Stated preference surveys of remnant native vegetation conservation

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Abstract

Improving the conservation status of remnant native vegetation on private property (RNV) has a number of economic benefits. RNV can contribute to on-farm productivity through provision of unimproved grazing, timber products and stock shelter. It may contribute to enhancing the productivity of downstream properties though amelioration of land degradation associated with salinity, water quality decline and soil erosion. The Australian community might also place value on certain attributes of RNV such as its scenic amenity and contribution to biodiversity conservation. Where these community values can be expressed in terms of trade-offs between RNV conservation and other things of value such as personal disposable income, they can be assessed using economic methods. It is these community values which are the subject of this paper.

Economic values held by the community for RNV conservation are nonmarket in nature. Since they are not revealed directly in the market place, and cannot be indirectly recovered though surrogate market techniques, they can only be assessed using stated preference methods. The most widely research stated preference method is contingent valuation (CV). Concerns about the validity of CV data have limited their use in environmental policy development, especially in Australia. The relatively new technique of choice modelling (CM) may offer a means of addressing such concerns. In addition, CM can enable more detailed exploration of participants' preferences across different quantities and qualities of the good being valued. We used both CV and CM to assess the nonmarket economic values of RNV in two study areas - northeast Victoria and the southern Riverina of NSW. Results from the two methods were not significantly different, providing evidence of convergent validity. However, the CM models have the advantage that they can be adjusted to take into account different policy options, and the associated welfare estimates also have narrower confidence intervals than those derived from CV models. Using the best CM model, aggregate compensating surpluses for improved conservation management of RNV in the southern Riverina of NSW and northeast Victoria were estimated to be $81 million and $59 million respectively.

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1. Introduction

Remnant native vegetation on private property (RNV) has a number of value components that are potentially relevant for an economic analysis of future management options. RNV can contribute to on-farm productivity through provision of unimproved grazing, timber products and stock shelter. It can impose an opportunity cost if the forested land could otherwise be cleared and used as improved pasture, pine plantation, or some other enterprise. RNV may also contribute to enhancing the productivity of downstream properties though amelioration of land degradation associated with salinity, water quality decline and soil erosion.

The Australian community might also place value on certain attributes of RNV such as its scenic amenity and contribution to biodiversity conservation. Where such values are expressed in terms of trade-offs between RNV conservation and other things of value such as personal disposable income, they can be assessed using economic methods.

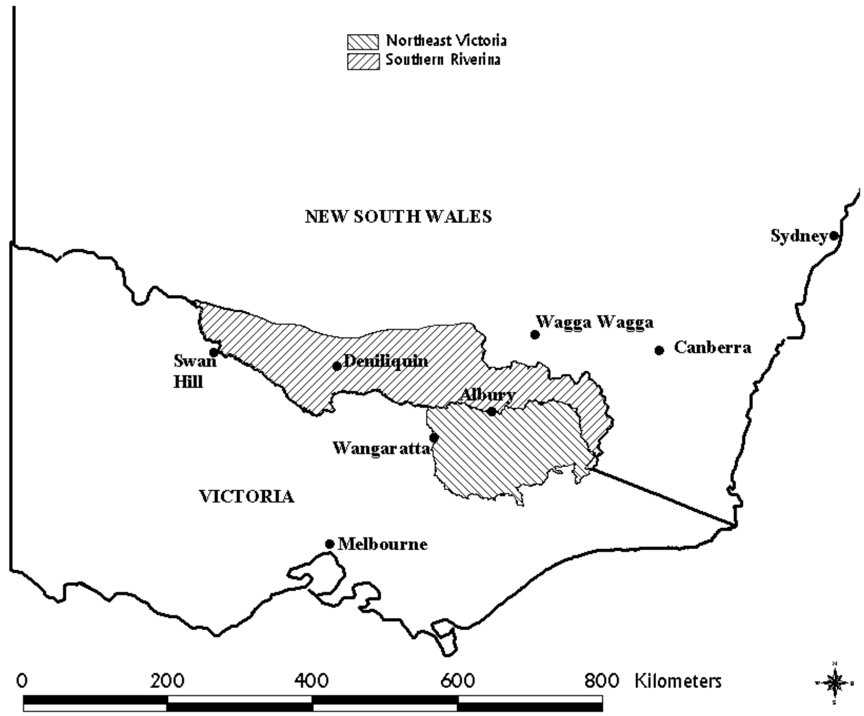
Economic values held by the community for RNV conservation are nonmarket in nature - that is, they are not expressed though any formal or organised market system. Since they are not revealed directly in the market place, and cannot be indirectly recovered though surrogate market techniques, they can only be assessed using stated preference methods. The most widely research stated preference method is contingent valuation (CV). Details of the theory, application and limitations of CV are given in Mitchell & Carson (1989). Concerns about the validity of CV data have limited their use in environmental policy development, especially in Australia (Bennett & Carter 1993, Lockwood 1998). The degree to which hypothetical values obtained in CV adequately reflect real economic constraints, such as the availability and potential expenditure on substitutes for the good being valued, is uncertain. The relatively new technique of choice modelling (CM) may offer a means of addressing such concerns (Morrison *et al*. 1996). In addition, CM can enable more detailed exploration of participants' preferences across different quantities and qualities of the good being valued.

We used both CV and CM to assess the nonmarket economic values of RNV in two study areas - northeast Victoria and the southern Riverina of NSW (Figure 1).

CV, in essence, asks people how much they are willing to pay (WTP) for some change in the provision of an amenity, usually a nonmarket good. The WTP valuations are determined in the context of a hypothetical market which is constructed in the survey. This hypothetical market typically comprises a description of the amenity, the change in its provision, and the means (payment vehicle) by which the participant can purchase a particular allocation of the amenity. Participants are asked for their WTP contingent upon the existence of the hypothetical market as described in the survey instrument.

A variety of methods have been used to elicit valuations from participants. These include bidding games, open ended questioning, and dichotomous choices. The CV survey can also be conducted as a face-to-face interview, a mail survey, or a telephone interview. The choice of survey technique has implications for the length and complexity of the survey, and is influenced by the good being valued, sample size, and budget.

Figure 1. Study areas



There has been considerable controversy in the literature concerning the ability of CV to produce valid estimates of economic welfare changes. While it is beyond the scope of this report to review this controversy, it is worth emphasising that for a CV survey to produce valid data participants must:

1. have the opportunity, if the good is unfamiliar to them, to construct their preferences in the course of answering the survey;

2. have the cognitive ability to express their preferences for environmental goods as a willingness to pay;

3. clearly apprehend the good they are to value in a manner that is congruent with the intentions of the surveyor;

4. consider their budget constraint;

5. consider the availability and their potential expenditure on substitutes for the good being valued;

6. find plausible the justification given in the CV scenario for why payment is required;

7. accept the legitimacy of the payment vehicle used in the survey - that is, have no ‘in principle’ objections to making a payment using this vehicle;

8. believe that if they do not pay for the good, it will not be provided; and

9. trust that any payment they might make would actually be used in the manner specified (Lockwood 1998).

Many of the attributes required to satisfy these validity conditions have been detailed elsewhere (Mitchell & Carson 1989, Arrow *et al*. 1993), and are now standard practice in most CV work. However, concerns remain, particularly with respect to points 2, 4 and 5 above. These lingering concerns have encouraged the exploration of alternative stated preference methods. One of these is CM.

