Towards the development of a transferable set of value estimates for environmental attributes.

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Paper presented at the 45th Annual Conference of the Australian Agricultural and Resource Economics Society, January 23 to 25, 2001, Adelaide, South Australia.

Towards the development of a transferable set of value estimates for environmental attributes.[1]

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Abstract:

Estimates of environmental values are frequently required as inputs to cost-benefit analyses when evaluating alternative resource use options. One strategy to avoid the high cost of conducting empirical work when non-market values are involved is to use value estimates from an existing study and to transfer them to the context of interest (a practice known as 'benefit transfer'). However, the transfer of values is subject to a host of potential errors and could lead to poor policy recommendations. This paper reports the results of an Australian Choice Modelling study that was designed to address the issue of benefit transfer. The Choice Modelling technique is amenable to benefit transfer because, unlike the Contingent Valuation Method, it produces values for resource use outcomes that can be 'decomposed' into component values associated with particular attributes of resource use change. These attribute values have the potential to be 'reconstructed' according to the scenario changes under investigation in the new policy context. In this study, tests are conducted to examine the validity of transferring estimates derived in a national context to different regional contexts and inferences are made about the impact that differing frames of reference and population characteristics have on value estimates.

Keywords: Choice modelling, benefit transfer, non market valuation, environment.

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[1] The research reported here was a component of a project commissioned by the National Land and Water Resources Audit (NLWRA). The work was undertaken by Unisearch Pty Ltd. when the authors were formerly located at the University of New South Wales. The views expressed in this paper are those of the authors and not necessarily those of the NLWRA. Errors and omissions are the responsibility of the authors.

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Introduction

Land and water degradation in Australia imposes a range of non-market costs on society but the size of these costs is not well understood. The absence of a market for environmental and social impacts means that community values for these goods are difficult to quantify. Consequently, government policies for addressing resource degradation are often formulated without explicitly incorporating non-market values into a formal benefit-cost analysis of the projects involved. The failure to account adequately for non-market values could result in environmental goods being under-supplied and/or lead to an inefficient allocation of public expenditure across projects with different environmental outcomes.

The efficient targeting of public investment requires an understanding of the trade-offs that the community is willing to make between alternative environmental outcomes and between environmental protection versus development. Whilst there is debate in the literature as to how these trade-offs should be measured, the neo-classical economic approach is to adopt an individual utility-maximising framework and use a money metric to quantify welfare measures for alternative outcomes. The economic techniques developed for estimating non-market values are broadly classified as either stated preference or revealed preference methods. The former includes a range of survey techniques that elicit respondent preferences (eg. Contingent Valuation), whilst the latter group of methods infer preferences and values from observed behaviour (eg. the Travel Cost Method).

Both types of methods have been used in Australia to value particular aspects of environmental damage associated with land and water degradation. One way of avoiding the relatively high cost of estimating values each time a new region or policy is investigated is to consult pre-existing studies and to transfer an 'appropriate' estimate to the target area of interest (a process known as 'benefit transfer'). A bank of existing studies are catalogued in ENVALUE, a database developed by the New South Wales Environmental Protection Authority[4]. Similar databases have been established overseas (eg. see Lincoln University, New Zealand[5] and the Canadian EVRI database[6]). While the concept of benefit transfer is appealing, it can lead to significant errors if the source values obtained from a pre-existing study are context-dependent and that context does not match the conditions which prevail at the target area of interest (Brouwer, 2000).

A primary aim of this study is to establish value estimates (implicit prices) for a set of generic environmental and social attributes in a national policy context and to develop a systematic procedure for their calibration so that they can be validly transferred to regional contexts within Australia. By selecting attributes that are generic, a wide range of different policy options with diverse environmental and social outcomes can be subjected to benefit transfer. Values for the attributes are estimated using a stated preference technique known as Choice Modelling. It was selected as the preferred method because it is particularly suited to the role of providing value estimates that can be used as a source of data for benefit transfer. This is because, relative to Contingent Valuation (CV), it enables better control over framing the goods or policy under investigation and affords the deconstruction of the total value of a resource change into its component attributes (Boxall *et al*. 1996).

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4 The ENVALUE database is located at http://www.epa.nsw.gov.au/envalue

5 The New Zealand database is located at http://learn.lincoln.ac.nz/markval/Default.htm

6 The EVRI database is located at http://www.evri.ec.gc.ca/evri

In order to determine the validity of transferring the national values to a regional context, Choice Modelling (CM) surveys were undertaken in two regional case studies using an identical set of attributes as those used in a national survey. The values from the different survey 'frames' and population samples are used to conduct a series of convergent validity tests (referred to as benefit transfer tests in this paper). These tests provide an insight into the scaling adjustments that are required if national value estimates are to be validly transferred to regional contexts.

The paper is organised as follows. Firstly, a brief description of the CM technique is provided. This is followed by a review of the literature that canvases the main factors responsible for errors in the benefit transfer process. In the third section the research design is outlined and an overview is given of the sampling and framing strategy that was used to facilitate the benefit transfer tests. The fourth section contains a summary of the methods used to design the questionnaire and administer the survey. Details about the model specification are contained in section five. In the sixth section of the paper, the results of the national study are presented, followed by the results of the benefit transfer tests. The paper concludes with a discussion of how these results can facilitate regional and national assessments of the non-market benefits associated with natural resource management policies.

The Choice Modelling technique

The CM technique originates from the marketing and transport literature where it has been used extensively to analyse consumers' choices of products and transport modes (McFadden, 1974, Ben-Akiva and Lerman, 1985). More recently the technique has been applied to the task of environmental valuation (eg. Adamowicz, Louviere, and Williams, 1994; Bennett and Blamey, 2001; Blamey, Rolfe, Bennett, and Morrison, 2000).

In a CM application, respondents are presented with a series of questions, each of which asks respondents to choose their preferred option from several alternatives. The set of options contained in each question is known as choice set. Typically, five to eight choice sets are included in a questionnaire. The options are presented to respondents as the outcomes of different management policies, where the outcomes are described in terms of a standard set of attributes. The options are differentiated from one another by allowing the levels of the attributes to vary systematically according to an orthogonal experimental design. Orthogonality is required to ensure there are no correlations between the attributes so that the separate importance of all the attributes can be determined in the choice model. One of the options in each choice set is defined as a 'no change' policy and, as such, the levels of attributes for this option are held constant at the status quo.

