, fish and other fauna) are larger for the samples of respondents living outside the catchments compared to the value estimates for the within catchment samples.
- Attribute value estimates generated from within catchment samples are predominantly different across rivers.

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[6] Information about the base level of recreational quality in each of the rivers is presented in Appendix I.

The implication of these results is that no single set of attribute value estimates can be used as a "source" for the purposes of benefit transfer. Rather, a protocol for the benefit transfer process will need to be developed to take full advantage of the value estimation data set generated in this project. Such a protocol is developed in the next section.

9. Value Estimates for Benefit Transfer

The attribute value estimates detailed in Section 8 are suited for use in the benefit transfer process. The attribute values held by people living within the catchment of rivers located in the five regions of the State represented by the five rivers studied in this report can be estimated with reference to the attribute values provided in Tables 4 to 8[7]. For instance, an estimate of the value of an additional 10 percent of healthy vegetation along the Macleay River on the north coast can be "transferred" from the Clarence River vegetation attribute value estimate. The exception to this protocol is when the attribute value estimates for a representative river are not significantly different from zero. These cases (Clarence/Fish and Georges/Fauna) are aberrations and require special attention. The approach recommended to deal with the situation is detailed later in this section.

The transference of "outside" catchment value estimates involves a number of complicating factors most importantly because only two rivers were subjected to "outside" sample CM applications in this study. These were the Murrumbidgee and Gwydir Rivers. For these catchments, and in other catchments represented by these two, the "outside" attribute value estimates detailed in Section 8 can be used to indicate an upper bound of the values held by people from outside of the catchment.

For other catchments a different approach is required.

In the case of Sydney urban catchments, the importance of "outside" catchment values is not so significant because of the large number of people living within that catchment, and the perception amongst people elsewhere in the state that urban issues should be dealt with by the urban populace. Hence, only within catchment value estimates need be considered.

However, for the northern and southern coastal catchments, where "outside" catchment values are more likely to play a significant role in determining the allocation of water, estimates of such values are required. Again, special attention needs to be given to the generation of these "outside" value estimates.

To provide estimates of attribute values where existing within catchment estimates are insignificant and where relevant outside catchment value estimates are not available, a benefit transfer model has been developed. The model is designed to predict value estimates on the basis of all the CM data collected from the "within" catchment and the "outside" catchment samples conducted, excluding the Georges River sample.

[7] The values estimated in this report are less reliable as "sources" for "target" rivers located outside the five regions, most notably the rivers of the far west of the State.

This sample has been excluded as it is not relevant for the estimation of “outside” catchment, attribute values for the coastal rivers.

The model allows a significant improvement in the degree of flexibility possible in the benefit transfer process compared to the straightforward transference of source to target value estimates. Its use requires the analyst to enter the relevant descriptors of the river in question and the sample. The output of the model is a set of attribute value estimates relevant to the type of river and sample of respondents under consideration. The inputs to the model are:

- Is the catchment in the north or south of the state?
- Is the catchment inland or coastal?
- Are the respondents whose values are to be estimated living within the catchment or outside the catchment?

The advantage of using this model is that it allows for transfer across the complete array of catchment/respondent “scenarios”. Specifically, out of catchment value estimates can be generated for the Bega and Clarence catchments as can estimates for the insignificant attribute values estimated from the within catchment samples. The model is presented in detail in Appendix F.

Attribute value estimates for the different catchments and different respondent locations are shown in Table 9.

Table 9: Attribute value estimates generated by the benefit transfer model

Catchment/Sample	Vegetation	Fish species	Fauna species*	Boatable to fishable	Fishable to swimmable
Southern, coastal, within catchment	$1.96	$6.27	$0.87	$55.55	$29.00
Southern, coastal, outside catchment	$2.61	$6.27	$0.87	$30.10	$38.74
Northern, coastal, within catchment	$1.96	$2.02	$0.87	$55.55	$29.00
Northern, coastal, outside catchment	$2.61	$2.02	$0.87	$30.10	$38.74
Southern, inland, within catchment	$1.25	$3.25	$0.87	$55.55	$29.00
Southern, inland, outside catchment	$1.90	$3.25	$0.87	$30.10	$38.74
Northern, inland, within catchment	$1.25	$3.25	$0.87	$55.55	$29.00
Northern, inland, outside catchment	$1.90	$3.25	$0.87	$30.10	$38.74

* The estimates of value for the fauna attribute are the same across all catchments/samples. This indicates that the benefit transfer model did not detect any significant impact of catchment or respondent location on the value held for additional species of fauna.

The attribute values generated by the benefit transfer model can be compared with those generated for the single catchments presented in Tables 4 to 8. For instance, the value of the vegetation attribute for the Clarence River estimated through the benefit transfer model is $1.96 compared to the direct estimate of $2.02. This represents a prediction error of only three percent. Other attribute value predictions are not so accurate. Estimate errors are presented in Tables 10 and 11.

Table 10: Benefit transfer model estimate errors (%)[#]: Within catchment samples

	Vegetation	Fish	Fauna	Fishable	Swimable
Southern coastal/Bega	-19	-19	-6	+4	-69
Northern coastal/Clarence	-3	*	-115	+14	+16
Southern inland/Murrumbidgee	-16	+21	-83	+4	+30
Northern inland/Gwydir	-19	+27	-171	+8	-108

A positive sign on the error indicates that the benefit transfer model overestimates the direct estimate.
* Insignificant attribute value estimate at the five percent level.

Table 11: Benefit transfer model estimate errors (%)[#]: Outside catchment samples

	Vegetation	Fish	Fauna	Fishable	Swimable
Southern inland/Murrumbidgee	-14	-17	-107	-1	-57
Northern inland/Gwydir	-6	-6	*	+3	+22

A positive sign on the error indicates that the benefit transfer model overestimates the direct estimate.
* Insignificant attribute value estimate at the five percent level.

The inconsistency of the benefit transfer model's ability to predict the value estimates generated directly from the CM data means that it should only be used where the direct data are unavailable or inappropriate. This is the case for the values held by outside catchment people for the attributes of southern and northern coastal rivers and the fauna attribute of inland northern rivers and for the within catchment values for the fish attribute in northern coastal rivers. In addition, the fauna attribute value estimate for the urban rivers would need to be generated from the benefit transfer model.

The estimates of values held for the environmental attributes of rivers recommended for use in five regions of NSW are set out in Tables 12 to 16.

Table 12: Attribute value estimates: southern coastal rivers.

Attribute	Value estimate ($ per within catchment household)	Value estimate ($ per outside catchment household)
Vegetation	2.32	2.61
Fish	7.37	6.27
Fauna	0.92	0.87
Water quality: Fishable	53.16	30.10
Water quality: Swimable	50.14	38.74

Table 13: Attribute value estimates: northern coastal rivers.

Attribute	Value estimate ($ per within catchment household)	Value estimate ($ per outside catchment household)
Vegetation	2.02	2.61
Fish	2.02	2.02
Fauna	1.86	0.87
Water quality: Fishable	47.92	30.10
Water quality: Swimable	24.73	38.74

Table 14: Attribute value estimates: southern inland rivers.

Attribute	Value estimate ($ per within catchment household)	Value estimate ($ per outside catchment household)
Vegetation	1.45	2.17
Fish	2.58	3.81
Fauna	1.59	1.80
Water quality: Fishable	53.43	30.50
Water quality: Swimable	20.35	60.68

Table 15: Attribute value estimates: northern inland rivers.

Attribute	Value estimate ($ per within catchment household)	Value estimate ($ per outside catchment household)
Vegetation	1.49	2.01
Fish	2.36	3.43
Fauna	2.36	0.87
Water quality: Fishable	51.31	29.19
Water quality: Swimable	60.21	30.35

Table 16: Attribute value estimates: urban (Sydney) rivers.

Attribute	Value estimate ($ per within catchment household)
Vegetation	1.51
Fish	2.10
Fauna	0.87
Water quality: Fishable	48.23
Water quality: Swimable	28.28

The confidence with which these estimates can be used varies from case to case. In general, the within catchment estimates can be rated as reliable. More caution must be taken when using the outside catchment estimates. There are two reasons for the lower level of confidence to be placed in the outside catchment estimates. First, the estimates for coastal catchments are based on the benefit transfer model that has been shown to be imperfect in its predictive capacity. The second reason for the lower confidence level centres on the characteristic of non-market value estimates known as "framing".

Value estimates generated from techniques such as CM are subject to the framing effect. This means that the values estimated are in part determined by the circumstances in which the valuation exercise is undertaken.

Of particular concern in the case of the environmental attributes of NSW rivers is the impact of framing on the outside catchment value estimates. It would be expected that the attribute values held by outside catchment residents estimated when only one river was being considered for environmental improvement would be greater than if many rivers were to be improved. This difference in value estimates comes about because respondents regard rivers as substitutes for each other and because they have limited budgets. With more rivers under consideration, the value on a per river basis can be expected to be lower.

The implication of the framing issue is that the outside catchment estimates presented here should be regarded as maximums because they were determined with only one river being considered by respondents. Where multiple river improvement programmes are being proposed across the State, the outside catchment values should not be applied in the assessment of all the proposals. A downward adjustment to reflect the framing effect should be made.

To determine the extent of this framing adjustment, a separate but parallel CM study of the values generated by environmental improvements in rivers across the whole of the State. The respondents sampled for this exercise were drawn from the population of the whole State. Hence, they are most appropriately considered as "outside" catchment responses. The results of "State-wide" study are presented in detail in Appendix H.

The estimates of environmental attribute values of rivers across the State that are held by NSW residents are set out in Table 17.

Table 17: Attribute value estimates for all rivers in the State

Attribute	Value ($ per household)
Vegetation	4.23
Fish	7.70
Fauna	2.37
Water quality: fishable	44.05
Water quality: swimable	87.17

The results demonstrate that the attribute value estimates for the whole of the state are larger than the outside catchment values estimates on a per catchment basis. However, it is clear that if the single catchment value estimates were used for a number of concurrent river improvement projects, the State-wide value estimates would be exceeded. Using the single catchment estimates for outside catchment values would cause an over statement of environmental improvement benefits.

The implication of these results is that outside catchment estimates for specific rivers can be generated by dividing these State-wide estimates by the number of rivers that are to be improved at the time. This strategy would ensure that outside values would be estimated conservatively.

10. Issues of Aggregation

The attribute value estimates provided by the individual catchment CM applications and the benefit transfer models can be used in the process of calculating estimates of the total value society gains from improvements in the environmental conditions of rivers across the state. However, to generate such estimates of aggregate value, a process of extrapolation must be applied.

First, it should be noted that the attribute values estimated in this project do not require aggregation over time. They were estimated as one-off payments made by households and as such represent respondents' "present values" of the stream of value they will enjoy from the attributes through time.

The "within" catchment value estimates can be extrapolated to the catchment population with reference to the number of households, given that the value estimates were generated on a per respondent household basis. As a conservative measure, the extrapolation should be made across 38% of the households. This is to account for the response rate achieved for the survey. Alternatively, the response rates achieved in each of the individual surveys could be used for the related rivers.

