CSIRO Land and Water

The Value of Habitat and Agriculture

RURAL SOLUTIONS SA

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The Department of Water, Land and Biodiversity Conservation


Scrublands


Grassy Woodlands


Wetlands

CSIRO Land and Water Client Report
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Final Report

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Errors and omissions remain the responsibility of the authors.

EXECUTIVE SUMMARY

Land provides valuable services to society in tangible and intangible ways. Different configurations of land affect the many different benefits available to individuals and society. As a result, governments are interested in improving the incentives and signals given to land holders about the most appropriate way to configure land. These signals and incentives will be changing and evolving with changes in scientific understanding and society's aspirations.

Cleared land typically provides a series of financial benefits for the landholder and the community through agricultural production and regional development opportunities. Cleared land, also, provides a stream of intangible benefits. People come to love the landscapes they live in – the place they call home.

Uncleared land, whether in a conservation area or on private land, provides a series of direct and indirect benefits to local people as well as people living in cities further away. The latter of these two types of land, uncleared land, is the focus of this report.

The report summarises the results of a non-market valuation study of Habitat and Agriculture in the Upper South East (Upper SE) of South Australia. A non-market valuation technique known as choice modelling was used to elicit values in the form of willingness to pay from people in the Upper SE, Adelaide and the rest of the State. The regional and state-wide preferences for the habitat improvement provide one more piece of information relating to the difficult issues around the configuration of the cleared and uncleared landscape in the Upper South East of South Australia.

At the most general level, choice modelling is concerned with understanding the behavioural choices of individuals. The technique is used for a wide array of research and policy-related problems which fall in the domain of choice. Choice modelling is based on the idea that the individual derives satisfaction from the properties or attributes of goods and experiences, including environmental quality. The individual, however, often faces trade-offs when considering the package of attributes versus the cost of each package as everything comes at a cost. People are comfortable with this notion as consumers make these decisions everyday with the goods they purchase. A well-presented choice experiment will convey the information in a way that minimises bias and engages the individual in a process of trading off outcomes against cost.

Choice modelling is from the family of stated preference techniques and is not without critics. However, choice modelling remains one of the few ways to estimate passive use values, the values associated with knowing that an area is being preserved even if one never intends to visit it. There are passive use values associated with ecosystem services and the preservation of indigenous species of plants, animals and birds. If these values are to enter the full cost-benefit analysis of natural resource management, then the estimates need to be directly comparable to the other costs and benefits.

The report contains a series of willingness to pay estimates based on extensive econometric analysis. There is support for habitat protection and improvement in South Australia and this support is likely to be genuine as the questionnaires went out with CSIRO, State Government and Commonwealth Government logos on the cover. The respondents knew that their responses could have an impact on policy-makers and therefore was not just an academic exercise. People are familiar with levies as there are a number of levies in place at present in South Australia which fund projects relating to the River Murray and Emergency Services. While it was made clear that this was a research project, people understood that the information would contribute to the debate about how landscapes might be configured.

The econometric analysis produced a series of estimated coefficients and implicit prices. Direct tests to select among the more sophisticated techniques are not available. From an analytical point of view, the estimation techniques which impose less structure on the error term, hold more appeal. Thus the results from the Multinomial Probit model and the Covariance–Heterogeneity model are probably the best estimates of willingness to pay that can be compiled at this time. South Australian's willingness to pay, using population distribution weights, are as follows:

Scrublands

- Cov-Het $808 per hectare
- MNP $717 per hectare

Grassy Woodlands

- Cov-Het $1,164 per hectare
- MNP $1,019 per hectare

Wetlands

- Cov-Het $1,909 per hectare
- MNP $1,543 per hectare

While we present the aggregated values for the State, it is important to note that there are very strong regional differences in willingness to pay. People in the Upper SE, the people living closest to these habitat areas, have very different preferences for habitat improvement. People in the Upper SE had a zero willingness to pay for grassy woodlands. They had a low willingness to pay for wetlands relative to the preferences of Adelaide and the rest of the State. However, they have a higher willingness to pay for scrublands than is observed in Adelaide and the rest of the State.

Putting the tangible benefits of agricultural production and some of the more intangible values into the same context, dollars, allows for a closer examination of the conflicting issues and values. It has been suggested that there are so many pressures to clear and develop land that it is difficult to imagine how policies will be put in place that seek to preserve habitat and slow the rate of biodiversity loss without demonstrating the economic value of what is to be preserved. The challenge for governments interested in both these intangible benefits to society and regional economic growth is in establishing appropriate means of trading off benefits accruing across society.

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1 INTRODUCTION

1.1 The Problem of Values Not Being Captured By Markets

Land provides valuable services to society in tangible and intangible ways. Different configurations of land affect the many different benefits available to individuals and society. As a result, governments are interested in improving the incentives and signals given to land holders about the most appropriate way to configure land.

- Cleared land typically provides a series of financial benefits for the landholder and the community through agricultural production and regional development opportunities. Cleared land, also, provides a stream of intangible benefits. People come to love the landscapes they live in – the place they call home.
- Uncleared land, whether in a conservation area or on private land, provides a series of direct and indirect benefits to local people as well as people living in cities further away.

The latter of these two types of land, the uncleared land, is the focus of this report. Areas of scrubland, grassy woodlands and wetlands on private land provide significant benefits to the landholder including the sense of being a good steward. People in the area may derive some recreational benefits relating to hunting, bird-watching, bush-walking etc. Wetlands may provide a number of ecosystem functions relating to the water cycle and water balance of a region. As well, uncleared land provides habitat of varying quality for plants, animals and birds. Uncleared land provides direct services to land holders in the form of livestock shelter, reduced erosion, pollination, etc. The knowledge that these same plants, animals and birds exist and are being looked after brings satisfaction to land holders and to people living in communities.

Some might argue that habitat and the biodiversity that it supports is of infinite value and resources should not be expended in valuation. Unfortunately, the use of land and space in the State for economic purposes comes into conflict with how habitat might be preserved. Land-clearing, draining wetlands, degradation of remnant vegetation and increasing fragmentation poses a threat to the remaining native vegetation. Communities of flora and fauna depend on the existence of suitable linked corridors and areas of good quality habitat.

Putting the tangible benefits of agricultural production and some of the more intangible values into the same context, dollars, allows for a closer examination of the conflicting issues and values. Pearce (2001) has suggested that there are so many pressures to clear and develop land that it is difficult to imagine how policies will be put in place that seek to preserve habitat and slow the rate of biodiversity loss without demonstrating the economic value of what is to be preserved.

The challenge for governments interested in both the intangible benefits to society and regional economic growth is in establishing appropriate means of trading off benefits accruing across society. The South Australian government has been using Benefit-Cost Analysis (BCA) to help in assessing the overall impact upon South Australia. However, this approach has been constrained by the ability to include monetary values for the expected changes in the value of environmental amenities such as habitat for many indigenous species of plants, animals and birds.

The Department of Land, Water and Biodiversity Conservation as a result of this interest in improving the quality and quantity of environmental valuations for the inclusion into BCA commissioned PIRSA Rural Solutions and the Policy and Economic Research Unit of CSIRO Land and Water to undertake this valuation study. The focus of this study is to extend techniques currently used in environmental economics to consider the problem of valuing habitat. There have been a number of non-market studies supported or commissioned in South Australia (Bennett, Blamey and Morrison, 1997; Whitten and Bennett, 2000 and 2002). These studies have tended to focus on wetlands. This study considers scrubland, grassy woodland and wetland areas. The Upper South East (Upper SE) of South Australia was chosen, as there was considerable depth of knowledge concerning the spatial land-use and native vegetation tenure, regional planning documents and scientific studies (DEHAA, 1999).

1.2 The Research Problem

Early in the research project, a Steering Committee was established to guide the development of the research problem and the hypotheses that would be tested. Expertise across a number of disciplines was sought including ecology, economics, policy analysis and agriculture. The original title of the brief was to establish values on biodiversity and the first task for the Steering Committee was to define the research problem.

In examining the myriad definitions of biological diversity, with biodiversity being the shorthand contraction, selecting an appropriate definition proved challenging and problematic. Biodiversity is a set of ideas and issues rather than a single precisely defined quantity. The starting point for many literature reviews is the definition that emerged with the Convention on Biological Diversity that defines biodiversity "as the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexities of which they are part" (United Nations Environment Programme, 1992, p. 4).

Pearce (2001) pointed out that there is an extensive literature on the economic value of endangered species and species as biological resources. Further an increasing awareness has emerged across a number of literatures regarding the values associated with biodiversity as a store of genetic material (Lockwood, 1999). Despite the number of non-market studies in existence, there are only a very few which consider the value of biodiversity. The reason pointed out in Christy *et al.* (2003) is that the public, at least in the UK and we suspect elsewhere, have a very poor understanding of the term biodiversity. It is easy to see why as the key features are not easy to grasp. Harper & Hawksworth (1995) have suggested that biological diversity needs to be considered at the genetic, organismal and ecological levels. Armsworth *et al.* (2004) emphasised the notion of species richness and evenness in terms of spatial distribution, the importance of recognising that communities of species interact as well as phylogenetic diversity to account for evolutionary divergence that occurs over time. Christy *et al.* (2002) pointed out the inadequacy of discussing biodiversity as the number of species in an area. However, the difficulty of conveying meaningful information to respondents and still moving away from the simplest definitions proved daunting for a number of research teams.

As a result of these difficulties, the Steering Committee and the researchers worked through the potential uses of non-market valuation and how the values elicited from society would eventually be used. It was decided that willingness to pay for increasing the quantity and quality of different habitats including wetlands, grassy woodlands and scrublands, which support a wide variety of flora and fauna, would be the most useful form of information.