By including a financial impost as one of the attributes (eg. an environmental levy) it is possible to estimate respondents' willingness to trade-off income for improvements in environmental and social outcomes relative to the status quo. The choices made by a respondent are assumed to be a product of utility maximising behaviour. The utility obtained by individual *i* from choosing alternative *j* in a choice set is given by:

$$V_{ij} = (q_j, c_{j,} s_{i,} \varepsilon_{ij})$$

where q_j is a vector of outcome attributes, c_j is the cost of the alternative (given by the levy attribute), s_j is a vector of the individual's socioeconomic characteristics, and ε_{ij} is an error term. An error term is included to reflect the fact that the researcher does not know all the factors that contribute to an individual's utility. Thus, the probability of individual *i* choosing alternative *j* is given by:

$$\Pr_{ij} = \Pr[\{v_{ij}(q_j, c_j, s_i) + \varepsilon_{ij}\} \geq \{v_{ik}(q_k, c_k, s_i) + \varepsilon_{ik}\}] \quad \forall j \neq k$$

This equation says that the probability of a respondent choosing alternative *j* is equal to the probability that the utility associated with that alternative exceeds the utility associated with any other alternative *k* in the choice set. The random utility model is made operational by adopting a particular cumulative density function for the unobserved component of utility, ε. If the ε's are independently and identically distributed with an Extreme Value Type I (Weibull) distribution, then the individual's probability of choosing alternative *j* from a total of *J* possible options is given by a multinomial logit model (McFadden, 1974):

$$\Pr_j = \frac{\exp(v_j)}{\sum_{k=1}^{J} \exp(v_k)}$$

Parameters of the utility function are estimated by Maximum Likelihood which finds values for the coefficients that maximise the likelihood of the pattern of observed choices.

The estimated utility functions permit the calculation of value estimates for environmental and social improvements. Two types of value estimates can be derived from the model. Firstly, the implicit price for attribute *n* is given by the marginal rate of substitution between the non-monetary attribute and the financial impost. Thus, the implicit price (*IP*) for an attribute *n* is

$$IP_n = \frac{\beta_n}{-\beta_\$}$$

calculated as follows:

where β_n is the coefficient on the n^{th} environmental or social attribute and $\beta_\$$ is the coefficient on the monetary attribute. The second type of value estimate provided by the model is a compensating surplus measure of welfare for policies that involve changes in the levels of multiple attributes. The calculation of welfare impacts of this type is beyond the scope of this paper. Instead, the present study focuses on the attribute implicit prices.

Review of benefit transfer issues

The validity of transferring value estimates from a source study to a new target area is dependent on the degree of similarity between the source study and target area with respect to frame and population characteristics. Here, the term 'frame' is used to describe the way in which aspects of a situation influence people's involvement in, and experience of, a situation. Therefore, when an individual is asked about his/her willingness to pay for policies to improve the environment, the 'commodity' under investigation is embedded in a frame that comprises a range of factors. The main factors are:

- scope of commodity provision.
- substitute and complementary goods.
- institutional setting.
- questionnaire cues.

A framing effect is said to occur when any one of these factors, or combination of factors, influences the size of respondent willingness to pay (Bennett and Blamey, 2001). The availability of substitute and complementary goods is a major component of the frame. Regular embedding is said to occur when respondents are willing to pay more for a good when it is assessed individually compared to when it is valued as part of a more inclusive package (Bennett, Morrison, and Blamey, 1998). This effect is consistent with standard economic theory in that the values for a good decrease when a consumer is provided with an increasingly larger array of substitute goods (Randall and Hoehn, 1996).

Therefore, the critical questions for practitioners of benefit transfer are: what array of substitutes is appropriate for the policy under investigation?, and can we be confident that the source values are derived from a study in which the commodity frame has been adequately communicated to the respondent? CM has a distinct advantage over CV in this regard because it enables the researcher to define the range of outcomes under investigation and to communicate the 'commodity frame' to respondents in a meaningful way. Similarly, the explicit presentation of attribute levels in a CM application could reduce the incidence of 'warm glow' effects, which refer to the situation where respondents perceive the questionnaire as an opportunity to purchase 'moral satisfaction', without paying attention to the actual changes being valued. By contrast, CV questionnaires often leave the range of impacts open to interpretation, making it difficult for the researcher to ascertain what types of impacts the respondent has valued (Willis and Garrod, 1995).

Another aspect of the valuation frame is the scope of provision of a good. If the scale of environmental changes valued in the source study are different to those under investigation in the target area, then it is possible that marginal values for the good(s) will not be transferable. The reasons for non-transferability are twofold: Firstly willingness to pay could diminish at the margin, implying that the implicit prices for attributes estimated using a questionnaire that deals with large changes in scope will be underestimates if transferred to a target area that involves small environmental improvements. Secondly, changes in scope often result in a widening or narrowing of the array of substitute goods presented to respondents (Rolfe, 1998). Therefore sensitivity to scope could be confounded by regular embedding.

In addition to framing effects, differences in population characteristics between the source and target areas could render value estimates non-transferable. Characteristics that influence values include socioeconomic factors, attitudes, social norms and demographics. Some of these factors, together with some elements of the frame (eg. site characteristics), can be controlled for by estimating willingness to pay as a function of explanatory variables. Indeed, benefit function transfer has been shown to out-perform the transfer of unadjusted point estimates in tests of convergent validity (Brouwer, 2000). However, many aspects of a population and frame that influence values cannot be adequately captured using explanatory variables. For this reason other ways must be found to 'calibrate' valuation models so that they are applicable across different frames and populations.