The practice of extrapolating the value estimates to the proportion of the population that responded to the survey is consistent with Boyle and Bishop (1987) who assumed that non-respondents have a willingness to pay equal to zero. Their rationale for this assumption is that by not answering the survey, respondents have implicitly indicated their willingness to pay. The problem with this approach is that the reasons people have not responding are varied and not necessarily indicative of a zero value for the good in question. For instance, some respondents may be unwell or away at the time of the survey. They may simply be too busy to take the required time out to complete the questionnaire. It is difficult, therefore, to gauge what proportion of non-respondents do have positive values without a comprehensive ex post survey of non-respondents. An alternative to the Boyle and Bishop approach is to use the method suggested by Morrison (2000). In a study that involved the estimation of values derived from environmental improvements to wetlands, Morrison found that potentially, about one-third of non-respondents have value estimates similar to respondents. For the current analysis, this would imply that the appropriate proportion of the population across which extrapolation could be made is 38 per cent plus one third of the 62 per cent non-respondents: that is 59 per cent. Clearly, this is a less conservative approach to the estimation of aggregate values.

Consider now an example of the aggregation process. Suppose that a river management option under consideration in a catchment on the south coast would increase the vegetation attribute by five percent, ensure the reintroduction of two fish species and improve the water quality across 15 percent of the length of the river from boatable to fishable. If the catchment had a household population of 4,000 then the appropriate calculation (based on the value estimates set out in Table 11) is:

Within catchment aggregate value estimate = 4000 x 0.38 [5 x 2.32 + 2 x 7.37 + 0.15 x 53.16]

= $52,157

Given a NSW population of approximately 1.8m households, the appropriate aggregation calculation for outside catchment values is:

Outside catchment aggregate value estimate = 1.8m x 0.38 [5 x 2.61 + 2 x 6.27 + 0.15 x 30.10]
= $20.59m

The total value to all the people of NSW of the improved river environment provided by the proposed management option is therefore in the order of $21m.

It is important to note that the aggregate value reported above is rounded to the nearest $10,000. This is done to avoid impressions of spurious accuracy.

This process can be used for NSW rivers that are located within the regions represented by the five rivers specifically considered in this report.

The relative magnitudes of the "within" and "outside" catchment aggregate value estimates provides a graphic illustration of the importance of the values enjoyed by people who live at a distance from the river. It also underlines the importance of ensuring that potential framing effects caused by the simultaneous assessment of multiple rivers are taken into account when estimating outside catchment values.

The aggregation process outlined in this section is subject to a particular limitation. It involves the aggregation of the estimates of individual attribute values. Theoretically, these values are estimates of what respondents are willing to pay to see them increase by one unit, given that no other changes occur simultaneously. Hence, to use them in the context of changes across a number of attributes can theoretically cause inaccuracy.

The more appropriate way to estimate the benefits of changes that involve multiple attributes is to use a more complete model of respondent choice behaviour. This involves the calculation of the benefits people receive from the environmental condition of rivers both before and after the change in water management that is being proposed. Technically, this value is called the Compensating Surplus of the proposed change. The complete model of choice (detailed in Appendix C, notably Table C2) is used to perform these calculations. A spreadsheet has been devised to perform these calculations. It is displayed in Appendix G.

The spreadsheet also enables the calculation of aggregated attribute values. This affords a comparison of the two approaches. Value estimates for environmental improvements defined by the mid-range levels used in the construction of the alternative options in the choice sets are provided in Table 18. A clear trend emerges from the comparison. In all cases, the aggregate values estimated using the attribute approach are greater than their compensating surplus counterparts. In most cases the extent of the difference is significant.

Table 18: Value estimates for multiple attribute changes (within catchment samples)

Proposed Change	**Aggregation Technique**	**Bega ($)**	**Clarence ($)**	**Georges ($)**	**Gwydir ($)**	**Murrum-bidgee ($)**
To mid range levels from the choice sets	Aggregate Attributes	189.10	122.37	125.97	152.64	145.59
	Compensating Surplus	66.82	9.71	51.60	142.83	95.60

The difference between the estimates provided by the two approaches is explained by the fundamental differences that underpin their calculation. The aggregate attribute approach ignores the overall picture that encompasses the proposed change. For instance, the impact of factors other than the specifics of a single attribute change are omitted from the calculation. In contrast, the compensating surplus calculation incorporates the impacts of the numerous factors that influence respondents' values. One factor that is incorporated in the compensating surplus calculation but omitted from the aggregate attribute approach is the propensity for respondents to reject change for reasons that go beyond the extent of the attribute change that is offered. For instance, respondents may simply reject change because they are inherently conservative. Such motivations are clearly important when large-scale changes are involved (such as those which are depicted in Table 18). However, where the proposed changes are marginal, such motives are likely to be irrelevant. The danger of using the compensating surplus measure in such cases is to grossly underestimate the value of the proposed change. Similarly, the danger of using the aggregate attribute approach for more substantial changes (as in Table 18) is one of overestimation.

It is therefore recommended that:

- for proposed changes which involve multiple attributes varying by less than 25 per cent, the aggregate attribute value should be used; and,
- for multiple attribute changes where larger variation is expected, the compensating surplus value should be used.

Because most river improvement projects will involve only marginal changes (less than 25 per cent increases in attributes) the aggregate attribute approach is likely to be most frequently employed.

11. Conclusion

This report has presented value estimates for the environmental attributes of NSW rivers. The value estimates have been developed specifically for use by the State's Water Management Committees in their economic analyses of alternative water sharing arrangements as part of the Water Reform Process. The estimates provide information on the "non-marketed" values that are generated by rivers. They therefore supplement information on marketed values provided by rivers such as farm production in any analysis of the trade-offs involved in alternative water sharing arrangements.

Specifically five "representative" rivers were selected for detailed analysis using the Choice Modelling technique. These rivers were the Bega, Clarence, Georges, Gwydir and Murrumbidgee. Values for four environmental attributes were estimated. Two of these attributes related to biodiversity values: number of fish species and water birds and other fauna present. Another attribute related to the condition and extent of riverside vegetation and wetlands. The fourth attribute used recreational activity suitability as a surrogate for water quality.

Values for these attributes were estimated for samples of households located in the catchments. For two of the rivers, the Murrumbidgee and Gwydir, samples of households resident outside the catchment were also targeted.

A process of benefit transfer has been developed to allow the values estimated for the five specific rivers – for both within and outside catchment respondents – to be "transferred" for use in the assessment of water sharing arrangements in other catchments across the state. The protocol designed for this process involves the recognition of regional differences between rivers as well as socio-economic diversity.

In addition, methods for calculating estimates of aggregated values are described. In the first instance, this involves the estimation of values aggregated across multiple attribute changes arising from a single alternative river management proposal on a per respondent basis. Secondly, the aggregation process involves the extrapolation of the per respondent value estimates to the wider population. The multiple attribute change aggregation can be carried out in two different ways, depending on the magnitude of the changes involved. The extrapolation to the broader community must involve an assumption regarding the extent to which values are held amongst non-respondent households.

The findings of this study represent a major advance in the provision of information relevant to natural resource decision making. Before mechanisms can be put in place to allocate resources, there is a need to define the outcomes that are desirable for society. It is only with a good understanding of both the biophysical relationships involved and the values that people place on alternatives (as expressed both in and outside the market) that these outcomes will become known with any confidence.

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Appendix A Attribute Determination

One of the key tasks involved in undertaking CM applications is determining which attributes should be used to depict the environmental outcomes of alternative water management strategies. It is important because unless the natural resource that is being valued can be decomposed into a parsimonious and meaningful set of attributes, then the validity and usefulness of the estimates could be compromised. While this may seem to be a straightforward task, it is arguably one of the most difficult and critical task in any environmental choice modelling application. Moreover, it is also necessary to select levels for attributes. This can also be very challenging. For marketed consumer goods and services, levels are usually readily defined. But this is not the case in environmental applications. For example, consider all of the different ways that water quality is measured. Which one should be used? Which one would be most meaningful for the general public?

In this appendix, the process used to determine these attributes and select the attribute levels is set out. A three-stage process was used to select attributes and the appendix is structured to reflect those stages. In section A.1, a review of the existing literature undertaken to determine the attributes previously used in studies seeking to value improved water quality or river health using choice modelling or similar approaches is outlined.

Next, "supply-side" determinants of attributes are discussed. These factors reflect the requirements of those conducting the research and those who will use the results of the CM applications. From this perspective, attributes must be defined to be useful in the policy determination process. Hence, they must be consistent with the environmental variables scientists are able to predict will change when water management strategies change, and for which scientific information is available. The link between management strategy and community value has to be maintained through the selection of attributes.

In section A.3 of the appendix, the "demand-side" influences on attribute selection are discussed. These factors relate to the requirements of the CM questionnaire respondents. The environmental outcomes described to respondents in a CM application must be meaningful to them. Environmental attributes that are outside the experience of respondents are therefore unlikely to encourage reliable responses. Again, the selection of attributes that are relevant to respondents maintains the linkage between management strategy and community value.

In sectionA.4, the strategy used to select attribute descriptors once the set of attributes had been determined is discussed. The appendix concludes with a discussion of the use of the set of attributes finally determined.

A.1 Previous research

In the first instance, some information on appropriate attributes, from the analyst's perspective, can be gleaned from the work of others.

Several previous studies have examined the value of improving the quality of rivers. The earliest of these, CVM applications by Whitmore and Cavadias (1974) and Smith and Desvousges (1986) did not seek to isolate attributes for the different aspects of improved river quality. Rather, they used what has been described as a ‘water quality ladder’ to represent changes in the quality of the river. In the Whitmore and Cavadias (1974) study there were five levels to the ladder:

(1) no-life,
(2) the present (ie current situation),
(3) swimming,
(4) drinking; and,
(5) natural.

In the Smith and Desvousges (1986) study, there were also five levels:

(1) worst possible water quality,
(2) okay for boating,
(3) gamefish like bass can live in it,
(4) safe for swimming; and,
(5) safe to drink.

These water quality ladders were used as a means of simplifying the communication of changes in water quality to respondents. However, it is only possible to use the results of these studies to value changes in these discrete quality levels.

In a more recent study that used conjoint analysis techniques, ACIL Economics and AGB McNair (1996) used a set of five environmental attributes (in addition to a set of management attributes). These attributes were:

(1) risk of algal bloom,
(2) number of unsafe swimming days,
(3) effects on fish stocks,
(4) need for treatment of water for drinking; and,
(5) effects on the catchment ecosystem.

Each of these attributes was not described quantitatively. Rather qualitative descriptors such as ‘unchanged’, ‘slightly increased’ and ‘moderately increased’ were used.

Garrod and Willis (1998) conducted a slightly different study using CM. Their objective was to estimate the loss of amenity value for inland waterways caused by public utilities. They, therefore, included three public utility attributes in their questionnaires instead of environmental outcomes. The utilities involved were pipe bridges, pylons and cable crossings. Each of these attributes was described in terms of percentage reductions.

The Centre for International Economics (1997) focused on the community’s willingness to pay for various water supply options in the Australian Capital Territory in their CM application. Several attributes relating to river quality were included. These were ‘environmental flows’ and ‘habitat loss’. The first attribute was described according to whether there would be improvements in flow in no, some or all rivers. The second attribute was quantitative, with habitat loss occurring for between zero and 10 species.

