Valuing Alternative Wetland Management Strategies using Choice Modelling[*]

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Abstract

Decisions regarding the use of natural resources frequently involve multiple options. Assessing each of the available options can be a time consuming and costly process where non-market environmental values relating to the options are to be estimated. Choice Modelling (CM) offers the potential to provide non-market value estimates for an array of alternative natural resource management options from a single data collection exercise. This cost-saving feature arises because CM enables the estimation of values for outcomes as a function of the attributes that characterise the outcomes as well as the socio-demographic features of those whose values are being estimated. The capacity of the technique is demonstrated in this paper through case study applications involving wetland management in the Upper South East of South Australia and the Murrumbidgee Floodplain in NSW.

Key words: Choice Modelling, Natural Resource Management, Wetlands

1 Introduction

Society faces a range of choices about how it uses wetland resources. Because of the public nature of some benefits that wetlands generate the choice remains when considering options for wetlands that are privately owned. Benefit-cost analysis (BCA) can be employed to assess the relative size of the private and public benefits from changing wetland management. However, many of the public benefits are non-monetary. In this paper the use of choice modelling (CM) surveys to assess the size of the public non-monetary benefits associated with changing wetland management on private lands in two case study areas is reported. The case study areas are located in the Upper South East (USE) of South Australia and on the Murrumbidgee River Floodplain (MRF) in New South Wales.

There have been several previous applications of the CM technique to environmental valuation in Australia (see for example Lockwood and Carberry (1998) and publications from the Choice Modelling research project such as Morrison, Bennett and Blamey (1998)).[1] The aim in this paper is to build upon these studies. Hence, the focus is on the new and innovative aspects of CM application applied during the research including:

- Previous studies[2] are useful as inputs to a BCA but they have not been framed specifically for the purpose. The choice modelling surveys within this paper were explicitly framed to provide numeric estimates of non-market environmental values for inclusion in a BCA of multiple options for wetland management on private land;
- The BCA framework led to inclusion of duck hunting as a potential non-monetary cost to non-hunters and benefit to hunters in the USE survey. These estimates complement the estimated use benefits to hunters of wetlands in the USE presented in a companion paper 'A Travel Cost Study of Duck Hunting in the Upper South East of South Australia' (Whitten and Bennett 2001);
- The survey design process - including focus groups - led to the inclusion of a socio-economic variable (number of farmers who would leave farming as a result of changing wetland management);
- The CM questionnaire was designed to include icons or picto-grams rather than the standard numerical framework; and,
- Use of a non-linear functional form to assess wetland values produced in the MRF.

In the next section of this paper a brief background is provided including explanation of the benefit cost structure. The third section comprises a summary of the theoretical requirements and reasons for the use of CM. In section four, an overview of the survey design and implementation is provided focusing on the choice sets. The resulting non-monetary wetland valuation estimates are reported in Sections 5 (USE) and 6 (MRF). Section 7 places the non-monetary valuation estimates in the wider context of wetland management and the next phases of the 'Private and Social Values of Wetlands' research project.

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[1] Research Reports from the project 'Using Choice Modelling to Estimate Non-Market Values' can be found at the following web address: apsem.anu.edu.au/staff/jbennettr.htm.

[2] Apart from Blamey, Rolfe, Bennett and Morrison (2000).

2 Background

Benefit-cost structure

When undertaking a benefit-cost analysis, the initial issue is to define the alternative management options that are available. The alternative management options will lead to differing biophysical outcomes from a continuation of current management (the business-as-usual (BAU) alternative).[3] The differing biophysical outcomes yield differing sets of values to wetland owners and the wider community. By examining how the alternative outcomes differ from a continuation of current wetland management the option attributes of characteristics that change can be identified and valued.

Changes to the attributes were initially quantified in terms of the physical marginal change. These changes must be converted to a common unit to enable comparison. An increase in waterbird numbers can only be compared with a reduction in agricultural production by conversion to a common unit. Economists use dollar values as the common comparative unit. Valuation of each of the marginal changes in monetary terms is termed economic modelling. The economic modelling reported in this paper is focused on the estimation of non-monetary, public values generated by wetlands in the two case study areas.

The case study areas

Figure 1: Location of case study areas

[3] The BAU case is defined in terms of any management changes that have already been decided upon.

The location of the two case study areas is shown in Figure 1. Whitten and Bennett (1999, 2000) define the changes that would occur to biophysical attribute levels under alternative wetland management strategies in the USE and MRF respectively. The comparison point is the values associated with the BAU position at a defined future point in time. A future point in time is used because the values generated by the BAU management strategy will continue to change over time. It is the marginal change in attribute values in the future, valued at the present time, that is being quantified as a comparative measure (using a BCA) of which strategy is preferred. The range of environmental values for which the marginal change must be defined is indicated in Tables 1 (for the USE) and 2 (for the MRF).

USE

In the USE large areas of wetlands have been cleared, drained and converted to pasture for agricultural production. Only 63,000 hectares of healthy wetlands, or less than seven percent of the original wetland area, remain in the region. The conversion of wetlands to pastoral production was motivated by the private values so obtained. However, the private and social values generated by natural wetlands in the region have been significantly reduced. The issue is whether the balance between private and social values is optimal. If not, society may wish to encourage alternative wetland management practices that will lead to increased net benefit to society as a whole.[4]

Table 1: Difference between 'BAU' and alternative strategies in the USE

Descriptive Attributes	Unit	Wetland retention	Pro-wetlands	Wetlands and remnants	Cumulative farm forestry	Farm forestry alone
Agricultural pasture	ha	0	-12,633	-29,725	-44,725	-15,000
	(%)	*(0.0)*	*(-2.3)*	*(-5.5)*	*(-8.2)*	*(-2.8)*
Healthy wetlands	ha	12,633	25,267	28,425	31,584	3158
	(%)	*(28.6)*	*(57.1)*	*(64.3)*	*(71.4)*	*(7.1)*
Degraded wetlands	ha	-12,633	-12,633	-15,792	-18,950	-3158
	(%)	*(-66.7)*	*(-66.7)*	*(-83.3)*	*(-100.0)*	*(-16.7)*
Healthy remnants	ha	0	0	51,275	51,275	0
	(%)	*(0.0)*	*(0.0)*	*(100.0)*	*(100.0)*	*(0.0)*
Degraded remnants	ha	0	0	-34,183	-34,183	0
	(%)	*(0.0)*	*(0.0)*	*(-100.0)*	*(-100.0)*	*(0.0)*
Farm forestry	ha	0	0	0	15,000	15,000
Annual pasture	ha	0	0	0	-15,000	-15,000
	(%)	*(0.0)*	*(0.0)*	*(0.0)*	*(-100.0)*	*(-100.0)*
Perennial pasture	ha	0	0	0	15,000	15,000
Total productivity	dse	-16,392	-79,629	-257,444	-258,231	2346
	(%)	*(-0.5)*	*(-2.4)*	*(-7.7)*	*(-7.7)*	*(0.1)*
Waterbird hunting	No.	3000	4000	6000	6000	-3000
	(%)	*(50.0)*	*(66.7)*	*(100.0)*	*(100.0)*	*(-50.0)*
Other hunting	ha	0	0	51,274	51,274	0
	(%)	*(0.0)*	*(0.0)*	*(294.5)*	*(294.5)*	*(0.0)*
Fencing required	km	442	948	2289	2399	111
Total tourist numbers	No.	11,900	26,150	35,150	35,150	0
	(%)	*(187.4)*	*(411.8)*	*(553.5)*	*(553.5)*	*(0.0)*
Improved conservation status of species*	No.	15	17	22	22	0

* Conservation status of flora vertebrate and fauna species only

[4] For more information about the actual and potential values of wetlands in the USE see Whitten and Bennett (1999).