The research design

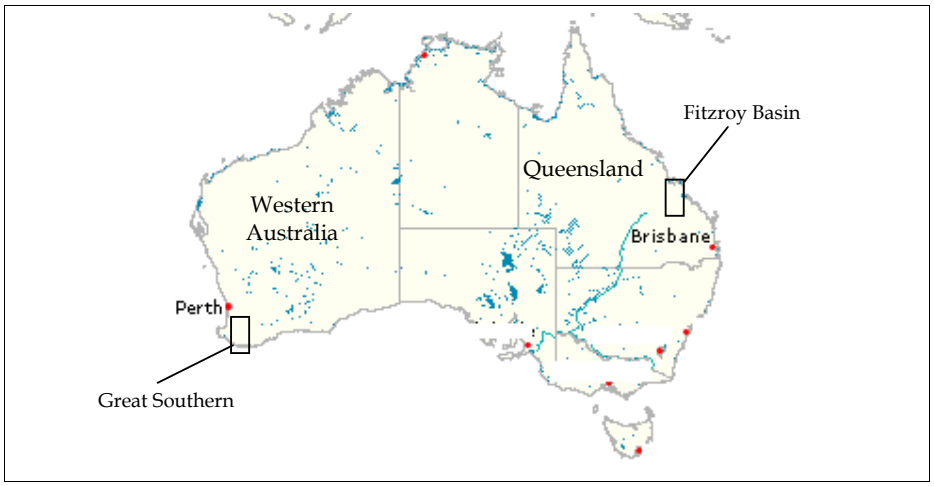
In this application the core study was a national survey in which Australian households were asked about their preferred outcomes from the management of land and water degradation in Australia. In order to test the effects of frame and population, separate versions of the CM questionnaire were developed for two case study regions (A and B). The regional questionnaires were identical in every respect to the national version (same attributes and question format) with the exception that:

- the levels of the social and environmental attributes were varied to reflect the conditions that prevail in each region (the range of levels used for the monetary attribute were the same across all versions); and
- the background information accompanying each questionnaire version was tailored to reflect the issues and policies that are pertinent to each study area.

The case study questionnaires were issued to households living in the vicinity of each region. Two population sub-samples were drawn for each case study region, one from the region's main population centre (RP) and the other from the region's state capital city population (CP). The overall framing and sampling strategy is shown in Table 1. The strategy allows an investigation of seven different combinations of frame and population.

The two agricultural regions selected for the study were the Great Southern Region of Western Australia (GSR), which covers an area of 8.3 million hectares, and the Fitzroy Basin of Central Queensland (FBR) which comprises 14.3 million hectares (Figure 1). The main population centres for the GSR and FBR are Albany and Rockhampton respectively. The capital cities are Perth and Brisbane respectively.

Figure 1: Location of case study areas and capital cities corresponding to each region.



The degradation issues in each of these regions are markedly different. Over 90 per cent of original vegetation in the Great Southern has been cleared for agriculture and dryland salinity is now emerging as a prominent problem, with approximately ten per cent land area salt-affected. In contrast, the Fitzroy Basin is still undergoing development and over 20 per cent of the region's native vegetation remains intact. Whilst degradation is less advanced in this region, some ecosystem types are not protected from clearing and concerns have been expressed about the pollution of waterways by agricultural activities (Queensland SOE Report, 1999). In addition to these physical differences between the two regions, there is evidence to suggest that Queenslanders have different attitudes towards the environment to Western Australians[7]. Thus,

[7] A survey by the Australian Bureau of Statistics (ABS) indicated that Western Australian residents have a greater awareness of environmental problems than any of the other States while Queenslanders have the lowest levels of awareness (ABS, Catalogue 4602, 1999).

the case studies provide a means of testing the transferability of the national estimates over a wide range of circumstances.

The research strategy facilitated five benefit transfer tests. The tests examine the equality of attribute implicit prices derived from models based on data generated from different combinations of questionnaire frame and population sample (Table 1). Each test constitutes a paired model comparison. The tests investigate the validity of:

1. transferring values from the national study (NF NP) to the case study regions (RF RP, or RF CP)[8];

2. transferring values from one case study region to another (eg. RF_ARP_A to RF_BRP_B);

3. transferring values held by a regional population from a case study region (RF RP) to a national context (NF RP).

4. transferring case study values from a regional population (RF RP) to a city population (RF CP).

5. transferring national study values to different populations (NF RP_A to NF RP_B to NF NP).

Table 1: The framing and sampling strategy used to facilitate tests of benefit transfer.

		POPULATION (P)				
		Regional (RP)		**Capital City (CP)**		**National (NP)**
		Region A	Region B	Region A	Region B	National
FRAME (F)	Region A	RF_ARP_A	8	RF_ACP_A	8	8
	Region B	8	RF_BRP_B	8	RF_BCP_B	8
	National	NF RP_A	NF RP_B	8	8	NF NP

Questionnaire design and survey administration

The questionnaire was developed in consultation with members of the public using structured focus groups. In total, 65 people attended seven focus group meetings over a period of two months. The meetings were primarily used to gain an understanding of public awareness of environmental issues associated with land and water degradation and to check communication aspects of the questionnaire. The concerns expressed by members of the focus groups formed the basis of the attributes selected for the CM application.

[8] See Table 1 for an explanation of the symbols.

Attribute selection

Five outcome-attributes of land and water degradation were selected for the application. They included three environmental attributes, a 'social impact' attribute and a monetary attribute (Table 2). The environmental attributes were defined so as to capture both the use and non-use values that members of the focus groups appeared to hold for the environment. Examples of use values are recreational pursuits (such as fishing) and the enjoyment of countryside aesthetics. Non use values are embodied in the endangered species attribute. In defining these attributes care was taken to minimise interdependencies between the attributes. A social impact attribute was included because the focus group discussions indicated that the public is concerned about rural population decline. It served to capture the effects of resource management policies that either enhance the prosperity of country communities or displace people from rural and regional areas.

Table 2 Attributes selected for the choice modelling questionnaire

Attribute	*Unit of measurement*
Endangered native species	The number of species protected from extinction.
Countryside aesthetics	The area of farmland repaired and bush protected (ha).
Waterway health	The length of waterways restored for fishing or swimming (km).
Country communities	The net loss of people from country towns each year.
Environmental levy	Annual household levy ($).

Scenarios

The valuation exercise was introduced to respondents by explaining that public money is currently being spent on a wide range of environmental projects and that this level of action would result in a specific set of outcomes 20 years hence (the status quo). Respondents were told that additional environmental improvements could be secured if extra funds were available. The questionnaire introduced the concept of a household levy to be paid annually over the next 20 years as one possible mechanism for funding extra action. The levy was set to zero in the status quo option but all other options involved a non-zero payment (a range of $20 to $200 was used).