In CM, participants are presented with several sets of choices each involving two or more options. The participant is asked to select their preferred option in each choice set. Each option is typically defined in terms of salient attributes, including a dollar WTP, and the levels of each attribute are varied across the choice set. CM has the advantage that it explicitly matches the tendency of participants to make decisions in 'attributes-space' (Blamey *et al*. 1997), compared with CV which tends to focus the choice problem on one attribute - price.

Specification of attribute levels is largely dictated by the research objectives (Louviere & Timmermans 1990). A given set of attributes and attribute levels can generate a large number of potential choice options. A CM design usually requires that a fraction of these potential options is selected for inclusion in the survey instrument. The selected options then need to be incorporated into choice sets (Louviere 1988).

Choice models produce estimates of the values of changes in individual attributes within an option as well as the value of aggregate changes in environmental quality. The analysis of the results of the CM provides a reflection of the trade-offs that each individual makes between the attributes of the options. CM has largely been used in analyses of transport choices (Hensher 1995, Thill 1992), consumer goods (Louviere & Woodworth 1983), tourism (Morley 1994) and shopping centre choice (Barnard & Hensher 1992). Applications to environmental valuation are a relatively new - examples include Adamowicz *et al*. (1994), Boxall *et al*. (1996), Rolfe & Bennett (1996), and Morrison *et al*. (1998).

2. Theoretical basis for choice based stated preference surveys

The surveys used in this work are choice based in that they offer two or more options, and ask that participants select their preferred option. In the CV surveys, a single decision is made. This decision is analysed as a dichotomous choice (DC). In the CM surveys reported in this paper, eight decisions are made by each participant. These decisions are analysed as a series of multinomial choices - in this study, choices between three alternatives.

Essentially, a DC CV elicitation format involves requesting survey participants to answer 'yes' or 'no' regarding their WTP a specified amount of money (the bid amount) contingent upon a hypothetical scenario. The bid amount is varied across participants to provide a probability distribution of 'yes' responses to a range of bid amounts. Pre-tests are conducted to determine an appropriate range for the bid vector, given the desirability of obtaining at least some positive responses to most bid amounts, and of having few positive responses to one or two bid amounts at the upper extreme of the bid range.

The DC method has several advantages over alternative methods such as iterative bidding methods which attempt to directly determine maximum WTP. DC requires less cognitive effort and determination on the part of the participant, more closely mimics political referenda (and is therefore perhaps a more familiar and acceptable question format in relation to public goods), and for a given scenario minimises the possibility of starting point and strategic biases (Bowker & Stoll 1988, Boyle & Bishop 1988, Cameron 1988). However, instead of eliciting a specific value such as maximum WTP, the DC method requires indirect estimation of a participants' valuations.

The theoretical basis for the DC CV model (and CM multinomial analysis) is random utility theory (McFadden 1974). It is assumed that utility U is an unobserved random variable that comprises an observable and systematic component V, sometimes referred to as indirect utility, and a random component ε such that:

(1) $$U = V + \varepsilon.$$

The random component can be thought of as involving factors such as measurement error, omitted variables, and each individual's uncertainty regarding their own utility. An individual's utility function in the case of a choice involving WTP for an environmental improvement can be represented as:

(2) $$U(q,Y,\mathbf{a},\mathbf{z}) = V(q,Y,\mathbf{a},\mathbf{z}) + \varepsilon,$$

where q = 0 at the current state of environmental quality and q = 1 after some specified improvement in environmental quality, Y is income, **a** is a vector of taste, preference or attitudinal variables, and **z** is a vector of the participant's characteristics. Following Hanemann (1984), the participant will agree to pay a given bid amount *B* if:

(3) $$V(1,Y-B,\mathbf{a},\mathbf{z}) + \varepsilon_1 \geq V(0,Y,\mathbf{a},\mathbf{z}) + \varepsilon_0$$

where ε_0 and ε_1 are independently and identically distributed with zero means. V is typically specified by a linear model:

(4) $$V = \alpha + \beta B + \boldsymbol{\gamma}\mathbf{a} + \boldsymbol{\delta}\mathbf{z} + \varepsilon$$

where α is a constant, β is the coefficient in the bid variable, and **γ** and **δ** are vectors of coefficients on the taste and characteristic variables. Since we can only observe whether the participant agrees to pay the amount *B* or not, V can be constructed as an index v such that v = 1 if equation (3) holds, and v = 0 otherwise. The probability that v = 1, P_1, is:

(5) $$P_1 = \Pr\{V(1,Y-B,\mathbf{a},\mathbf{z}) - V(0,Y,\mathbf{a},\mathbf{z}) \geq \varepsilon_0 - \varepsilon_1\}.$$

The choice probability is thus given by the cumulative distribution function of $\varepsilon_n = (\varepsilon_0 - \varepsilon_1)$. Normally distributed errors lead to the probit model and logistically distributed errors lead to the logit model (Ben-Akiva & Lerman 1985). In this work the logit specification is used where:

(6) $$P_1 = \frac{1}{1+e^{-\mu\varepsilon_n}}$$

where μ is a scale parameter which is generally assumed to equal 1. The choice probability is then given by:

(7) $$P_1 = \frac{1}{1+e^{-\mu\Delta V}}$$

where $\Delta V = V(1,Y-B,\mathbf{a},\mathbf{z}) - V(0,Y,\mathbf{a},\mathbf{z})$. This can be written as:

(8) $$\ln[P_1/(1 - P_1)] = \Delta V.$$

The dependent variable is thus the log of the odds that a particular choice will be made. The parameters of this equation are usually determined by maximum likelihood estimation (Green 1993). The significance of the parameters can be assessed using a test which involves comparison of the unrestricted log likelihood *Lu* (that is, the log likelihood of the null model with only the dependent variable and the constant) and the restricted log likelihood *Lr* of the model being assessed . The test yields a χ^2 statistic which is calculated from:

(9) $$\chi^2 = -2[Lr - Lu].$$

A goodness of fit indicator ρ^2 is calculated from:

(10) $\rho^2 = 1 - [Lr/Lu]$ (Ben-Akiva & Lerman 1985).

A good fit is indicated by $\bar{\rho}^2 > 0.2$, and a $\bar{\rho}^2$ approaching 0.4 is considered an extremely good fit (Hensher & Johnson 1981). When comparing models, a superior goodness of fit indicator is $\bar{\rho}^2$, which takes into account the number of degrees of freedom:

(11) $$\bar{\rho}^2 = 1 - \{[(Lr/(N(C-1-K))]/[Lu/(N(C-1))]\}$$

where N is the number of choices, C is the number of choice options (assuming all participants face the same number of choices), and K is the number of variables in the model (Hensher & Johnson 1981).

A utility theoretic basis for obtaining economic welfare measures from dichotomous choice data was established by Hanemann (1984, 1989). For this report, the relevant welfare measure is compensating surplus (CS) - the benefits of an environmental improvement measured at the level of utility that exists before the improvement is implemented. The CS is the mean of the non-negative WTP distribution, and is given by:

(12) $$CS = -1/\beta \ln[1 + e^{\alpha}].$$

The median WTP, which is the WTP at which 50% of people would say ‘yes’, is given by:

(13) $$WTP_{med} = -\alpha/\beta.$$

When a multivariate formulation is used, α is expanded to include the additional independent variables by summing the products of each variable's mean and coefficient to the constant. Cameron (1988) developed an alternative specification of the choice problem which directly estimates a WTP function. In this case, the welfare measure is the dollar value at which the average household is indifferent between the 'yes' and 'no' options (Whitehead 1990). This leads to the same result as (13). Thus the Cameron 'mean' is the same as the Hanemann median. Hanemann (1984, 1989) discussed some of the issues regarding the relative merits of the two measures.