Whitten and Bennett (1999) identified a set of potential management strategies for the USE. The changes in biophysical outcomes of the alternative strategies compared to the 'BAU' option are reported in Table 1. Table 1 includes several environmental attributes of the alternative outcomes such as the area of healthy wetlands, the area of healthy remnant vegetation, the conservation status of species and, to some extent, the number of waterbirds hunted. It is changes to these environmental attributes in the USE for which value estimates are reported in this paper. For example, if the 'wetlands and remnants' management strategy were adopted the area of healthy wetlands would increase by 28,425 ha, the area of healthy remnants by 51,275, the number of endangered species fall by 22 but approximately 6000 more ducks would be hunted. The changes in environmental outcomes are compared at a point in time 30 years from now.

MRF

There are about 47,000 hectares of wetlands on the MRF between Wagga Wagga and Hay (Thornton and Briggs (1994) adjusted in Whitten and Bennett (2000)). Many of these wetlands have been degraded as a result of land and water management practices. Only about 2500 hectares of wetlands remain healthy. As in the USE region, the change in land and water management was motivated by private values generated from irrigation, grazing and timber production. But unlike the USE region where the private values are confined to wetland owners, private values in the MRF are divided between wetland owners (benefits resulting from grazing, logging and some irrigation) and irrigators downstream.

A set of alternative management strategies was also derived for the MRF (Whitten and Bennett (2000)). Changes in biophysical attributes for the MRF under a range of alternative strategies, compared to the 'BAU' option are reported in Table 2. The definable impacts were regarded as those that would occur over a 15-year period (rather than the 30-year period used for the USE). The shorter time period relates to the faster response anticipated in the MRF wetland systems. Table 2 includes several environmental attributes such as the area of healthy wetlands, the number of water and woodland birds, the number of native fish, and to a lesser extent the quantity of timber harvested. It is changes to these environmental attributes on the MRF for which estimates are reported in this paper. For example, if the 'combined strategies' were adopted the area of healthy wetlands would increase by 11,000 ha, the number of water and woodland birds increase by 75% and the number of native fish increase by 100%.

3 Method selection and theoretical requirements

The environmental values in Tables 1 and 2 are split between pure private values and social values. Values that are purely private are those held by the owners of the wetlands. The trade-offs associated with the values of wetland owners are reported in Whitten and Bennett (1998, 2000) but do not include monetary estimates. In a companion paper 'A Travel Cost Analysis of Duck Hunting in the Upper South East of South Australia' (Whitten and Bennett 2001) an estimate of the consumer surplus associated with hunting is reported. This paper is focused on the estimation of social, non-monetary, tourism, aesthetic and non-use values of wetlands in the two case study areas.

Table 2: Difference between 'BAU' and other strategies on the MRF

Descriptive Attributes	Unit	Water management	Grazing management	Timber management	Combined strategies
Water purchased from	Ml	41,700	0	0	41,700
irrigation	*(%)*	*(1.7)*	*(0.0)*	*(0.0)*	*(1.7)*
Set stocking rate	ha	0	-8259	0	-8259
	(%)	*(0.0)*	*(-38.1)*	*(0.0)*	*(-38.1)*
Rotational or crash	ha	0	-2296	0	-2296
grazing management	*(%)*	*(0.0)*	*(-9.6)*	*(0.0)*	*(-9.6)*
No grazing	ha	0	10,555	0	10,555
	(%)	*(0.0)*	*(172.4)*	*(0.0)*	*(172.4)*
No logging	ha	0	0	8745	8745
	(%)	*(0.0)*	*(0.0)*	*(42.5)*	*(42.5)*
Fallen timber harvesting	ha	0	0	-596	-596
	(%)	*(0.0)*	*(0.0)*	*(-18.0)*	*(-18.0)*
Sustainable timber	ha	0	0	-6111	-6111
Harvesting	*(%)*	*(0.0)*	*(0.0)*	*(-42.6)*	*(-42.6)*
Unsustainable timber	ha	0	0	-2039	-2039
harvesting	*(%)*	*(0.0)*	*(0.0)*	*(-50.0)*	*(-50.0)*
Total productivity	dse	0	-15,539	0	-15,539
	(%)	*(0.0)*	*(-28.1)*	*(0.0)*	*(-28.1)*
Sawn timber yield	ha	0	0	-15,280	-15,280
	(%)	*(0.0)*	*(0.0)*	*(-43.9)*	*(-43.9)*
Residual timber yield	ha	0	0	31,156	31,156
	(%)	*(0.0)*	*(0.0)*	*(-42.7)*	*(-42.7)*
Fencing required	km	0	718	0	718
	(%)	*(0.0)*	*(42.0)*	*(0.0)*	*(42.0)*
Environmental Outcomes					
Healthy wetland area	ha	2500	6500	0	11,000
	(%)	*(100.0)*	*(260.0)*	*(0.0)*	*(440.0)*
Number of water and woodland birds	(%)* change	50.0	25.0	25.0	75.0
Number of native fish	(%)* change	50.0	25.0	25.0	100.0

* Percentage changes from current numbers.

Method selection

The techniques available to value changes in the non-marketed, environmental attributes can be divided into two main groups: those using revealed preferences and those using stated preferences. For changes in environmental attributes to be estimated by revealed preferences they need to be directly related to actions in the market place. The environmental attributes for which monetary estimates are reported in this paper do not rely on marketed goods in any way except for tourism benefits. Hence demand for these outcomes is not revealed even indirectly in the market place and cannot be estimated via revealed preference methods.

Stated preference techniques avoid direct use of market data. They involve individuals being asked, in a survey, to place a value on the change in environmental outcomes (Turner, Pearce and Bateman 1994). There are five main stated preference techniques. They can be divided between contingent valuation (CV) based methods and conjoint based methods. The advantage of CVM methodology is that it is well known in Australia and internationally with a relatively extensive listing of applications. However, the CVM can only assess the outcomes of one proposed alternative management strategy at a time. Hence, use of CVM to value the potential

changes summarised in Section 2 would require a separate survey for each strategy – a prohibitively expensive strategy.

There are four potential conjoint methods that can be used: contingent ranking, contingent rating, paired comparison and choice modelling. While each method involves respondents evaluating a number of alternative management strategies, only choice modelling directly generates theoretically unbiased estimates of the willingness to pay (WTP) of each option to be derived (providing a BAU option is included) (Morrison, Blamey, Bennett and Louviere 1996). It is this WTP that is required for use in a BCA framework. CM also provides additional information about preferences for the components (attributes) that make up the outcome. This information can be used in two ways:

1. To develop new management strategies leading to outcomes preferred to those initially examined.
2. To compare other management options that may arise against those initially tested (so long as the outcomes of these new options can be measured and described using the same attributes as the existing options).