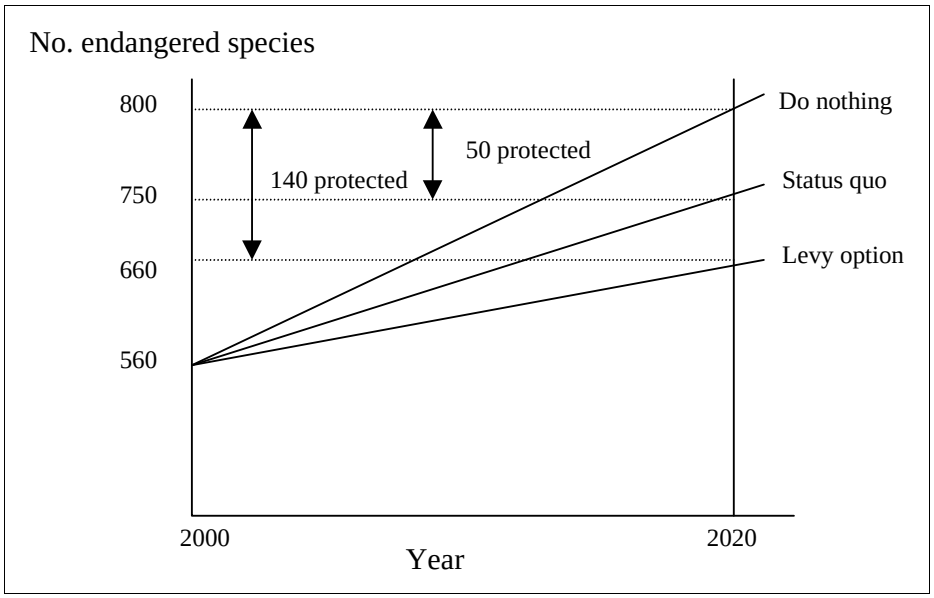
The environmental and social outcomes associated with each option, including the status quo, were expressed relative to a hypothetical benchmark scenario, namely a 'do nothing' scenario for which not even the current level of action is undertaken. In Figure 2 an example is given using the endangered species attribute. Country populations were assumed to decline under all scenarios, but the size of loss was greater for some options than others.

Each version of the questionnaire consisted of five choice sets with three alternatives per choice set. The alternatives included a status quo option (A) and two different levy options (B and C). A sample choice set is contained in the appendix. Three levels were assigned to each attribute, the upper and lower levels being chosen so as to encompass the range of potential outcomes that could eventuate from alternative policies. The levels of the different attributes were combined systematically to make up alternative options according to an experimental design[9]. In order to

[9] A fractional factorial experimental design was used to assign attribute levels to the alternatives. The resultant alternatives were assigned to 5 blocks such that each respondent was only presented with the alternatives that comprise one block of the fractional factorial.

assist respondents with their deliberations, approximations of the current levels of each attribute were summarised in an introductory pamphlet that accompanied the questionnaire[10].

Figure 2: An example of scenario outcomes for endangered species.



Administration

The questionnaire was pre-tested over two days using a door-to-door, drop off and pick up method. 25 households were selected for the pre-test. Households from a broad range of socioeconomic strata were included in the pre-test sample. Only minor modifications were made to the questionnaire following the pre-testing phase as debriefs with the respondent households did not reveal any significant communication problems.

A market research firm (Barbara Davis and Associates) was contracted to administer the questionnaire as a mail-out; mail-back survey. A random sample of households were drawn from the telephone directory. The size of the total sample was 10,800 households, comprising a main national sample and smaller samples for each case study region (Table 3).

Table 3: Sample sizes.

	Questionnaire Frame		
	National (NF)	Great Southern (RF_A)	Fitzroy Basin (RF_B)
Population sample			
NP (National)	3200	-	-
RP_A (Albany)	1200	1200	-
RP_B (Rockhampton)	1200	-	1200
CP_A (Perth)	-	1400	-
CP_B (Brisbane)	-		1400

[10] A copy of the complete questionnaire and information pamphlet are available from the authors upon request.

Model specification

A nested structure was used to model respondents' choices of alternative options[11]. This structure assumes that respondents make an initial upper level decision to either support an environmental levy or retain the status quo (SQ). If the levy was supported, then the respondent was faced with a second-level decision that involved the choice between two different levy options. The utility functions underpinning each choice alternative were specified using the variables described in Table 4.

Table 4: Description of explanatory variables

Variable	*Description*
Species	Endangered species, measured by the number of species protected from extinction by 2020.
Look	Landscape aesthetics, measured by the area of farmland repaired and bush protected (hectares) by 2020..
Water	Waterway health, measured by the total length of waterways restored for fishing or swimming (kilometres) by 2020..
Social	Viability of country communities, measured by the net annual loss of population from country towns in 2020.
Cost	The environmental levy, measured as an annual levy on household income over a 20 year time period.
ASC	Alternative specific constant for the levy option, assigned a value of 1 for options B and C and zero otherwise.
Sex	Respondent's gender, assigned a value of 0 for females and 1 for males.
Age	Respondent's age category, ranging from 1 to 6 (youngest to oldest).
Income	Respondent's before-tax household income category, ranging from 1 to 8 (lowest to highest).
Green	Dummy variable assigned a value of 1 for respondents who are members of, or donate to, an environmental organisation and 0 otherwise.
Confuse	Dummy variable assigned a value of 1 for respondents who reported that they found the background information confusing, 0 otherwise.
IV	Inclusive value representing the expected utility from alternatives in the lower level of the nest.

The utility function associated with the upper-level choice of a levy option was hypothesised to be influenced by the respondent's socioeconomic characteristics (*Age, Sex, Income*), environmental disposition (*Green*), and whether or not the respondent was confused by the background information (*Confuse*). The probability of the levy being supported was expected to increase with income and pro-environment sentiment, but decrease for respondents who reported confusion. In addition to these individual-specific variables, the choice between retaining the status quo or paying a levy was assumed to be influenced by a constant term (*ASC*) and an inclusive value (*IV*) which is a measure of expected utility from the alternatives nested beneath the upper level choice[12]. The utility functions for the upper level alternatives are given below:

$$V_{\text{levy}} = ASC + \beta_1 Sex + \beta_2 Age + \beta_3 Income + \beta_4 Green + \beta_5 Confuse + \alpha_1 \text{IV}_{\text{levy}}$$

$$V_{\text{SQ}} = \alpha_2 IV_{\text{SQ}}$$

[11] Initially a multinomial logit model was used to describe the data relationships. However, this specification was shown to result in breaches of the Independence of Irrelevant Alternatives (IIA) assumption. See Kling and Herriges (1995) for more details on nested logit models.