Griner (1997) conducted a further study that used conjoint analysis. Specifically, conjoint ranking was used to value improved river quality. The only environmental attribute used was "river health" and that was described as being either "unpolluted", "moderatley polluted" or "severely polluted".

In summary, the literature provides few guidelines for the definition of attributes to describe the environmental quality of rivers. Apart from the ACIL Economics and AGB McNair (1996) study, none of the studies reviewed attempted to disaggregate river quality into its component attributes. This dearth of evidence places even more importance on other approaches to determining attributes.

A.2 Supply-side Determinants

After the literature review was conducted, a sample of policy makers and researchers were surveyed to determine, from a management perspective, what attributes they thought should be used to describe river health. Twenty three respondents[8], were contacted by email and asked a short sequence of questions:

> *"Q1: Please indicate up to 10 environmental attributes/characteristics that can be used as indicators of river health. Bear in mind that these attributes must be readily understood by members of the general public.*
>
> *Q2: Please indicate on what basis you made your selection. In other words, why are the attributes/characteristics you chose appropriate indicators of river health?*
>
> *Q3: If you were limited to only choosing five out of the 10 attributes, what would they be? Why?"*

The attributes suggested by respondents in the survey included:

- Flow (natural flow, degree of regulation)
- Fish (native fish population, species diversity)
- Vegetation (riparian, wetland, floodplain, aquatic)
- Exotics (carp, willows, gumbosia, weeds)
- Channel condition (bank erosion, sediments)
- Waterbirds
- Water quality (algal blooms, salinity, turbidity, nutrients, pesticides, coliforms)
- Water dependent fauna (macroinvertibrates, stream fauna, eg frogs and platypus, aquatic biodiversity)
- Recreational use
- Visual amenity

---

[8] Respondents were drawn from the various state government departments that are involved in the water reforms process (eg, Agriculture, Forestry, Land and Water Conservation, Fisheries and the EPA), non-government conservation organisations and community representatives. The respondents included people with both research and policy backgrounds.

The five attributes that were mentioned most frequently by the respondents were:

- Flow
- Fish (including exotics)
- Vegetation (including wetland and channel condition)
- Water quality
- Water dependent fauna

A feature of the approach taken to the supply-side definition was an attempt to temper the responses of the research/ policy stakeholders by asking them to provide attributes that would be "readily understood by members of the general public". In this way, the first step was taken to reconciling any possible divergence between the supply and demand sides of the attribute definition task.

Furthermore, the attributes discovered using the supply-side approach, were tested during the demand-side phase, which is discussed in the following section.

A.3 Demand-side determinants

While policy concerns can influence which attributes are included in choice sets, it is unwise to include attributes that are only relevant from a policy perspective and not relevant to respondents. This is because they will probably be ignored by respondents and hence will be insignificant explanatory variables. However, some attributes of marginal relevance to respondents, but important for policy, could be included.

Focus groups are a useful means of identifying attributes that are relevant for respondents. It provides the opportunity to ask respondents directly or indirectly which attributes they think are most relevant.

One approach to identifying relevant attributes in focus groups was described by Morrison, Bennett and Blamey (1997). Respondents were told that there were two different options for the improvement in the quality of a wetland. They were then asked what information they would like to know if they were to choose between the options. The strength of this approach is that participants are placed in a position of choice when they are identifying relevant information. The weakness was that they tended to identify large amounts of information, which had to be distilled by the researchers.

There are several alternatives to the approach used by Morrison et al (1997). One alternative is to augment their procedure. First, respondents can be asked to identify all relevant attributes or characteristics of rivers that are relevant to them in making their choices. If a large number are identified, respondents can be asked which attributes they would want to know about if they could only be told about a few of them.

An alternative is to start with a list of the attributes identified by the survey of research/policy stakeholders. Respondents can be asked to add any other attributes that they consider important to this list. Then, similar to the previous approach, respondents can be asked which attributes they would want to know about if they could only be told about a few.

Both of these approaches were used in a sequence of four focus groups that were held between June and August 1999 to determine river environment attributes from a demand side perspective. Two of the focus groups were held in Sydney and the remaining two were held in the regional centres of Yass and Wagga Wagga[9]. Professional marketing research firms were used to recruit the participants for two of the focus groups[10]. The participants for the remaining groups were recruited using community contacts in Sydney and in Yass.

Prospective participants for the groups were told that they would be attending a discussion about an "issue of community concern". Recruitment was designed to ensure an even distribution of ages and an approximately equal balance between men and women. The authors of this report moderated the focus groups meetings[11]. All of the meetings were recorded using audio-tapes.

The focus group participants were initially asked several questions about their beliefs regarding the condition of rivers, and what action is being taken to reduce these problems.

After the issue of river health had been sufficiently introduced and respondents were made aware of the purpose of the focus group, they were then asked the following question:

> *"Suppose that the government was considering two different options for improving the quality or health of the Murrumbidgee River (or one of the other rivers previously mentioned). Suppose also that you were asked which of these two alternatives you preferred. If you could ask for information about changes in any of the characteristics or attributes of the river, what would you want to know?"*

Various river characteristics emerged from the discussions that arose in the two groups, including the following:

- flow
- healthy vegetation
- fish
- waterbirds
- clean water
- non-eroded banks
- healthy ecosystem
- habitat
- balance amongst water users

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[9] The Sydney groups were held on Monday 21 June and Wednesday June 30, the Yass group was held on Tuesday 15 June, and the Wagga Wagga group was held on Friday 17 August.

[10] Applecorn Research recruited the participants to the first Sydney focus group, and Art Professional Marketing recruited the participants to the Wagga Wagga focus group.

[11] The assistance of Stuart Whitten in moderating the Wagga Wagga focus group is gratefully acknowledged.

- recreational quality

Because the number of attributes in a CM choice set has to be limited to a number that is within the cognitive limits of most respondents, this list had to be prioritised. If too many attributes are used to describe environmental outcomes, respondents may seek to simplify the exercise by using heuristics (Mazotta and Opaluch 1995, Swait and Adamowicz 1996). Alternatively, they may choose not to complete the questionnaire at all if the outcome descriptions become too complex because of the number of attributes included. According to Carson, Louviere, Anderson, Arabie, Bunch, Hensher, Johnson, Kuhfeld, Steinberg, Swait, Timmermans and Wiley (1994) the average questionnaire includes about seven attributes. In the context of river environments, respondents typically know much less about the good involved and may find a questionnaire difficult to answer if seven or more attributes are included. Hence the use of fewer attributes may be appropriate.

The focus group participants were asked the following question to reduce the number of attributes to be used to describe the environmental outcomes:

> *"Suppose that from this list of attributes/characteristics that have just been generated you could only receive information about five of them. Which five would you want to know about (in order of priority)?"*

Respondents were asked to write down their answers on a sheet of paper. The top four rankings given to each of the attributes in the two groups are summarised in Table 1.

It is evident from Table A.1, that water quality is the most important attribute to respondents in both focus groups. Both vegetation and wildlife (including both waterbirds and fish) were consistently important to participants in both focus groups. Flow tended to be more important to participants in the Sydney focus group, while recreational quality was a more important characteristic to participants in the Yass focus group.

These attributes closely parallel those found in the survey of policy advisers and researchers detailed in the previous section of this paper. In that stakeholder survey the five main attributes that emerged were flow, fish, vegetation, water quality and water dependent fauna.

The convergence between the attributes suggested by stakeholders and members of the community, as represented by the focus group participants, provides useful evidence that the attributes emerging will be both useful to policy makers and relevant to CM questionnaire respondents.

Table A.1: Rankings of attribute importance*

Attributes	R1(Y)	R2(Y)	R3(Y)	R4(Y)	R1(S)	R2(S)	R3(S)	R4(S)
Clean Water	5	2	1	-	2	4	-	2
Vegetation	-	3	2	4	-	4	1	3
Wildlife (birds/fish)	-	2	3	-	-	1	1	-
Water birds	1	-	1	1	-	-	-	1
Fish	-	-	2	-	1	-	4	-
Flow	1	-	-	-	5	-	1	-
Recreation Quality	1	3	-	3	-	-	-	-

* R1 (Y) represents a ranking of 1 (the highest ranking) for the Yass group. Correspondingly, R1(S) represents the highest ranking of the Sydney group. Hence, in the Yass focus group, five participants ranked "clean water" as the most important attribute, whilst in the Sydney group five participants ranked "flow" as the first priority

However, one problem remains with this list of attributes. This relates to the existence of causality amongst attributes. Some relevant environmental attributes may be perceived by respondents to be causally prior to other environmental attributes. For example, a change in water quality in a wetland may be believed by respondents to cause a change in the number of waterbirds breeding. If respondents have this belief, they may focus on the 'indicator' attribute and discount information about the other attributes[12]. The inclusion of an 'indicator' or causally prior attribute may make other attributes redundant. Hence it may be desirable to include either the indicator or the other attributes, but not both. The omission of attributes that focus group participants have identified as being of significance can however other impacts. Respondents may be frustrated that an attribute they believe should be detailed is not included. The plausibility of the CM questionnaire may therefore be cast into doubt.

The attribute that the focus group participants considered most important (water quality) is potentially an indicator attribute. To some extent this problem can be addressed through the way attributes are defined for respondents.

A.4 Selection of Attribute Descriptors

After the attributes have been selected, it is necessary to select ways to describe each of these attributes. In CM applications it is possible to use both qualitative and quantitative descriptors of the attributes, however the latter are preferred for the river valuation exercise because they are more useful for benefit transfer. This is because they can be measured in a more objective fashion across different river systems.

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[12] A test of the effect of causal attributes was reported in Blamey, Rolfe, Bennett and Morrison (1997). The authors found some support for the hypothesis that the inclusion of a causal heuristic can affect respondents' choices.

Attempts were initially made to select suitable levels by questioning respondents. In the Yass focus group, participants were asked the following question:

> *"So far we have identified a number of characteristics or attributes of rivers. We would also like to identify different ways of describing these characteristics. For the following characteristics (flow, fish, vegetation, water quality and water dependent fauna) could you list all of the different ways that you can think of describing them?"*

Participants generally had difficulty in suggesting suitable descriptors for the attributes but they were able to suggest the key words and phrases set out in Table A.2:

Table A.2: Attribute key words and phrases.

Flow: • natural flow • following seasons, rainfall events **Fish:** • number of different species • no carp • healthy **Vegetation:** • native • healthy • no noxious weeds	**Water quality:** • drinkable • blue green algae • clear • no smell **Water dependent fauna:** • existence of native fauna (platypus, frogs, turtles) • diversity

Based on the information gathered from this focus group, the information derived from the literature review and the information previously provided through the survey of policy makers and researchers, a list of different alternatives was developed. This list was used as the basis of a discussion amongst the participants in the first Sydney focus group. That list of alternatives is shown in Table A.3.

For the flow attribute, Options 2 and 3 received the most support from focus group participants. For the fish attribute, participants preferred Options 2 and 4. Participants wanted the number of native fish species present to be described, but they also liked having the health of the species being described. For vegetation, Option 2 was the clear favourite. One participant suggested that a percentage rather than actual area be used as the descriptor.