In the case of choices between multiple alternatives, the probability that a particular option *i* is chosen from a set of competing alternatives C is given by:

(14) $P(i|C) = P[(V_i + \varepsilon_i) > (V_j + \varepsilon_j)], \forall j \; \varepsilon \; C, j \neq i.$

Taking the ε_i and ε_j as independently and identically distributed according to the extreme value (Gumbel) distribution, leads to the multinominal logit model:

(15) $P(i\,|\,C) = \dfrac{e^{\mu V_i}}{\sum_{j \varepsilon C} e^{\mu V_j}}$ (Maddala 1983).

As with the binomial logit model, goodness of fit can be assessed using $\bar{\rho}^2$. The distributional assumptions with respect to the error terms lead to the independence from irrelevant alternatives property (IIA) of the multinomial logit model. The IIA assumption requires that the ratio of choice probabilities for any two alternatives is not affected by the V of any other alternative - in other words, addition or removal of other alternatives from the choice set makes no difference. Hausman & McFadden (1984) developed a test for violation of the IIA property. The test compares the model with all choices included to an alternative specification with a reduced choice set. Blamey *et al*. (1998) list some of the options available for dealing with any IIA violations detected using the Hausman-McFadden test.

In the multinominal case, CS is given by:

(16) $CS = -\dfrac{1}{\beta}\left[\ln \sum_{i \in C} e^{V_i'} - \ln \sum_{i \in C} e^{V_i''}\right]$ (Adamowicz *et al*. 1994),

where V_i' are the indirect utility functions before the change, and V_i'' are the functions after the change. This computes a welfare change which takes into account the availability of multiple goods. When only one good is being valued, equation (16) simplifies to:

(17) $CS = -\dfrac{1}{\beta}\left[V' - V''\right]$ (Boxall *et al*. 1996).

The change is then restricted to moving from V' with attribute levels at their base values, to V'' with attribute levels set at their post-change levels. Setting these post-change levels to match the CV scenario enables comparison between the CM and CV welfare estimates. Where there is a positive WTP, equations (16) and (17) will yield a negative result, since CS is specified as the reduction in income needed to offset the environmental improvement such that utility remains at the initial level V′.

Cameron (1991) developed a procedure for estimating confidence intervals for the equation (13) welfare estimate from CV surveys. Her approach takes advantage of the fact that the WTP function is a linear in parameters formulation, in which equation (4) is re-parameterised to give:

$$(18) \qquad \text{WTP} = \alpha` + \gamma`\mathbf{a} + \delta`\mathbf{z},$$

where ` denotes that each of the parameters in equation (4) have been divided by β. This formulation is now analogous to the conventional least squares regression model, which allows confidence intervals to be derived from the parameter variance-covariance matrix Σ, and the vector of mean values for the dependent variables in the WTP function $\mathbf{V}_0$:

$$(19) \qquad \text{CI}_{0.95} = \text{WTP}_{\text{med}} \pm t_{0.025}\sqrt{\mathbf{V}_0 \Sigma \mathbf{V}'_0}\,.$$

Confidence intervals for the CS from equation (12) can be calculated, after Park *et al*. (1991), using the simulation method developed by Krinsky & Robb (1986). This approach uses a large number of random draws from a multivariate normal distribution of the estimated parameters to build up a distribution for the CS estimate. The same approach can be used to estimate confidence intervals for the CS from equations (16) or (17).

3. Development of survey instruments

This section describes the development of the four survey instruments used in this research:

- a CV instrument addressing RNV conservation in the southern Riverina, NSW;
- a CV instrument addressing RNV conservation in northeast Victoria;
- a CM instrument addressing RNV conservation in the southern Riverina, NSW; and
- a CM instrument addressing RNV conservation in northeast Victoria.

As discussed in Section 3.4, the two CM instruments each had two sub-versions.

3.1. Focus groups and pretests

Four focus groups were initially conducted with a total of 28 participants. Each focus group built on the information from the previous focus group, and successive drafts of the survey instruments were developed using information and feedback from each session. Obtaining representative subsamples is generally not possible in focus group work. However, it is important that some attempt be made to cover a range of ages, incomes, and social backgrounds. To ensure that the focus groups covered a number of different people, three group sessions were conducted in Sydney and one in the regional town of Orange. Since there was no reason to suggest that the basic perceptions of Victorians would be significantly different from those of NSW residents, the information obtained from the NSW focus groups was assumed to be applicable to the Victorian component of the study.

The focus groups had a central person who arranged for a number of associates to participate in the groups. As Morrison *et al.* (1997) noted, this is not an ideal method, but is a pragmatic approach given the difficulty and expense of recruiting participants. Each participant was then sent a formal letter inviting them to attend the activity and giving an outline of the topic, location and time**.** Participants were paid $20 as reimbursement for expenses associated with attending the focus group. The sessions were recorded on audio tape and notes taken.

Issues explored in the focus groups included:

- perceived importance of various conservation issues;
- relative value of different vegetation types;
- attributes contributing to the conservation quality of native vegetation;
- relative importance of native vegetation on public and private land;
- effect of presence or absence of rare species in forests;
- perceptions of agricultural management;
- willingness to pay for RNV conservation; and
- preferred mechanisms for collecting and managing any funds generated through participants' WTP.

The focus groups also addressed issues such as question order (particularly in relation to order of issues in questions 1 to 4), language (less use of jargon and technical terms) and visual aids (removal of a graph and photos from the drafts). The amount that participants would be prepared to donate as a one-off payment to improve management of remnant native vegetation on private property provided a range of potential bid values for the CV and CM choices. A review of the results of several rural NSW focus groups, conducted by Hodgkins *et al.* (1996) for another project, was also undertaken. These focus groups were similar in their structure and questions, though they did not address the economic values issue. Draft surveys were also circulated to the project advisory committee and several economists familiar with the CV and CM methods. These outcomes were also incorporated with the above results to assist survey design.

Draft survey instruments developed using insights gained from the focus groups were then pretested. The pretest was undertaken to as far as possible replicate the final survey construction, delivery and sample population. Fifteen CV and 15 CM surveys were mailed out to 30 acquaintances not associated with this field of research. The surveys were accompanied by a reply paid envelope and a letter outlining the project and asking the receiver to complete the enclosed survey, and to make additional comment on the instrument. It was suggested that such feedback could relate, but not be restricted to, areas such as language, clarity, difficulty, question order and length of time to complete. The 30 participants were equally distributed throughout the Sydney area and regional NSW.

The CV pretest survey instrument was easier than the CM instrument for participants to understand and generated fewer comments. The average time to complete the survey was approximately 12 minutes for the CV survey and 20 minutes for the CM survey. The CM survey instrument used in the pre-test included 16 choice sets. Many participants commented that this was an excessive number of questions. To reduce the burden on participants, the final CM instrument used two blocks of 8 choice sets. Other modifications made as a result of the pretest included:

- clarification of the purpose of the study;
- provision of additional information on the geographic location of the study area;
- removal of a graph used to detail the condition of the various types of vegetation in the study area, which was considered by participants to be of little use;
- improvements to the structure and appearance of the surveys; and
- inclusion of a Native Vegetation Trust to manage the money.

Following the focus groups and the pretesting, a hybrid of these two techniques was conducted to get further comment on revised draft survey instruments. This 'intensive pretesting' involved 12 people from the Sydney region, who were each mailed copies of both survey instruments for them to complete. These participants then came together in two separate groups to discuss the surveys. Questions asked of the participants related to:

- realism of the scenarios outlined;
- additional information required to answer the survey;
- use of visual aids;
- realism of the payment vehicle; and
- use of quantitative versus qualitative attribute levels in the CM instrument.