[12] The IV coefficient for the levy alternative (α_1) is an estimated parameter, while the α_2 coefficient on the status quo IV was restricted to one.

At the lower level of the nest, the utility associated with the SQ option and each levy option was assumed to be influenced by the attributes and their corresponding levels. Thus, the utility for option *j* is given by:

$V_j = \beta_6 Species + \beta_7 Look + \beta_8 Water + \beta_9 Social + \beta_{10} Cost$

Results

The overall response rate to the survey was 16 per cent, which equated to 1569 completed questionnaires. This response rate is net of the ten per cent of questionnaires that were undeliverable due to outdated address details. Of those respondents who completed a questionnaire, the majority (89 per cent) answered all five choice sets, while a small proportion (8 per cent) only answered a subset of the five questions. Three per cent of respondents failed to complete any of the choice sets. A majority (80 per cent) of respondents who answered all the choice questions opted for a levy option in at least one of the choice sets. The remaining 20 per cent consistently selected the status quo option.

The national study

The national model (NF NP) was one of seven nested logit models that were estimated using data from different combinations of questionnaire frame and population sample as depicted in Table 1. Whilst only the parameter estimates for the national model are reported in this article (Table 5), all seven models are found to exhibit a satisfactory goodness of fit[13]. The Likelihood Ratio Indices (LRI) range between 0.17 and 0.26. In the majority of models, the environmental attributes (*Species*, *Look*, and *Water*) are statistically significant and have positive signs, which indicates that increases in the levels of these attributes add to an individual's utility. The signs on *Social* and *Cost* are significant and negative across all models, which means that utility is reduced by increases in the levy and higher levels of population loss from country areas.

The individual-specific socio-demographic variables (*Sex, Age, Income, Green*, and *Confuse*) are also significant in explaining respondent choices. The probability of choosing a levy option is shown, in most models, to increase with a respondent's income and pro-environment disposition. The positive sign on income supports the theoretical validity of the models, as willingness to pay should be accompanied by an ability to pay. *Confuse* is a significant variable in all but one of the models. Its negative sign agrees with the prior that respondents who were confused by the questionnaire were more inclined to choose the status quo option. *Age* and *Sex* are significant in some of the models but the effect of these variables on choice is not consistent.

Attribute implicit prices calculated using the national model are reported in Table 6. These estimates indicate that respondent households are willing to pay 68 cents per annum over the next 20 years for every species that is protected from extinction. Landscape aesthetics are valued at 7 cents per 10,000 hectares of countryside restored, while a similar amount (8 cents) is estimated for the restoration of 10 kilometres of waterway. The implicit price of social decline is a 9 cent cost for every 10 people that leave country areas. These estimates provide a basis for assessing the size of benefits that are attributable to a specific environmental improvement or, alternatively, the cost associated with a decline in environmental quality or rural population at the national level[14].

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[13] See van Bueren and Bennett (2000) for full results of all the models estimated.

[14] A linear relationship is assumed for the attribute implicit prices. While *a priori* a non-linear relationship would be expected, reflecting diminishing marginal utility for increases in the quantity of an attribute, the

Table 5: Parameter estimates for the National model (NF NP)

Lower level choice		
Species	5.49E-03	**
Look	6.01E-08	**
Water	6.33E-05	**
Social	-6.94E-05	**
Cost	-8.13E-03	**
Upper level choice		
ASC	-5.85E-01	**
Sex	-3.24E-01	**
Age	7.96E-02	**
Income	2.62E-01	**
Green	2.47E-01	**
Confuse	-7.07E-01	**
Inclusive values		
IV staus quo	1	
IV levy	0.3434	**
No choice sets	2329	
Log Likelihood	-2196.05	
LRI	0.2271	
LRI adjusted	0.2251	

* denotes significance of parameter at the 10% level,

** denotes significance at the 5% level.

Table 6: Attribute implicit prices derived from the National model (NF NP), expressed in terms of annual household values.

Attribute	Units	Mean	95% confidence interval
Endangered species	$ per species protected	0.68	0.47 -- 0.88
Look of the land	$ per 10,000 ha restored	0.07	0.02 -- 0.14
Waterway health	$ per 10 km restored	0.08	0.04 -- 0.16
Country communities	$ per 10 persons leaving	-0.09	(- 0.11) – (-0.07)

data does not support this prior as log and quadratic transformations of the explanatory variables did not prove superior in terms of the statistical significance of the variables and goodness of fit statistics.

Benefit transfer tests

Five benefit transfer (BT) tests were undertaken, comprising paired comparisons of implicit prices estimated using the seven different models. The hypotheses for these tests and the test results are reported below. For each test, the null hypothesis of equality is rejected if the 95 per cent confidence intervals associated with the two *IP's* for each attribute *n* do not overlap. Confidence intervals for the value estimates were calculated using the Krinsky and Robb (1986) technique.

BT Test 1

This test examines the equality of implicit price (*IP*) estimates sourced from the national study (*NF,NP*) and those sourced from each case study frame and regional population (RF_x,RP_x), where *x* denotes case study *A* or *B*. Both population and frame vary in this comparison.

H_0: IP_n (NF,NP) = IP_n (RF_x,RP_x)

H_1: IP_n (NF,NP) ≠ IP_n (RF_x,RP_x)

The implicit prices derived from each of the three models are plotted in Figure 3. For all the attributes the null hypothesis is rejected and it is concluded that implicit prices from the national study are significantly lower than those estimated for attributes in the regional frame. The results support the prior of regular embedding; that is, consumers place a lower value on attributes when framed in a wide, national context versus a narrow, local context. A scope effect could also be responsible for the value differences given the larger changes presented to respondents in the national study. However, the nature of the test does not allow firm conclusions to be drawn about the cause of the differences because frame, scope and population are all variables.

Note that for species protection, the difference in value obtained from the national study and those obtained from the GSR study appears to be small relative to the other attributes. Therefore it is not possible to generalise the scaling factor required for transferring *IP*'s from the national study to a region as value differences appear to be attribute-dependent.