Table A.3: Alternative attribute descriptors

Attribute	**Descriptor**
Flow:	
Option 1	Percentage of natural flow
Option 2	Percentage of average natural flow
Option 3	Percentage of average natural flow/ Large summer and low winter flows
Option 4	No change, moderate increase, large increase
Fish:	
Option 1	Percentage of native fish species present
Option 2	Number of native fish present
Option 3	Number of native fish species present
Option 4	Percentage of native fish present/Health of species (poor, fair, good)
Vegetation:	
Option 1	Area of wetlands and riverside vegetation
Option 2	Area of healthy wetlands and riverside vegetation
Option 3	Poor condition, moderate health, healthy
Water Quality:	
Option 1	Worst possible quality, OK for boating, OK for fishing, OK for swimming
Option 2	Unpolluted, moderately polluted, severely polluted
Option 3	Mostly poor, sometimes OK, Mostly good
Option 4	Number of unsafe swimming days pa
Option 5	Number of days pa affected by algal blooms
Wildlife:	
Option 1	Native species present along the river
Option 2	Number of water bird and other native species along the river
Option 3	Water bird species present
Option 4	Threatened and non-threatened species present

Of particular note is the treatment of the water quality attribute. The approach taken was to channel participants' interest in water quality toward its impacts specifically on recreation opportunities. In this way, the causality of the attribute was diffused. Option 1 received the greatest support. This was because of its relevance to the public. Hence, the strategy of using this descriptor demonstrated that problems with indicator attributes may be minimised or avoided. To enhance this effect, the attribute was re-named "recreation use".

Finally, for the wildlife attribute, Option 2 clearly received the greatest support.

Except for flow, these attribute and their descriptors were selected as the most appropriate for use in the choice modelling applications for the water reform process. Flow was excluded as an attribute for parsimony, and because it was thought that flow was a management strategy rather than an outcome attribute. Because it would be one of the main factors causing the changes in the environmental attributes, the difficulties of attribute causality would again have been apparent.

A.5 Conclusions

A critical issue in any environmental choice modelling application is the selection of attributes and respective levels. It is critical because it determines the usefulness and validity of the resulting estimates. The selection of attributes for environmental valuation purposes is far more difficult than for applications involving marketed consumer good. In the latter, the attributes of a good are far more apparent. In an environmental choice modelling application it is necessary to consult both the end users of the value estimates so obtained and the community.

A three-stage process was used to select attributes for the water reform process choice modelling application detailed here. First a literature review was conducted, second managers and researchers were surveyed, and finally a series of four focus groups was completed. Five attributes were selected through this process: flow, fish, vegetation, water quality and wildlife. A noteworthy finding was the convergence in views amongst managers and researchers and the community. However, some issues still remained for the selection of attributes, particularly how to resolve the perceived (and actual) causality amongst attributes. This necessitated the exclusion of one of the attributes (flow) and the use of recreational characteristics to proxy for water quality.

The methodology used to select attribute levels has also been discussed. Similar to the selection of attributes, this is again arguably more challenging in the environmental valuation case than for marketed consumer goods and services. The approach of asking focus group participants to suggest indicators was initially trialed. However, this task was met with some difficulty. The approach used in later focus groups, of showing participants sets of alternative descriptors and asking them to nominate their preferred alternatives or make suggestions, was more effective.

APPENDIX BIBLIOGRAPHY

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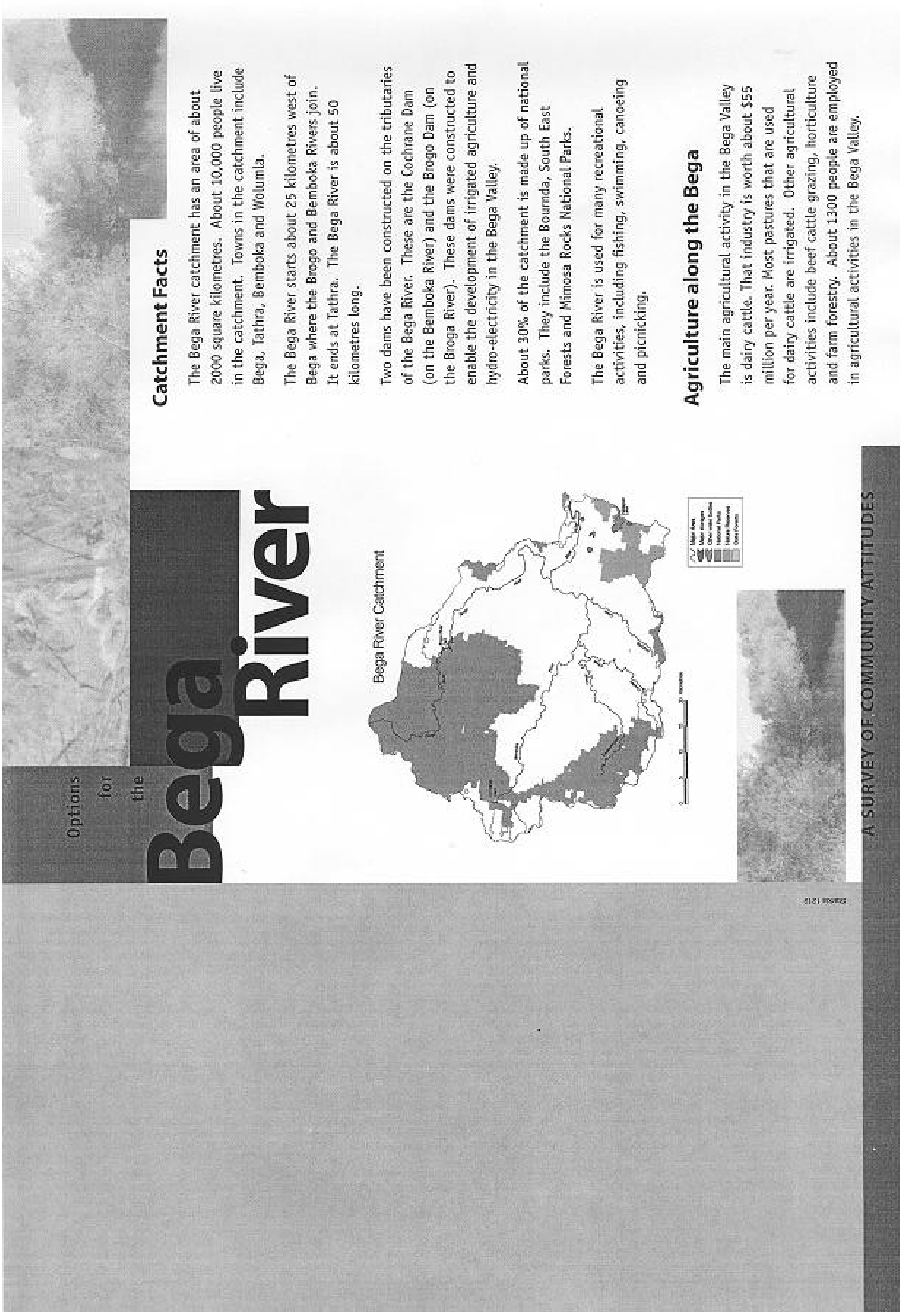
Appendix B: Sample Questionnaire



Options for the

Bega River

Bega River Catchment

A SURVEY OF COMMUNITY ATTITUDES

Catchment Facts

The Bega River catchment has an area of about 2000 square kilometres. About 10,000 people live in the catchment. Towns in the catchment include Bega, Tathra, Bemboka and Wolumla.

The Bega River starts about 25 kilometres west of Bega where the Brogo and Bemboka Rivers join. It ends at Tathra. The Bega River is about 50 kilometres long.

Two dams have been constructed on the tributaries of the Bega River. These are the Cochrane Dam (on the Bemboka River) and the Brogo Dam (on the Broga River). These dams were constructed to enable the development of irrigated agriculture and hydro-electricity in the Bega Valley.

About 30% of the catchment is made up of national parks. They include the Bournda, South East Forests and Mimosa Rocks National Parks.

The Bega River is used for many recreational activities, including fishing, swimming, canoeing and picnicking.

Agriculture along the Bega

The main agricultural activity in the Bega Valley is dairy cattle. That industry is worth about $55 million per year. Most pastures that are used for dairy cattle are irrigated. Other agricultural activities include beef cattle grazing, horticulture and farm forestry. About 1300 people are employed in agricultural activities in the Bega Valley.

Summary Table

	Past level	Current level
Native fish	25 native fish species present	15 native fish species present
Healthy vegetation and wetlands	Along 100% of river	Along 30% of river
Waterbirds and other fauna	88 species present	48 species present
Recreational uses (across entire river)	✓Picnics ✓Boating ✓Fishing ✓Swimming	✓Picnics ✓Boating ✗ Fishing ✗ Swimming

Environmental Issues

There has been a general decline in the condition of the Bega River over time. This is shown by the following changes:

Native fish

There has been a decline in native fish species and an increase in introduced species.

It is estimated that earlier this century 25 native fish species were found along the Bega. Recent surveys by NSW Fisheries identified 15 native and 1 introduced fish species in the

Healthy native riverside vegetation and wetlands

Wetlands and other areas of native vegetation along the river have been lost. The health of the remaining areas has also declined.

Along the length of the river, 30% of native riverside vegetation is considered to be in a healthy condition.

Waterbirds and other fauna

Surveys by the National Parks and Wildlife Service have shown that the number of waterbirds and other river dependent fauna along the river has declined.

Information from earlier this century indicates that 88 waterbird and other species were found along the Bega River. This has now fallen to 48 species.

Recreational uses

The declining quality of the Bega River has affected its use for recreation.

Water quality monitoring by the Department of Land and Water Conservation at four sites along the Bega River found that water quality was:

- not always good enough for fishing at 75% of the sites
- not always good enough for swimming at 25%of

What this survey is for

We want to know your views on options for managing the Bega River and its tributaries.

This survey is being undertaken as part of the NSW Government's water reform process. Your input will help to improve the management of the Bega River and its tributaries.

How you were chosen

You were chosen at random from your local telephone directory.

What we ask you to do

Any adult member of your household can complete this survey. The questionnaire should take about 30 minutes to complete.

You don't need to know about river management to do this survey. There are no right or wrong answers—we are interested in your views.

Your answers will be treated as completely confidential.

Further information

Your questions are welcome. Please leave a voice message for Jeff Bennett, of Environmental and Resource Economics on 02 6236 8228, and we will return your call.

Return of survey

Thank you for participating in this survey. Please return your completed questionnaire to us using the reply-paid envelope provided.

The Bega River

To start off, we would like to ask you about your previous experience of the Bega River (including its tributaries).

Question 1: Have you ever heard of the Bega River? *Tick one box*

☐ Yes ☐ No ☐ Not sure

Question 2: Have you ever visited the Bega River? *Tick one box*

☐ Yes ☐ No ☐ Not sure

Question 3: Do you plan to visit the Bega River in the future? *Tick one box*

☐ Yes ☐ No ☐ Not sure

The Issue

Scientists agree that the quality of many the Bega River and its tributaries has det over time. There have been falls in:

- the number of native fish species
- the amount of healthy riverside vegeta wetlands
- the number of water bird and other fau
- recreation opportunities such as fishin swimming.