As a result of this meeting, the payment vehicle was further refined, commodities were described quantitatively, visual aids were omitted as they were seen to cause bias, and further modifications were made to the layout and design of the instruments. On advice from participants, the final CM instruments also placed more emphasis on the importance of reading the insert prior to answering the questions. While there were still comments on the difficult nature of the CM questions, the participants were generally happier than previous groups, primarily because fewer choices had to be made.

3.2. Common elements in the CV and CM instruments

In order to facilitate comparison between the two methods, it was important to ensure that as far as possible participants were presented with identical information and questions, apart from the willingness to pay or choice questions.

Each version had the same cover, included a map of the study area, and explained the purpose of the survey. There were five sets of questions common to both survey instruments**.** Question 1 assessed participants' views on the relative importance of various RNV values. Question 2 asked whether participants had ever been to the study area, and if so if they recalled the general appearance of the landscape. Both these questions potentially provide information to assist the interpretation and validation of participants' responses to the economic valuation questions. Questions 3 and 4 were framing questions aimed at helping participants make their valuation in an appropriate context. Question 3 prompted participants to consider their views on the importance of environmental issues other than native vegetation conservation. Question 4 prompted participants to consider the importance of RNV in the study area relative to native forest elsewhere in Australia and around the world. The valuation decisions were also framed by an explicit reminder to participants that:

- there are many other calls on their household budget;
- there may be other environmental issues they care about; and

- there are other areas of native vegetation in NSW [Victoria].

The final questions in the survey instruments gathered socioeconomic data from the participants.

3.3. CV scenario

The CV scenarios were as follows:

> *Farmers face many economic pressures in producing food, wool, etc. Sometimes they decide to clear areas of native vegetation to increase their incomes from grazing, crops or pine plantations. They may also use native vegetation for bush grazing and extraction of timber products. These activities reduce or eliminate some of the nature conservation values associated with native vegetation.*
>
> *If the current situation continues, native vegetation will be cleared and degraded in the Southern Riverina [northeast Victoria]. To ensure that this does not occur, farmers need to be helped to protect these areas. Money is needed to cover the costs of fencing areas to keep stock out, managing the native vegetation, and compensating the farmers for lost income.*
>
> *The government does not have enough money to cover these costs. This means extra money is required. To ensure sufficient money is available, NSW [Victorian] households would have to make a one-off payment.*
>
> *The money would be collected by the Australian Taxation Office as part of your 1998 tax return, and the total sum given to a special Native Vegetation Trust Fund. This trust will be responsible for transferring the money to the farmers and ensuring that is spent appropriately.*
>
> *We would like to know how much you are willing to pay to go from the current situation to a future situation where conservation of the native vegetation is improved. The table on the following page describes the current situation and the possible future situation.*

Participants were then asked to read some additional information concerning the current situation, and the proposed future situation. As far as possible, this information was presented in a similar fashion to the material provided in the CM instrument. The attributes used to describe these situations were the area of native vegetation remaining in five years time; the one-off payment required to secure the change; future use by the farmers; and the average number of native plants and animals present in the RNV. Levels of the attributes for the two versions reflected differences in the NSW and Victorian study areas.

A DC valuation question was then asked:

> *Would you be willing to make a one-off payment of $x to conserve native vegetation on private property in the Southern Riverina [northeast Victoria]?*

Based on the responses in the focus groups and pretests, the dollar values used in the CV survey were $5, $10, $20, $30, $50, $100, $150, and $300.

We followed Arrow *et al*. (1993)'s recommendation that respondents be offered a 'no answer' option as well as the usual 'yes' and 'no' options. Offering a 'no answer' option is one way of diminishing the incidence of 'yea saying', since participants are not forced to make a definitive choice. The issue then arises as to how to deal with the 'no answer' responses. Two obvious possibilities are either to simply drop these participants from the sample, or to equate a 'no answer' with a 'no'. The former option effectively assumes that the preferences of those responding with 'no answer' are no different from the rest of the sample. This seems unlikely. The latter option assumes that doubts about their willingness to pay would probably translate into the amount not being paid. We believe this is a reasonable assumption. The desirability of taking this conservative option is reinforced by the tendency of CV results to overestimate actual WTP. A third option taken by Wang (1997) is to model 'no answer' choices as occupying a region of uncertainty around each individual's maximum WTP. According to this view, an offered bid amount close to the expected value of WTP will give rise to choice uncertainty and hence selection of the 'no answer' option. While this is plausible, we still, following Carson *et al*. (1994), prefer to take the conservative option and assume that 'no answer' responses are best regarded as 'no's.

If the answer to the WTP question was 'no' or 'no answer', a separate question was then asked to determine the reason for these responses. Options given to participants were:

- I would be willing to pay something, but not as much as the amount given in question 5;
- my household does not benefit from conservation of native vegetation on private property in Southern Riverina;
- I believe farmers have the right to do what they like on their properties
- my household cannot afford to pay;
- native vegetation in Southern Riverina should be conserved, but the costs should be paid for in some other way;
- there is not enough information for me to make a decision; and
- other - please give reason.

The first four options are legitimate economic reasons why a participant may have a zero willingness to pay. These zero responses were included in the calculation of welfare estimates. Participants selecting the fifth or sixth options may have a WTP if the question was presented in some other fashion, or if more information was available. Since we cannot be sure that the WTP of these participants was in fact zero, they were left out of the welfare calculation. The answers of each participant who offered another reason under the last option were individually assessed to determine whether or not they should be considered a zero WTP response.

3.4. CM questions

Based on responses from the focus groups and pretests, RNV area, payment amount, future management by farmers and biodiversity were the attributes selected to define the choice problem. Selection of attribute levels was constrained by the biophysical attributes of the two study areas and management possibilities for RNV, and informed by feedback from focus group and pretest participants. The attributes and levels used in the CM surveys are shown in Table 1. Each choice set comprised three options. The base levels for each alternative (for the NSW survey these were 80,000 ha, $0, extensive use, and 60 species) were used to describe the current situation. This option was included in all choice sets. The remaining levels for each attribute were constructed into two alternative choice options, each of which involved an environmental improvement and a WTP component.

Table 1. Attributes and levels used in the CM surveys

Attribute	Level (NSW)	Level (Victoria)
Area of native vegetation remaining in five years time	80,000 ha 110,000 ha 140,000 ha	75,000 ha 95,000 ha 115,000 ha
Your one-off payment	$0 $10 $50 $150	$0 $10 $50 $150
Future use by the farmers[1]	No use Some use Extensive use	No use Some use Extensive use
Average number of native plants and animals	60 species 85 species 110 species	60 species 85 species 110 species

For each version, Addelman's (1962) orthogonal main effects Basic Plan 3 was used to select a set of 16 choice options. A fold over design was then used to generate a further 16 options. Each option was then paired with the corresponding foldover option to give 16 choice sets, each comprising two options. These 16 sets were randomly split into two blocks of 8 choice sets. To each set was added the constant base option. The final design thus involved two survey sub-versions, each of which contained a block of 8 choices, with each choice offering three options.

A foldover design tends to maximise the number of tradeoffs between options, and minimise the number of implausible choices. Implausible choices can arise when a participant is asked to choose, for example, between an option with a low payment with high environmental improvement, and high payment with low or zero environmental improvement. The high efficiency in terms of maximising tradeoffs comes at the cost of a high cognitive burden on participants - there are no easy choices.

[1] Computation of CM models showed that some use $\succ$ current use $\succ$ no use, so the *use* variable was coded such that some use = 1, current use = 0, and no use = -1.