1.3 Selection of Research Techniques

There are a number of different techniques within environmental economics which have been developed to elicit values concerning intangible benefits such as the value of a forest for hiking or the cost of human actions such as pollution in a stream. The economic value of a change in environmental quality relates only to the contribution it makes to society's welfare. These values are by definition anthropocentric.

Environmental economic value is considered to be a bundle of use, option and passive values. Use values are those derived from human use of the environment and examples include the use values associated with mountain-biking, hunting, fishing, etc. Option values are held by people who are willing to pay to ensure access to a resource or an area in the future. Passive values include existence values, which is the value attached to knowing a resource merely exists. Textbox 1 contains a classification and a further explanation of natural resource use values.

There are a number of techniques which could provide monetary estimates of environmental benefit and/or damage. The techniques can be grouped broadly as:

- **Market value approaches** which rely on observable market data for prices to estimate costs or benefits of the environment. Some of the most widely used market value approaches include change in productivity, replacement cost and defensive expenditure;

- **Revealed preference approaches** which rely on the price or cost of surrogate goods or services like land to reveal willingness to pay for environmental quality. Some of the most used techniques include travel cost and hedonic pricing; and
- **Stated preference approaches** which construct information from respondents to propositions that ask them to state their preference for different outcomes. These are usually benchmarked against a plausible monetary outcome as part of a surrogate market approach such as in contingent valuation and choice modelling.

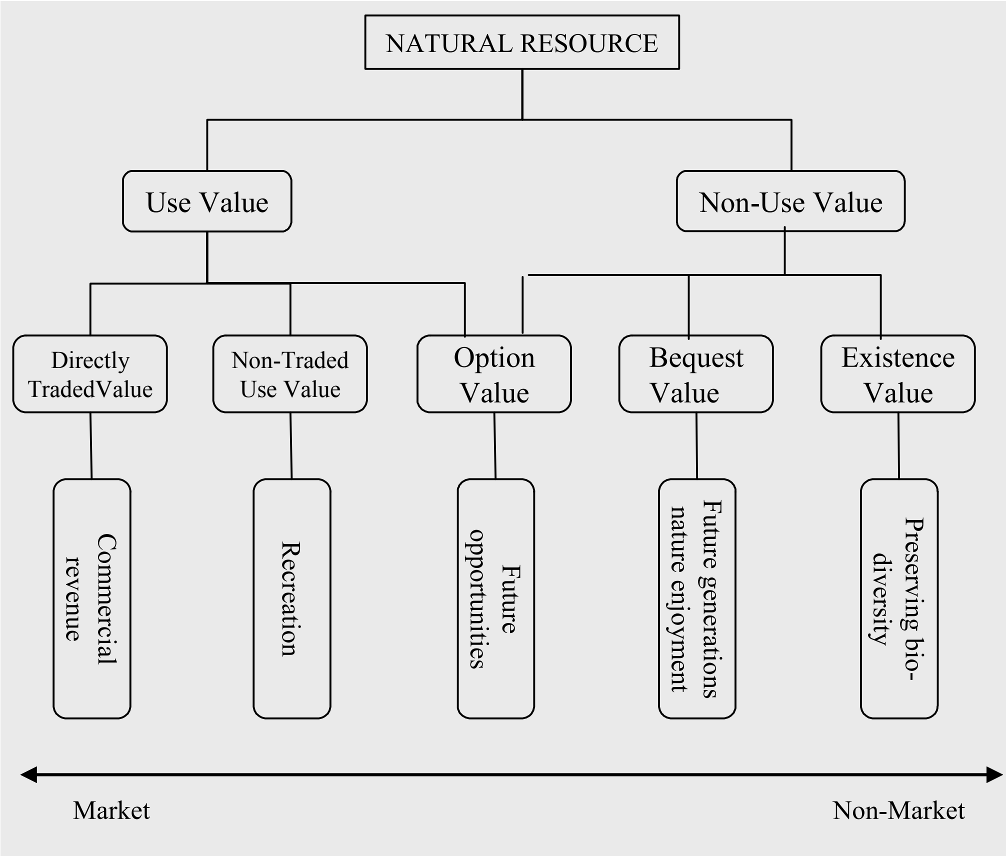
To estimate passive, bequest, option and existence values, it is necessary to use a stated preference technique, as market data are not available. The use of the Contingent Valuation Method (CVM) for this purpose has come under scrutiny and debate. Pearce & Moran (1994) summarise some of these issues as problems of reliability, bias and validity. Many studies have been undertaken investigating these issues and the design, analysis and interpretation of results have improved significantly since the mid 1980s (Adamowicz, 2004). Arrow *et al.* (1993) concluded that CVM provided a starting point for eliciting passive values associated with changes in environmental quality. Following the guidelines issued by the National Oceanic and Atmospheric Administration Panel could reduce problems associated with CVM. The guidelines have not settled all the issues, but established some minimum standards.

Choice modelling emerged in the wake of the CVM controversy (Bennett & Adamowicz, 2001). Typically a CVM study will ask respondents if they are willing to pay some amount of money to achieve a particular environmental outcome. CVM techniques rely on a detailed description of a particular situation or scenario where the detail is crucial to the analysis. A CM application presents the survey respondent with a number of different alternatives and as a result provides a richer set of information for policy makers.

1.4 Outline of the Report

This report is the first part of the Value of Habitat and Agriculture Study where we will report on the preliminary results regarding the preferences of South Australians with respect to improving the quality and quantity of habitat in the Upper SE. The essential ideas and approaches used in CM are introduced and an outline of our approach is presented. A selection of results from the questionnaire including attitudes, results from a quiz on respondents' understanding (on the information in the questionnaire and fact sheets) and socio-demographic characteristics are presented. The purpose of this information is to provide a clear indication of the characteristics of the people we sampled and the context of their responses, i.e. did they understand the information supplied with the questionnaire. We present a non-technical guide to the econometric analysis and the estimates from this analysis. The implicit prices for habitat areas are then presented for the different models. The implicit prices will be of most interest to policy-makers and analysts interested in the willingness to pay of South Australians to provide habitat area for indigenous plants, animals and birds. Careful use of these values, taking into account the context of the response, has the potential to contribute to a fuller discussion of how land and habitat could be configured in the Upper SE.

Textbox 1 - A classification of resource use values.



- Use Values: Derived from the actual use of the environment.
- Non-Use Values: A value expressed by humans for environmental resources which are unrelated to human use. These values include concern, sympathy and respect for the rights or welfare of non-human beings.
- Directly Traded Use Values: Sum of traded value of what people paid for the resource.
- Non-Traded Use Values: Values that people do not pay for, or fully pay for, under present circumstances.
- Option Values: The willingness to pay to ensure access to a resource or an area at some stage in the future. It is often considered to be a motive for existence value but some authors treat it as a separate component of existence value.
- Bequest Values: The value one places on the environmental good for one's descendants. For example, for an individual it is the value they put on knowing that the resource will be there for the children to enjoy in the future.
- Existence Values: Similar to bequest values, it is basically the desire to know that something still exists. For example, there is large concern for the plight of blue whales in the world, although most people will never see or use them.

Based on Hajkowicz *et al.* (2000).

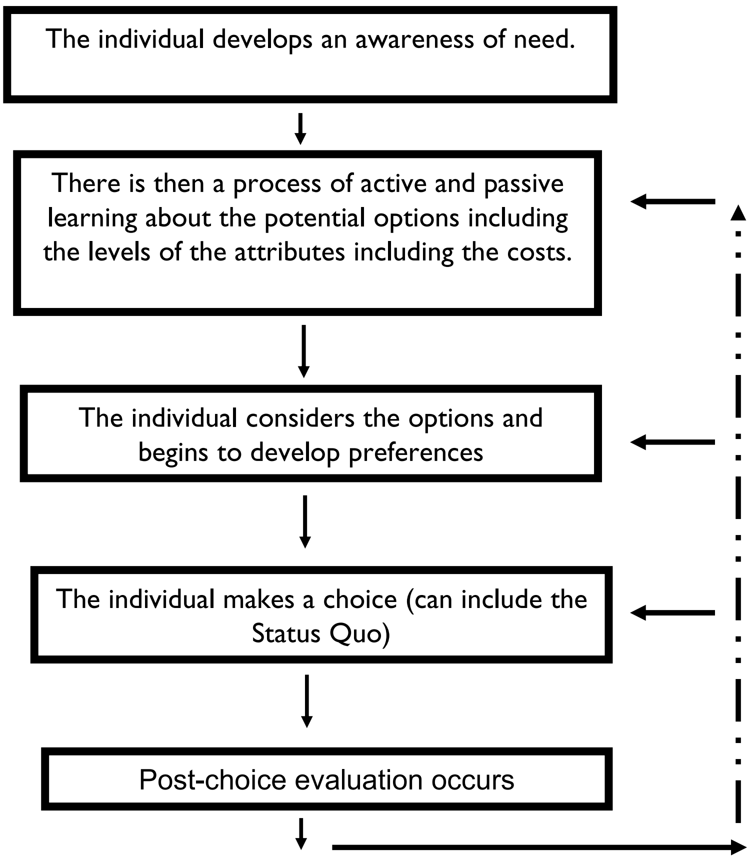
2 CHOICE MODELLING

2.1 Introduction

Choice modelling (CM) or choice-based conjoint analysis has emerged from extensive use and application to problems of choice in consumer marketing, transportation and health. The field has been shaped by advances in economics, decision theory, econometrics and biostatistics over forty years. In its simplest form, CM involves presenting choices to individuals and asking them to indicate which one they prefer.