> ***Please read carefully the information fold-out cover. It gives some details c these changes.***

Various factors have contributed to this,

- use of water for irrigation has reduced of water in the river
- treated water from sewage treatment p flowing into the river
- polluted run-off from urban areas, espe during wet weather (Run-off is water t off the land into streams and rivers.)
- land-clearing which has increased eros the depositing of sediment in the river
- erosion of river banks because of stock and walking down to the river to drink
- farmland run-off containing fertilisers pesticides
- non-native fish species and weeds (suc willow trees)

While some progress has been made in improving the quality of the Bega River through Rivercare and Landcare projects, more can still be done. Because of this, the Bega River has been chosen for further environmental improvement projects.

> ***For more information** about the factors causing the environmental decline in the Bega River, and what has already been done to improve the quality of the Bega River, see:*
>
> - *Water Quality and River Flow Interim Environmental Objectives www.epa.nsw.gov.au/ieo*
> - *Healthy Rivers Commission (1999). Independent Inquiry into the Bega River System (www.hrc.nsw.gov.au)*

Question 4: How interested are you in the I
Tick one

- ☐ very interested
- ☐ moderately interested
- ☐ slightly interested
- ☐ not at all interested

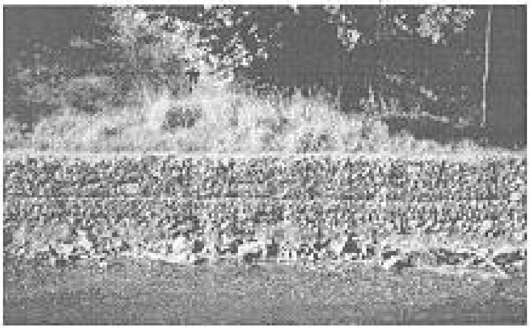
Improving the quality of the Bega River

There are several ways that the State Gov could improve the quality of the Bega Riv include, but are not limited to:

- **Improvements to sewage treatment p**

Sewage treatment plants discharge wa contains nutrients such as phosphorou nitrogen. These nutrients can cause p with water quality. By upgrading sewa treatment plants, less nutrients would discharged into the river.

- **Construction work to reduce erosion and acid-sulfate soils**



In areas where erosion or acid-sulfate soils are a problem, construction work can be used to reduce the impacts of these problems.

- **Fencing to protect riverside vegetation**

By managing stock access to the river, the banks of the river would be protected and erosion controlled. This would lead to better water quality. Farmers would need to provide alternative water supplies for their stock and would lose valuable grazing areas.

- **Control of weeds**

Weeds can be controlled through their removal (which is done when removing trees) or the spraying of chemicals tha harmful to the river.

These are just a few of the projects avai improving the quality of the Bega River. environmental projects are also available

The environmental improvements achie and the costs involved, would depend o combination of projects chosen.

How this could affect you?

These projects would improve the quality Bega River but they would be expensive.

One possibility for funding projects is for State Government to collect **a one-off le water rates** for all households in the Beg catchment during the year 2001. If your does not pay water rates, an alternative collecting the levy would be arranged. Th would only be used for projects like the c described above.

The size of the levy and the environment improvements achieved would depend on projects were chosen.

Question 5: Thinking about this information, please indicate how strongly you agree or disagree with EACH of the following statements.
Tick the option that is closest to your view

A river improvement levy is a good idea

- ☐ Strongly Agree
- ☐ Agree
- ☐ Neither Agree nor Disagree
- ☐ Disagree
- ☐ Strongly Disagree

I thought the projects described above would lead to improved river quality

- ☐ Strongly Agree
- ☐ Agree
- ☐ Neither Agree nor Disagree
- ☐ Disagree
- ☐ Strongly Disagree

I don't trust the government to make the increase in water rates one-off

- ☐ Strongly Agree
- ☐ Agree
- ☐ Neither Agree nor Disagree
- ☐ Disagree
- ☐ Strongly Disagree

What do you think?

We would like to know what you think abo extra water rates to improve the quality of River. To do this we ask you to consider el different options that we have called **Optic** Work on achieving these options would st the beginning of next year and improvem the river environment would be noticeabl following two years.

Option A is the current situation, which m there is no levy on water rates and no new mental projects. All of the other options ir levy on water rates that is used to pay for a environmental projects. **Different types a nations of projects are funded under eac**

Because there are so many options, we as consider only three at a time in Question From each set of three options, choose yo preferred option by looking at the **levy a** and the **effects** the projects will have on environment. Some of these outcomes m strange. However, remember that they de the combination of projects chosen.

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

Don't forget to refer to the informati the fold-out cover—it may help you answering these questions.

Question 6: Carefully consider each of the following three options for the Bega River. Suppose Options A, B and C were the ONLY ones available, which one would you choose?

	Levy on water rates (one-off) $	Recreational uses	Healthy riverside vegetation and wetlands	Native fish	Waterbi other fa
Option A (Current situation)	no extra cost	✓Picnics ✓Boating ✗ Fishing ✗ Swimming	Along 30% of river	15 native species present	48 speci present
Option B	$50	✓Picnics ✓Boating ✗ Fishing ✗ Swimming	Along 40% of river	18 native species present	72 speci present
Option C	$100	✓Picnics ✓Boating ✓Fishing ✓Swimming	Along 60% of river	25 native species present	72 speci present

Which of these options would you choose

- ☐ I would choose Option A
- ☐ I would choose Option B
- ☐ I would choose Option C
- ☐ Not sure

The next four questions are similar to the last, except that the numbers in the boxes for the second and third options change from one question to the next.

Question 7: Carefully consider each of the following three options for the Bega River. Suppose Options A, D and E were the ONLY ones available, which one would you choose?

	Levy on water rates (one-off) $	Recreational uses	Healthy riverside vegetation and wetlands	Native fish	Waterbi other fa
Option A (Current situation)	no extra cost	✓Picnics ✓Boating ✗ Fishing ✗ Swimming	Along 30% of river	15 native species present	48 speci present
Option D	$50	✓Picnics ✓Boating ✓Fishing ✓Swimming	Along 80% of river	21 native species present	59 speci present
Option E	$50	✓Picnics ✓Boating ✗ Fishing ✗ Swimming	Along 80% of river	25 native species present	88 speci present

Which of these options would you choose

☐ I would choose Option A

☐ I would choose Option D

☐ I would choose Option E

☐ Not sure

Question 8: Carefully consider each of the following three options for the Bega River. Suppose Options A, F and G were the ONLY ones available, which one would you choose?

	Levy on water rates (one-off) $	Recreational uses	Healthy riverside vegetation and wetlands	Native fish	Waterbi other fa
Option A (Current situation)	no extra cost	✓Picnics ✓Boating ✗ Fishing ✗ Swimming	Along 30% of river	15 native species present	48 speci present
Option F	$100	✓Picnics ✓Boating ✗ Fishing ✗ Swimming	Along 60% of river	21 native species present	88 speci present
Option G	$50	✓Picnics ✓Boating ✓Fishing ✓Swimming	Along 80% of river	21 native species present	59 speci present

Which of these options would you choose

- ☐ I would choose Option A
- ☐ I would choose Option F
- ☐ I would choose Option G
- ☐ Not sure

Question 9: Carefully consider each of the following three options for the Bega River. Suppose Options A, H and I were the ONLY ones available, which one would you choose?

	Levy on water rates (one-off) $	Recreational uses	Healthy riverside vegetation and wetlands	Native fish	Waterbi other fa
Option A (Current situation)	no extra cost	✓Picnics ✓Boating ✗Fishing ✗Swimming	Along 30% of river	15 native species present	48 speci present
Option H	$100	✓Picnics ✓Boating ✓Fishing ✓Swimming	Along 40% of river	25 native species present	72 speci present
Option I	$200	✓Picnics ✓Boating ✗Fishing ✗Swimming	Along 40% of river	21 native species present	72 speci present

Which of these options would you choose

☐ I would choose Option A

☐ I would choose Option H

☐ I would choose Option I

☐ Not sure

Question 10: Carefully consider each of the following three options for the Bega River. Suppose Options A, J and K were the ONLY ones available, which one would you choose?

	Levy on water rates (one-off)	Recreational uses	Healthy riverside vegetation and wetlands	Native fish	Waterbi other fa
Option A (Current situation)	no extra cost	✓Picnics ✓Boating ✗ Fishing ✗ Swimming	Along 30% of river	15 native species present	48 speci present
Option J	$200	✓Picnics ✓Boating ✓Fishing ✗ Swimming	Along 40% of river	21native species present	59 speci present
Option K	$200	✓Picnics ✓Boating ✓Fishing ✓Swimming	Along 60% of river	21 native species present	59 speci present

Which of these options would you choose

- ☐ I would choose Option A
- ☐ I would choose Option J
- ☐ I would choose Option K
- ☐ Not sure

We would now like to ask you some further questions about the options for the Bega River

Question 11: When answering Questions 6 to 10, did you always choose Option A (continue the current situation)?

☐ Yes ☐ No

If you answered yes, which of the following statements most closely describes your reason for doing so? *Tick one box only*

☐ I prefer the continuation of the current situation

☐ I support improving river quality, but cannot afford a levy of any amount

☐ I support improving river quality, but object to a levy of any amount

☐ I didn't know which option was best, so I stuck with the current situation

☐ Some other reason. *Please specify*

____

____

____

Question 12: Thinking about the informa presented earlier, please indicate how str you agree or disagree with EACH of the following statements.
Tick the option which is closest to your vie

I understood the information in the que

☐ Strongly Agree
☐ Agree
☐ Neither Agree nor Disagree
☐ Disagree
☐ Strongly Disagree

I needed more information than was pr

☐ Strongly Agree
☐ Agree
☐ Neither Agree nor Disagree
☐ Disagree
☐ Strongly Disagree

The information in the questionnaire w in favour of preserving the river

☐ Strongly Agree
☐ Agree
☐ Neither Agree nor Disagree
☐ Disagree
☐ Strongly Disagree

I found answering Questions 6 to 10 cc

☐ Strongly Agree
☐ Agree
☐ Neither Agree nor Disagree
☐ Disagree
☐ Strongly Disagree

In this last section, we would like to ask you a few questions to make sure the people we are surveying are from a wide range of backgrounds

Question 13: Over the years, when you have heard about proposed projects where there is a conflict between development and the environment, have you tended to:

- ☐ Favour preservation of the environment more frequently
- ☐ Favour development more frequently
- ☐ Favour development and environmental preservation equally

Question 14: What is your age?______

Question 15: What is your sex?

☐ Male ☐ Female

Question 16: Do you have any children?

☐ Yes ☐ No

Question 17: Are you a member of an organisation that is association with environmental conservation?

☐ Yes ☐ No

Question 18: Are you, or a member of your close family, associated with the farming industry?