4 Choice Modelling Methodology

Theoretical basis

The underlying basis of CM is random utility theory.[5] Random utility theory states that consumers make choices that would lead to their utility being maximised. That is, consumers will choose option 'A', if, and only if, option 'A' generates at least as much utility as any other option. The utility generated by an option is assumed dependent on the characteristics or attributes of the good (x), the characteristics of the individual (s) and an unobservable component (e). The unobservable component is assumed random and usually assumed independently and identically distributed (IID). Hence, the utility of option 'A' can be specified:

$$U_A = V(X_A, S_A) + e_A \qquad \text{where 'V' is an indirect utility function.}$$

In addition, the probability that an individual 'i' will choose option 'A' from the set of choices 'J' is:

$$P(A|A, A \in J) = P[(V_{Ai} + e_{Ai}) > (V_{Ji} + e_{Ji})$$

That is, the probability that an individual will choose 'A' from the set of options J is equal to the probability that the utility they obtain from 'A' (including the random component) is higher than for any other element of 'J'.

Estimation of choice probabilities is via a multinomial logit model as follows:

$$P_A = \exp(\lambda V_A) / \Sigma\exp(\lambda V_J)$$

Where: $j = 1,\ldots,n$

V = the systematic component of utility

λ = a scale parameter that is usually arbitrarily set to 1

Multinomial logit models rely on the independence of irrelevant alternatives (IIA). IIA arises from the IID assumption. IID of the error term means that it has an extreme value error distribution (Ben-Akiva and Lerman (1993)). IIA means that the

[5] The information about CM is primarily drawn from Bennett (1999) and Morrison *et al*. (1996).

probability of choosing an alternative is dependent only on the options from which a choice is made, and not on any other options that may exist. If the IIA condition is violated, the estimates derived from the model may be biased and may not generate suitable values for inclusion in cost benefit analysis. IIA violations can be corrected for via the use of more complicated nested logit models.

Attribute selection

In Section 2 the environmental outcomes to be valued were briefly summarised. These outcomes must be defined succinctly to allow the environmental goods to be assessed and compared. The definition is generally via the use of several attributes. The attributes of significance to policy makers must be communicable to the wider community and wetland owners and be measurable (Bennett 1999). The attributes selected for inclusion in the choice modelling survey must fulfil two similar objectives:

- They must represent changes in outcome that respondents value (that is they must have meaning to respondents) (Bennett 1999); and,
- They must cover the range of changes in outcomes that are of significance to respondents.

Focus groups were convened in order to ensure attribute selection was not biased by the previously determined policy attributes and to assist in designing the survey (see Box 1). Four focus groups were held: two in Canberra and one each in Adelaide and Griffith. Each group consisted of 8 to 10 people that were loosely representative of the population eligible to vote in terms of age and sex. During the recruitment of participants incentive payments ($35 per participant) were mentioned after the person had agreed to attend. The focus groups were structured into three sections: attribute selection and ranking, assessment of information provided to respondents and tests of questionnaire design.

Box 1: Focus groups

Focus groups are a planned discussion involving between eight and ten participants. A Facilitator guides the discussion. Groups are held in a neutral, non-threatening environment. Participants are encouraged to share their opinions and attitudes about the topic being discussed – in this case wetlands. Groups are often held in specially designed rooms where participants seated around a large table and last between one and a half and two hours. Groups are generally audio or video recorded to allow opinions expressed to be examined in detail. (Morrison, Bennett and Blamey 1997a)

The attributes selected following the focus groups must coincide with those listed in Tables 1 and 2 in order to facilitate the BCA. The attributes selected for inclusion following the focus groups are shown in Table 3. Because the nature of the wetland management changes proposed was taken to imply an adverse impact on farmers a 'farmers leaving' due to management changes replaced an earlier draft attribute (water diverted from irrigation). The 'farmers leaving' attribute was designed to increase the plausibility of the survey. This was despite the modelling indicating a very small impact on farm production.

Table 3: USE and MRF survey attributes

Attributes for USE survey	Attributes for MRF survey
• Cost to the respondent • Area of healthy wetlands • Area of healthy remnants • Threatened species that will benefit • Number of ducks hunted	• Cost to the respondent • Area of healthy wetlands • Population of native water and woodland birds • Population of native fish • Number of farmers leaving

Survey design

The design and structure of the questionnaire is determined, in part, by the intended survey methodology. Preliminary quotations from a number of market research firms indicated that any type of individual approach would be extremely expensive (for example face to face, drop-off pick-up and drop-off mail-back). The detailed information that respondents are required to use along with the inherently difficult nature of the trade-offs required in the CM process also precluded telephone-based surveys. Hence the selected survey delivery mechanism was mail-out, mail-back. The survey[6] consisted of the following sections (based on Bennett (1999)):

- Letter of introduction;
- Preamble including background and contextual information (framing);
- Statement of the problem;
- Statement of the potential solution;
- Introducing the choice sets;
- The choice sets;
- Debriefing questions;
- Socio-economic and attitude based data; and,
- Opportunity for additional feedback.

Each of the sections above were developed and refined in three main phases:

1. An initial survey draft was designed based on questionnaire designs from Blamey, Rolfe, Bennett and Morrison (1997) and Morrison *et al.* (1997a).
2. The draft questionnaires were answered and feedback collected as part of each focus group. The draft surveys were then refined prior to the following focus group. Focus group discussion targeted the preamble, statements of the issue and solution and the choice sets.
3. The final questionnaire was formatted into the layout required to undertake a mail-based survey. A graphic design artist undertook the final questionnaire preparation phase in close consultation with the authors.

The choice sets

The choice sets are the heart of the CM questionnaire and are designed to elicit the choice based information. The trade-offs that are expected of respondents are difficult. Hence, simplicity and clarity are two key aspects of choice set presentation. Choice set methodology followed Bennett (1999). Choice sets were generically labelled (except the BAU option) and a 'blocked' fractional factorial design was used in the survey. A draft choice set format was developed based on previous CM

[6] Copies of the questionnaires are available from the authors.

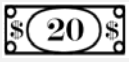
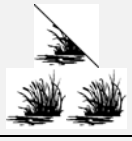
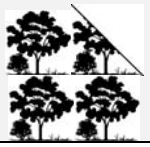
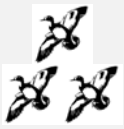
surveys from the Choice Modelling Research Project. Because these questions are the most important part of the questionnaire, and because they are often difficult for respondents to answer, a number of alternative formats were designed and trialed during the focus groups. The initial draft version, shown in Figure 2, has the options read vertically and is based on absolute quantities.

Figure 2: Draft choice set question for USE questionnaire

Outcome	**Option A Current management**	**Option B Changed management**	**Option C Changed management**
• One-off levy on your income	$0	$20	$50
Change in:			
• Area of healthy wetlands	44,000 Ha	55,000 Ha	75,000 Ha
• Area of healthy remnant vegetation	52,000 Ha	70,000 Ha	85,000 Ha
• Threatened species that benefit	0	6	22
• Hunting in wetlands	6000	9000	9000
Which option do you prefer? *Tick one box only*	☝	☝	☝

Respondents found the initial design difficult to interpret and answer. Particular problems related to respondents' difficulties in identifying what they received for payment of the levy. It was also apparent the numerical presentation of the trade-offs caused some participants difficulty. Responses included "the hectare numbers are too much", "it seemed like a mathematics test rather than an opportunity to write down an opinion", and, "I would like to see the results of spending my money … what I get for what I pay".