CM is based on the idea that the individual derives satisfaction from the properties or attributes of consumer goods and experiences. The individual, however, often faces trade-offs when considering the package of attributes versus the cost of each package. Consumers make these decisions everyday with the goods they purchase. A well-presented choice experiment will convey the information in a way that minimises bias and engages the individual in a process of trading off outcomes against cost. Conceptually, the process of choice, based on Louviere, Hensher & Swait (2000) is presented in Figure 1 below.

Figure 1 - Process of Choice

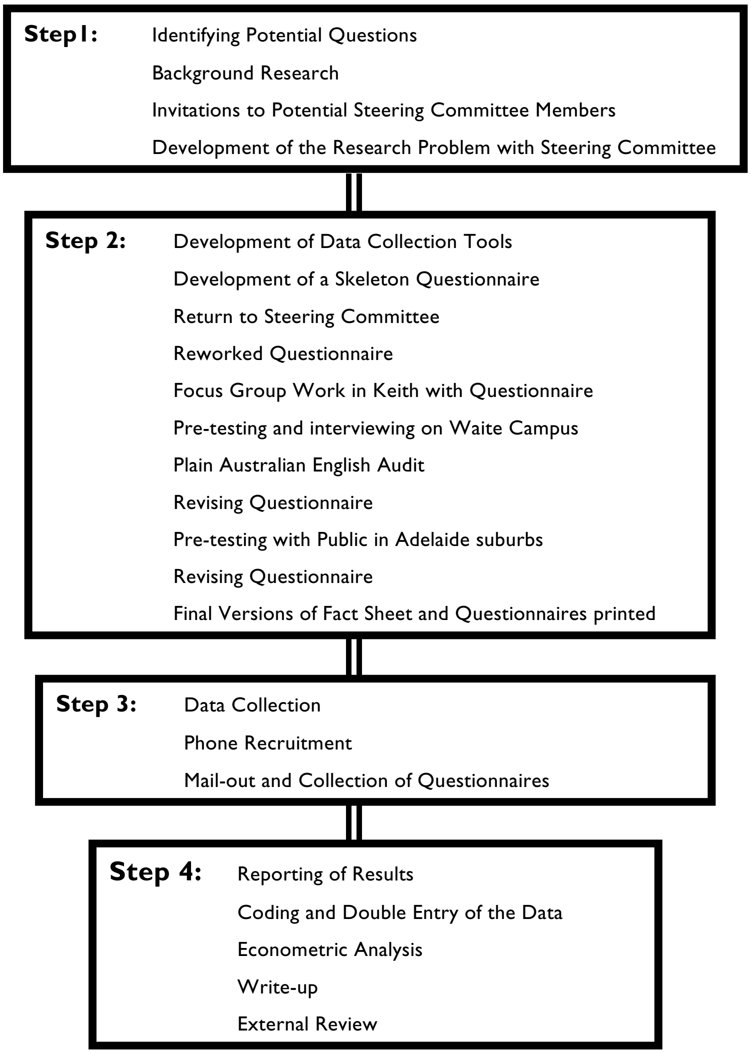


In an environmental application, a process of choice concerning changes in environmental qualities is used to generate data. Individuals might be presented with a realistic problem which requires a response by government with respect to a change in environmental quality. The changes in environmental quality could be positive or negative. Some policy scenarios could dictate that the choice experiment involve a decrease in some environmental quality. In this situation, the choice experiment would involve decreases in quality and offsetting levels of compensation. Conversely, costs of improvements in environmental quality would be borne by each household through taxes and levies. It is important that the problem being considered is reasonable to respondents and takes into account their perceived property rights.

2.2 Outline of the Research Approach In This Project

This project followed a structured process. First the Steering Committee examined which questions could reasonably be addressed. Then the data collection tools were developed and the data collection was undertaken. The final stage involved the statistical analysis and reporting of results. More detail is provided in Figure 2:

Figure 2 - Outline of Project Steps



2.3 The Questionnaires

A questionnaire with a number of variations (three split samples and 9 to 18 versions per split sample for a total of 36 variants) was developed over the time period of August to October 2003 to elicit values from South Australians regarding the importance and willingness to pay for habitat. The first split sample, referred to as the base questionnaire, will be the focus of this project report. The second and third questionnaires use the base as a reference point for testing the nature and context of the values.

The Base Questionnaire

The base questionnaire was designed to ask South Australians to trade-off scrublands, grassy woodlands and wetlands against changes in a levy. The base version questionnaire follows conventional questionnaire design principles (Bennett *et al.*, 2001).

Respondents were presented with some warm-up questions, six choice sets, some debriefing questions and then some socio-demographic questions. The choice sets offered the status quo and two options where the levy amount and the area of good quality habitat varied according to an experimental design. Each respondent was presented with six choice sets as this was thought to be the maximum number of choices respondents would be willing to consider following the pretest. As there were a total of 54 choice sets as part of the experimental design, the choice sets were organised in 9 blocks with 6 choice sets in each questionnaire version (versions 1.1 to 1.9). The presentation order was changed in versions 1.10 through 1.18 where the first 3 choice sets were exchanged with the last 3 choice sets.[1]

Time Version Questionnaire

In the time questionnaire, the timeframe over which changes in habitat area were to occur are specified as twenty years whereas the timeframe in the base questionnaire is ten years. The purpose of this split sample is to test whether extending the time frame over which changes occur makes a difference in people's choices. We are also attempting to test whether timeframes combined with whether people live in Adelaide or close to the area of habitat conservation makes a difference in people's choices. The time questionnaires were sent to households in Adelaide (200 to 250 targeted) and the Upper SE (200 to 250 targeted).

The Budget Reallocation Version Questionnaire

A third version of the questionnaire was developed which used a State budget reallocation instead of a levy in order to test whether the way habitat preservation and improvement is paid for makes a difference. This questionnaire was sent to households in Adelaide.

2.4 The Attributes

The levy amount varied from a no levy in Option A (the status quo) to amounts of:

$10, $20, $40, $60, $80 and $100.

The expected levels of the habitat were expected to decline with current practices over ten years time (scrubland: 66,000 ha, grassy woodland: 46,000 ha and wetlands: 73,000 ha). In the other options, the habitat area was increased by approximately 10%, 20% and 35% as follows:

- scrublands: 73,000, 80,000 and 90,000 ha
- grassy woodlands: 51,000, 56,000 and 63,000 ha
- wetlands: 81,000, 88,000 and 99,000 ha

[1] This allows us to investigate the role of order of presentation in the choice process. This suggestion was made by Mary Barnes, CMIS.

A sample choice set is included in Figure 3.

Figure 3 - A Sample Choice Set

	Levy per year for 5 years **$**	**Scrublands** 	**Grassy woodlands** 	**Wetlands** 
Area in 1980		250,000 ha	75,000 ha	187,000 ha
Current Area		77,000 ha	54,000 ha	86,000 ha
		Area Expected in Ten Years		
Option A ***Continue Current Practices***	No levy	66,000 ha Decrease of 11,000 ha	46,000 ha Decrease of 8,000 ha	73,000 ha Decrease of 13,000 ha
Option D ***Area in 2014 with change to current practice***	$60	73,000 ha	63,000 ha	88,000 ha
Option E ***Area in 2014 with change to current practice***	$40	90,000 ha	51,000 ha	88,000 ha

3 RESULTS

3.1 Characteristics of the Sample

A random sample of households listed in the white pages in South Australia (Australia on Disk database) was drawn by Barbara Davis & Associates. Households were initially contacted by telephone and asked if they would be willing to respond to a questionnaire being conducted by CSIRO for the South Australian government. Households who agreed on the phone to this request were sent a questionnaire. The goal was to obtain 850 questionnaires back from South Australians with

- 350 responses from Adelaide
- 250 responses from Upper SE
- 250 responses non-Adelaide, non-Upper SE other responses

A minimum of 200 usable questionnaires was required from each target area. The response rate was 38.2% using this phone recruitment followed by mail-out strategy.

Socio-Demographic Characteristics of the Sample

The questionnaire respondents, can be described as follows:

- 70.4% describe their interest in the environment as strong (28.9% describe their interest in the environment as little);
- 45.0% of the respondents were female (55.0% were male);
- 80.5% of respondents have children (just under 20.0% do not have children);
- 54.0% of respondents are not involved in farming (24.0% and 21.4% are directly and indirectly involved in farming);
- 26.3% of respondents have a total weekly household income before tax of over a $1000 (with 12.7% ticked 1500+ per week - the highest ABS category);
- 50.5% have completed a tertiary degree, diploma or certificate (with 21.1% having completed a degree); and
- The mean age is 52.3 years. The median age is 52 years.

Familiarity with the Upper SE

- 72.6% have visited the Upper SE in the past 5 years (21.2% have not visited the Upper SE in the past 5 years and roughly 2% missing or not sure);
- 63.6% plan to visit the Upper SE in the next 5 years (21.9% are not sure and 13.5% did not think they would visit the Upper SE);
- 64.8% did not have family who owned land or worked in the Upper SE (33.1% did have family who owned land or worked in the Upper SE).

Perceptions of Distance

Respondents were asked how long they thought it would take to drive from their home to Keith in the Upper SE. Respondents' answers were grouped as follows:

- under an hour 7.6 %
- over an hour but less than 3 hours 48.1 %
- over 3 hours but less than 4 hours 22.3 %
- over 4 hours but less than 5 hours 8.7 %
- over 5 hours 13.3 %

Did They Understand the Information in the Questionnaire?

Respondents were presented with eight questions as part of a true or false quiz and asked to tick the appropriate box. This question was intended to see whether respondents were reading and understanding all the information provided in the questionnaire and the information sheet. Results are as follows:

- 53.8% answered all the questions correctly;
- 70.8% answered at least 7 out of 8 correctly;
- 82.3% answered at least 6 out of 8 correctly.

