The value of habitat and agriculture in the Upper SE, South Australia

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Abstract

Governments face challenges in balancing the financial benefits from land-clearing and agriculture and the benefits associated with the existence of quality habitat for indigenous flora and fauna. Land clearing and draining of wetlands to enable increased agricultural production pose a threat to the remaining native vegetation. The benefits associated with these conflicting land uses can be compared by converting the tangible benefits of agricultural production and some of the more intangible values associated with remnant vegetation into the same metric – dollars. This study uses a non-market valuation technique known as choice modelling to elicit monetary values for three main types of remnant vegetation – wetlands, scrublands and grassy wooldlands. The study focuses on a region in South Australia known as the Upper South East where there are significant areas of habitat that are currently under threat. Willingness to pay values for habitat area using multinomial probit and covariance heterogeneity models are presented. Significant differences between responses from people in the Upper SE and Adelaide, the largest metropolitan area in the State, are found.

1. Introduction

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 given to landholders about the most appropriate ways to configure land. Cleared land typically provides a series of financial benefits for landholders and the community through agricultural production and regional development opportunities. Uncleared land also provides a stream of intangible benefits. Uncleared land, whether in a conservation area or on private land, provides a series of direct and indirect benefits to local people and to people living in cities further away.

Areas of scrubland, grassy woodlands and wetlands on private land provide significant benefits to the landholder. People may derive some recreational benefits relating to hunting, bird-watching, walking and hiking, etc. Wetlands may also 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 that provide both 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 may bring satisfaction to others, which economists call *existence* or *passive use* value.

This paper focuses on habitat areas and the indigenous plants, animals and birds that are supported by these habitats. This approach builds and extends the valuation literature that has tended to focus on the preservation of single and multiple species (Pearce, 2001; Nunes and van den Bergh 2001). However, there have been significant steps forward with valuation studies such as Garrod and Willis (1997) that consider biodiversity improvements in coniferous forest habitat. Christie et al (2004) has extended this approach further by considering key elements of biodiversity and ecosystem services.

This paper summarises the results of a non-market valuation study of habitat for indigenous plants, animals and birds in an area of the State of South Australia, known as the Upper South East (Upper SE). The study uses a non-market valuation technique known as Choice Modelling (CM) to elicit monetary values from people in the Upper SE, Adelaide and the rest of the State for improved habitat. There have been a number of non-market studies supported or commissioned in Australia that consider the existence values associated with wetlands and river health (Bennett et al., 1997; Whitten and Bennett, 2000 and 2002, van Bueren and Bennett 2004, Morrison and Bennett, 2004).

Pearce (2001) has suggested that there are so many pressures to clear and develop land that 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. This study is designed to add to the information set for policy-makers considering changes to policies and programs. 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 suitably linked corridors and areas of quality habitat. Putting the tangible benefits of agricultural production and some of the more intangible values associated with habitat into the same metric, as dollars, enables a clearer understanding of these conflicting values from the perspective of society. Economists have argued that incorporating these existence values in benefit cost analysis is a means of transparently setting out the trade-offs in the face of scarce resources (Randall, 2000 and Hanley and Shogren, 2002). The challenge for governments interested in both these intangible benefits to society from habitat and regional economic growth due to agricultural production is in establishing appropriate means of trading off benefits accruing across society.

2. Approaches to valuation

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. There are number of techniques which could provide monetary estimates of environmental benefit and/or damage. The techniques can be broadly grouped as market value approaches, reveled preference techniques and stated preference approaches. A stated preference techniques was employed in this study, where respondents were given a set of scenarios and asked to state their preference for different outcomes. These usually involve respondents making a monetary payment to achieve an improved environmental outcome as in contingent valuation and choice modeling (CM).

To estimate option and existence (including bequest) values, it is necessary to use a stated preference technique, as there are no market data available. The CM approach is often preferred to contingent valuation because it provides a richer set of information for policy makers. This is because the technique is used to provide estimates of the value of environmental attributes, which can then be used to provide value estimates for any alternative within the attribute space used in the study.

The CM technique is used for a wide array of research and policy-related problems which fall in the domain of choice. CM can be used to evaluate problems such as the potential response of individuals to the introduction of a new product or a government program with public and private implications. CM is based on the idea that people derive satisfaction from the properties or attributes of consumer goods and experiences. The individual, however, often faces trade-offs when considering the attributes of the various goods and services on offer and their cost. Consumers make these decisions everyday with the goods and services they purchase.