☐ Yes ☐ No

Question 19: What is the highest level o education you have obtained or are obtai

- ☐ Never went to school
- ☐ Secondary/Year 12
- ☐ Primary only
- ☐ Diploma or certificate
- ☐ Junior/Year 10
- ☐ Tertiary degree
- ☐ Other (please specify)

Question 20: To the best of your knowle indicate the total income (before taxes) t and your spouse (if applicable) earned la

☐ Under $6239	☐ $6239-10
☐ $10,400-15,599	☐ $15,600-
☐ $20,800-25,999	☐ $26,000-
☐ $31,200-36,399	☐ 36,400-4
☐ $41,600-51,999	☐ 52,000-7
☐ $78,000-103,999	☐ More thar
☐ Don't know	

If you would like to make any other comments about options for the Bega River, or about this questionnaire, please make them in the following space.

Please use the reply-paid envelope to mail your completed questionnaire to:

Reply Paid 156
Campbell ACT 2612

Thank you very much for doing this questionnaire.
We hope that you enjoyed taking part in this survey.

BEG1

Appendix C Modelling results

Each of the data sets were analysed using a nested logit model. In the nested logit model unobserved components of utility are assumed to be shared between certain alternatives. Hence the errors of the alternatives are correlated and not independent. This form of model is used to avoid problems associated with potential violations of the required condition that alternatives be independent and irrelevant.

When using nested logit models a ‘tree-structure’ is pre-specified. Tree structures reflect the existence of homogenous sets of alternatives that have correlated errors. They can have multiple levels. All of the alternatives are in the branches at the bottom of the structure. These alternatives are then grouped at the next level using the limbs of the tree. The tree effectively represents the choice process used by respondents when deciding between alternatives. Hence, it is assumed that respondents first decide if they want to support any change in river management (ie they choose between Option A, the status quo, and the other options). Subsequently, if they have not selected the status quo then they are assumed to choose between the “change” alternatives on the basis of their attributes .

Following Kling and Thompson (1996), the nested logit model can be specified as follows. The probability of a particular alternative being chosen (P_{jm}) is equal to the probability that the limb that the alternative is in is chosen (P(*m*)) multiplied the probability that the alternative is chosen from within the limb P(*j*|*m*). That is:

$$P_{jm} = P(j|m).P(m)$$

where:

$$P(j\,|\,m) = \frac{\exp(V_{jm}\,|\,\alpha_m)}{\exp(I_m)}$$

$$P(m) = \frac{\exp(\alpha_m I_m)}{\sum_{k=1}^{M}\exp(\alpha_k I_k)}$$

$$I_m = \log\left[\sum_{i=1}^{J_m}\exp(V_{im}/\alpha_m)\right]$$

In the above equation, I_m is the inclusive value and is the sum of the utility of all of the alternatives. The model works by estimating the probability that an alternative is chosen within a limb P(j|m) and estimating the probability that a limb is chosen (P(m)).

The coefficients estimated using the nested logit model are used to derive estimates of the value of an environmental improvement. The focus of this report is on the estimation of implicit prices. These are point estimates of the value of a unit change in an attribute. They are useful for management decisions where information is required about the value of marginal changes in environmental quality, such as the value of an extra waterbird specie preserved. They are also useful for identifying the relative importance people place on different attributes.

Attribute values (implicit prices) are calculated as follows, where utility is a linear function of all attributes:

$$IP = \beta_A/\beta_M$$

where IP is the implicit price, β_A represents the coefficient of the Ath non-monetary attribute, and β_M represents the coefficient of the monetary attribute.

The variables used in the nested logit models, and their expected signs, are presented in Table C.1. Note that for the socio-demographic variables, the expected signs are opposite to what would normally be expected as these variables have been interacted with the constant representing the continuation of the current situation option.

Table C.1: Variables used in the nested logit models

Variable	Definition	Expected sign
ASC1, 2	Alternative Specific Constants	?*
RATE	Increase in water rates	–
VEGET	% healthy native riverside vegetation	+
FISHSPEC	Number of native species present	+
FISHING[1]	Suitable for fishing	+
SWIMMING	Suitable for swimming	+
FAUNA	Number of waterbirds and other fauna present	+
PROGRE	Progreen environmental orientation	–
PRODEV	Prodevelopment environmental orientation	+
AGE	Age (years)	+
INCOME	Income ($)	–
INCDUM	Dummy variable that takes on a value of one if a respondent did not report their income	?

[1] FISHING and SWIMMING have been included in the model as effects codes rather than dummy variables

The nested logit models are presented in Table C.2. The choice set attributes are significant and correctly signed in all models except for FISHSPEC (Clarence, Georges) and FAUNA (Georges, Gwydir-out of catchment sample, State). INCOME is significant in five models, AGE is significant in six models, and PROGRE is significant in all seven models, providing evidence of theoretical validity. The explanatory power of the models is relatively high, with the adjusted rho-squared ranging from 0.21 to 0.41 (values greater than 0.2 indicate a robust model).

Table C.2: Nested logit models

Variables	Bega (coeff-icients)	(p-values)*	Clarence (coeff-icients)	(p-values)	Georges (coeff-icients)	(p-values)	Gwy-with (coeff-icients)	(p-values)
ASC1	0.204	0.032	0.161	0.149	0.227	0.053	0.272	0.013
RATE	-0.015	0.000	-0.018	0.000	-0.015	0.000	-0.015	0.000
VEGET	0.035	0.000	0.036	0.000	0.023	0.000	0.022	0.000
FISHSPEC	0.111	0.000	0.001	0.975	0.032	0.049	0.035	0.007
SWIM1	0.777	0.000	0.646	0.000	0.576	0.000	0.834	0.000
FISHING	0.400	0.000	0.426	0.000	0.363	0.000	0.384	0.000
FAUNA	0.014	0.016	0.033	0.001	0.010	0.187	0.028	0.000
ASC2	-2.253	0.000	-1.125	0.127	0.877	0.109	-1.940	0.000
PROGRE	-0.389	0.000	-0.254	0.000	-0.285	0.001	-0.288	0.001
PRODEV	0.659	0.001	0.816	0.000	-0.042	0.848	0.193	0.085
AGE	0.028	0.000	0.017	0.000	-0.011	0.047	0.025	0.000
INCOME	-0.004	0.182	-0.016	0.000	-0.022	0.000	-0.003	0.182
INCDUM	1.117	0.000	0.530	0.010	-0.611	0.019	1.089	0.000
IV	0.422	0.000	0.393	0.000	0.413	0.000	0.306	0.000
Summary Statistics								
Log-likelihood	-1090.035		-1092.060		-736.850		-896.269	
Rho-squared adj	0.278		0.191		0.206		0.223	
N	1304		1274		832		1027	

* p-values indicate the significance level of the coefficients (ie a p-value of 0.05 indicates the coefficient is significant at the 5% significance level)

Table C.2 (cont): Nested logit models

Variables	Gwy-out (coeff-icients)	(p-values)	Murr-with (coeff-icients)	(p-values)	Murr-out (coeff-icients)	(p-values)
ASC1	0.111	0.242	0.201	0.041	0.124	0.173
RATE	-0.013	0.000	-0.015	0.000	-0.013	0.000
VEGET	0.026	0.000	0.021	0.000	0.027	0.000
FISHSPEC	0.045	0.000	0.038	0.000	0.048	0.000
SWIM1	0.391	0.000	0.548	0.000	0.573	0.000
FISHING	0.192	0.008	0.397	0.000	0.192	0.005
FAUNA	0.007	0.251	0.024	0.010	0.023	0.013
ASC2	-1.387	0.026	-1.687	0.001	-0.819	0.246
PROGRE	-0.440	0.000	-0.163	0.065	-0.705	0.000
PRODEV	-0.218	0.440	0.217	0.224	0.576	0.001
AGE	0.005	0.528	0.025	0.000	-0.005	0.413
INCOME	-0.015	0.000	-0.015	0.000	-0.023	0.000
INCDUM	-1.454	0.000	-0.078	0.729	-0.518	0.094
IV	0.429	0.001	0.440	0.000	0.302	0.007
Summary Statistics						
Log-likelihood	-711.923		-898.699		-783.802	
Rho-squared adj	0.383		0.299		0.410	
N	929		1108		1075	

Attribute values derived from these nested logit models are presented in Table C.3. It is these attribute value estimates that will be of greatest use to WMCs in their consideration of alternative water sharing arrangements. They represent the amount on average that a household is willing to pay to see an additional unit of the attribute achieved.

Table C.3: Attribute Values

	VEGET (per % of river covered with healthy native vegetation)	**FISHSPEC (per specie)**	**SWIMABLE (across river)**	**FISHABLE (across river)**	**FAUNA (per specie)**
Bega	$2.33	$7.45	$102.39	$53.24	$0.92
Clarence	$2.02	$0.42*	$72.23	$47.77	$1.87
Georges	$1.51	$2.10	$76.02	$48.19	$0.69*
Murr-local	$1.45	$2.58	$73.78	$53.43	$1.59
Murr-outside	$2.17	$3.81	$91.18	$30.50	$1.80
Gwy-local	$1.49	$2.36	$111.52	$51.31	$1.89
Gwy-outside	$2.01	$3.43	$59.54	$29.19	$0.55*

* insignificant coefficients in model at the 5 percent level.

Appendix D Differences in Attribute Value Estimates Across Catchments and Samples

Table D.1 presents tests of differences between the attribute value estimates for pairs of rivers (within catchment samples) that are displayed in Table C.3. The information presented provides an indication of similarities and differences between the values estimated for the different rivers from samples of people living locally and is hence useful in determining the importance of establishing a benefit transfer protocol.

Table D.1: Probability values# for tests of differences between attribute value estimates across rivers: within catchment samples.

RIVER PAIR	VEG	FISH	FAUNA	FISHABLE QUALITY	SWIMABLE QUALITY
Bega vs Clarence	0.00	0.00	0.00	0.01	0.00
Bega vs Georges	0.00	0.00	0.04	0.01	0.00
Bega vs Murrumbidgee	0.00	0.00	0.00	0.03	0.00
Bega vs Gwydir	0.01	0.00	0.07	0.54	0.42
Clarence vs Georges	0.00	0.14	0.00	0.32	0.37
Clarence vs Murrumbidgee	0.00	0.08	0.23	0.00	0.13
Clarence vs Gwydir	0.03	0.20	0.42	0.42	0.02
Georges vs Murrumbidgee	0.19	0.01	0.00	0.00	0.25
Georges vs Gwydir	0.44	0.40	0.04	0.39	0.04
Murrumbidgee vs Gwydir	0.49	0.29	0.48	0.61	0.04

Probability values are estimated using the approach described in Poe et al (1994).

At the five percent level of significance, the Bega River estimates are not different to the estimates for all the other rivers apart from the Gwydir. However, the Bega River appears to be a special case in this respect. The remaining four rivers have multiple attributes for which the value estimates differ from the other rivers. The Gwydir is the most “dissimilar” to all the other rivers in terms of attribute value estimates. The preponderance of significant difference in value estimates across the rivers indicates the importance of establishing a benefit transfer protocol for within catchment sample estimates. One value estimate does not “fit all”.

Table D.2 sets out the results of tests of differences between the attribute value estimates for the Murrumbidgee and Gwydir Rivers for the within and outside catchment samples.