The question that respondents had the most difficulty with included:

- understanding the levy would be each year for five years;
- understanding that there have been programs and projects in the past;
- understanding that there has been significant land clearing in the Upper SE.

It is difficult to interpret the latter two results as the quiz may be picking up people's beliefs rather than how they are retaining the information.

Attitudes to the Environment

Cumulatively, 84.7% of the sample agreed (with 43.4% agreed and 41.3% strongly agreed) that it was important to increase the size and quality of areas of scrubland, wetlands and grassy woodlands. Only 4% disagreed with increasing size and quality of habitat in the Upper SE.

Outdoor Activity

Respondents were asked to tick the boxes if they did any of the following:

- bushwalk 50.3%
- bird watch 31.7%
- hunt 8.2%
- fish 37.9%

Attitude to Preserving Habitat in Other Areas

Cumulatively 23.7% of the sample agreed that other areas of the state might be important as habitat for native plants, animals and birds with only 3.4% strongly agreed. Interestingly, 59.7% of the respondents were on the fence - neither agreeing nor disagreeing with the statement.

Choices

The summary statistics indicate that respondents are generally choosing options other than Status Quo. The Status Quo was chosen in approximately 20% of the choice sets. Approximately 17.1% of respondents choose the Status Quo all the way through.

What influenced these Choices?

- 72.8% of respondents indicated that they looked for a combination of habitat areas in making their choices;
- 14.4% of respondents looked at the area of wetlands with grassy woodlands and scrublands being used as a single criterion in a very small number of cases.

How did people feel about the questionnaire?

A series of questions were asked to probe how people felt about the survey. Likert scales were used with five tick boxes ranging from strongly agreeing to strongly disagreeing.

I understood the information in the questionnaire

- 19.3% strongly agree
- 63.9% agree
- 12.6% neither agree nor disagree
- 2.5% disagree
- 1.0% strongly disagree

I needed more information than was provided

- 2.1% strongly agree
- 19.6% agree
- 37.1% neither agree nor disagree
- 34.7% disagree
- 4.0% strongly disagree

Information was biased in terms of increasing size and quality

- 3.6% strongly agree
- 23.5% agree
- 29.8% neither agree nor disagree
- 37.0% disagree
- 5.5% strongly disagree

Found the questionnaire confusing

- 3.6% strongly agree
- 23.5% agree
- 29.8% neither agree nor disagree
- 37.0% disagree
- 5.5% strongly disagree

Information downplayed the importance of habitat

- 1.0% strongly agree
- 7.2% agree
- 29.2% neither agree nor disagree
- 52.8% disagree
- 9.6% strongly disagree

3.2 Modelling Respondents' Choices

A series of statistical techniques were used to explain the relationships among the probability of choosing a particular option and the levels of the different habitat areas, the levels of the levy, and socio-demographic characteristics of the respondents.

The techniques included:

- Multinomial Logit (MNL) Models
- Covariance–Heterogeneity (Cov-Het) Models
- Random Parameter Logit (RPL) Models
- Multinomial Probit (MNP) Models

One of the important results from the empirical modelling has been the clustering of results. The different models tended to provide similar value estimates, despite differences in model specification and assumptions. While there were outliers or exceptions, a convergence of results was apparent.

The MNL Model is considered to be the "workhorse" in the field of stated preferences given the ease of estimation and its ubiquitous presence in the empirical literature. The MNL model is restrictive in a number of ways. For example, it relies on restrictive assumptions concerning the nature of the error structure such as not allowing for the variance to be different across alternatives. However, using estimation techniques that impose less restrictive assumptions of the error structure generally comes at a cost in terms of computational time. Only with the development of new algorithms in the standard software and improvements in processing speed have some of these techniques become practical.

In this section, the results from these four modelling techniques are presented. The MNL model is provided as a base for comparison. As the modelling techniques become more computationally intensive, the number of variables that can be included in the specification is often greatly reduced. The purpose of using a number of different estimation techniques is to determine whether different assumptions about the error structure have affected value estimates.

Textbox 2 provides a summary of the explanatory variables.

Textbox 2 – Explanatory Variables	
ASC	Alternative specific constant which picks up the variation in choices not associated with the attributes or socio-demographic variables.
SCRUB	Area of scrubland.
GRASS	Area of grassy woodlands.
WETLAND	Area of wetlands.
LEVY	The amount of the levy each year for 5 years.
GENDER	Gender of the respondent (1=male)
CHILD	Does the respondent have children (1=yes)?
INCOME	Income of the respondent.
VISIT	Does the respondent plan to visit the Upper SE in the next 5 years (1=yes)?
IMPORT	Respondent agrees that it is important to improve the size and quality of scrublands, grassy woodlands and wetlands in the Upper SE? (1=yes).
AGE	Age of the respondent.
AGE^2	Age of the respondent squared (used to test a hypothesis about the curvature in the age-choice relationship).
LAND	Has the respondent or respondents' family owned land or worked in the Upper SE? (1=yes).

3.3 Intuitive Explanation of Model Results

The interpretation of results from models based on choice data is different from an ordinary least squares regression. With the MNL model, the focus is on the probability of choosing an option. The underlying theory is that as individual's satisfaction or utility increases, the more likely the individual is to choose a particular option. The probability of choosing an option is a function of the levy amount (negative relationship) and the area of scrubland, grassy woodlands and wetlands (positive relationship).

Over-all Goodness of Fit of the Model

The overall goodness of fit can be reported in a number of ways. Most software packages report a likelihood ratio index (pseudo-R^2 or ρ^2), which is a computed value between zero and one. Typically in models of choice, good models are in the range of 0.2 and 0.4 (Louviere, Hensher and Swait, 2000). This is in contrast to R^2 values for an ordinary least regression with cross-sectional data which will be considerably higher (0.7 to 0.9) and time series data which tend to be in the range of 0.9 to almost 1.

Statistically Significant Coefficients

As part of the process of selecting a model, tests of the individual estimated coefficients are compiled. A good model will include estimated coefficients that are statistically different from zero. Each of the tables includes an indication (by the number of stars) of whether the estimated coefficient is different from zero at the 10%, 5% or 1% level.

Sign of Coefficients

The sign on the estimated coefficients is important. For instance, one might expect that as the area of habitat increased, the probability of choosing a particular option would increase (positive sign). However, with the levy, one might expect that as the levy increased the probability of choosing a particular option would decrease (negative sign).

Alternative Specific Constant

The role of the Alternative Specific Constant (ASC) is to pick up variations in choice that cannot be explained by the levy, areas of habitat or the socio-demographic characteristics of the respondents. It therefore represents reasons people might choose to pay to improve habitat areas that are not captured by the design variables. The ASC is zero for the Status Quo option and one for the other two choices.

A simple model involving the ASC, the habitat areas, the levy and population weights[2] was estimated and is reported in Table 1. In this simple model, all the estimated coefficients are statistically significant at the 1% level. The ρ^2 is low but in the acceptable range. Socio-demographic information and information about attitudes of the respondents towards the environment can be incorporated in the estimation by interacting the variable with the ASC. This in effect shows how a sociodemographic variable influences the probability of choosing an option to improve habitat areas. For example, the propensity of respondents to choose options which increase habitat area will tend to increase as income increases.

Table 1 - Simple MNL Model – SA

Variable	Estimated Coefficient	Standard Error	t-ratio
ASC	0.737***	0.148	4.996
SCRUB	0.0142***	0.00418	3.409
GRASS	0.0216***	0.00707	3.0489
WETLAND	0.0279***	0.00453	6.159
LEVY	-0.0205***	0.00129	-15.865
ρ^2	0.167		

*** significantly different from 0 at the 1% level

In Table 2 results are presented for the whole State and then results are presented separately for Adelaide, the Upper SE and for the rest of the State (excluding Adelaide and Upper SE). Important differences in parameter estimates start to emerge when comparing results from the different areas of the State. The estimated coefficient on grassy woodlands is statistically insignificant in the Upper SE model. This suggests that respondents in the Upper SE are not willing to pay to improve the quality and quantity of grassy woodlands as habitat. As this land is valuable for agriculture, it is possible that respondents do not support this habitat area being increased as it takes productive land out of agriculture.

2 Throughout this report it should be noted that models estimated using the full dataset were estimated with population weights. The population of the Upper SE and the Rest of State is relatively small in contrast to the sample proportions.

Table 2 - MNL Model

Variable	All SA Estimated Coefficient (Standard Error)	Adelaide Estimated Coefficient (Standard Error)	Upper SE Estimated Coefficient (Standard Error)	Rest of State Estimated Coefficient (Standard Error)
ASC	-1.434 (1.108)	-2.590*** (0.960)	-5.083*** (0.993)	-3.351*** (0.965)
SCRUB	0.0158*** (0.00434)	0.0158*** (0.00406)	0.026*** (0.00524)	0.012** (0.00548)
GRASS	0.0216*** (0.00730)	0.0209*** (0.00692)	-0.002 (0.00859)	0.022** (0.00845)
WETLAND	0.0291*** (0.00466)	0.030*** (0.00441)	0.015*** (0.00537)	0.025*** (0.00547)
LEVY	-0.0207*** (0.00133)	-0.0205*** (0.00126)	-0.0226*** (0.00162)	-0.0212*** (0.00153)
GENDER	-0.517*** (0.167)	-0.511*** (0.161)	-0.181 (0.190)	-0.0092 (0.170)
CHILD	0.441* (0.244)	0.275 (0.244)	0.537*** (0.180)	0.748*** (0.207)
INCOME	0.00001*** (0.000003)	0.00002*** (0.000003)	-0.000004 (0.000003)	0.000003 (0.000003)
VISIT	0.578*** (0.169)	0.501*** (0.158)	0.837*** (0.237)	0.552*** (0.181)
IMPORT	1.060*** (0.106)	1.208*** (0.103)	1.733*** (0.121)	1.166*** (0.110)
AGE	-0.0872** (0.0376)	-0.0672** (0.0326)	-0.0313 (0.0353)	-0.0463 (0.0332)
AGE^2	0.0007** (0.000343)	0.0005* (0.000300)	0.00008 (0.000338)	0.0004 (0.000323)
LAND	-0.644*** (0.180)	-0.713*** (0.168)	-0.081 (0.182)	-0.239 (0.209)
ρ^2	0.249	0.248	0.280	0.223
# of choice sets log likelihood	4203 -3200.737	1732 -1361.060	1318 -940.819	1297 -984.638

*** significantly different from 0 at the 1% level, ** 5% level or * 10% level

The inclusion of socio-demographic variables in the MNL model allows for testing which of the socio-demographic characteristics of respondents may be influencing choice.