The CM scenario was as follows:

> *Questions 5 to 12 all concern the native vegetation on private property in the region shown on the map on the inside front cover.*
>
> *Farmers face many economic pressures in producing food, wool, etc. Sometimes they decide to clear areas of native vegetation to increase their incomes from grazing, crops or pine plantations. They may also use native vegetation for bush grazing and extraction of timber products. These activities reduce or eliminate some of the nature conservation values associated with native vegetation.*
>
> *In each question we want you to choose between three options concerning the future of the native vegetation on private property (see the example on the next page). Each option is slightly different in terms of the area of the vegetation, your payment amount, use by the farmer, and numbers of plants and animals. These features are described in more detail on the colour page inserted in this booklet.*
>
> *Option 3 is the situation in five years time if changes are not made now. Options 1 and 2 are two other possible situations in five years time, where some action has been taken to conserve the native vegetation on private property in the Southern Riverina. Of course there may be other options, but we want you to only consider the ones presented in options 1 and 2.*
>
> *Questions 5 to 12 are specially designed to help us measure which features influence your choices about native vegetation. We need you to answer every question without worrying about the options given in the other questions.*
>
> *Some of the options may seem a little odd - for example an option that involves less area and more native species. However, such a possibility could occur if the smaller area is all high quality habitat, and some of the larger area is of lower quality.*
>
> *Some of the options include you making a* ***one-off payment*** *to cover the costs of fencing the areas, managing the native vegetation, and compensating the farmers for lost income. See the blue page inserted into this survey for more details.*

An example choice set and answer was then provided to visually show participants the required method for answering each question.

An insert was provided with each CM survey instrument that gave participants background details and explanations of the attributes.   This information was included as a separate sheet to enable participants to easily refer to it when completing the choice sets.   The attributes used in the choice sets were the same as those used to describe the current and future situations in the CV survey.

3.5. Participant sample and survey implementation

Participants were recruited from a random samples of 2000 Victorian and 2000 NSW voters obtained from the state electoral rolls. Each of the four survey instruments were mailed to 1000 potential participants. The mail out procedure followed Dillman's (1978) Total Design Method. The first mailout was conducted on Thursday 28th August 1997, followed by a reminder postcard on Friday 12th September 1997. A second mail package was sent to those who had not replied by Wednesday 1st October 1997.

4. Results

4.1. Return rates

Return rates from the mailouts are shown in Table 2. The minimum return rate was for the NSW CM survey (46.8% completed, 54.4% total), and the maximum return rate was for the Victorian CV survey (56.4% completed, 63.1% total). Incomplete returns included participants who either:

- mailed back a survey with a note or letter, or rang up indicating that they did not want to fill out the survey because they had no interest in the issue;

- mailed back a survey with a note or letter, or rang up indicating that they did not want to pay anything:

  - *I donate to other causes, I cannot donate to this one;*
  - *I am an 80 year old pensioner. I can't afford to pay anything;*
  - *We are both on low incomes - although we support protection and conservation of nature we could not afford to support it financially;*

- mailed back a survey with a note or letter, or rang up indicating that they did not know anything about, or were too far away from, the study area:

  - *I don't have any connection to the area - native vegetation does mean a lot to me, but I would prefer to support a more local area;*
  - *Haven't been to the Riverina for 20 plus years and can't imagine my answers will be of any use;*
  - *I am an 85 year old pensioner and have no knowledge of the Riverina and hence have nothing to say about this topic;* or

- mailed back a blank survey.

Table 2. Return rates

Survey version	NSW		Victoria	
	CV	CM	CV	CM
1st mail out	1000	1000	1000	1000
Undeliverable	86	92	101	86
1st completed returns	323	298	346	351
2nd mail out	599	616	571	558
2nd completed returns	155	127	161	133
Total completed returns	478	425	507	484
Incomplete returns	66	69	60	65
Total returns	544	494	567	549
Completed return rate (%)	52.3	46.8	56.4	53.0
Total return rate (%)	59.5	54.4	63.1	60.1

4.2. Results for questions common to all survey versions

Demographics

A comparison between the demographic characteristics of the samples and that of the relevant population is given in Table 3. These data indicate that the samples are a good demographic representation of the NSW and Victorian populations. The most notable differences are for the Victorian CV sample, which has a higher proportion of females and a lower mean income than for the Victorian population.

Table 3. Sample and population demographics

Variable	NSW Mean[1]	NSW CV Mean	NSW CM Mean	Victoria Mean[1]	Victoria CV mean	Victoria CM mean
Sex (% female)	0.51	0.49	0.52	0.51	0.54	0.49
Age (years)	45.1	46.1	45.8	44.3	46.5	44.9
Education (years)	13.3	13.0	12.9	13.6	12.8	13.0
Annual household income ($)	41,847	39,274	42,085	40,400	38,635	40,140

[1]Based on CLIB96 (1997)

Visitation

Considerably more Victorians had visited northeast Victoria and remembered what it looked like, compared with NSW participants' visitation and remembrance of the Southern Riverina (Table 4). This difference probably reflects the relative proximity of the study areas to the major population centres of the two states - Melbourne is much closer to northeast Victoria than Sydney is to the southern Riverina.

Table 4. Visitation to the study areas

	NSW CV	NSW CM	Victoria CV	Victoria CM
Visited the study area (%)	53	56	81	83
If visited, remember what the landscape looked like (%)	68	67	83	83

Participants were asked a series of attitudinal and framing questions in both survey instruments in order to gain some insight into their responses to the economic questions, and to provide a context in which the valuation questions could be answered. Responses to these questions are given in Table 5. There were no notable differences in the responses to these questions between the four survey instruments. The most important reasons for valuing native vegetation on private property were to prevent land degradation, to protect native vegetation, and to conserve for future generations. Comments provided in relation to the 'other reason' option included scientific research, ecosystem protection, clean water and air quality.

Table 5. Results for questions 1, 3 and 4

Question	NSW CV mean[1]	NSW CM mean[1]	Victoria CV mean[1]	Victoria CM mean[1]
Q1. Do you value native vegetation on private property?				
Q1a Protecting native animals	3.6	3.6	3.6	3.6
Q1b Scenic attraction	2.9	3.0	3.0	3.0
Q1c Conserving for future generations	3.7	3.6	3.6	3.6
Q1d Grazing area for stock	2.7	2.8	2.7	2.7
Q1e Preventing land degradation	3.7	3.7	3.7	3.7
Q1f Source of timber	2.5	2.4	2.4	2.5
Q1g Conserving rare plants	3.5	3.5	3.4	3.5
Q1h Other	4.0	3.8	3.7	3.7
Q3. Are other environmental issues important to you?				
Q3a Controlling pollution	3.8	3.8	3.8	3.7
Q3b Minimising rural land degradation	3.6	3.6	3.6	3.6
Q3c Conserving native plants and animals	3.6	3.7	3.6	3.6
Q3d Water conservation	3.8	3.8	3.7	3.8
Q3e Reducing the greenhouse effect	3.6	3.6	3.6	3.6
Q4. How important to you is conservation of native vegetation in various parts of the world?				
Q4a Private property forests in your local area	3.3	3.4	3.2	3.3
Q4b Tropical rainforests in South America	3.4	3.6	3.5	3.5
Q4c Private property forests in the Southern Riverina [northeast Victoria]	3.2	3.4	3.3	3.4
Q4d Native forests of Europe	3.3	3.4	3.3	3.4
Q4e NSW [Victorian] forests on public land	3.6	3.7	3.6	3.7

[1]On a scale of 1 = not important, 2 = slightly important, 3 = important, 4 = very important

Question 3 addressed the importance of other environmental issues to the participant and provided situations from the global level through to local considerations. Participants generally rated all of the situations described as very important. The next framing question asked participants to rate the importance of conservation of native vegetation in various parts of the world. Participants generally rated the areas described as important, but forests on public land in the participant's state were clearly seen as the most important.