Table D.1: Probability values# for tests of differences between attribute value estimates across catchment samples: Murrumbidgee and Gwydir Rivers

RIVER PAIR	VEG	FISH	FAUNA	FISHABLE QUALITY	SWIMABLE QUALITY
Murrumbidgee-within vs Murrumbidgee-outside	.01	.13	.44	.04	.25
Gwydir-within vs Gwydir-outside	.05	.15	.03	.10	.01

Probability values are estimated using the approach described in Poe et al (1994).

Again it is clear that, for the majority of attributes, the value estimates are different between respondents living within the river catchment and those living outside. Only the vegetation attribute is not different in both the Murrumbidgee and the Gwydir comparisons. The implication from this result is that the location of the respondent is an important determinant of attribute value. Once more the conclusion must be that a benefit transfer protocol is required to account for the difference.

Furthermore, a comparison between the Murrumbidgee-outside and Gwydir-outside attribute value estimates reveals significant differences across all attributes at the five percent level. This indicates that the outside sample values different rivers differently. This must be a further element of a benefit transfer protocol.

The nature of the differences between within and outside catchment sample derived estimates is worth further attention. Table D.3 sets out the ratios between the within and the outside catchment sample attribute value estimates.

Table D.3: Ratios of attribute value estimates: within versus outside samples

	Murrumbidgee	**Gwydir**
Vegetation	0.67	0.74
Fish	0.68	0.69
Fauna	0.88	*
Fishable quality	0.60	1.87
Swimable quality	1.75	1.76

** Outside sample estimate not significantly different from zero*

For the vegetation, fish and fauna attributes in both rivers, the ratio of within to outside value estimates averages consistently around 2:3. This implies that for “non-use” attributes, the values enjoyed by people outside the catchment are higher than those living locally to the river. The picture is reversed for the water quality attribute which is more a “use” value. There, apart from the Murrumbidgee fishable quality attribute, the ratio is approximately 7:4. Local people appear to value water quality – and recreational uses – more than people living away from the river.

The consistency of the ratios displayed in table D.3 gives a strong indication that a benefit transfer protocol that can take advantage of trends in the data is a possibility. That possibility is explored further in Appendix F.

Appendix E Respondents’ Attitudes to the Questionnaire

Questions were included in the questionnaire to determine whether respondents found (1) the survey scenario plausible, (2) the information presented in the questionnaires understandable, sufficient and unbiased and (3) and answering the choice sets confusing. This information was collected using Likert Scale questions.

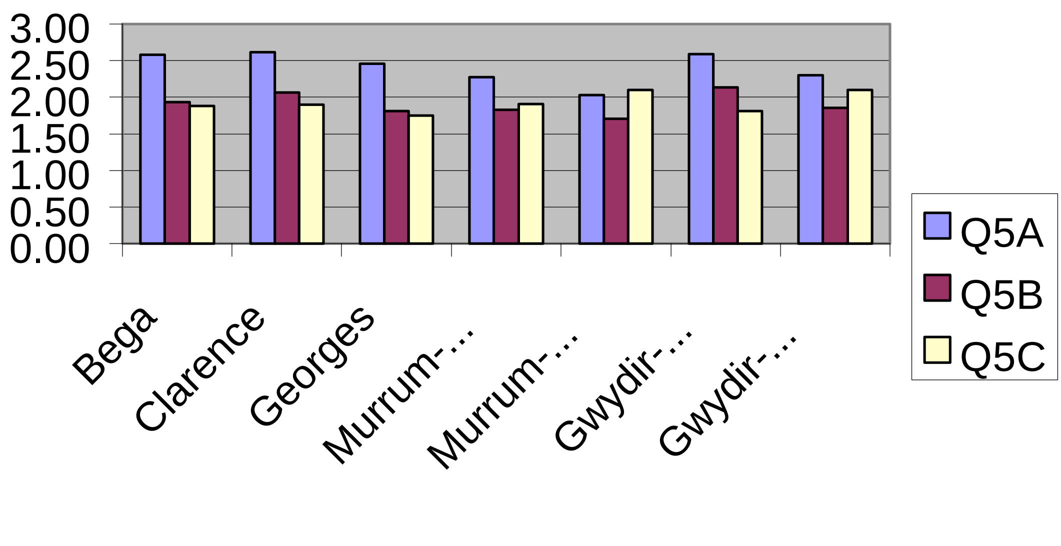
To determine the plausibility of the questionnaire, respondents were asked the extent to which they agreed with the following three statements (1-strongly agree, 5-strongly disagree):

- A river improvement levy is a good idea
- I thought that the projects described above would lead to improved river quality
- I don’t trust the government to make the increase in water rates one-off

The mean response to each of these questions is shown in the following figures. Ideally, mean responses to the first two questions will be less than three, and for the third question will be greater than three.

It is evident from the results presented in Figure E.1, that respondents thought that the projects described in the questionnaire would lead to better river quality and, to a lesser extent, they also thought that a river improvement levy was a good idea. However, there were doubts about whether payment would indeed be one-off. Previous research has demonstrated that these doubts lead to reduced willingness to pay and more conservative estimates (Morrison and Bennett 2000).

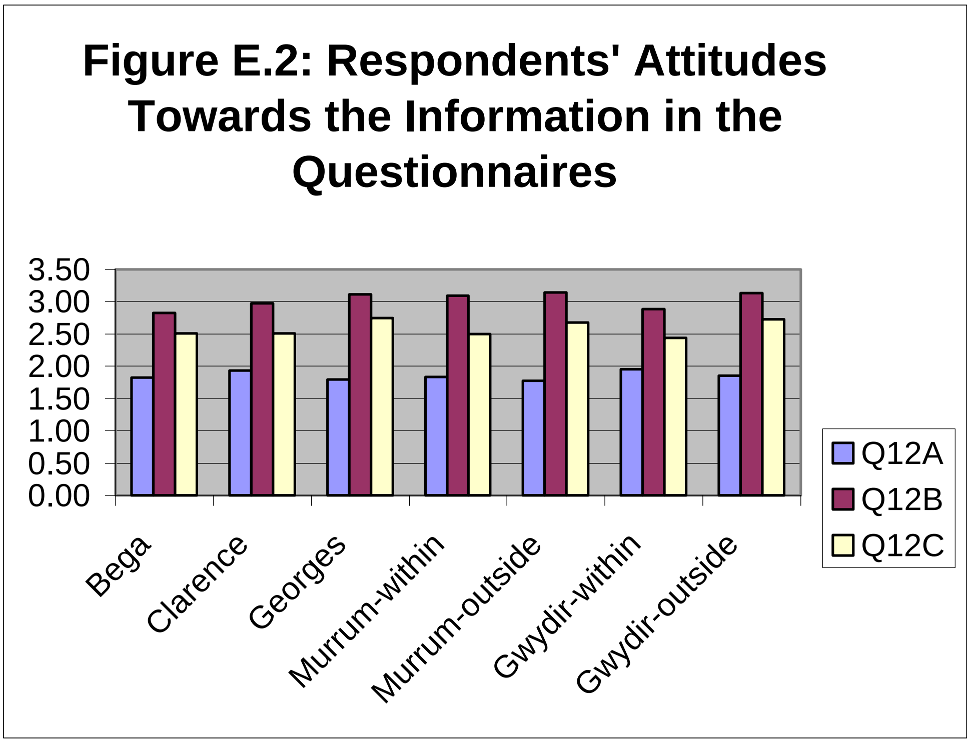
Figure E.1: Respondents' Attitudes Towards the Survey Scenario



Questions asked to determine whether respondents felt that appropriate information was presented in the questionnaire included:

- I understood the information in the questionnaire
- I needed more information than was provided
- The information in the questionnaire was biased in favour of preserving the river

Responses to these Likert Scale questions (1-strongly agree, 5-strongly disagree) are presented in Figure E.2. Respondents' views were fairly consistent across the catchments. Respondents found that the information was understandable, and neither agreed nor disagreed that more information was needed. This latter finding is satisfactory given the difficulty of providing the appropriate amount of information to all respondents. On average, there was some evidence that respondents felt that the questionnaire was biased towards preserving rivers, however this is to be expected given the nature of this survey.



Finally, a Likert scale question was asked to determine whether respondents found answering the choice set questions confusing (1-strongly agree, 5-strongly disagree). The purpose of this question was to gauge whether respondents were able to meaningfully answer these questions. The evidence (displayed in Figure E.3) indicates that in each of the catchments respondents, on average, did not find answering the choice set questions confusing. Respondents in the urban and out of catchment samples appeared to have the least difficulty.

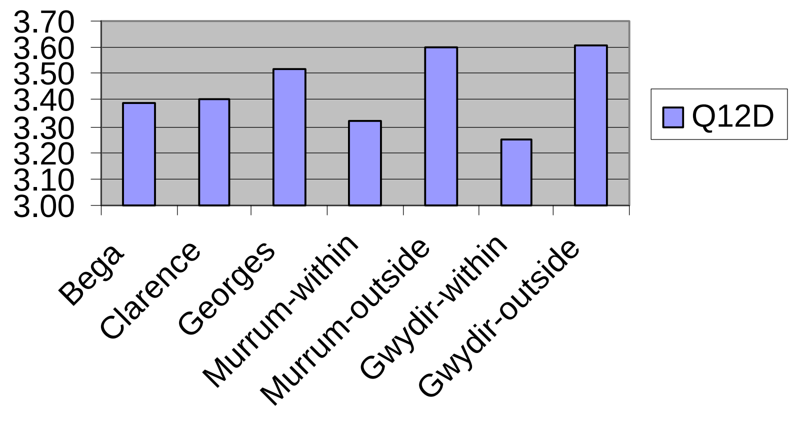


Figure E.3: Did Respondents Find Answering the Choice Sets Confusing?

Appendix F The Benefit Transfer Model

Various researchers have advocated the transfer of demand functions when using benefit transfer (eg Desvousges, Naughton and Parsons 1992). The use of choice modelling provides an example of this sort of transfer, where allowance can be made for both differences in socio-economic characteristics and within-catchment site characteristics. The development of a benefit transfer model enables an even more refined use of benefit transfer as allowance is made for differences in catchment characteristics.

The benefit transfer model is presented in Table F.1. The model specification has been deliberately kept simple because of the large number of variables in the model. A multinomial logit model has been used because of problems with the estimation of the nested logit model; however, this change in model specification should not significantly affect implicit prices (Hausman and Ruud 1987).

Two catchment differences have been included in the model. These are whether the catchment is inland or coastal (INLAND) and in the north or south of the state (NORTH). The differences have been included through the use of dummy variables that have been interacted with the choice set attributes. An additional dummy is also used to capture differences in respondent preferences according to whether they reside within the catchment or outside of the catchment (LOCAL).

This model will allow benefit transfer to a greater variety of catchments than is possible using transfer only between similar catchments. Value estimates are generated for eight different catchment/respondent “scenarios”. This can be contrasted with using benefit transfer between like catchments. In this project five individual catchments have been analysed with two out of catchment samples collected, a total of seven “scenarios” analysed. Thus this model will enable greater use of benefit transfer.