BT Test 2:

This test examines the equality of value estimates obtained for region *A* and region *B*, sourced from the populations residing in each region:

H_0: IP_n (RF_A,RP_A) = IP_n (RF_B,RP_B)

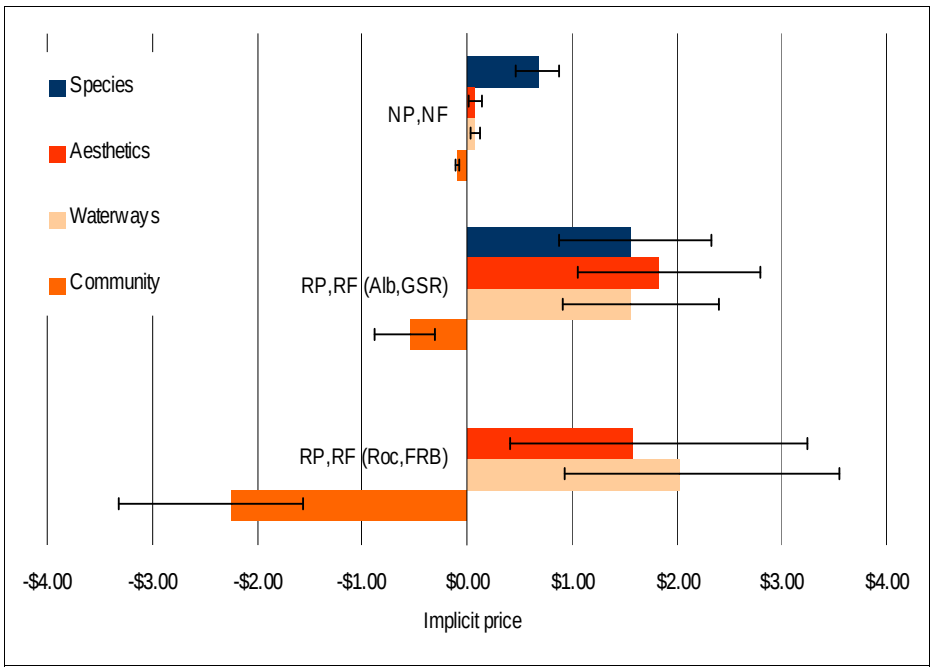
H_1: IP_n (RF_A,RP_A) ≠ IP_n (RF_B,RP_B)

and for populations residing in the capital city corresponding to each region:

H_0: IP_n (RF_A,CP_A) = IP_n (RF_B,CP_B)

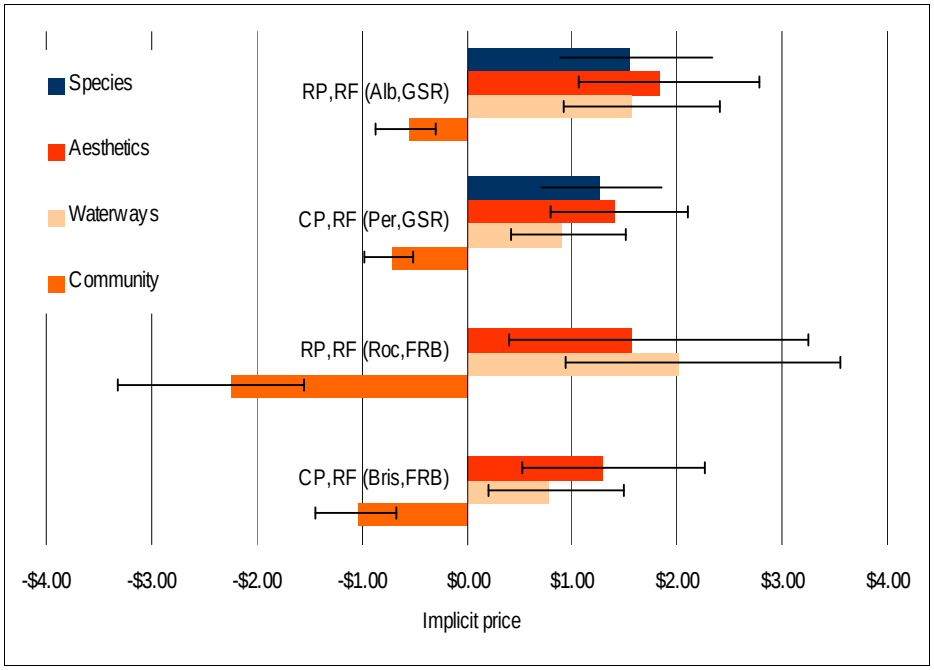
H_1: IP_n (RF_A,CP_A) ≠ IP_n (RF_B,CP_B)

Figure 3: Attribute implicit prices examined under BT Test 1.



Note: Values for non-significant attributes are not plotted. Confidence intervals are shown by the error bars.

Figure 4: Attribute implicit prices examined under BT Tests 2 and 4.



Note: Values for non-significant attributes are not plotted. Confidence intervals are shown by the error bars.

The objective of BT Test 2 is to understand whether the same attributes are valued differently by respondents in different case study regions. Whilst the attributes are the same, the frame in which they are 'embedded' is substantially different. Furthermore, the characteristics of each case study population are likely to be different. Some of this variation in population characteristics is controlled for by the socioeconomic variables included in the utility functions but attitudinal differences remain unaccounted for.

The results indicate that the implicit prices for Waterways and Aesthetics are consistent across the two case study regions for both city and regional populations (Figure 4). However, the regional population of the FRB hold a significantly higher value for social impacts in their region. Conversely, species protection is not valued in the FRB (a non-significant attribute) but it is significant in the GSR. Thus, differences in frame and/or population characteristics prohibit the direct transfer of *IP*'s for the species and social attributes from one region to another.