A well-presented choice experiment will convey information about brands, attributes and prices or costs in a way that minimises bias and engages the individual in a process of trading off outcomes against cost. In an environmental valuation application, a real problem (eg declining river health) which requires a response by government with respect to a change in environmental quality is described to respondents. Typically, the problem is one of poor environmental quality, and the response by government is to implement projects to improve quality. This would require each household to pay increased taxes and levies. However, some policy scenarios could involve a decrease in some environmental quality. In this situation, the choice experiment would involve decreases in quality and levels of compensation. In experimental settings, willingness to pay has often been found to be lower than willingness to accept compensation for similar changes (eg Kahneman et al., 1991). Thus it is important to ensure that the scenario presented to respondents is consistent with their property rights when designing stated preference questionnaires.

3. Theoretical model

The random utility model underlies the choice modelling approach. In a choice modeling question, a respondent is assumed to choose one choice set of habitat areas over any other if the satisfaction derived from that option and its corresponding attributes is greater than the other alternatives. This random utility model has served as the basis for modelling choices in a variety of applications (Ben-Akiva and Lerman, 1985). The respondent, t, receives utility from choosing a particular combination of habitat areas. Utility is assumed to have two parts, an observable systematic component (V_{tk}) and a random unobservable component (ε_{tk}).

$$U_{tk} = V_{tk} + \varepsilon_{tk} \tag{1}$$

where V_{tk} equals the product of B_t, a vector of coefficients, and X_{tk} the observable variables that relate to the alternative k and the individual t. The probability (π_{tk}) that any particular set of habitat areas k of the choice set C is chosen by individual t can be written as:

$$\pi_{tk} \quad = \quad \Pr\,[\, V_{tk} \;+ \varepsilon_{tk} \geq V_{tl} \;+ \varepsilon_{tl} \;;\, \forall\, k \neq l \in C \,] \tag{2}$$

If the unobservable components are identically, independently distributed (IID assumption) as Type I extreme values according to Maddala (1983), the probability that any particular alternative will be chosen can be written as:

$$\pi_{tl} \quad = \quad \frac{\exp\,(V_{tl}\,)}{\sum \exp(V_{tk}\,)} \tag{3}$$

This formulation allows for a closed form solution and the estimation of a multinomial logit (MNL) model of choice. However, the formulation implies a number of restrictions, in particular the property of independence of irrelevant alternatives (IIA property). Within the literature, a number of less restrictive specifications of this model of choice have been developed including nested logit, random parameters logit and multinomial probit. In this paper we will focus on a variant of the nested logit model and the multinomial probit model.

Following Bhat (1997), the Nested Logit model can be specified as

$$\begin{aligned} P_{ta} &= \frac{\exp(V_{ta})}{\exp(V_{ta}) + \exp(\theta_t + \ln \Gamma_t)} \\ P_{tm} &= \frac{\exp(\theta_t + \ln \Gamma_t)}{\exp(V_{ta}) + \exp(\theta_t + \ln \Gamma_t)} \cdot \frac{\exp(V_{tb} / \theta_t)}{\Gamma_t} \;\; \mathit{for}\ m = b, c \\ \mathit{with} \quad & \Gamma_t = \exp\,(V_{tb} / \theta_t) + \exp\,(V_{tc} / \theta_t) \end{aligned} \tag{4}$$

where θ_t is the scale parameter, the subscripts a, b and c are the three options in the choice set.. The covariance heterogeneity model is then a variant of the nested logit model where the scale parameter θ_t is constrained to be between 0 and 1 and specified to be a function of the attributes:

$$\theta_t = F(\alpha + \gamma' z_t)$$

where z_t is a vector of individual characteristics, γ is a vector of parameters to be estimated and F is a transformation function. If γ equals 0, then there is thought to be an absence covariance hetrogeniety. (5)

The Multinomial Probit model consists of

$$U_{tk} = B_t^{'} X_{tk} + \varepsilon_{tk} \sim N\left[\,0, \Sigma\,\right] \quad (6)$$

where X_{tk} is again the alternative specific information relating to alternative k and individual t, B_t is the associated vector of parameters, but ε_{tk} is a random term that is distributed normally with a mean of zero and a variance-covariance matrix of Σ.

3.1 Implicit prices for habitat areas

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 a 1000 hectares of good quality habitat is added to the stock of habitat in the Upper SE that would otherwise occur in ten years. The implicit price is a per household value, each year for five years.

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

$$IMPLICIT\ PRICE = -\frac{B_{Habitat\ Area}}{B_{Levy}} \quad (7)$$

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. Implicit prices provide information on the relative importance of different habitat areas to respondents.