- The significance of age and age^2 in the Adelaide sample suggests a curvature in the age-choice relationship. Intuitively young respondents and older people (such as grandparents) are choosing options that include improvements in habitat areas compared with those in their middle age.
- In Adelaide, the coefficient for the gender of respondents is statistically significant. Male respondents are less likely to choose options that include improvements in habitat areas. If we had specified the gender variable the other way, the interpretation would be that female respondents are more likely to choose options which involve improvements in habitat area (positive relationship).

- In the Upper SE and the Rest of State, having children was a positive influence on choosing options that include improvements in habitat areas. In Adelaide, higher income levels were also associated with choosing options that include improvements in habitat areas.
- In all three areas, agreeing with the statement that it is important to improve the quality of scrublands, grassy woodlands and wetlands in the Upper SE was positively correlated with choosing options that include improvements in habitat areas. In all three areas, having visited the Upper SE had a positive influence on choosing options that include improvements in habitat areas.

The existence of significant coefficients for these variables is also an important indicator of theoretical validity, as these variables tend not to be significant when biases are present. The large number of significant socio-demographic variables in these models suggests that the questionnaire worked well.

Why an MNL Model May Not Be Appropriate

The MNL model has the property called independence from irrelevant alternatives (IIA). This means that the probability of choosing one of the options in a choice set is independent of the remaining probabilities. The property would imply that, in the case of the choice sets, removing one of the alternatives would not change the parameter estimates systematically (Greene, 2003). In practice, violations of this property can happen for many reasons, such as respondents having heterogeneous preferences. Indeed, it is fairly common in environmental CM studies for this property to be violated. A Hausman-McFadden test for IIA violations was therefore conducted, which involves removing an alternative from the choice set and testing whether the parameter estimates are different. This test indicated that removing an alternative does have an effect on the relative probabilities.

A commonly used variant of MNL, the Nested Logit model, is a way of relaxing the IIA structure. Attempts at modelling a number of Nested Logit models were unsuccessful, as the models would not converge or the inclusive values were not statistically different from zero. However as the existence of IIA violations remained a potential problem, this suggested that other statistical techniques should be explored. Therefore, three alternative modelling approaches were used, including the covariance-heterogeneity model, the random parameters logit model and the multinomial probit model.

The end product of this modelling is the calculation of the implicit prices (willingness to pay) which is based on the estimated coefficients in the Tables 2 through 8.

Covariance–Heterogeneity Models

The covariance–heterogeneity model is an extension of the nested logit model where the variance (error) of the model is allowed to vary with the socio-demographic characteristics of respondents. The decision is partitioned into a choice of 'Status Quo' and the 'Non-Status Quo' options. Covariance–heterogeneity is accommodated by specifying a number of individual characteristics (income, viewing improving the size and quality of habitat as important, gender, owning land or connected to land in Upper SE). If these parameters are statistically insignificant from zero, the model collapses back to the Nested Logit case. Intuitively, the covariance–heterogeneity model allows for the error variance to be higher for certain respondents (eg lower income) and lower for others. Because the model allows the error to vary according to respondents' characteristics, the strong IID (identically and independently distributed) error terms assumption that is part of the MNL model is relaxed.

Finally, in these models, the alternative specific constant is specified slightly differently. In this case, ASC_1 equals 1 for Status Quo .

Table 3 – Covariance-Heterogeneity Models

Variable	All SA Estimated Coefficient (Standard Error)	Adelaide Estimated Coefficient (Standard Error)	Upper SE Estimated Coefficient (Standard Error)	Rest of State Estimated Coefficient (Standard Error)
ASC_I	-3.762*** (0.830)	-3.705*** (0.740)	0.835 (1.417)	-1.436 (1.606)
SCRUB	0.0170*** (0.00464)	0.0170*** (0.00438)	0.0301*** (0.00516)	0.0162*** (0.00550)
GRASS	0.0245*** (0.00765)	0.0246*** (0.00728)	0.00866 (0.00828)	0.0256*** (0.00857)
WETLAND	0.0324*** (0.00482)	0.0334*** (0.00456)	0.0209*** (0.00518)	0.0285*** (0.00566)
LEVY	-0.021*** (0.00128)	-0.0208*** (0.00121)	-0.0221*** 0.00158	-0.0214*** (0.00152)
Inclusive Values				
Non-Status Quo Options	0.0469 (0.0408)	0.0359¥ (0.0271)	0.475¥ (0.231)	0.282¥ (0.222)
Status Quo	1	1	1	1
Covariance Heterogeneity parameters				
S_{INCOME}	0.00645*** (0.00162)	0.00647*** (0.00139)	0.00034 (0.000568)	0.00193* (0.00099)
S_{IMPORT}	0.519*** (0.145)	0.589*** (0.130)	0.256*** (0.00674)	0.246** (0.101)
S_{GENDER}	-0.300*** (0.0966)	-0.295*** (0.0828)	-0.0688** (0.0319)	-0.0508 (0.0470)
S_{LAND}	-0.218** (0.0857)	0.0240** (0.0273)	0.0240 (0.0273)	-0.00139 (0.0428)
ρ^2	0.35	0.355	0.325	0.304
# of choice sets log likelihood X^2	4203 -1231.166 1324.943	1732 -1358.895 1497.931	1318 -977.852 940.264	1297 -1002.996 874.728

*** significantly different from 0 at the 1% level, ** 5% level or * 10% level

¥ significantly different from 1 at the 5% level

Random Parameters Logit

In the MNL model, the coefficients are fixed across individuals. That is, a single parameter vector is estimated for all individuals. However, with the random parameters logit model, some or all of the parameters are allowed to be distributed across individuals. For example, it is possible to assume that one or more parameters are normally distributed across respondents. Hence for some respondents the parameter may have a large value and for others it may have a small value. The derived standard deviation (denoted Ns in Tables 4 through 7) in the RPL model allows for testing whether there are important differences across individuals. A significant Ns-variable name indicates that the standard deviation is different from zero.

The random parameter logit models in this report are estimated using a quasi-random simulated maximum likelihood technique known as Halton sequences (Hensher & Greene, 2002) as the problem is no longer a closed form. Halton sequences with draws of 500 have been used which is consistent with the literature.

In Table 4 the results from a random parameters logit model are presented where the constants have been normally distributed. This model is included as it is conceptually similar to the multinomial probit model (Greene, 2003), which is presented inTable 8. It is important to note that RPL models do not always converge and the All of SA and Adelaide models failed to converge. Note also that the standard deviations for the ASC's in the two models that did converge are not significant.

Table 4 - RPL Model - Distributing ASC

Variable	All SA Estimated Coefficient (Standard Error)	Adelaide Estimated Coefficient (Standard Error)	Upper SE Estimated Coefficient (Standard Error)	Rest of State Estimated Coefficient (Standard Error)
ASC	Failed to converge	Failed to converge	-5.237*** (0.495)	-3.975*** (0.550)
SCRUB	Failed to converge	Failed to converge	0.0256*** (0.00522)	0.0130** (0.00549)
GRASS	Failed to converge	Failed to converge	-0.00232 (0.00857)	0.0217** (0.00843)
WETLAND	Failed to converge	Failed to converge	0.00142*** (0.00535)	0.0251*** (0.00548)
LEVY	Failed to converge	Failed to converge	-0.0225*** (0.00161)	-0.0212*** (0.00154)
INCOME	Failed to converge	Failed to converge	0.00245 (0.00290)	0.00667** (0.00328)
IMPORT	Failed to converge	Failed to converge	1.592*** (0.110)	1.0826*** (0.143)
GENDER	Failed to converge	Failed to converge	-0.437** (0.171)	-0.0727 (0.168)
LAND	Failed to converge	Failed to converge	0.162 (0.166)	0.0996 (0.194)
NsASC	Failed to converge	Failed to converge	0.00560 (0.579)	0.143 (1.948)
ρ^2			0.266	0.212
# of choice sets log likelihood X^2			1318 -959.328 693.843	1297 -998.117 537.17

*** significantly different from 0 at the 1% level, ** 5% level or * 10% level

McFadden and Train (2000) proposed a Lagrange Multiplier test for the presence of random parameters. This test involves creating an additional parameter vector where each variable corresponds to one of the original choice set variables. The variables in this new vector are designed to show whether there is any heterogeneity in respondents' preferences. This new vector is included in a multinomial logit model. If any of the coefficients for these new variables is significant, it indicates the presence of heterogeneity, and that the variables should be distributed. While this test is considered to be relatively weak, it did suggest that it was appropriate to distribute the levy. Most previous applications of the RPL technique have chosen either to distribute only cost (Layton, 2000) or non-price variables (Anderson, 2003). Therefore, the estimation using these particular specifications in Table 5 and in Table 6 are consistent with previous empirical work.