Figure 3: Final choice set design for USE questionnaire

6. Suppose options A, B and C are the **ONLY** ones available, which would you choose?	**I Pay** Levy	**What I get** Healthy wetlands	Healthy remnant vegetation	Threatened species that benefit	Ducks hunted	**I would choose** *Tick one box only*
Option A: No Change	**NIL**			**NIL**		☝1
Option B						☝2
Option C						☝3

Note: The symbols were related to the quantitative numbers in the preamble of the survey and reminded of the key to the numbers in the introduction to the choice sets.

The final choice set design shown in Figure 3 was achieved after several iterations. The design shown in Figure 3 has several key differences to the initial design:

1. The choice options are read horizontally;
2. The labels 'What I pay' and 'What I get' clarify the trade-offs facing respondents; and,
3. Icons represent the attribute levels. The icon levels were shown in a key that folded out to allow respondents to view it while completing the choice sets (shown for the USE in Figure 4).

Figure 4: Foldout symbol key used in questionnaire

Symbol key

(for questions 6 to 10)

Healthy wetlands		= 22,000 Hectares (55,000 acres)
Healthy remnant vegetation		= 25,000 Hectares (60,000 acres)
Threatened species that will benefit		= 6 Species
Ducks hunted		= 3000 Ducks

A summary of the situation

Healthy wetlands	44,000 Ha.
Healthy remnant vegetation	50,000 Ha.
Total number of threatened species	24*
Ducks hunted	6000

** Includes several species that would become extinct in the Upper South East (but not Australia)*

The final focus group indicated they had no particular problems answering the question, commenting it was "clear enough" and "easy to answer". Despite the confidence achieved that respondents would have few difficulties answering the choice set debriefing questions were included to assess any such difficulties. This was the first environmental CM survey in Australia to use the pictorial approach to introducing trade-offs.

Survey implementation

The sample frame determines who is to be surveyed and how many. Previous studies have indicated that the values held for wetlands are likely to differ in relation to the geographic proximity of the respondent (see for example Rolfe and Bennett 2000). To account for this in the USE, surveys[7] were undertaken in the Naracoorte (800), Adelaide (800) and Canberra (400). For the MRF surveys were undertaken in Griffith

[7] Sample sizes are given in brackets for each sub-sample area.

(800), Wagga Wagga (800), Canberra (800) and Adelaide (400). The cross-samples can be used to test hypotheses about the effects of distance on values.

Both the USE and MRF surveys were undertaken as mail out/mail back.[8] This survey format decision was based on the relative costs of obtaining a suitable sample size and feedback received in focus groups. The White Pages based 'Australia on Disk' was used to derive a sample of some 2,000 names and addresses for the USE surveys and 2,800 for the MRF surveys. Due to the costs associated with survey production, only one mail out of the survey followed up by two reminders spaced at two and three and a half weeks after the initial mail out were undertaken. The initial mail out was undertaken on the sixth and seventh of March 2000. Reminders were sent on 17 and 27 March 2000.

5. Environmental values for the Upper South East of South Australia

Response rate

A total of 2,000 surveys were mailed out, 247 were returned to sender and 542 surveys were returned for a response rate of 30.8%. The response rate was relatively consistent across all samples and questionnaire versions. The response rate compares favourably with other mail out CM surveys in Australia such as Rolfe and Bennett (2000) and Lockwood and Carberry (1998).

Sample characteristics and representativeness

The basic respondent characteristics are shown in Table 4. The mean age of respondents was 51 years (median 50) and 58.1 percent of respondents were male. The median age of respondents was uniformly six to nine years older than the population. The income level of respondents was also generally higher than the wider population.

Table 4: Summary of respondent demographics

		Yes	**No**	**Maybe**
Have you visited the USE region?		78.4%	21.6%	n.a.
Will you visit the USE in the future?		63.7%	8.9%	27.4%
Have you ever hunted ducks?		15.2%	84.8%	n.a.
Will you hunt ducks in the future?		4.7%	95.3%	n.a.
		Male	**Female**	
Survey answered by		58.1%	41.9%	
Respondent age		**Education**		
under 25	2.4%	Completed primary only		5.1%
24-34	14.6%	Completed Year 10/Junior/Intermediate		19.1%
35-44	19.1%	Completed Year 12/Senior/Leaving		21.0%
45-54	26.5%	Diploma or certificate (trade qualification)		21.3%
55-64	15.1%	Tertiary degree		27.4%
65-74	13.8%	Other qualifications		5.0%
75 or over	8.4%			

The education qualifications of respondents were skewed towards higher levels with 27.4% having tertiary or higher qualifications. Seventy eight percent of respondents had visited the USE region. Canberra residents were much less likely to have visited the region (37.3%) or to visit the region in the future (only 25.5% say they will).

[8] Barbara Davis and Associates were contracted to coordinate the survey logistics.

Only a small proportion of respondents indicated they are likely to hunt ducks in the future.

Table 5: Representativeness of sample

	ACT	ACT sample	Naracoorte	Naracoorte sample
Age (median)	39	48	43	50
Sex (%Male)	48.7%	50.5%	41.0%	61.1%
Income	$48,699	$52,000-77,999	$28,647	$36,400-51,999
Tertiary education	23.9%	46.1%	5.1%	16.0%
	Adelaide	**Adelaide sample**	**Australia**	**Sample**
Age	43	49	42	50
Sex (%Male)	47.8%	59.9%	48.9%	58.1%
Income	$30,971	$36,400-51,999	$34,322	$36,400-51,999
Tertiary education	10.4%	29.7%	11.0%	27.4%

Notes: Age and percentage male is reported for individuals over 17 years of age.
Income is median annual income.

Results

The initial data received from the survey report must be organised into format suitable for analysis – see Bennett (1999) for details. Definitions of the variables used in the modelling process are provided in Table 6.

Table 6: Definition of all variables included in the modelling process

Variable	Definition
Cost	Size of levy
Wetlands	Area of healthy wetlands (hectares)
Remnants	Area of healthy remnant vegetation (hectares)
Species	Number of threatened species that benefit
Duck hunt	Number of ducks hunted
ASC	Alternative specific constant for options 2 and 3
Age	Age of respondents
Sex	Gender of respondent (1 for female, 0 for male)
Income	Log of respondent income
Canberra	Dummy variable equals 1 for Canberra else zero
Naracoorte	Dummy variable equals 1 for Naracoorte else zero
Tert	Dummy variable equals 1 for tertiary education else zero
Trade	Dummy variable equals 1 for diploma/trade qualification else zero
Hschool	Dummy variable equals 1 for high school qualifications else zero
Other	Dummy variable equals 1 for other educational qualifications else zero
Visit	Dummy variable equals 1 for respondents who visited the region else zero
Intended visit	Dummy variable equals 1 for respondents who intend to visit the region else zero
Hunt	Dummy variable equals 1 for respondents who reported hunting ducks else zero
Green	Dummy variable equals 1 for respondents who indicated they preferred conservation in decisions between conservation and development else zero
NDT	Dummy variable equals 1for respondents indicating they don't not trust government to make levy one-off or who protested against the payment vehicle, else zero
Confusion	Dummy variable equals one for respondent reporting they were confused about survey design or information else zero
Wgreen	Green * Wetlands
Dhhunt	Hunt * Duck hunt

Once the data were prepared, an initial series of generic models was estimated (using the LIMDEP statistical package) as follows:

Status quo: $V_1 = ß_1$ Cost + $ß_2$ Wetlands + $ß_3$ Remnants + $ß_4$ Species + $ß_5$ duck hunt