4. Questionnaire design

A questionnaire was designed and data collection undertaken between October and November 2003 to elicit values from South Australians regarding the importance and willingness to pay for habitat. The questionnaire asks respondents to trade-off scrublands, grassy woodlands and wetlands against changes in a levy. The base version questionnaire follows conventional questionnaire design principles (Bennett and Adamowicz, 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 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 nine blocks with six choice sets in each questionnaire version. The attributes are presented in Table 1. A description of the habitat areas is included in Figure 1. An example of a choice set included in the questionnaire is included in Figure 2.

5. Modelling the choices of respondents

A random sample of households listed in the white pages in South Australia (Australia on Disk database) was drawn for three areas in South Australia, the capital city Adelaide, the Upper SE and the rest of State (excluding Adelaide and the Upper SE). 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. The response rate was 38.2% using this phone recruitment followed by mail-out strategy. A total of 731 usable surveys from Adelaide, the Upper SE and the rest of the State were received. The basic socio-demographic characteristics of the sample are summarised in Table 2.

Several regression techniques were used to explain the relationships between the levels of the habitats, the levels of the levy, socio-demographic characteristics of the respondents and the probability of choosing a particular option. The techniques included Multinomial Logit (MNL), Covariance-Heterogeneity (Cov-Het) and Multinomial Probit (MNP) models.

The MNL Model is considered to be the "workhorse" in the field of choice modelling given the ease of estimation. The MNL model is provided as a base for comparison. As the modelling techniques become more computational 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. The variables used in model estimation are summarised in the Textbox below.

Summary of 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 respondent's family owned land or worked in the Upper SE? (1=yes)

EDUC - education level of the respondent

In this section, the results from the application of these modelling techniques are presented. The MNL model is presented first in Table 3. Some summary statistics are reported including the overall goodness of fit in the form of a likelihood ratio index (ρ^2), which is a computed value between zero and one that reflects the improvement over a model containing only the constant. Typically good models are in the range of 0.2 and 0.4 (Louviere et al., 2000). The next consideration is the sign and significance of the estimated parameters. 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).

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 (much more so than scrublands), it is possible that respondents do not support this habitat area being increased as it takes productive land out of agriculture. Socio-demographic information and information about attitudes of the respondents towards the environment were incorporated in the estimation by interacting the variables with the ASC.

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 who are less likely to choose an option to improve habitat. Male respondents are less likely to choose options that include improvements in habitat areas. However, in the Upper SE and Rest of State models, the gender of respondents is statistically insignificant. In the Upper SE and the rest of State, having children had a positive and significant influence on choice of habitat improvement options. In the All of State and Adelaide models, higher income levels were also associated with increased probability of 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 a positive and significant influence on choosing habitat improvement options. Similarly in all three areas, having visited the Upper SE had a positive and significant influence.

The MNL model has the property called independence from irrelevant alternatives (IIA), which means that the probability of choosing one of the options in a choice experiment 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 initial parameter vector.

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, several alternative modelling approaches were used, including the covariance-heterogeneity and the multinomial probit models.

5.1 Covariance heterogeneity models

The covariance heterogeneity model in Table 4 is an extension of the nested logit model in which the variance (error) of the models is allowed to vary with the socio-demographic characteristics of respondents. The tree is specified as a Status Quo/Non-Status Quo and the covariance heterogeneity is accommodated by specifying a number of individual characteristics (income, attitude towards whether improving the size and quality of habitat is 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 the Status Quo alternative.

5.2 Multinomial probit model

The multinomial probit model presented in Table 5 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 property. However, with the multinomial probit model, a normal distribution is assumed for the error terms. 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. In the models presented here, the standard deviations were allowed to be different, but the errors were specified as being uncorrelated due to computational limitations.

A number of interesting results emerged from the estimation and the calculation of implicit prices presented in Table 6. The covariance heterogeneity models tended to produce implicit prices which were higher than MNP models. The preference orderings of respondents in the rest of State and Adelaide are fairly similar with the Upper SE being different. In the Upper SE, people value scrubland areas higher than respondents in Adelaide and the rest of State, and have a zero willingness to pay for grassy woodlands. For wetlands, they have a lower willingness to pay than respondents in Adelaide or rest of State. Adelaide respondents have a relatively higher willingness to pay for wetland areas and grasslands than the rest of the State. In all of the models, rest of State and

Adelaide view scrublands as less valuable than grassy woodlands and wetlands. This is of the opposite of the preferences of respondents in the Upper SE.

Tests of differences between implicit prices generated using the Covariance-Heterogeneity model were also conducted using the approach described by Poe et al. (2002). These results are shown in Table 7 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 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.