- **BT Test 3:**

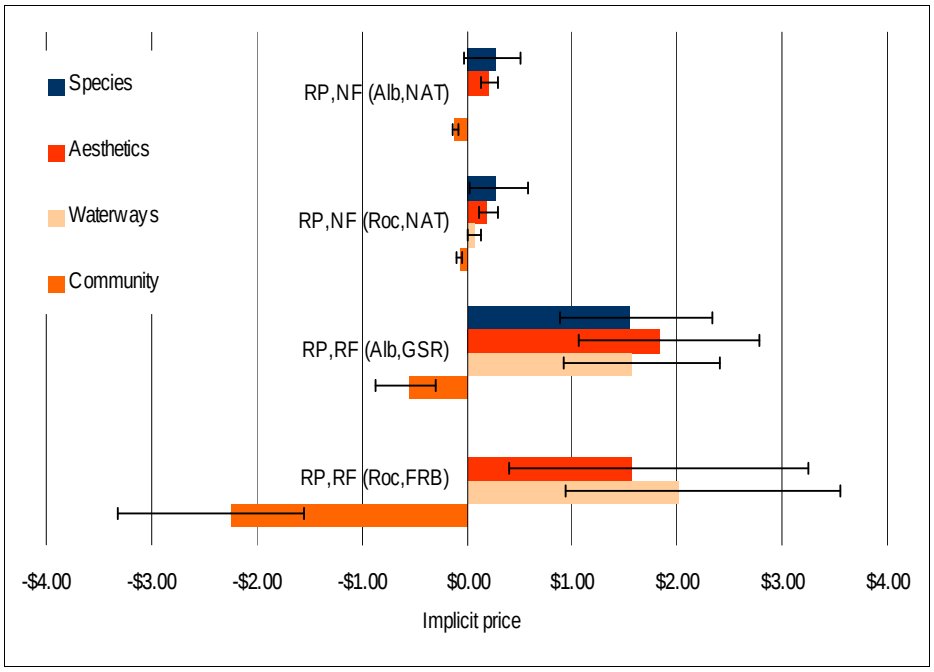
This test examines the equality of value estimates sourced from the national (*NF*) and regional (RF_x) versions of the questionnaire that were issued to separate samples of the same regional population (RP_x):

H_0: $IP_n\ (NF,RP_x) = IP_n\ (RF_x,RP_x)$

H_1: $IP_n\ (NF,RP_x) \neq IP_n\ (RF_x,RP_x)$

The objective of this test is to gauge the extent of the framing effect. This is made possible because the two samples for each case study test are drawn from the same population, so population effects are controlled for. Upon comparing the *IP*'s from each frame, the null hypothesis is rejected for all attributes. It is concluded that respondents have significantly higher values when attributes are framed in a regional context (Figure 5).

Figure 5: Attribute implicit prices examined under BT Test 3



Note: Values for non-significant attributes are not plotted. Confidence intervals are shown by the error bars.

- **BT Test 4:**

This test examines the equality of value estimates sourced from the regional versions of the questionnaire (RF_x) that were issued to a regional population (RP_x) and city population (CP_x). The hypotheses are:

H_0: $IP_n\ (RF_x,RP_x) = IP_n\ (RF_x,CP_x)$

H_1: $IP_n\ (RF_x,RP_x) \neq IP_n\ (RF_x,CP_x)$

The objective of the test is to establish the extent to which the values held by people living locally in a case study region extend beyond the region to city households. The results indicate that, with the exception of the social attribute, implicit prices for the attributes are statistically equivalent for regional and city households (Figure 4). This result is contrary to the common presumption that use values (eg. recreation and aesthetics) decrease with distance from the policy site. While city respondents appear to hold smaller values for Waterways and Aesthetics relative to local people in the region, the differences are not statistically significant. In the case of social impacts, regional households in the FBR study do have significantly higher values than households residing in Brisbane city.

- **BT Test 5:**

This test examines the equality of value estimates sourced from the national study (NF NP) and those sourced from the national version of the questionnaire that was issued to respondents in regions A and B. The hypotheses for this test are:

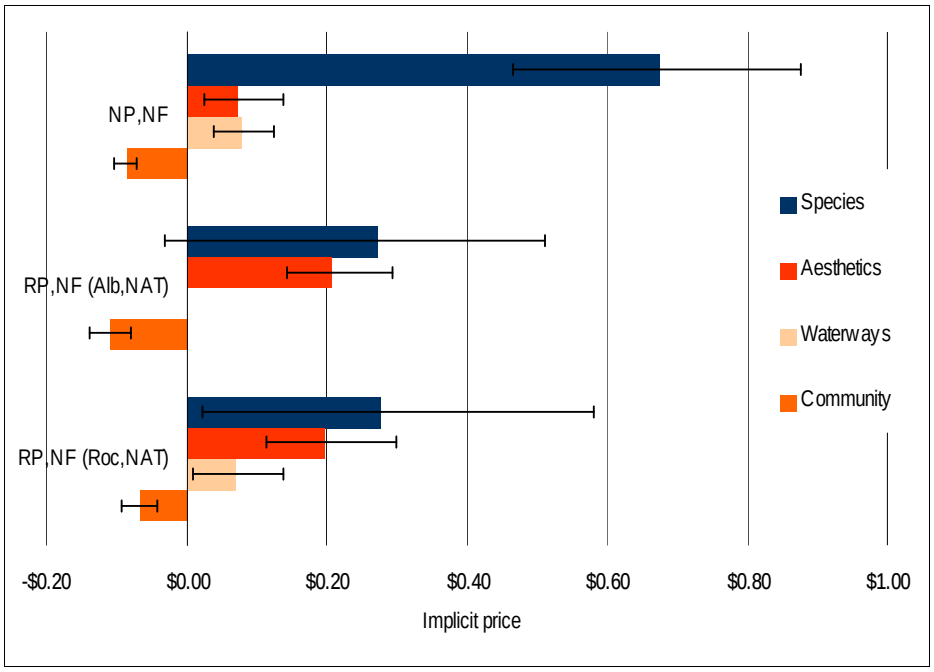
H_0: $IP_n\ (NF,NP) = IP_n\ (NF,RP_A) = IP_n\ (NF,RP_B)$

H_1: $IP_n\ (NF,NP) \neq IP_n\ (NF,RP_x)$ *or* $IP_n\ (NF,RP_A) \neq IP_n\ (NF,RP_B)$

The objective of this test is to determine whether population characteristics that are unaccounted for in the choice model influence significantly the attribute values. This is achieved by holding the frame constant (ie. the national version of the questionnaire) but allowing the population to vary. The implicit price estimates plotted in Figure 6 support the hypothesis that population effects are important for some attributes. Specifically;

- species protection is more highly valued by the national sample of households compared to households from the two case study regions; and
- countryside aesthetics is more highly valued by regional respondents than the national sample.

Figure 8: Attribute implicit prices under examination in BT Test 5



Note: Values for non-significant attributes are not plotted. Confidence intervals are shown by the error bars.