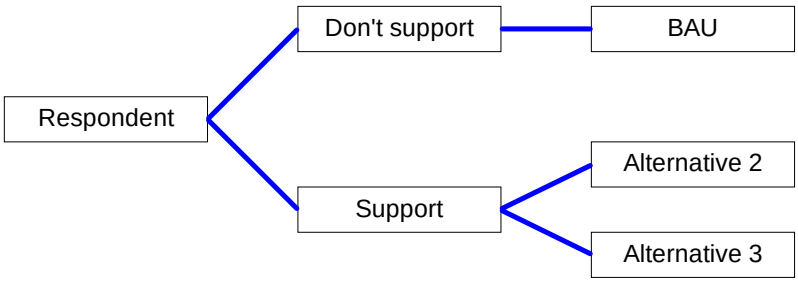
Alternative 2: $V_2 =$ ASC + $ß_1$ Cost + $ß_2$ Wetlands + $ß_3$ Remnants + $ß_4$ Species +

$$\text{Alternative 3: } V_3 = \text{ASC} + ß_1\,\text{Cost} + ß_2\,\text{Wetlands} + ß_3\,\text{Remnants} + ß_4\,\text{Species} + ß_5\,\text{duck hunt} + ß_i\,(\text{socio-economic and attitudinal variables})$$

Because the choice sets in the survey were generic, the ASC term in alternative 2 and 3 is the same. Labelled choice sets (for example as 'some wetlands', 'most wetlands') require differing ASC terms. A second set of preliminary models was run including *Wgreen* and *Dhhunt*. *Wgreen* was included as the first models indicated the wetland area variable was not significant. The *Wgreen* variable separates out the values of pro-conservation respondents for additional healthy wetland area. *Dhhunt* was included to values for additional ducks hunted by duck hunters from those held by the remainder of the population.

Tests indicated that the 'assumption of independence of irrelevant alternatives' was violated (IIA violation).[9] Hence, a nested logit model was constructed using the tree shown in Figure 5. The choice at the first level (between support and don't support) is hypothesised to be explained by socioeconomic variables (such as age, sex, income and location) and attitudinal variables (such as not trusting government, being confused by the choices in the survey or some other protest against the proposal). Choices at the second level (between alternative two and alternative three) are explained by the levels of the attributes (wetland area, remnant area, endangered species that benefit and number of ducks hunted). The results of the nested model are reported in Table 7.

Figure 5: Tree diagram for nested multinomial logit model



The coefficients for all of the attributes in the choice sets, except the area of healthy wetlands, are significant at the one-percent level. All coefficients except wetland area have the expected sign.[10] The overall model result is also significant at the one-percent level as shown by the chi-squared statistic. The explanatory power of the model is very high with an adjusted rho-squared of 32.8 percent.[11] The nested structure of the model is also highly significant with the inclusive value parameter significant at the one-percent level. The negative cost coefficient indicates that

[9] Testing of the best performing multinomial logit model using the test procedure developed by Hausman and McFadden (1984) showed IIA violations at the 1 and 5 percent level.
[10] A potential reason for a negative wetland coefficient is that some respondents may be recalling the (undesirable) appearance of saline wetlands that can be seen from the major roads through the region.
[11] Rho-squared is similar to R^2 in standard regression analysis. It is equal to one minus the ration of the unrestricted log-likelihood ratio over the restricted log-likelihood ratio. Rho-square values between 20 percent and 40 percent are considered extremely good fits Henscher and Johnson (1981).

respondents are less likely to choose options as cost increases. Likewise, respondents are less likely to choose options with larger numbers of ducks hunted. Similarly, respondents are more likely to choose options with larger numbers of endangered species protected and larger areas of healthy remnant vegetation. The positive *Wgreen* coefficient indicates that respondents who indicated they favour conservation over development also value increased wetland area. The positive *Dhhunt* coefficient indicates that duck hunters value increased numbers of ducks hunted.

Table 7: Results of nested multinomial logit model

Variables	Coefficient	Standard error
Utility functions		
ASC_1	0.203*	0.695E-1
Cost	-0.131E-1*	0.536E-5
Wetlands	-0.161E-4*	0.414E-5
Remnants	0.121E-4*	0.416E-5
Species	0.632E-1*	0.617E-2
Duck hunt	-0.572E-4*	0.121E-4
Wgreen	0.359E-4*	0.616E-5
Dhhunt	0.968E-4*	0.314E-4
Branch choice equations		
ASC	7.624*	1.153
Income	-0.683*	0.993E-1
Intended visit	-0.510*	0.158
Age	-0.147E-1*	0.479E-2
Confusion	0.381*	0.141
NDT	2.357*	0.150
Canberra	-0.338+	0.190
Inclusive value parameters		
Support	0.995*	0.618E-1
No support (fixed parameter)	1.000	0.000
Model statistics		
N (choice sets)	2385	
Log L	-1337.703	
Adjusted rho-square (%)	32.882	
Chi-square (constants only)	1329.599*	

Note: ASC_1 is coded one for 'Alternative 2' and zero otherwise.
* indicates significance at the one percent level, + at the ten percent level.

Theory provides guidance as to the expected sign of the socio-economic and attitudinal variables. Respondents who were confused, did not trust the government or protested against the payment vehicle (the levy) would all be more likely to support the BAU approach and hence possess a positive coefficient when predicting the likelihood of supporting BAU. The significance of these variables indicates that despite the careful design and proofing of the survey an element of confusion and protest remained. Individuals with higher incomes should be more likely to support the proposal hence a negative income coefficient. Intended visitors would also be expected to support changed management as a reflection of their option values, again a negative coefficient is expected. Education, gender and location dummies were insignificant with the exception of the Canberra dummy.

Location hypothesis tests

The results of hypothesis tests of the impact of distance on respondent values are shown in Table 8. All location variables are insignificant at the 5 percent level but

Canberra is significant at the 10 percent level. The location dummies are also jointly insignificant at the ten-percent level using the likelihood ratio test.[12]

Table 8: Location hypothesis tests

Location	Significance
Adelaide	0.359^
Naracoorte	0.699^
Canberra	0.754E-1^
All	3.196 (not significant at 10%)#

^ = Probability values of t-statistics.
# = Chi-square test statistic of likelihood ratio test.

While Canberra residents were expected to have a lower willingness to pay based on their distance from the USE these affects are likely to have been confounded by differences in taste. One indication of differences in taste is provided by the results to Question 20 in the survey. Canberra residents are more likely to favour conservation than Adelaide residents are. Similarly, Adelaide residents are more likely to favour conservation than Naracoorte residents are. This is confirmed by a chi-squared test of association that indicates that the difference in distributions is significant at the one-percent level (χ^2 probability 1.973E-2). Hence, residents who live further from the USE wetlands may be willing to pay more to achieve conservation confounding the effects of distance. Morrison, Bennett and Blamey (1997b) found a similar effect when valuing the Gwydir Wetlands where Sydney residents were willing to pay more than residents of Moree despite the significant difference in distance from the wetlands.

Estimation of willingness to pay

The results of the CM estimation can be used to estimate two types of values:
1. Implicit prices: the willingness to pay for a unit change in a single attribute; and,
2. Compensating surplus: the change in welfare, measured in dollars, resulting from a change in management reflected by changes across multiple attributes.