4.3. CV results

Question 6 in the CV survey asked participants who answered 'no' to question 5 (the WTP question) to outline the reason(s) for their reply. As noted in Section 3.3, this question was used to identify participants who may have been incorrectly identified as having a zero WTP. For the NSW survey, 50 such participants were identified out of the 475 who answered the WTP question. The corresponding figure for the Victorian survey was 75 out of 500 participants. Responses of the remaining participants were analysed using logistic regression to estimate the magnitudes of the parameters in equation (8). Taste and demographic variables were assessed for their significance (as indicated by t-statistics) and those found to have a significance of 0.05 or better were included in the models. Sample sizes for the analyses were reduced where participants did not answer the questions related to these taste and/or demographic variables. With the exception of the income variable, this caused only a minor reduction in sample size.

As noted in Section 3.3, the CV surveys gave participants three options: to indicate a WTP, to decide not to pay, or to remain undecided. Undecided participants can be dealt with in two ways. First, they can simply be left out of the analysis (model 1). Second, a conservative decision can be made that at this time their indecision suggests they actually have zero WTP, since they did not actively indicate a willingness to make the payment (model 2). The results for these two models are given in Table 6.

Mean WTP for RNV conservation in the southern Riverina was about $87 from model 1 and about $81 from model 2. Model 1 was a better fit, although both models have acceptable values for ρ^2. Coefficients on the variables are all significant at better than $p = 0.05$, and have theoretically defensible signs. Mean WTP for RNV conservation in the northeast Victoria was about $98 from model 1 and about $77 from model 2. Although neither model has a particularly good fit, model 2 was the better. Coefficients on the variables are all significant at better than $p = 0.05$, and have the expected signs.

Confidence intervals on the mean WTP estimates are very wide. This is due to the manner in which the errors on the parameters accumulate when entered into equation (12). By comparison, the different algebraic form of equation (13) gives rise to much tighter confidence intervals on the median WTP.

Table 6. CV results

Model	Variable	Coefficient	t value	Significance
NSW model 1	Bid	-0.0132	-5.80	0.0000
(N = 304)	Income	2.59E-05	4.27	0.0000
	Education	0.224	3.22	0.0014
	Sex	-0.865	-2.84	0.0048
	Protecting native animals (Q1a)	0.900	3.11	0.0021
	Preventing land degradation (Q1e)	0.732	2.26	0.0248
	Native forests of Europe (Q4d)	0.632	3.47	0.0006
	Constant	-10.864	-5.93	0.0000
	-2 Log Likelihood	210.0		
	χ^2 (sig @ 7 *df*)	141.0 (0.000)		
	ρ^2	0.34		
	$\bar{\rho}^2$	0.32		
			$CI^{-}_{0.95}$	$CI^{+}_{0.95}$
	Mean WTP	$86.79	$0.84	$478.3
	Median WTP	$28.12	-$22.72	$78.97
NSW model 2	BID	-0.0113	-5.52	0.0000
(N = 340)	Income	2.27E-05	4.27	0.0000
	Education	0.198	3.10	0.0021
	Sex	-0.826	-2.99	0.0029
	Protecting native animals (Q1a)	1.161	4.12	0.0000
	Scenic attraction (Q1b)	-0.354	-2.19	0.0289
	Preventing land degradation (Q1e)	0.897	3.06	0.0024
	Constant	-9.284	-5.73	0.0000
	-2 Log Likelihood	230.7		
	χ^2 (sig @ 7 *df*)	128.3 (0.000)		
	ρ^2	0.28		
	$\bar{\rho}^2$	0.26		
			$CI^{-}_{0.95}$	$CI^{+}_{0.95}$
	Mean WTP	$80.69	$1.17	$476.07
	Median WTP	$25.20	-$2.32	$52.72
Vic. model 1	BID	-0.00798	-4.23	0.0000
(N = 304)	Income	3.04E-05	5.96	0.0000
	Forests on public land (Q4e)	0.837	3.233	0.0014
	Constant	-4.061	-4.074	0.0001
	-2 Log Likelihood	206.6		
	χ^2 (sig @ 4 *df*)	71.5 (0.000)		
	ρ^2	0.17		
	$\bar{\rho}^2$	0.16		
			$CI^{-}_{0.95}$	$CI^{+}_{0.95}$
	Mean WTP	$98.40	$9.56	$340.72
	Median WTP	$22.16	-$14.63	$58.94
Vic. model 2	BID	-0.00918	-4.99	0.0000
(N = 351)	Income	2.90E-05	6.08	0.0000
	Forests on public land (Q4e)	0.744	3.03	0.0027
	Constant	-3.811	-4.05	0.0001
	-2 Log Likelihood	229.7		
	χ^2 (sig @ 4 *df*)	80.5 (0.000)		
	ρ^2	0.18		
	$\bar{\rho}^2$	0.17		
			$CI^{-}_{0.95}$	$CI^{+}_{0.95}$
	Mean WTP	$77.35	$8.49	$326.91
	Median WTP	$3.71	-$30.67	$38.09

4.4. CM results

Basic CM models were computed using the multinomial logit model (equation 15). Two CM models were developed for each study area - a basic model that included only the attribute variables from the choice problem (*dollar*, *area*, *use*, *species*), and an extended model in which the significant demographic and attitudinal variables were interacted with the alternative specific constants. The indirect utility functions for the four models were specified as follows. The codes for the attitudinal questions are as per Table 5. The alternative specific constant α was constrained to be equal across V_1 and V_2.

NSW model 1

$V_1 = \alpha + \beta dollar + \gamma area + \chi use + \delta species$
$V_2 = \alpha + \beta dollar + \gamma area + \chi use + \delta species$
$V_3 = \beta dollar + \gamma area + \chi use + \delta species$

NSW model 2

$V_1 = \alpha + \alpha Q1a + \alpha Q1b + \alpha Q1e + \alpha sex + \alpha education + \alpha income + \beta dollar + \gamma area + \chi use + \delta species$
$V_2 = \alpha + \alpha Q1a + \alpha Q1b + \alpha Q1e + \alpha sex + \alpha education + \alpha income + \beta dollar + \gamma area + \chi use + \delta species$
$V_3 = \beta dollar + \gamma area + \chi use + \delta species$

Victoria model 1

$V_1 = \alpha + \beta dollar + \gamma area + \chi use + \delta species$
$V_2 = \alpha + \beta dollar + \gamma area + \chi use + \delta species$
$V_3 = \beta dollar + \gamma area + \chi use + \delta species$

Victoria model 2

$V_1 = \alpha + \alpha Q4e + \alpha income + \beta dollar + \gamma area + \chi use + \delta species$
$V_2 = \alpha + \alpha Q4e + \alpha income + \beta dollar + \gamma area + \chi use + \delta species$
$V_3 = \beta dollar + \gamma area + \chi use + \delta species$

Results for these models are given in Table 7. The values for 'N' indicate the number of choices used in the analysis. Coefficients for the attributes are generally significant and have the expected signs. The exceptions are *area* in NSW model 1 and α in Victoria model 1, neither of which are significant at $p < 0.05$. Positive WTP values are associated with increasing area of RNV; sound use and management of the remnants; and an increase in the number of native species present in the RNV. Model fits are adequate, but generally inferior to the CV models. Hausman-McFadden tests indicate IIA violations in both model 1s, and to a lesser extent in NSW model 2. Marginal rates of substitution (MRS) indicate the ratio of the marginal utility of each attribute with the marginal utility of income - that is, the dollar value of a unit change in the attribute.