Conclusion

The most notable result obtained by this study is the impact of framing on attribute values. The results show unequivocally that implicit price estimates sourced from the national study are lower than those derived from the regional case studies. One possible reason for the value differences is regular embedding. That is, respondents could be cognisant of a larger array of environmental issues in the national frame and, hence, associate smaller values to the attributes under investigation. Alternatively, a scope effect could be responsible for the differences meaning that the small changes in attribute levels presented to respondents in the case study questionnaires are valued more highly at the margin than the large changes in the national study.

Regardless of which factor is the dominant reason for the value differences, household value estimates from the national study should be scaled up if they are to be validly transferred to a regional policy context. Using the empirical data collected in this study (ie. BT Test 1) it is possible to formulate guidelines about the approximate size of scaling factor for calibrating the national value estimates to a regional context. A set of scaling factors for each attribute is presented in Table 7. A range of values is given, reflecting the variability between the regions examined in this study.

In applying these estimates to a regional context it is necessary to establish the geographic extent of the market. The results from BT Test 4 indicate that the market extends beyond the immediate case study region to include city residents in the State where the region is located. This being the case, regional values could validly be aggregated to the State's household population but it is beyond the scope of this study to make inferences about the validity of aggregating these benefit estimates to the national population.

Table 7: Scaling factors for calibrating the national estimates.

Attribute	*Scaling factor*
Species	x 2
Aesthetics	x 20 – 25
Waterways	x 20 – 25
Country communities	x 6 – 26

This study is the first of its kind in Australia to estimate non-market values for multiple impacts associated with land and water degradation within the same valuation framework. By contrast many previous valuation studies have employed CV which is limited to focusing on one-dimensional changes in environmental quality. The multi-attribute CM approach adopted in this study facilitates the testing of benefit transfer by presenting respondents in different regions with trade-off decisions involving a standard set of generic attributes. Thus, the results from this study are an advance on previous studies that do not consider adequately the impact of context effects and the transferability of benefit estimates.

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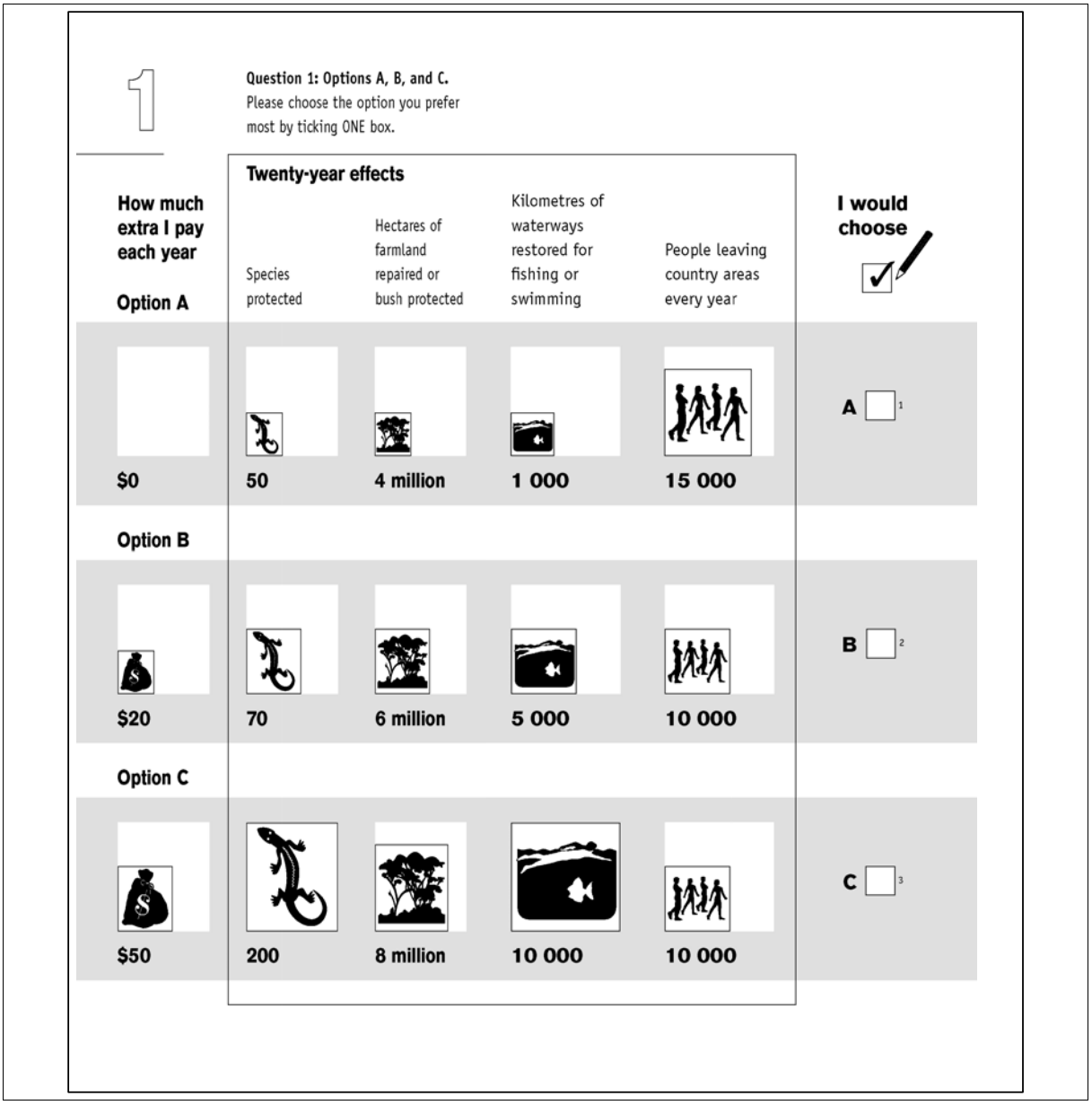
Appendix

Example of a choice set used in the CM questionnaire



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Question 1: Options A, B, and C.
Please choose the option you prefer most by ticking ONE box.

How much extra I pay each year	Twenty-year effects: Species protected	Hectares of farmland repaired or bush protected	Kilometres of waterways restored for fishing or swimming	People leaving country areas every year	I would choose
Option A					
$0	50	4 million	1 000	15 000	A ☐ 1
Option B					
$20	70	6 million	5 000	10 000	B ☐ 2
Option C					
$50	200	8 million	10 000	10 000	C ☐ 3