In both the All SA and Adelaide models the standard deviations for levy were found to be significant.

Table 5 - RPL Model - Distributing Levy

Variable	All SA Estimated Coefficient (Standard Error)	Adelaide Estimated Coefficient (Standard Error)	Upper SE Estimated Coefficient (Standard Error)	Rest of State Estimated Coefficient (Standard Error)
ASC	-3.85*** (0.521)	-4.522*** (0.521)	-5.243*** (0.498)	-3.95786*** (0.468)
SCRUB	0.0161*** (0.00486)	0.0161*** (0.00463)	0.0257*** (0.00526)	0.0132** (0.00558)
GRASS	0.0249*** (0.00828)	0.0242*** (0.00800)	-0.00222 (0.00863)	0.0227*** (0.00871)
WETLAND	0.0314*** (0.00527)	0.0328*** (0.00511)	0.0143*** (0.00540)	0.0253*** (0.00558)
LEVY	-0.0302*** (0.00337)	-0.0317*** (0.00337)	-0.0230*** (0.00327)	-0.0235*** (0.00306)
INCOME	0.0198*** (0.00334)	0.0204*** (0.00315)	0.00244 (0.00291)	0.00694** (0.00320)
IMPORT	1.147*** (0.117)	1.320*** (0.118)	1.598*** (0.116)	1.09578*** (0.105003)
GENDER	-0.688*** (0.178)	-0.702*** (0.173)	-0.440** (0.173)	-0.0855 (0.168)
LAND	-0.505*** (0.187)	-0.641*** (0.180)	0.163 (0.166)	0.101 (0.197)
NsLEVY	0.0216*** (0.00438)	0.0239*** (0.00430)	0.00408 (0.0126)	0.00923 (0.00564)
ρ^2	0.244	0.251	0.266	0.212
# of choice sets log likelihood X^2	4203 -1223.358 794.369	1732 -1363.519 911.566	1318 -959.311 693.879	1297 -997.681 538.038

*** significantly different from 0 at the 1% level, ** 5% level or * 10% level

Table 6 - RPL Model - Distributing Habitat Areas (Normal Distribution)

Variable	All SA Estimated Coefficient (Standard Error)	Adelaide Estimated Coefficient (Standard Error)	Upper SE Estimated Coefficient (Standard Error)	Rest of State Estimated Coefficient (Standard Error)
ASC	-4.556*** (0.639)	-5.393*** (0.691)	-5.237*** (0.495)	-4.868*** (0.740)
SCRUB	0.0184*** (0.00526)	0.0188*** (0.00512)	0.0256*** (0.00522)	0.0127* (0.00724)
GRASS	0.0276*** (0.00869)	0.0273*** (0.00850)	-0.00232 (0.00857)	0.0246** (0.0103)
WETLAND	0.0280*** (0.00585)	0.0291*** (0.00571)	0.0142*** (0.00535)	0.024*** (0.00722)
LEVY	-0.0246*** (0.00183)	-0.0248*** (0.00197)	-0.0225*** (0.00161)	-0.0264*** (0.00303)
INCOME	0.0232*** (0.00402)	0.0243*** (0.00398)	0.00245 (0.00290)	0.00941** (0.00428)
IMPORT	1.347*** (0.156)	1.550*** (0.177)	1.592*** (0.110)	1.446*** (0.220)
GENDER	-0.751*** (0.205)	-0.759*** (0.202)	-0.437** (0.171)	-0.182 (0.223)
LAND	-0.629*** (0.221)	-0.797*** (0.220)	0.162 (0.166)	0.0725 (0.253)
Ns_{SCRUB}	0.000140 (0.0388)	0.000105 (0.0240)	0.000710 (0.0308)	0.0598** (0.0262)
Ns_{GRASS}	0.00529 (0.0667)	0.0236 (0.0641)	0.000353 (0.0235)	0.000988 (0.0331)
$Ns_{WETLAND}$	0.0815*** (0.0156)	0.0844*** (0.0149)	0.00006 (0.0346)	0.0700*** (0.0224)
ρ^2	0.245	0.252	0.266	0.215
# of choice sets log likelihood X^2	4203 -1230.742 799.600	1732 -1361.118 916.368	1318 -959.328 693.845	1297 -994.175 545.0510

*** significantly different from 0 at the 1% level, ** 5% level or * 10% level

RPL Panel Data

With the RPL modelling technique, it is possible to take into account that respondents are making a series of choices. A respondent might answer all six choice sets or only two and it is reasonable to assume that choices will be correlated. By allowing the coefficients to vary across individuals and accounting for the correlation between choices of the individual, a richer specification is possible. However, the trade-off is that the models must be relatively simple in order to converge and computational time increases significantly. Distributing levy (using a normal distribution) while allowing for panel data proved to be one of the few specifications which would converge. Results are presented in Table 7.

Table 7 - RPL Panel Data – Distributing Levy

Variable	All SA Estimated Coefficient (Standard Error)	Adelaide Estimated Coefficient (Standard Error)	Upper SE Estimated Coefficient (Standard Error)	Rest of State Estimated Coefficient (Standard Error)
LEVY	-0.0785*** (0.00879)	-0.0812*** (0.00886)	-0.0879*** (0.0117)	-0.0855*** (0.0114)
ASC	-2.971*** (0.937)	-3.880*** (0.934)	-4.563*** (0.925)	-2.813*** (0.955)
SCRUB	0.0251*** (0.00590)	0.0251*** (0.00562)	0.0357*** (0.00672)	0.0234*** (0.00702)
GRASS	0.0357*** (0.00961)	0.0344*** (0.00920)	0.00422 (0.0108)	0.0381*** (0.0109)
WETLAND	0.0458*** (0.00616)	0.0482*** (0.00592)	0.0276*** (0.00668)	0.0375*** (0.00709)
INCOME1	0.0299*** (0.00665)	0.0298*** (0.00632)	0.00152 (0.00612)	0.0109 (0.00697)
IMPORT	1.352*** (0.208)	1.614*** (0.206)	2.014*** (0.215)	1.317*** (0.225)
GENDER	-1.213*** (0.352)	-1.223*** (0.353)	-1.023*** (0.357)	-0.424 (0.369)
LAND	-0.709** (0.360)	-0.850** (0.353)	0.136 (0.341)	-0.0646 (0.424)
NsLEVY	0.0956*** (0.0108)	0.0989*** (0.0110)	0.010*** (0.0144)	0.110*** (0.0149)
ρ^2	0.393	0.403	0.391	0.362
# of choice sets log likelihood X^2	4203 -989.976 1281.132	1732 -1085.884 1466.836	1318 -795.916 1020.669	1297 -808.177 917.046

*** significantly different from 0 at the 1% level, ** 5% level or * 10% level

While the Random Parameter Logit models are becoming more common in the applied literature these models are not without their critics. For example, Louviere (2004) suggests that there may be underlying problems with these models.

Multinomial Probit Model

The multinomial probit model is a sophisticated model that until recently has not been practical to estimate because of computational limitations. In the multinomial logit (MNL) model, the error terms are drawn from independent extreme value distributions, which is what leads to the IIA (independence of irrelevant alternatives) property. However, with the multinomial probit model, a different type of distribution – the normal distribution - is assumed for the errors. In this model it is possible to allow for the standard deviations of the errors of the alternatives to be different (i.e. not identically distributed), and for the errors to be correlated across alternatives (i.e. not independently distributed). Thus it is possible to fully relax the IIA property. Multinomial probit models estimated for each of the data sets are reported in Table 8.

A few new variables appear in Table 8. "Income$_I$" is the household income divided by 1000 which aids in convergence of the model. The parameter, s[alt A] is the estimated standard deviation. In these models, the number of choices (in this case three) minus two (n – 2 = 1) standard deviations can be estimated. During the estimation phase, different standard deviations were specified with minimal effect on the other estimated parameters.

Table 8 - MNP Results

Variable	All SA Estimated coefficient (Standard Error)	Adelaide Estimated coefficient (Standard Error)	Upper SE Estimated coefficient (Standard Error)	Rest of State Estimated coefficient (Standard Error)
ASC	-2.895*** (0.348)	-3.237*** (0.325)	-3.955*** (0.394)	-3.212*** (0.420)
SCRUB	0.0122*** (0.00366)	0.0118*** (0.00331)	0.0220*** (0.00470)	0.0109** (0.00496)
GRASS	0.0174*** (0.00625)	0.0160*** (0.00563)	-0.00231 (0.00770)	0.0214*** (0.00825)
WETLAND	0.0240*** (0.00445)	0.0231*** (0.00401)	0.0123** (0.00478)	0.0237*** (0.00544)
LEVY	-0.0171*** (0.00189)	-0.0160*** (0.00165)	-0.0199*** (0.00230)	-0.0200*** (0.00252)
INCOME$_I$	0.0127*** (0.00203)	0.0128*** (0.00188)	0.00155 (0.00254)	0.00581** (0.00243)
IMPORT	0.805*** (0.0755)	0.887*** (0.0695)	1.201*** (0.0874)	0.864*** (0.0935)
GENDER	-0.448*** (0.118)	-0.4415*** (0.111)	-0.309** (0.133)	-0.128 (0.136)
LAND	-0.345*** (0.125)	-0.424*** (0.1184)	0.111 (0.125)	0.0336 (0.142)
s[ALTA]	1.079*** (0.197)	0.968*** (0.177)	1.236*** (0.214)	1.359*** (0.241)
ρ^2	0.239	0.246	0.266	0.212
# of choice sets log likelihood X^2	4203 -1240.117 780.851	1732 -1372.457 893.690	1318 -963.751 684.999	1297 -997.877 537.647

*** significantly different from 0 at the 1% level, ** 5% level or * 10% level

There are no direct tests to guide selection among the RPL technique, the Cov-Het model and the MNP approach, as the likelihood functions are not comparable. The RPL Panel model holds appeal as it allows for variation across respondents and for correlation between responses of each individual. The MNP and covariance-heterogeneity models are appealing with their less restrictive error structures.