Table 7. Results for CM models

Model	Variable	Coefficient	t value	Significance	Std Error	MRS
NSW model 1	Area	2.54E-06	1.64	0.1007	1.549E-06	0.00025
(N = 2718)	Dollar	-0.0104	-16.60	0.0000	6.241E-04	1.00
	Use	0.344	10.25	0.0000	0.0237	-33.16
	Species	0.0141	7.55	0.0000	1.8724E-03	-1.36
	α	0.660	5.67	0.0000	0.0116	
	χ^2 (sig @ 4 *df*)	841 (0.0000)				
	ρ^2	0.14				
	$\bar{\rho}^2$	0.14				
	IIA test (p)	0.21				
NSW model 2	Area	3.84E-06	2.50	0.0125	1.539E-06	-0.00038
(N = 2085)	Dollar	-0.0102	-14.53	0.0000	7.30E-04	1
	Use	0.318	11.73	0.0000	0.0271	-31.15
	Species	0.0172	9.30	0.0000	0.00186	-1.69
	α	1.29E-05	6.73	0.0000	1.912E-06	
	χ^2 (sig @ 4 *df*)	687 (0.000)				
	ρ^2	0.15				
	$\bar{\rho}^2$	0.15				
	IIA test (p)	0.09				
Vic. model 1	Area	7.32E-06	3.34	0.0009	2.194E-06	-0.00086
(N = 3099)	Dollar	-0.00845	-13.99	0.0000	6.044E-04	1.00
	Use	0.247	10.25	0.0000	0.0241	-29.19
	Species	0.0209	11.20	0.0000	0.001865	-2.47
	α	0.0994	0.86	0.3924	0.1162	
	χ^2 (sig @ 4 *df*)	786 (0.0000)				
	ρ^2	0.12				
	$\bar{\rho}^2$	0.11				
	IIA test (p)	0.13				
Vic. model 2	Area	4.83E-06	2.82	0.0049	2.212E-06	-0.00053
(N = 2258)	Dollar	-0.00910	-14.73	0.0000	6.798E-04	1.00
	Use	0.235	8.72	0.0000	0.0263	-25.83
	Species	0.0157	10.61	0.0000	0.00179	-1.72
	α	1.66E-05	2.23	0.0261	2.084E-06	
	χ^2 (sig @ 4 *df*)	739 (0.0000)				
	ρ^2	0.15				
	$\bar{\rho}^2$	0.15				
	IIA test (p)	0.01				

To enable comparison with the CV results, welfare estimates were calculated from equation (17), based on the better performed model 2. For the NSW study area, the current situation was assumed to be that:

- those landholders currently making extensive use of their RNV for grazing, timber products and so on would continue to do so;
- over the next five years 17,479 ha of the 203,429 ha RNV would be cleared (based on the rate of clearing over the past ten years); and
- incremental degradation would cause the average biodiversity to decline to 60 species per ha.

For the Victorian study area, the current situation was assumed to be that:

- those landholders currently making extensive use of their RNV for grazing, timber products and so on would continue to do so;
- over the next five years 3,931 ha of the 113,313 ha RNV would be cleared (based on the rate of clearing over the past ten years); and
- incremental degradation would cause the average biodiversity to decline to 60 species per ha.

The value of policy interventions that result in improvements to this situation can be assessed. The following improvements were evaluated for both study areas:

- landholders use will be restricted, but not prohibited;
- no RNV clearing would be permitted; and
- average biodiversity would either remain constant at 110 species per ha, or decline somewhat to 85 species per ha.

Mean WTP for RNV conservation in the southern Riverina was $79.93 for the moderate biodiversity decline and $122.14 for maintenance of current biodiversity levels. Mean WTP for RNV conservation in the northeast Victoria was $71.01 for the moderate biodiversity decline and $114.11 for maintenance of current biodiversity levels. The confidence intervals are much narrower than for the CV means, and slightly narrower than for the CV medians.

4.5. Aggregation of WTP

Welfare estimates from the different techniques and models are summarised in Table 8. We have adopted the CM model 2 results as the preferred estimates for converting the sample WTPs to aggregate values for the two states. Compared with the CM model 1, these models are better fit and are less affected by IIA violations. The CM was chosen in preference to the CV mean estimates because they have much narrower confidence intervals.

In aggregating the CM model 2 results up to the level of all NSW and Victorian households, we assumed that all participants whom we categorised as refusing to fill out the survey, together with all those households which apparently received the survey but did not respond in any way, had a zero WTP. The proportion of completed CM responses then gives a factor which can be multiplied by mean sample WTP to give a mean WTP for the population. The aggregate WTP for the population is then this population mean multiplied by the number of households in the respective states. Table 9 gives the results of this aggregation procedure. The aggregate benefit of conserving RNV in the southern Riverina is $81 million, and in northeast Victoria $59 million.

Table 8. Summary of welfare estimates

	NSW WTP ($) (95% CI's)	Victorian WTP ($) (95% CI's)
CV model 1 mean	86.79 (0.84 to 478.30)	98.40 (9.56 to 340.72)
CV model 2 mean	80.69 (1.17 to 476.07)	77.35 (8.49 to 326.91)
CV model 1 'median'	28.12 (-22.72 to 78.97)	22.16 (-14.63 to 58.94)
CV model 2 'median'	25.20 (-2.32 to 52.72)	3.71 (-30.67 to 38.09)
CM model 2 mean (moderate biodiversity decline)	79.93 (64.82 to 95.84)	71.01 (56.47 to 86.80)
CM model 2 mean (no biodiversity decline)	122.14 (98.43 to 147.98)	114.11 (89.78 to 141.89)

Table 9. Aggregation of CM model 2 (moderate biodiversity decline) WTP estimates

	NSW	VIC
Sample household WTP	$79.93	$71.01
Completed return rate (%)	0.47	0.53
Population household WTP	$37.41	$37.64
No. households	2,163,510	1,575,765
Population aggregate WTP (rounded to nearest $1 million)	$81 million	$59 million

5. Discussion and conclusion

In general, a comparison of CV and CM results will not give unequivocal evidence of the validity of either technique. There is no reliable measure of the nonmarket economic value of RNV against which the results of the CV and CM can be compared. A check of criterion validity (the ability of the instruments used in this work to predict actual WTP), is not available. In general, the evidence for criterion validity is equivocal, but tends to suggest that stated preference methods may overestimate actual WTP (Lockwood 1998). Results from the two methods that are not significantly different, as is the case here, provides evidence of convergent validity - that is, evidence that the two independent methods lead to the same ends. It is still possible that this 'end' is not the required construct - compensating surplus. The fact that income is positively related to WTP in all models provides some support for the theoretical construct validity of the methods.

The results are different from those of Boxall *et al*. (1996), who found that CM produced much lower WTP estimates than CV. A potentially significant difference between our CM and the Boxall study is that their choice options were alternative sites, whereas our options were different possible states of RNV across the same 'site'. The Boxall results could be explained by CM participants' taking into account the fact that one site can be a substitute for another, whereas the CV participants do not have the same opportunity built into the choice problem. Boxall *et al*. (1996) showed that using equation (17) to compute the CM welfare estimates (that is, effectively reducing the choice problem to only involve two sets of conditions at the one site), gave a similar WTP result to the CV survey.