Implicit prices (IP) are the marginal rates of substitution between the non-marketed attributes and the monetary attribute. The marginal rates of substitution are derived as the differentiation of the attribute of interest with respect to utility. That is, they are estimated as the ratio of the coefficient of the non-monetary attribute and the coefficient of the monetary attribute:

$$IP = ß_{attribute} / ß_{money}$$

Confidence intervals can also be calculated for the IP estimates following the procedure developed by Krinsky and Robb (1986).[13] Implicit price and confidence intervals for the USE attributes are presented in Table 9. For example, respondents who indicated they were pro-conservation were willing to pay $1.38 for an additional 1000 hectares of healthy wetlands ($2.56 more than other respondented). Similarly,

[12] Details of the test can be found in standard econometric texts including Ben-Akiva and Lerman (1993), p.168.
[13] To estimate confidence intervals a random draw (of 200 in this case) parameter vectors is made from a multivariate normal distribution with a mean and variance equal to the ß vector and a variance-covariance matrix from the estimated nested logit model. IP can then be estimated using these parameter vectors and confidence intervals can be calculated.

duck hunters were willing to pay $2.85 an additional 1000 ducks ($7.08 more than non-hunters). Non duck hunting respondents were willing to pay $4.22 to have 1000 fewer ducks hunted for an average of minus $3.10 per additional 1000 ducks hunted. The willingness to pay of duck hunters and the average willingness to pay were not significantly different from zero at the 95 percent level.

Table 9: Estimates of Implicit Prices

Attribute	Mean IP	95% Confidence Interval	
		Upper	Lower
Wetland area (non-green respondents per 1000 ha)	-$1.22	-$0.53	-$1.92
Wetland area (green respondents per 1000 ha)	$1.51	$2.35	$0.66
Wetland area (average per 1000 ha)	-$0.61*	$0.05	-$1.24
Remnant area (per 1000 ha)	$0.92	$1.54	$0.25
Species (per specie)	$4.81	$5.70	$3.94
Ducks hunted (non hunters per 1000)	-$4.35	-$2.62	-$6.07
Ducks hunted (hunters per 1000)	$3.01*	$7.35	-$1.34
Ducks hunted (average per 1000)	-$1.79*	$0.06	-$3.49

Note: Prices are in dollars at year 2000 levels estimated at the sample mean.
* Implicit price is not significantly different from zero at the 95 percent level of confidence.

The marginal rates of substitution can also be used to estimate the trade-offs between differing attributes. For example, respondents are willing to trade-off:

1 additional threatened species benefits = 5,219 ha of extra remnant vegetation
= 2,684 fewer ducks hunted (at the mean coefficient)

Compensating surplus is the appropriate estimate of the willingness to pay for a change from the current situation.[14] The willingness to pay for a change from the current situation incorporates other reasons why respondents might (or might not) choose to make the change that are incorporated in the ASCs, socioeconomic and attitudinal variables. Compensating surplus estimates are calculated using:

$$CS = -1 / ß_{cost} * (V_C - V_N)$$

Where: V_C represents the utility of the BAU option
V_N represents the utility of the new option

To demonstrate the methodology the CS is calculated for one alternative wetland management scenario from Table 1, 'Wetlands and Remnants'. The BAU situation and the situation under 'Wetlands and Remnants' are shown in Table 10.

Table 10: USE 'BAU' and 'Wetlands and Remnants' strategy outcomes

Attribute	BAU	Wetlands and remnants*
Area of healthy wetlands (ha)	44,000	72,425
Area of healthy remnants (ha)	50,000	101,275
Threatened species that benefit	0	22
Number of ducks hunted	6,000	12,000

* Table 1 data is change in attribute due to management change, hence the wetlands and remnants totals are calculated by adding the changes to the base levels at BAU.

[14] The measure of compensating surplus calculated is the Hicksian surplus. If the marginal utility of income is assumed constant across the ranges estimated then the Hicksian surplus and the Marshallian surplus are equivalent. The Marshallian surplus is commonly known as the consumer surplus.

BAU utility (V_C) is estimated by substituting the coefficients and attribute levels (except cost) for the current situation. The utility of the current situation also includes the other determinating factors (ASC, socioeconomic and attitudinal variables):

$$V_C = ASC + (\Sigma\ ß_{attributes} * attributes) + (\Sigma\ ß_{socioeconomic\ \&\ attitudinal} * \text{Socio-economic and attitudinal})$$

Where: Attribute values are at BAU levels
Socioeconomic and attitudinal values are at mean levels

The new utility is calculated by multiplying the IV parameter by the new attribute levels:

$$V_N = IV\ parameter * (ASC\_1 / 2 + \Sigma\ ß_{attributes} * attributes)$$

Where: Attribute values are at the new levels

The mean willingness to pay of respondents to move from the BAU scenario to the 'Wetlands and Remnants' outcome is $131.43. The 95 percent confidence interval boundaries for the CS (using the same methodology as for the IP) are $112.63 to $157.38. Note that this is the mean willingness to pay of the sample. Since the means of the sample socioeconomic characteristics differ from the means of the population, the mean willingness to pay of the sample will also differ from that of the population mean. To calculate a mean CS for a population the same formula is used but population means are incorporated rather than the sample means. For example, the mean willingness to pay for the South Australian population is $109.29 (assuming identical visit intentions).[15] As indicated, some degree of confusion and protest remains amongst respondents. By setting attitudinal variables that incorporate these elements to zero, a protest-free estimate of compensating surplus can also be calculated. The protest-free CS is $180.50, a difference of $49.00 indicating that protests have a significant impact on estimates.

Population willingness to pay data can be aggregated to determine the willingness to pay of the wider community to achieve management changes. For example, aggregating the willingness to pay across the South Australian population generates an aggregate willingness to pay of $18.8 million dollars (assuming non-responses have zero willingness to pay and not adjusted for protest responses). That is, the population of South Australia as a whole is willing to pay $18.8 million to move from the BAU option to the Wetlands and Remnants option. Aggregate willingness to pay can be compared to aggregate costs in a cost benefit framework to assess whether the community as a whole is likely to benefit from the proposed change to management.

6. Environmental values for the Murrumbidgee River Floodplain

Response rate

Two thousand eight hundred surveys were mailed out, 378 were returned to sender and 732 surveys were returned for a response rate of 30.2 percent. The response rate is relatively consistent across all samples except the Griffith sample (22.0 percent). The relatively low Griffith response rate is partly due to a survey assembly error that

[15] To estimate a mean willingness to pay for the SA population mean values from the 1996 Census for gender, age, income (adjusted to 2000 using the CPI), survey means for duck hunting were used and the Canberra proportion set to zero.

was not discovered until responses were being processed.[16] The response rate compares favourably with other mail out CM surveys in Australia and the USE response rate.

Sample characteristics and representativeness

The basic respondent characteristics are shown in Table 11. Seventy-seven percent of respondents had visited the USE region. As would be expected the proportion of respondents who had visited the region was highest in Wagga Wagga and Griffith (93 percent) and lower in Canberra (67 percent) and Adelaide (47 percent). Likewise Adelaide residents are much less likely to visit the region in the future (33 percent say they won't versus less than ten percent for the remainder of the sample). The mean age of respondents was 51 years (median 50) and 60.9 percent of respondents were male. The median age of respondents was uniformly eight to eleven years older than the population median age. The income level of respondents was also generally higher than the wider population. The education qualifications of respondents were skewed towards higher levels with 35.9% having tertiary or higher qualifications.