4 IMPLICIT PRICES FOR HABITAT AREAS

4.1 The Calculation

The implicit prices of habitat is the amount that individuals in an area of the State, or the State as a whole, are willing to pay in the form of a levy in exchange for ensuring that 1000 hectares of good quality habitat is added to the stock in the Upper SE. The implicit price is a per household value, each year for five years.

These implicit prices are made on the basis of what economists call a "ceteris paribus" change where the increase in habitat area is made with everything else staying the same.

The estimated coefficients are used in the calculation of the implicit prices for habitat. The calculation is quite straightforward as:

$$IMPLICIT\ \ PRICE = \ -\frac{B_{Habitat\ Area}}{B_{Levy}}$$

Marginal rates of substitution could also be made across habitat areas. For instance, how much scrubland area would people in Adelaide be willing to trade off for more wetland area and so on.

4.2 Presentation of Results

Implicit prices provide information on the relative importance of different habitat areas to respondents. There are some strong regional differences in Table 9.

However, overall a strong clustering of results from the different modelling techniques is apparent.

The following preliminary observations[3] can be made about the differences between areas:

- The Upper SE is different from the rest of the State in the sense that respondents are willing to make different relative trade-offs than respondents in Adelaide or the rest of the State. They value scrubland areas higher than respondents in Adelaide and the rest of the State.
- Respondents in the Upper SE have a zero willingness to pay for grassy woodlands.
- Adelaide respondents have a relatively higher willingness to pay for wetland areas than the rest of the State.
- Adelaide and the rest of State respondents are reasonably similar in their preferences.[4]
- In most of the models, rest of State and Adelaide view scrublands as less valuable than grassy woodlands and wetlands. This is in reverse of the Upper SE preferences.
- Respondents in the Rest of State appear to value grassy woodlands and wetlands about the same.
- The Random Parameter Logit Panel (using a normal mixing distribution on the levy) produced results that were considerably lower. These results, while reported, may well be outliers.

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[3] Investigation of the statistical differences in estimated coefficients between areas will be undertaken as part of future work with this dataset. It is possible that some of these observations may not be valid when the variability between samples is taken into account. Time constraints prevented inclusion of these investigations at this time.

[4] Testing of differences in p values is completed in this section. More work is necessary to firm up these observations and will be undertaken as part of further research with this dataset.

Table 9 - Implicit Prices for Habitat

	Implicit Prices (Per Household, Per 1000 hectares, each year for 5 years)		
	Scrublands	Grassy Woodlands	Wetlands
Whole State			
simplest MNL	$0.70	$1.05	$1.36
MNL with socio-demographics	$0.76	$1.05	$1.41
Cov-Het Model	$0.81	$1.16	$1.54
RPL model – asc (N ~)	failed to converge		
RPL model - levy (N~)	$0.53	$0.82	$1.02
RPL model - habitats (N~)	$0.75	$1.12	$1.14
RPL model - panel levy (N~)	$0.32	0.46	$0.58
MNP	$0.72	$1.02	$1.40
Adelaide			
MNL with socio-demographics	$0.77	$1.02	$1.45
Cov-Het	$0.82	$1.18	$1.60
RPL model – asc (N ~)	failed to converge		
RPL model - levy (N~)	$0.51	$0.77	$1.04
RPL model - habitats (N~)	$0.76	$1.10	$1.17
RPL model - panel levy (N~)	$0.31	$0.46	$0.58
MNP	$0.74	$1.00	$1.44
Upper SE			
MNL with socio-demographics	$1.17	statistically insignificant from zero	$0.64
Cov-Het	$1.36	statistically insignificant from zero	$0.95
RPL model - asc(N ~)	$1.14	statistically insignificant from zero	$0.63
RPL model - levy (N~)	$1.12	statistically insignificant from zero	$0.62
RPL model - habitats (N~)	$1.14	statistically insignificant from zero	$0.63
RPL model - panel levy (N~)	0.41	statistically insignificant from zero	$0.31
MNP	$1.11	statistically insignificant from zero	$0.62
Rest of State			
MNL with socio-demographics	$0.56	$1.02	$1.19
Cov-Het	$0.76	$1.20	$1.33
RPL model - asc(N ~)	$0.61	$1.02	$1.18
RPL model - levy (N~)	$0.56	$0.97	$1.08
RPL model - panel levy (N~)			
RPL model - habitats (N~)	$0.48	$0.93	$0.92
MNP	$0.55	$1.07	$1.19

Tests of differences between implicit prices generated using the Covariance-Heterogeneity model were also conducted using the approach described by Poe, Giraud and Loomis (2002). These results are shown in Table 10 and indicate that the implicit prices for scrublands, grassy woodlands are statistically the same between Adelaide and the Rest of the State. However, all three implicit prices are different at the 10% significance level for the comparison between the Upper South East and Adelaide, and two are different at the 5% level. For the comparison between the Upper South East and the Rest of the State, the implicit prices for scrubland and wetlands are significantly different at the 10% level. These results also provide further evidence of where benefit transfer can most validly be used. They indicate that the transfer of value estimates from the population within the region to another population outside of the region is likely to be subject to greater error than transfers between populations that are both outside of the region studied.

Table 10: P-value Tests of Difference Between Implicit Prices

	Upper South East vs Adelaide	Upper South East vs Rest of State	Adelaide vs Rest of State
Scrublands	0.073*	0.070	0.473
Grassy Woodlands	0.040	0.040	0.425
Wetlands	0.023	0.137	0.228

* the value 0.073 indicates that the implicit prices for scrubland in the Upper South East ($1.36) and Adelaide ($0.82) are significantly different at the 7.3% significant level

This result has implications for future sample survey work in South Australia. For instance, it suggests for this habitat valuation problem that it may not be necessary to survey respondents in rest of State and that surveying Adelaide may be sufficient. This has the potential to lower the cost of undertaking this type of research in the State.

4.3 Willingness to Pay

Issues in Aggregation

In funding this study, the South Australian government was interested in being able to use the non-market benefits in cost-benefit analysis. This requires aggregation from the welfare measures at the sample mean to the population. Approaches to extrapolation often utilise population data to adjust for differences between the sample and the population. In other cases, it is assumed that the preferences of the non-responses are very similar to the respondents. Morrison (2000) found when contacting non-respondents that approximately

- 32% were too busy to complete the questionnaire,
- 59% were not interested,
- 5% were too old/too sick
- 4% illiterate/can't speak English
- 1% other

It is quite likely that those who are not interested in the survey are likely to have a low willingness to pay for habitat protection. However, those who are too busy may well have preferences that are very similar to those who responded to the survey.

Morrison (2000) demonstrated that taking into account the reasons for non-response produces an estimate of non-market benefits that is conservative relative to adjusting calculations based on mean values.

Estimates for South Australia

The calculation of the aggregate values for South Australia were made using the following information and assumptions:

- Implicit prices in Table 9;
- A total of 598,373 households in South Australia (ABS, 2002) based on census information;
- A conservative estimate of 50% of households in South Australia have the same preferences as respondents in the study. Values of 60% could also be used in sensitivity analysis (noting that the 60% would be the sum, rounded up of our sample survey response rate and a 32% of non-responses having the same preferences as those who answered);
- Respondents are discounting the levy at a rate no different from the government (say, 5%)

The estimates based on different model specifications are arranged from highest to lowest (excluding the RPL Panel results which are consistently so much lower than the cluster of estimates) for the State by each habitat in Table 11.

- Willingness to pay for scrubland areas ranges from $717 to $1,037 per hectare depending on the model. This is the tightest range of values for the different types of habitats.
- Willingness to pay for grassy woodlands ranges from $1,019 to $1,523 per hectare depending on the modelling approach.
- Willingness to pay for wetlands is from $1,413 to $1,912 per hectare depending on the modelling approach.

The preferred models, Cov-Het and MNP models, are highlighted in Table 11.

These estimates are conservative in the sense that the response only takes into account the non-use values of South Australians and excludes the values of people living in other parts of Australia who may also hold existence values for indigenous plants, animals and birds that depend on intact habitat areas. Studies such as Pate & Loomis (1997) suggest that as distance increases willingness to pay decreases and is not limited to boundaries drawn by local or State governments.