The CM models do not fit as well as the CV models, but the standard errors on the parameters are smaller, and the mean WTP estimates are generally lower. The median WTP from the CV surveys are the lowest of the measures, and have narrow confidence intervals. However, application of the potential compensation criterion requires that the mean should be used if the data is to be incorporated into a benefit cost analysis. The CM estimates also have the advantage that WTP for a range of changes in key attributes (*area*, *use* and *species*) can be estimated. This enables WTP to be estimated for a number of different policy options.

Their ability to be adjusted to take into account different policy options, has led us to prefer the CM over the CV models. The CM model 2s were chosen above model 1s because of their better fit and less evidence of IIA violations. On this basis, aggregate compensating surpluses for a change in management of RNV in the southern Riverina of NSW and northeast Victoria were estimated to be $81 million and $59 million respectively.

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7. References

Addelman, S. (1962) Orthogonal main-effect plans for asymetrical factorial experiments. *Technometrics* 4: 21-46.

Arrow, K., Solow, R., Portnoy, P.R., Leamer, E.E., Radner, R., Schuman, H. (1993) Report of the NOAA panel on contingent valuation. *Federal Register* 58(10): 4601-4614.

Adamowicz, W., Louviere, J., Williams, M. (1994) Combining revealed and stated preference methods for valuing environmental amenities. *Journal of Environmental Economics and Management* 26(1): 271-292.

Barnard, P.O., Hensher, D.A. (1992) The spatial distribution of retail expenditures. *Journal of Transport Economics and Policy* 26: 299-312.

Ben-Akiva, M., Lerman, S. (1985) *Discrete choice analysis: theory and applications to travel demand*. MIT Press, Cambridge.

Bennett, J., Carter, M. (1993) Prospects for contingent valuation: lessons from the south-east forests. *Australian Journal of Agricultural Economics* 37: 79-93.

Blamey, R.K., Rolfe, J.C., Bennett, J.J., Morrison, M.D. (1997) *Environmental choice modelling: issues and qualitative insights*. Choice Modelling Research Report No. 5, University of New South Wales, Canberra.

Blamey, R.K., Bennett, J.W., Louviere, J.J., Morrison, M.D., Rolfe, R. (1998) The effect of option labels in environmental choice modelling studies. Paper presented to the Australian Agricultural Economics Conference, Armidale.

Boxall, P.C., Adamowicz, W.L., Swait, J., Williams, M., Louviere, J.J. (1996) A comparison of stated preference methods for environmental valuation. *Ecological Economics* 18: 243-253.

Bowker, J.M., Stoll, J.R. (1988) Use of dichotomous choice nonmarket methods to value the whooping crane resource. *American Journal of Agricultural Economics* 70: 372-381.

Boyle, K.J. Bishop, R.C. (1988) Welfare measurements using contingent valuation: a comparison of techniques. *American Journal of Agricultural Economics* 70**:** 20-29.

Cameron, T.A. (1988) A new paradigm for valuing non-market goods using referendum data: maximum likelihood estimation by censored logistic regression. *Journal of Environmental Economics and Management* 15: 355-379.

Cameron, T.A. (1991) Interval estimates of non-market resource values from referendum contingent valuation surveys. *Land Economics* 67: 413-421.

Carson, R.T., Hanemann, W.M., Kopp, R.J., Krosnick, J.C., Mitchell, R.C., Presser, S., Ruud, P.A., Smith, V.K. (1994) *Prospective interim lost use value due to DDT and PCB contamination in the Southern California Bight*. Natural Resource Damage Assessment Inc., La Jolla.

CLIB96 (1997) *Census of population and housing 1996, release 2*. Australian Bureau of Statistics, Canberra.

Dillman, D. (1978) *Mail and telephone surveys: the total design method.* Wiley, New York.

Green, W.H. (1993) *Econometric analysis* (2nd ed). Macmillan, New York.

Hanemann, M. (1984) Welfare evaluations in contingent valuation experiments with discrete responses. *American Journal of Agricultural Economics* 66: 332-341.

Hanemann, M. (1989) Welfare evaluations in contingent valuation experiments with discrete response data: Reply. *American Journal of Agricultural Economics* 71: 1507-1601.

Hausman, J., McFadden, D. (1984) A specification test for the multinomial logit model. *Econometrica* 52: 1219-1240.

Hensher, D.A. (1995) Stated preference analysis of transport choices: the state of practice. *Transportation Research* 29: 363-374.

Hensher, D.A., Johnson, L.W. (1981) *Applied discrete choice modelling*. Wiley, New York.

Hodgkins, D. S., Watson, G., Goldney, D.G., Tyson, G. (1996) The attitudes of landholders to a range of environmental issues, including the values of remnant bushland in the Central Western Region of NSW. Orange Agricultural College, University of Sydney, unpublished.

Krinsky, I., Robb, A.L. (1986) On approximating the statistical properties of elasticities. *Review of Economics and Statistics* 68: 715-719.

Lockwood, M. (1998) Contribution of contingent valuation and other stated preference methods to evaluation of environmental policy. *Australian Economic Papers* 37: 292-310.

Louviere, J.J. (1988) *Analysing decision making: metric conjoint analysis*. Sage, Newbury Park.

Louviere, J.J., Woodworth, G. (1983) Design and analysis of simulated consumer choice or allocation experiments: an approach based on aggregate data. *Journal of Marketing Research* 20: 350-367.

Louviere, J.J., Timmermans, H. (1990) Stated preference and choice models applied to recreation research: a review. *Leisure Sciences* 12: 9-32.

Maddala, G.S. (1983) *Limited-dependent and qualitative variables in econometrics*. Cambridge University Press, Cambridge.

McFadden, D. (1974) Conditional logit analysis of qualitative choice behaviour, **in** Zarembka, P. (ed) *Frontiers in Econometrics.* Academic Press, New York.

Mitchell, R., Carson, T. (1989) *Using surveys to value public goods: the contingent valuation method*. Resources for the Future, Washington.

Morley, C.L. (1994) Experimental destination choice analysis. *Annals of Tourism Research* 21: 780-791.

Morrison, M.D., R.K. Blamey, R.K., Bennett, J.W., Louviere, J.J. (1996) *A comparison of stated preference techniques for estimating environmental values*. Choice Modelling Research Report No. 1, University of New South Wales, Canberra.

Morrison, M.D., Bennett, J.W., Blamey, R.K. (1997) *Designing choice modelling surveys using focus groups: results from the Macquarie Marshes and Gwydir Wetlands case studies*. Choice Modelling Research Report No. 5, University of New South Wales, Canberra.

Morrison, M.D., Bennett, J.W., Blamey, R.K. (1998) *Valuing improved wetland quality using choice modelling*. Choice Modelling Research Report No. 6, University of New South Wales, Canberra.

Park, T., Loomis, J.B., Creel, M. (1991) Confidence intervals for evaluating benefit estimates from dichotomous choice contingent valuation studies. *Land Economics* 67: 64-73.

Rolfe, J., Bennett, J. (1996) Valuing international rainforests using a choice modelling approach. Vanuatu forest conservation report, School of Economics and Management, UNSW.

Thill, J.C. (1992) Choice set formation for destination choice modelling, *Progress in Human Geography* 16: 361-382.

Wang, H. (1997) Treatment of ‘don’t-know’ responses in contingent valuation surveys: a random valuation model. *Journal of Environmental Economics and Management* 32: 219-232.

Whitehead, J.C. (1990) Measuring willingness-to-pay for wetlands preservation using the contingent valuation method. *Wetlands* 10(2): 187-201.