Table 11: Summary of respondent demographics

		Yes	**No**	**Maybe**
Have you visited the USE region?		77.4%	22.6%	n.a.
Will you visit the USE in the future?		63.3%	10.5%	26.3%
		Male	**Female**	
Survey answered by		60.9%	39.1%	
Respondent age		**Education**		
under 25	2.3%	Completed primary only		4.2%
24-34	11.0%	Completed Year 10/Junior/Intermediate		15.5%
35-44	24.7%	Completed Year 12/Senior/Leaving		15.6%
45-54	23.3%	Diploma or certificate (trade qualification)		21.9%
55-64	17.3%	Tertiary degree		37.9%
65-74	12.9%	Other qualifications		4.8%
75 or over	8.4%			

Table 12: Representativeness of MRF sample

	ACT	**ACT sample**	**Wagga Wagga**	**Wagga sample**	**Griffith**	**Griffith sample**
Age	39	48	39	49	41	52
Sex (%Male)	48.7%	61.8%	48.5%	55.8%	50.3%	66.2%
Income	$48,699	$52,000-$77,999	$32,850	$36,400-$51,999	$33,163	$36,400-$51,999
Tertiary education	23.9%	52.3%	8.9%	28.4%	6.1%	26.0%
	Adelaide	**Adelaide sample**	**Australia**	**Sample**		
Age	43	52	42	50		
Sex (%Male)	47.8%	60.2%	48.9%	60.9%		
Income	$30,971	$36,400-$51,999	$34,322	$36,400-$51,999		
Tertiary education	10.4%	42.5%	11.0%	37.9%		

Notes: Age and percentage male is reported for individuals over 17 years of age.
Income is median annual income.

[16] Some pages of the questionnaire were stapled into the booklets upside down. The error was only present in MRF version 5 that were sent to Griffith and led to a response rate of 10.4 percent for Version 5 in Griffith.

Results

The same data preparation was undertaken with the MRF survey data as for the USE. Definitions of the variables used in the modelling process are provided in Table 13. Once the data were prepared, an initial series of models was run using an equivalent generic model to the USE. Alternative model structures were also tested on the MRF data because:

1. There were no interaction terms (such as *wgreen* and *dhhunt* in the USE model) providing a much simpler model structure.
2. The range over which the attribute levels was estimated was larger for the MRF than the USE. Theory indicates declining utility from additional units of goods. That is, additional units of attributes should yield progressively smaller additions to total utility. Because a linear function yields identical additional amounts across the range estimated it is less likely to be appropriate for estimates across a large change in attribute levels.

The generic model structure selected (due to giving the best fit) was:

Status quo: $V_1 = ß_1$ Cost + $ß_2$ * 1 / Wetlands + $ß_3$ * 1 / Birds + $ß_4$ * 1 / Fish + $ß_5$ * Farmers leaving

Alternative 2: V_2 = ASC + $ß_1$ Cost + $ß_2$ * 1 / Wetlands + $ß_3$ * 1 / Birds + $ß_4$ * 1 / Fish + $ß_5$ * Farmers leaving + $ß_i$ (socio-economic and attitudinal variables)

Alternative 3: V_3 = ASC + $ß_1$ Cost + $ß_2$ * 1 / Wetlands + $ß_3$ * 1 / Birds + $ß_4$ * 1 / Fish + $ß_5$ * Farmers leaving + $ß_i$ (socio-economic and attitudinal variables)

Table 13: Definition of all variables included in the modelling process

Variable	Definition
Cost	Size of levy
Wetlands	Area of healthy wetlands (hectares)
Birds	Number of native birds as a percentage of pre-1800 numbers
Fish	Number of native fish as a percentage of pre-1800 numbers
Farmers leaving	Number of farmers who leave as a result of management changes
ASC	Alternative specific constant for options 2 and 3
Age	Age of respondent
Sex	Gender of respondent (1 for female, 0 for male)
Adelaide	Dummy variable equals 1 for Adelaide else zero
Canberra	Dummy variable equals 1 for Canberra else zero
Griffith	Dummy variable equals 1 for Griffith else zero
Visit	Dummy variable equals 1 for respondents who visited the region else zero
Intended visit	Dummy variable equals 1 for respondents who intend to visit the region else zero
Income	Log of respondent income
Tert	Dummy variable equals 1 for tertiary education else zero
Trade	Dummy variable equals 1 for diploma/trade qualification else zero
Hschool	Dummy variable equals 1 for high school qualifications else zero
Other	Dummy variable equals 1 for other educational qualifications else zero
NDT	Dummy variable equals 1 for respondent who don't trust government to make levy one-off or protested against the payment vehicle on other grounds else zero
Confusion	Dummy variable equals 1 for respondent reporting they were confused about survey design or information else zero
Levy	Dummy variable equals 1 if respondents indicated levy is not a good idea else zero

The generic model structure uses a 1/*x* form for the *wetland area*, *birds* and *fish* attributes. The 1/*x* form allows for diminishing marginal value to increases in

attribute levels. That is, as the increase in the attribute grows larger the willingness to pay for additional increases grows smaller. Note that the farmers leaving and cost attributes remain linear due to the zero starting coefficients. The results from the initial modelling process indicated that the 'assumption of independence of irrelevant alternatives' was violated.[17] A nested logit model was then developed using the same methodology and choice path as for the USE survey data (reported in Section 5).

The results for the nested logit model are reported in Table 14. The coefficients for all of the attributes in the choice sets are significant at the one-percent level. All coefficients have the expected sign. The overall model result is also significant at the one-percent level as shown by the chi-squared statistic. The explanatory power of the model is very high with an adjusted rho-squared of 33.6 percent. The nested structure of the model is also highly significant with the inclusive value parameter significant at the one-percent level.

The negative cost coefficient indicates that respondents are less likely to choose options as cost increases. Likewise, respondents are less likely to choose options with more farmers leaving. The negative coefficients for wetland area, birds and fish are a reflection of the functional form and indicate respondents are more likely to pay for options with more healthy wetlands, birds and fish, but at a decreasing rate.

Table 14: Results of nested multinomial logit model

Variables	Coefficient	Standard error
Utility functions		
ASC_1	0.120#	0.532E-1
Cost	-0.122E-1*	0.570E-3
1 / Wetlands	-7831.35*	829.351
1 / Birds	-0.508*	0.110
1 / Fish	-0.328*	0.495E-1
Farmers leaving	-0.700E-1*	0.892E-2
Branch choice equations		
ASC	5.809*	0.992
Income	-0.345*	0.716E-1
Intended visit	-0.444*	0.109E-1
Age	0.101E-1*	0.349E-2
Tertiary education	-0.216+	0.112
NDT	1.553*	0.106
Levy	2.111*	0.110
Griffith	0.539*	0.124
Adelaide	-0.228	0.141
Inclusive value parameters		
Support	0.465*	0.686E-1
No support (fixed parameter)	1.000	0.000
Model statistics		
N (choice sets)	3148	
Log L	-2400.297	
Adjusted rho-square (%)	33.58	
Chi-square (constants only)	2445.566*	

Note: ASC_1 is coded one for 'Alternative 2' and zero otherwise.
* indicates significance at the one percent level, # at the five percent level and + at the ten percent level.

[17] Testing of the best performing multinomial logit model using the test procedure developed by Hausman and McFadden (1984) showed IIA violations at the 1 percent level.

The expected signs of the socio-economic and attitudinal variables are the same as in the USE model. Other significant coefficients were *levy* and *tertiary education*. Respondents who consider the levy a bad idea will also be more likely to choose the BAU branch. Respondents with tertiary education were also hypothesised to support changed management (a result also shown in other surveys such as Rolfe and Bennett (2000)). The negative tertiary coefficient supports this hypothesis but is only significant at the 10-percent level.