Table 11 - Willingness to Pay for Habitat - State Level Aggregation

Model	Willingness to Pay per hectare	Willingness to Pay per hectare (5% discount rate)
Scrublands		
MNL with socio-economic	$1,141	$1,037
RPL model - habitats (N~)	$1,121	$1,019
simplest MNL	$1,041	$947
Cov-Het Model	$889	$808
RPL model - levy (N~)	$798	$726
MNP	$788	$717
RPL model - panel levy (N~)	$479	$435
Grassy Woodlands		
RPL model - habitats (N~)	$1,675	$1,523
simplest MNL	$1,577	$1,433
MNL with socio-economic	$1,567	$1,424
Cov-Het Model	$1,280	$1,164
RPL model - levy (N~)	$1,232	$1,121
MNP	$1,121	$1,019
RPL model - panel levy (N~)	$681	$619
Wetlands		
MNL with socio-economic	$2,103	$1,912
MNP	$2,100	$1,909
simplest MNL	$2,040	$1,855
RPL model - habitats (N~)	$1,701	$1,547
Cov-Het Model	$1,697	$1,543
RPL model - levy (N~)	$1,554	$1,413
RPL model - panel levy (N~)	$872	$793

Using the Estimates in Cost-Benefit Analysis

It is important to remember these estimates are specific to the way in which the questions were asked as part of the questionnaire. For instance, respondents were asked in the context of a trade-off involving a levy and other habitat areas in the Upper SE. The appropriateness of transferring these benefit estimates to other areas of the State would have to be examined carefully to ensure that the populations were similar and the salient characteristics of the problems were compared carefully. Morrison *et al* (2002) suggested that transfer of benefits in the form of implicit prices was valid in the majority of cases tested with respect to wetland areas and populations within Australia. However, to transfer these benefits to a very different type of habitat such as heathlands or coastal dunes would be inappropriate.

Respondents were asked to trade-off different habitat areas and as a result the implicit prices reflect the mixtures of habitat types being improved. Therefore the value of wetlands is part of a broader set of initiatives to protect habitat areas and is not entirely separate from grassy woodland and scrubland areas.

The questionnaire refers to improving the quantity and quality of habitat area. The implicit prices therefore refer to good quality habitat. This would require revegetation of cleared areas, creating linked corridors of habitat as well as undertaking pest control and measures to protect and maintain these areas over time.

Care must taken in comparing these welfare estimates and the market value of agricultural land. Selling prices reflect current market conditions and all the institutional arrangements that govern the use of a given parcel of land. Thus the market price of a cropping area reflects the institutional arrangements that allow this land to be used for agriculture combined with the characteristics of the land such as rainfall, soil types, infrastructure, etc. The implicit prices reported here are welfare estimates that reflect the amount of money that respondents are willing to pay as part of a levy for increased habitat area. Grazing land, potentially suitable for revegetation currently sells at the upper end of South Australians' willingness to pay for scrubland habitat. However, South Australians' willingness to pay for grassy woodlands is considerably lower than the current selling prices for cropping land (for barley) which might sell for $1900 to $2500 (Pers. Comm. P Taylor, Elders Real Estate, October 22, 2004).

The estimates in this report refer to willingness to trade off an amount of household income in the form of a levy each year for 5 years only. There are other vehicles for paying for these habitat improvements including reallocated resources within the public sector. One of the split samples in this study considers the changes in welfare estimates when the State budget is reallocated instead of a levy being introduced to fund these changes. Results will be presented in a subsequent report.

If the policy environment in South Australia changes significantly with respect to habitat protection or other significant levies are introduced, the use of these implicit prices may become difficult to justify. As time passes attitudes and awareness of issues change and this is likely to be reflected in elicited values.

5 CONCLUDING REMARKS

The purpose of this study was to add and extend the economic valuation of habitat for South Australia. Asking people to make choices generates data but it also raises awareness about the difficult choices. Through the process of engaging the community as part of focus group work, pre-testing the questionnaire and finally surveying the community, it became apparent that people were concerned about the balance between preserving habitat and the livelihoods of people. They expressed concern for both the people and the environment.

The report contains a series of willingness to pay estimates based on extensive econometric analysis. There is support for habitat protection and improvement. This support is likely to be genuine as the questionnaires went out with CSIRO, State Government and Commonwealth Government logos on the cover. There are a number of levies in place at present in South Australia which fund projects relating to the River Murray and Emergency Services. While it was made clear that this was a research project, people understood that the information would contribute to the debate about how landscapes might be configured.

The econometric analysis produced a series of estimated coefficients and implicit prices. Direct tests to select among the more sophisticated techniques are not available. From an analytical point of view the estimation techniques which impose less structure on the error term hold more appeal. Thus the results from the Multinomial Probit model and the Covariance-Heterogeneity model are probably the best estimates of willingness to pay that can be compiled at this time. South Australian's willingness to pay, using population distribution weights, are as follows:

Scrublands

- Cov-Het $808 per hectare
- MNP $717 per hectare

Grassy Woodlands

- Cov-Het $1,164 per hectare
- MNP $1,019 per hectare

Wetlands

- Cov-Het $1,909 per hectare
- MNP $1,543 per hectare

There are very strong regional differences in willingness to pay. People in the Upper SE, the people living closest to this habitat, have very different preferences for habitat improvement. The Upper SE has a zero willingness to pay for grassy woodlands. They have a low willingness to pay for wetlands. However, they have a higher willingness to pay for scrublands than is observed in Adelaide and the rest of the State.

When comparing South Australian's willingness to pay estimates with recent real estate transactions, it is apparent that South Australians' willingness to pay for scrubland habitat is close to the market price for land suitable for grazing. However, South Australians' willingness to pay for grassy woodlands is considerably lower. Willingness to pay for wetlands is more difficult to assess, as there is limited market value for a wetland.

This is the first report from the Value of Habitat and Agriculture study. Two subsequent reports will be released in 2005. The second report will focus on the importance of the timeframe for the improvements to habitat to occur using this report as a base. The third report will focus on the differences between using a levy and re-allocating the existing State budget towards habitat improvement.

REFERENCES

Adamowicz, W. (2004). "What's it worth? An examination of Historical Trends and Future Directions in environmental Valuation". *Australian Journal of Agricultural and Resource Economics* 48: 419-444.

Adamowicz, W. & P. Boxall (2001). "Future directions of Stated Choice Methods for the Environment Valuation". Paper prepared for Choice Experiments: A New Approach to Environmental Valuation. London April 10, 2001.

Anderson, C. (2003). "Policy Implication of Alternative Economic Approaches to Population Heterogeneity in Stated Preference Surveys". Paper presented at the American Agricultural Economics Association Meetings.

Armsworth, P., B. Kendall & F. Davis (2004). "An introduction to biodiversity concepts for environmental economists" *Resource and Energy Economics* 26: 115-136.

Arrow, K. *et al.* (1993). "Report of the NOAA Panel on Contingent Valuations". *US Federal Register* 58: 4602-4614.

Australian Bureau of Statistics. (2002). 2001 Census Basic Community Profile and Snapshot.

Bennett, J. & W. Adamowicz (2001). "Some Fundamentals of Environmental Choice Modelling". *The Choice modelling Approach to Environmental Valuation*. J. Bennett and R. Blamey, ed. Edward Elgar, pp. 37-72.

Bennett, J., R. Blamey and M. Morrison (1997). *Valuing damage to South Australian wetlands using the Contingent Valuation Method*. Canberra, LWRRDC Occasional Paper 13/97.

Christy, M. et al. (2002). *Developing Measures for Valuing Changes in Biodiversity: Phase 1 a Review of Relevant Ecological and Economic Literature*. Report to DEFRA London, UK.

Christy, M. et al. (2003). *Developing measures for Valuing Changes in Biodiversity: Phase 2 Report*. Report to DEFRA London, UK.

Department of Environment Heritage and Aboriginal Affairs. (1999). *Biodiversity Plan for the South East of South Australia*.

Greene, W. (2003). *Econometric Analysis*. 5th Edition. Prentice Hall.

Harper, J. & D. Hawksworth (1995). *Biodiversity: Measurement and Estimation*. D Hawksworth, ed. Chapman and Hall, LondonHajkowicz, S., M. Young, D. Hatton MacDonald, S. Wheeler and D. Young (2000). *Supporting Decisions: Understanding Natural Resource Management Techniques*, CSIRO Land and Water Client Report, June 2000.

Layton, D. (2000). "Random Coefficient Models for Stated Preference Surveys". *Journal of Environmental Economics and Management* 40: 21-36.

Lockwood, J. (1999). "Agriculture and biodiversity: finding our place in this world". *Agriculture and Human Values* 16: 365-379.

Louviere, Jordan J. (2004). "Random Utility Theory-Based Stated Preference Elicitation Methods: Applications In Health Economics With Special Reference to Combining Sources of Preference Data" *CenSoC Working Paper No. 04-001*.

Louviere, J., D. Hensher & J. Swait. (2000). *Stated Choice Models: Analysis and Application*. Cambridge University Press.

McFadden, D. & K. Train. (2000). "Mixed MNL Models for Discrete Response". *Journal of Applied Econometrics* 15: 447-470.

Morrison, M. (2000). "Aggregation Biases in Stated preference Studies". *Australian Economic Papers* 76: 215-230.

Morrison, M., J. Bennet, R. Blamey & J. Louviere. (2002). 'Choice Modeling and Tests of Benefit Transfer', *American Journal of Agricultural Economics*, vol. 84, issue 1, pp. 161.

Pearce, D & D. Moran. (1994). *The Economic Value of Biodiversity*. IUCN - the World Conservation Union. Earthscan Publications.

Pearce, D. (2001). "Valuing Biological Diversity: Issues and Overview". *Valuation of Biodiversity Benefits: Selected Studies*. OECD, Paris.

Poe, G.L., Giraud, K.L. and Loomis, J.B. (2002). Simple Computational Methods for Measuring the Difference of Empirical Distributions: Application to Internal and External Scope Tests in Contingent Valuation. AAEA/AERE Summer Meeting, Long Beach, CA

United Nations Environment Programme. (1992). *Convention on Biodiversity*, NA 92-7807, June 5, 1992, New York.

Whitten, S. & J. Bennett (2000). "Wetland Management Trade-offs in the Upper South-East of South Australia. *Rural Society* 10(3): 341-360.

Whitten, S. and J. Bennett (2002). "A Travel Cost Study of Duck Hunting in the Upper South East of South Australia". *Australian Geographer* 33:207-221.