The South Australian government was interested in being able to use the non-market benefits in cost-benefit analysis. This requires aggregation from 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 and 59% were not interested. 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. 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. Using this experience of valuing the size and quality of the Macquarie Marshes, it is assumed in extrapolating from the sample to the population for this project that 50% of households in South Australia have the same preferences as the study sample.

5.3 WTP estimates for South Australia

The willingness to pay estimates are arranged from highest to lowest for the State by each habitat in Table 8. These aggregate values were calculated assuming a discount rate of 5% across the five years that the levy was to be collected.

Grazing land, potentially suitable for revegetation for as scrubland, 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).

6. Concluding remarks

The purpose of this study was to add and extend the information available about the economic value of habitat in 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 in the region and the environment.

The results from this study suggest that there is support for habitat protection and improvement. This support is likely to be genuine as the questionnaires went out with a CSIRO, State Government and Commonwealth Government logos on the cover – hence respondents were likely to believe that the results from this study would be consequential. 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.

Substantial regional differences in willingness to pay were found. 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 and a higher willingness to pay for scrublands than is observed in Adelaide and the rest of the State. No differences were found between the willingness to pay of respondents in Adelaide and the rest of the State. The willingness to pay of respondents in Adelaide for all three kinds of habitat was found to be the same as respondents in the rest of the State.

These are important findings for the benefit transfer literature. The first finding, that respondents residing in the study area have different values to those living outside of the study area confirms the findings in the existing literature (eg Morrison et al 2002, Van Bueren and Bennett 2004, Morrison and Bennett 2004). However, the results presented here also represent an original contribution to the benefit transfer literature. While further studies would indicate the generalisability of this finding, the results suggest that value estimates do not need to be derived separately for (1) a major capital city and (2) all other areas within a state located away from a case study site within a regional area. 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. Thus preserving grassy woodlands will need to be a public policy decision. Willingness to pay for wetlands is more difficult to assess, as there is limited information about market prices for wetlands.

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Tables

Table 1 – Attributes Used in Choice Sets

	Status Quo	Attribute levels in other alternatives
Levy	$0	$10, $20, $40, $60, $80 and $100
Habitat Areas:		
Scrublands	66,000	73,000, 80,000 and 90,000 ha
Grassy Woodlands	46,000	51,000, 56,000 and 63,000 ha
Wetlands	73,000	81,000, 88,000 and 99,000 ha

Table 2 – Socio-Demographic Characteristics of Respondents

Variable Description	Sample Characteristics
Socio-Demographic Information:	
Mean age	52.3 years
Gender of respondents	55% male
Children	80.5% have children
Education	21.1% completed a tertiary degree 37.3% Started and/or completed diploma or certificate 27.3% completed high school 20.7% had not completed high school
Income level	33.5% under $500 gross weekly income 33.3% have $500 to $1000 gross weekly income 13.6% have $1000 to $1499 gross weekly 12.7% 1500 + missing 6.9%
Attitudes, Knowledge &Activities:	
Interest in the environment	70.3% Strong interest 29.0% Little interest
Involvement in farming	45.4% either directly or indirectly involved in farming 54.6% of respondents are not involved in farming
Recent Visit to Upper SE	72.6% have visited the Upper SE in the past 5 years
Answered quiz questions about survey	82.3% answered at least 6 out of 8 correctly
Attitude to preserving habitat in other parts of State	23.7% agreed that other areas of the State might be important as habitat 59.7% neither agreed nor disagreed that other areas of the State might be important as habitat 14.6% disagreed that other areas of the State might be important as habitat

Outdoor Activities	50.3% bushwalk 31.7% bird watch 8.2% hunt 37.9% fish

Table 3 - MNL Model

Variable	All SA	Adelaide	Upper SE	Rest of State
	Estimated Coefficient (Standard Error)	Estimated Coefficient (Standard Error)	Estimated Coefficient (Standard Error)	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**	-0.0672**	-0.0313	-0.0463

	(0.0376)	(0.0326)	(0.0353)	(0.0332)
AGE^2	0.0007**	0.0005*	0.00008	0.0004
	(0.000343)	(0.000300)	(0.000338)	(0.000323)
LAND	-0.644***	-0.713***	-0.081	-0.239
	(0.180)	(0.168)	(0.182)	(0.209)
ρ^2	0.249	0.248	0.280	0.223
# of choice sets	4203	1732	1318	1297
log likelihood	-3200.737	-1361.060	-940.819	-984.638

*** significant at the 1% level, ** significant at the 5% level, * significant at the 10% level

Table 4 - 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_1	-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***	-0.295***	-0.0688**	-0.0508

	(0.0966)	(0.0828)	(0.0319)	(0.0470)
S_LAND	-0.199**	-0.218**	0.0240	-0.00139
	(0.092)	(0.0857)	(0.0273)	(0.0428)
ρ^2	0.35	0.355	0.325	0.304
# of choice sets	4203	1732	1318	1297
log likelihood	-1231.166	-1358.895	-977.852	-1002.996
X^2	1324.943	1497.931	940.264	874.728

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

¥ significantly different from 1 at the 5% level.