The Griffith location dummy variable is also significant and negative indicating a lower willingness to pay for Griffith residents. Due to the low response rate from MRF Version 5 in Griffith, the model was examined carefully prior to inclusion of this dummy variable. Specifically the model was re-estimated with the Griffith data only and with the Griffith data excluded. The coefficients did not differ significantly in these models so the Griffith data and dummy variable were included. Other education and some location dummies were insignificant and were removed from the final model using the same criteria as for the USE

Location hypothesis tests

Location hypothesis tests were conducted by testing the significance of dummy variables (t-statistics) for individual sub samples and jointly using a log-likelihood ratio test (chi-square). All location variables were separately significant at the 10 percent level except the ACT. However, joint tests revealed that the strength of the Griffith and Adelaide dummy coefficients was driving the significance. Hence, the final model only includes Griffith and Adelaide dummy variables for location.

Expectations about Adelaide and Canberra residents were again confounded by differences in taste. Canberra residents are most likely to favour conservation followed by Adelaide, Wagga Wagga and Griffith. As indicated previously, Adelaide residents may also perceive an impact on the quality of their domestic water. Hence, residents who are further from wetlands may be willing to pay more to achieve conservation confounding the effects of distance.[18]

Estimation of willingness to pay

As for the USE survey data the results can be used to estimate both implicit prices and the compensating surpluses associated with changes in wetland management strategies. Implicit prices are estimated as the rate of change in the attribute divided by the rate of change of the cost coefficient. The rate of change is found by differentiating the utility function with respect to the specified attribute. Hence the implicit price formula (given the $1/x$ inverse functional form) for *wetland area*, *birds* and *fish* is:

$$IP = - (-ß_{attribute} / attribute^2) / ß_{cost}$$

Because the implicit price is related to the level of the attribute, the implicit price will change across the range of areas evaluated. Implicit price estimates for farmers leaving are calculated using the same formula as used in Section 5. Implicit price and confidence intervals for the MRF attributes are presented in Table 15. The estimates

[18] A second factor that potentially affected the results is the reliance of Griffith on the irrigation industry. Respondents may have perceived that increasing wetland health would result in a reduction in water available for irrigation and hence a personal cost to Griffith residents.

for wetland area, birds and fish are evaluated at the midpoints of the attribute levels evaluated in the survey. For example, the results indicate that respondents are willing to pay $11.39 for an extra 1000 hectares of healthy wetlands and $0.55 for a one-percent increase in the number of native birds. As indicated the IPs for *wetland area*, *birds* and *fish* vary in relation to the size of the attribute. For example, at the midpoint (7,500 hectares of healthy wetlands) the *wetland area* IP is $11.39 per 1000 hectares. At the BAU level (2,500 hectares of healthy wetlands) the willingness to pay is $102.53 for an additional 1,000 hectares. While at the maximum level in the survey (12,500 hectares of healthy wetlands) the IP is $4.10 for an additional 1,000 hectares.

Table 15: Estimates of MRF Implicit Prices

		95% Confidence Interval	
Attribute	**Mean IP**	**Upper**	**Lower**
Wetland area (per 1000 ha)	$11.39	$13.71	$9.05
Number of native birds (per 1%)	$0.55	$0.79	$0.35
Number of native fish (per 1%)	$0.34	$0.45	$0.24
Farmers leaving (per farmer)	-$5.73	-$4.21	-$7.35

Note: Prices are in dollars at year 2000 levels and evaluated at the midpoint of the levels surveyed.

The marginal rates of substitution can also be used to estimate the trade-offs between differing attributes. At the survey midpoints, respondents are willing to trade-off:

> 1 more farmer leaving = 503 ha of extra healthy wetlands = 10.4% extra native bird numbers = 17.0% extra native fish numbers

Compensating surpluses are calculated using the methodology explained in Section 5. To demonstrate the methodology, the CS is calculated for one alternative from Whitten and Bennett (2000) and displayed in Table 2, the 'water management' strategy. The attributes under the BAU situation and the situation under water management scenario are shown in Table 16. The mean willingness to pay of respondents to move from the BAU scenario to the wetlands and remnants outcome is $121.40. The 95 percent confidence interval for the CS is $136.53 to $108.75. Note that this is the mean willingness to pay of the respondents.

Table 16: MRF BAU situation and situation after change to wetlands and remnants strategy

Attribute	**BAU**	**Water management**
Area of healthy wetlands (ha)	2,300	5,000
Number of native birds (% pre 1800 pop.)	40%	60%
Number of native fish (% pre 1800 pop.)	20%	30%
Number of farmers leaving	0	0

* Table 2 data is change in attribute due to management change, hence the wetlands and remnants totals are calculated by adding the changes to the base levels at BAU.

Population and protest free means can again be calculated for the MRF. The mean willingness to pay for the Murrumbidgee population (statistical district) is $118.40 (assuming identical visit intentions).[19] The protest-free CS is much higher at $199.90, a difference of $78.50, indicating that protests do have a significant impact on estimates. Aggregating the willingness to pay across the Murrumbidgee population generates an aggregate willingness to pay of $5.98 million dollars (assuming non-

[19] To estimate a mean willingness to pay for the Murrumbidgee statistical area population, mean values from the 1996 Census for gender, age, income (adjusted to 2000 using the CPI) were used and the Adelaide proportion set to zero.

responses have zero willingness to pay and setting the Adelaide proportion to zero). That is, the population of the Murrumbidgee statistical district as a whole is willing to pay $5.98 million to move from the BAU option to the water management option.

7 Conclusions

Non-monetary values of potential wetland management changes in the USE and MRF are reported in this paper. These values were estimated using a CM survey of individuals living in Canberra, Adelaide, Wagga Wagga and Griffith for the MRF and Canberra, Adelaide and Naracoorte for the USE. The use of CM surveys facilitates estimation of dollar values for a range of non-monetary values held by the community. These non-monetary values can then be incorporated in a benefit cost framework to assess the values generated by a range of alternative wetland management strategies.

In both the USE and MRF, respondents held significant values for non-monetary wetland outputs. In the USE, significant positive values were held for remnant vegetation and endangered species. Some respondents also held significant and positive values for additional areas of healthy wetlands. Other respondents held significant negative values for additional duck hunting. In the MRF, respondents held significant positive values for additional areas of healthy wetlands and larger bird and fish populations. Respondents were also willing to pay to reduce the number of farmers that could leave due to wetland management changes. In both the USE and MRF, the size of the values was affected by income, age, intention to visit the wetlands and to a lesser extent location. The willingness of respondents to pay for management changes was also impacted by their degree of trust in the payment vehicle and its management by government.

The estimates that are reported in this paper comprise the major estimate of non-monetary values to the wider community from changes to wetland management. These values will be incorporated with other estimates of non-monetary and estimates of monetary benefits and costs in a cost benefit framework. The non-monetary values estimated will be used in this context to provide advice to policy makers about the aggregate costs and benefits of pursuing alternative wetland policies. The outcomes of the cost-benefit analysis will be reported in the next two research reports of the 'Private and Social Values of Wetlands' research project.[20]

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[20] Future Private and Social Values of Wetlands will be placed on the web-site on completion. The website is: apsem.anu.edu.au/staff/jbennettr.htm

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