The results from this model indicate that:

- Use values are higher in the within catchment samples;
- Existence values for vegetation are higher in coastal catchments, and lower if you are from a within catchment sample;
- Existence values for fish species are higher if you are from a coastal catchment, but lower if you are from a northern coastal catchment;
- Existence values for fauna species are not systematically affected by catchment characteristics;
- Respondents to the inland, southern and out of catchment samples were more likely to choose an option to improve river health;
- Respondent’s environmental orientiation (ie progreen or prodevelopment) will influence their likelihood of choosing an option to improve river health; and
- Willingness to pay is a function of sociodemographic characteristics (income and age).

Table F.1: Benefit Transfer Model

Variables	**Coefficients**	**P-values**
ASC1	0.574	0.000
ASC2	0.510	0.001
ASC * PROGRE	0.379	0.000
ASC * PRODEV	-0.422	0.000
ASC * NORTH	-0.240	0.002
ASC * LOCAL	-0.790	0.000
ASC * COASTAL	-0.534	0.001
RATE	-0.009	0.000
RATE * INCOME	0.000	0.000
RATE * INCOME DUMMY	-0.003	0.000
RATE * AGE	0.000	0.000
VEGETATION	0.022	0.000
VEGETATION * LOCAL	-0.007	0.000
VEGETATION * COASTAL	0.008	0.001
FISHABLE	0.171	0.000
FISHABLE * LOCAL	0.144	0.009
SWIMABLE	0.391	0.000
SWIMABLE * LOCAL	0.089	0.112
FISH SPECIES	0.037	0.000
FISH * COASTAL	0.034	0.015
FISH * NORTH * COASTAL	-0.048	0.000
FAUNA SPECIES	0.010	0.000
Summary statistics		
Log-likelihood	-5786.911	
Adjusted rho-squared	0.198	
N	6575	

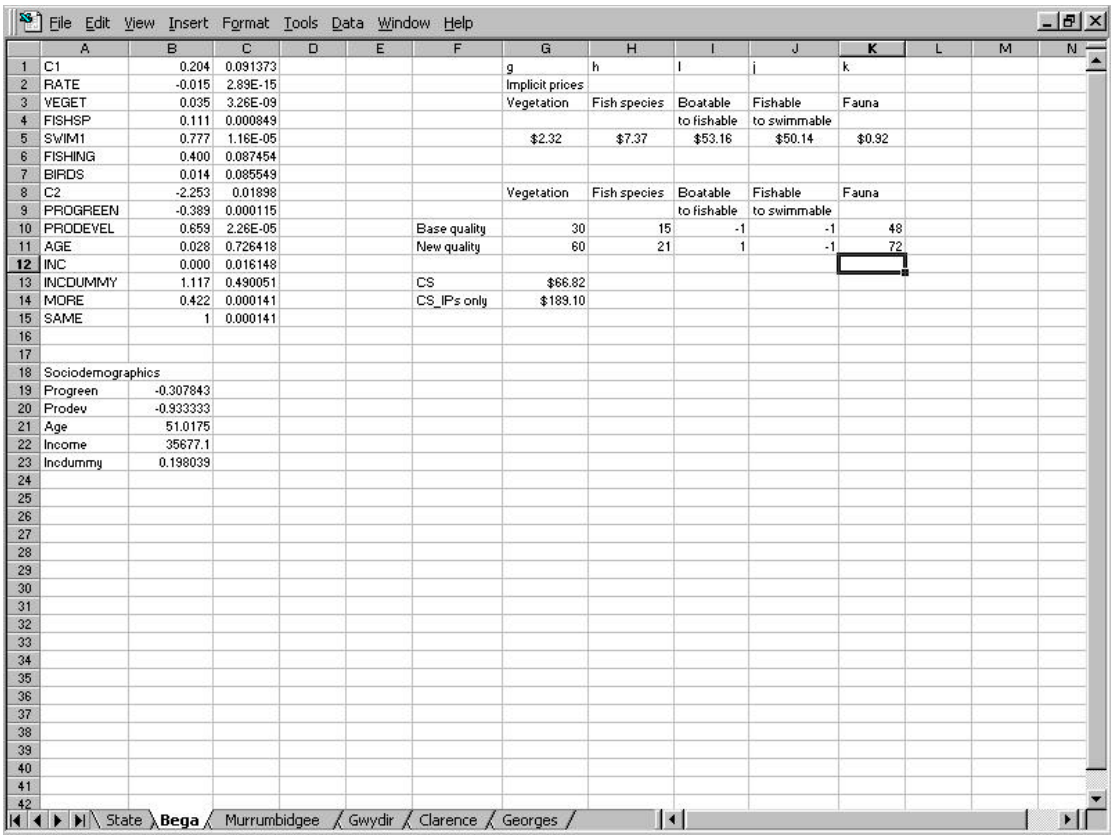
Appendix G Attribute Value and Compensating Surplus Estimation Spreadsheet

A spreadsheet decision support tool has been developed to estimate aggregate attribute values and compensating surplus values for specified changes in environmental attributes.

The model allows the analyst to specify before and after scenarios of river condition. In addition, the mean levels of income and age in the catchment can be specified to account for variations across catchments.

The spreadsheet is shown in Figure G.1. It is found on the accompanying disk on file a:\implicit price_spreadsheet.xls.

Figure G.1: Value estimator spreadsheet



	A	B	C	D	E	F	G	H	I	J	K
1	C1	0.204	0.091373				g	h	I	j	k
2	RATE	-0.015	2.89E-15				Implicit prices				
3	VEGET	0.035	3.26E-09				Vegetation	Fish species	Boatable	Fishable	Fauna
4	FISHSP	0.111	0.000849						to fishable	to swimmable	
5	SWIM1	0.777	1.16E-05				$2.32	$7.37	$53.16	$50.14	$0.92
6	FISHING	0.400	0.087454								
7	BIRDS	0.014	0.085549								
8	C2	-2.253	0.01898				Vegetation	Fish species	Boatable	Fishable	Fauna
9	PROGREEN	-0.389	0.000115						to fishable	to swimmable	
10	PRODEVEL	0.659	2.26E-05			Base quality	30	15	-1	-1	48
11	AGE	0.028	0.726418			New quality	60	21	1	-1	72
12	INC	0.000	0.016148								
13	INCDUMMY	1.117	0.490051			CS	$66.82				
14	MORE	0.422	0.000141			CS_IPs only	$189.10				
15	SAME	1	0.000141								
16											
17											
18	Sociodemographics										
19	Progreen	-0.307843									
20	Prodev	-0.933333									
21	Age	51.0175									
22	Income	35677.1									
23	Incdummy	0.198039									

State | Bega | Murrumbidgee | Gwydir | Clarence | Georges

Appendix H: State-wide Estimates of the Value of Environmental Attributes of Rivers

At the same time as the individual catchment surveys were being undertaken, a separate survey of NSW residents' values for the environmental attributes of rivers across the whole State was carried out. The aim of the additional survey was to identify the likely extent of framing effects in the outside catchment value estimates when multiple rivers are being considered for environmental improvement measures. Because the State-wide sample was drawn from across the whole State, the appropriate comparison to be made is between the outside catchment surveys and the State-wide survey.

The questionnaire used for the State-wide survey was of the same form as used for the individual catchment surveys apart from two notable features. First, the description of the situation respondents were asked to consider was broadened from one river to all the rivers of the state. Second, the payment vehicle was modified from being a one-off levy on water rates as used in the individual catchment questionnaire to a levy over three years. This change in payment vehicle was necessary to reflect the extent of the additional budgetary pressure the scale of the proposed changes would impose on respondents. A survey protocol identical to the one used for the individual catchments was employed.

The details of the survey response rate and the socio-demographic features of the sample are set out in tables H.1 and H.2 respectively.

Table H.1: Response rate: state-wide survey

	State-wide sample
Useable responses	239
Successfully delivered	717
Response rate	33.3%

Table H.2: Socio-demographics of sample: state-wide survey

	State-wide sample
Age (yrs)	52.9
Sex (% female)	39%
Children	81%
Education#	4.3
Income	$51,662

1-never went to school, 6-tertiary degree

The data collected in the State-wide survey were analysed using a nested logit model following the same process as was used for the individual catchments' data (see Appendix C). The model of respondent choice is displayed in Table H.3.

Table H.3: State-wide model of respondents' choices

Variables	State-wide (coefficients)	Significance of coefficients (p-values)
ASC1	0.175	0.091
RATE	-0.017	0.000
VEGET	0.025	0.000
FISHSPEC	0.046	0.001
SWIM1	0.388	0.000
FISHING	0.130	0.087
FAUNA	0.014	0.086
ASC2	-1.591	0.019
PROGRE	-0.321	0.000
PRODEV	0.751	0.000
AGE	0.002	0.726
INCOME	0.000	0.016
INCDUM	0.178	0.490
IV	0.372	0.000
Log-likelihood	-815.183	
Rho-squared adj	0.258	
N	950	

Table H.4: Attribute value estimates: State-wide model

Attribute	Value per annum over three years ($)	Present value at 7 per cent discount rate ($)
Vegetation	1.51	4.23
Fish	2.74	7.70
Fauna	0.84	2.37
Water quality: Boatable to fishable	15.69	44.05
Water quality: Fishable to swimable	31.04	87.17

Comparisons between the State-wide survey results and the outside catchment surveys for the individual catchment results are difficult to make because of a number of confounding factors.

The difference in the scopes of the individual catchment cases and the whole of the State's rivers is sufficiently large to make direct comparisons unreliable.

Comparisons are also confounded because the vast majority of NSW residents live in the catchment of a river and so in answering the State-wide survey may have included some element of a within catchment value as well as outside catchment values.

A further confounding difference between the individual and state-wide surveys was the difference in payment vehicle time horizon – from a one-off to three yearly payments.

Given these difficulties, direct comparisons should not be made. The usefulness of the State-wide results is two-fold.

First, they provide an indication of the value held by NSW residents for environmental improvements in the state's rivers. This is important from a policy perspective in terms of the assessment of budgetary priorities for the State government.

Second, the value estimates provide a boundary for the use of outside catchment value estimates when framing effects are expected.

Appendix I: Status Quo or Business as Usual Levels for Environmental Attributes

In each of the choice modelling surveys, respondents were asked to indicate their preferred choice of river management options from a selection of three possibilities. In every choice set, one of the three alternatives available was always the status quo or business as usual option. This was defined as the current levels of the environmental attributes and a zero levy on water rates. The other alternatives were defined across the range which attributes could be expected to vary under various river management regimes.

The calculation of value estimates for changes in environmental conditions in rivers is based on a projection of how river attributes will change away from the status quo levels. To facilitate the calculation of these expected changes, the status quo levels for all the environmental attributes of each catchment considered are reported in this appendix.

Table I.1: Status quo attribute levels

River **Attribute**	**Bega**	**Clarence**	**Murrum-bidgee**	**Gwydir**	**Georges**
Vegetation (% of river with healthy riverside vegetation and wetlands)	30	40	10	10	20
Fish (# of native fish species present)	15	22	8	10	12
Fauna (# of waterbirds and other fauna present)	48	67	60	45	65
Water quality across the whole of the river (% of river)					
• **Fishable**	25%	0%	38%	33%	13%
• **Swimmable**	75%	21%	5%	14%	67%