Table 5 - MNP Results

Variable	All SA	Adelaide	Upper SE	Rest of State
	Estimated coefficient (Standard Error)	Estimated coefficient (Standard Error)	Estimated coefficient (Standard Error)	Estimated coefficient (Standard Error)
ASC	-2.895*** (0.348)	-3.237*** (0.325)	-3.955*** (0.3935)	-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)
INCOME1	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	4203	1732	1318	1297
log likelihood	-1240.117	-1372.457	-963.751	-997.877
X^2	780.851	893.690	684.999	537.647

*** significant at the 1% level, ** significant at the 5% level, * significant at the 10% level

Table 6 - Implicit Prices for Habitat

	Implicit Prices (Per Household, Per 1000 hectares, each year for 5 years)		
	Scrublands	Grassy Woodlands	Wetlands
Whole State:			
MNL	$0.76	$1.05	$1.41
Cov-Het Model	$0.81	$1.16	$1.54
MNP	$0.72	$1.02	$1.40
Adelaide:			
MNL	$0.77	$1.02	$1.45
Cov-Het	$0.82	$1.18	$1.60
MNP	$0.74	$1.00	$1.44
Upper SE:			
MNL	$1.17	*	$0.64
Cov-Het	$1.36	*	$0.95
MNP	$1.11	*	$0.62
Rest of State:			
MNL	$0.56	$1.02	$1.19
Cov-Het	$0.76	$1.20	$1.33
MNP	$0.55	$1.07	$1.19

* Statistically insignificant from zero

Table 7: 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

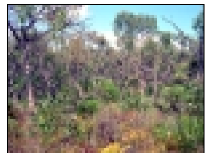
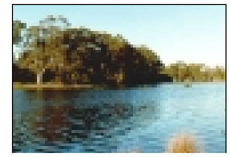
* the value 0.073 indicates that the implicit prices for scrubland in the Upper South East ($1.36) and Adelaide ($0.82) are significantly different at the 7.3% significant level

Figure 1 – Information about different types of native vegetation in the Upper South East

	Scrublands 	Grassy Woodlands 	Wetlands 
Description and Habitat Value	Scrublands are low, thick vegetation such as shrubs and mallee. The land has limited potential for agriculture. Scrublands provide habitat for a wide variety of birds and animal species. A number of different wrens can be found in scrublands.	Grassy woodlands are open areas with larger trees. These areas are often cleared because the land is good for agriculture. Woodlands provide habitat for nesting for bird species such as Red-tailed Black Cockatoos. They also provide habitat for a variety of other animals such as possums and kangaroos.	Wetlands are areas where water accumulates for short or long periods during the year. They contain open water, rushes and sedges and may have shrubs and trees around their edges. Wetlands provide habitat for fish, frogs, snakes, migratory waterbirds such as ducks and wading birds such as the Red-capped Plover.
Rare, Vulnerable or Endangered Species Present	**Animals such as** Red-Necked Wallabies Pygmy Possums **Birds such as** Malleefowl, Yellow-tailed Black Cockatoos and Heathwrens **Plants such as** Spiral Sun-orchid and Monarto mintbush	**Animals such as** Wombats Sugar Gliders **Birds such as** Red-tailed Black Cockatoos, Little Lorikeets, Diamond Firetails, Black-chinned Honeyeaters Stone Curlews **Shrubs and plants including** Jumping Jack Wattles Orchids	**Animals such as** Tortoises Goannas **Birds such as** Freckled Ducks Latham's Snipe **Freshwater fish such as** Pygmy Perch
Ecosystem	Prevention of water logging and control of	Prevention of waterlogging and control	Water purification Flood mitigation

Functions	salinity Windbreaks Pollination	of salinity Shelter for stock and native species Pollination	Fish breeding Bird breeding Recharge of groundwater
Area in 1980	250,000 hectares	75,000 hectares	187,000 hectares
Current area	77,000 hectares	54,000 hectares	86,000 hectares
Expected area in 10 yrs time	66,000 hectares	46,000 hectares	73,000 hectares
Expected Change in 10 yrs	Loss of 11,000 hectares	Loss of 8,000 hectares	Loss of 13,000 hectares

Figure 2 – 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