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

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Estimates of environmental values are frequently required as inputs to cost-benefit analyses when evaluating alternative options for managing natural resources. 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 source study and to transfer them to the target 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 significant overestimation or underestimation of welfare change. The present paper reports the results of a choice modelling study in which household values for the impacts of land and water degradation in Australia are estimated. A key objective of the present study was to test the validity of transferring estimates derived in a national context to different regional contexts. On the basis of these test results, inferences are made about the impact that differing contexts have on value estimates. The scale of value differences across the different contexts provides a guide for calibrating benefit transfer estimates.

1. 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 changes means that community values for these impacts are difficult to quantify. Consequently, government policies for addressing resource degradation are often formulated without explicitly incorporating non-market values into formal benefit-cost analyses. 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.

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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 published literature as to how these trade-offs should be measured, the neo-classical economic approach is to adopt a utility-maximising framework to estimate an individual's willingness to pay for environmental improvements or willingness to accept compensation for decrements. 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 (e.g., contingent valuation and choice modelling (CM)), whilst the latter group of methods infer preferences and values from observed behaviour (e.g., the travel cost method).

Both approaches 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.[1] Similar databases have been established overseas (e.g., see Lincoln University, New Zealand[2] and the Canadian Environmental Valuation Reference Inventory (EVRI) database[3]). 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 (Brouwer 2000).

1.1 Context factors

The context of a non-market valuation survey is governed by the frame of reference in which the non-market good is embedded. The frame constitutes a variety of factors, including: (i) the number and type of environmental goods (substitutes or complementary goods) that the respondent is aware of at the time of valuing the outcomes of a public policy; (ii) the scale of

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

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

[3] The EVRI database is located at http://www.evri.ec.gc.ca/evri

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environmental improvement (or the scope of provision); (iii) the institutional setting – for example, how environmental programs will be implemented and by whom; and (iv) various aspects of the questionnaire that might provide cues to the respondent. 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 (Rolfe and Bennett 2001).

Some of the framing effects can be accounted for by using a benefit function to transfer values from a pre-existing source study to a target area of interest. With this approach, a relationship is estimated which describes willingness to pay as a function of various environmental attributes and demographic characteristics of the respondent sample. The advantage of this approach – compared to using a simple average estimate of willingness to pay – is that differences in the source and target areas with respect to environmental attribute levels and population demographics can be partly accounted for in the transfer process. The relevant levels for these variables need only be substituted into the benefit function to estimate values for environmental impacts at the target site. However, this process assumes that the parameter coefficients of the source function are appropriate for describing the willingness to pay relationship at the target site – which is a brave assumption.

There are a number of reasons why the data relationships may change when moving from one context to the next. Not all the elements of framing can be accounted for by the transfer function. As mentioned above, the availability of substitutes has a major influence on values estimated using non-market surveys (e.g., Boxall *et al*. 1996). It is common to witness a result where 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. This effect is termed regular embedding and is consistent with standard economic theory. That is, the values for a particular good decrease when a consumer is provided with an increasingly larger array of substitute goods (Randall and Hoehn 1996; Bennett *et al.* 1998).

Another cause of transfer error is the failure to account for differences in the scale of environmental changes when moving from the source study to the target site. If the scale of environmental changes being evaluated at the target site differ extensively from the source study, it is possible that the parameter coefficients will differ. For example, a linear benefit function derived from the source study may not be appropriate for valuing large scale environmental impacts at a target site because values could diminish at the margin with higher levels of environmental quality. Furthermore, changes in scope often result in a widening or narrowing of the array of substitute and complementary goods presented to respondents (Rolfe 1998). Therefore sensitivity to scope could be confounded by regular embedding.

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In addition to framing effects, differences in population characteristics between the source and target areas could render the benefit function non-transferable. While some population characteristics can be controlled for by way of explanatory variables in the benefit function (e.g., age, income, education), there are many other factors that are difficult to capture such as attitudes and social norms. These factors have the capacity to influence willingness to pay, meaning that parameter coefficients could vary from the source study and the target site of interest.

Owing to the various framing and population effects that influence willingness to pay, a systematic way is needed for calibrating benefit functions and value estimates so that they are applicable across different contexts.

1.2 The present study

The study reported in the present paper investigates systematically the impact of context on value estimates and develops guidelines for calibrating value estimates. The objective of the guidelines is to allow practitioners of benefit transfer to select a set of value estimates that are most appropriate for the target area of interest and, where necessary, make scaling adjustments to the values as a means of correcting for contextual differences between the source study and the target area.

The CM technique is used to estimate people's willingness to pay for improvements in a number of generic environmental and social attributes – through a range of different resource management scenarios. The policy setting is land and water degradation in Australia. Choice modelling facilitates the disassembly of total scenario benefits/costs into component part worths – also known as attribute implicit prices. The implicit prices are a convenient way of transferring attribute values from a source study to a target site. The total benefit of an environmental improvement at the target site is estimated by repackaging the attribute values in accordance with the new levels of each attribute. This approach is, however, a shortcut to transferring the full choice model function and calculating compensating surplus measures of welfare change. As such, socioeconomic differences between the source and target populations are not adjusted for in the transfer process. Nor is the unobserved component of utility incorporated into the benefit estimate (this is captured by the alternative specific constant in the full-choice model).

Separate surveys are undertaken to estimate community values for national and regional policies. National policies are potentially relevant to the whole Australian population as attributes across the country are affected. The effects of regional policies are assumed to be more localised as the attribute changes are limited to one or two States. In the present study, the same set of attributes is used in each survey. The implicit prices

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Figure 1 Research design and benefit transfer tests.

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 the present paper). These tests provide an insight into the scaling adjustments that are required if national implicit price estimates are to be validly transferred to regional contexts.

Figure 1 sets out the structure of the research design and the tests employed. The segments of the triangle represent the different frames – that is, the national survey and the two regional surveys (Region A and Region B). The circles represent the different populations that were sampled, namely; the national population, the population of each region and the populations of the State capital cities corresponding to the two States in which the regions were located. In total, seven separate choice models were estimated, corresponding to the various combinations of frame and population depicted by the intersections in figure 1. This research design facilitated a variety of paired model comparisons as indicated by the numbered arrows. The five benefit transfer tests are as follows:

1. Test 1 examined the equivalence of values across the regional and national populations for attributes in the national frame. It tested for population effects, as frame was held constant and the population varied.

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2. Test 2 examined the transferability of national estimates to the case study regions. Therefore, it tested whether values held by the national population for attributes in the national context are equal to those held by regional populations for attributes in their local area. In this test both frame and population differ.
3. Test 3 examined the equivalence of values estimated for attributes in the national frame versus a regional frame, holding population constant.
4. Test 4 examined the equivalence of values held by regional households for attributes in each of the two case study regions. In this test both frame and population differ.
5. Test 5 investigated whether city and regional populations hold the same values for attributes in a given case study region. In this test the regional frame is held constant and the population is varied.

The objective of this testing procedure was to disentangle the effects of framing from population influences and to gauge the magnitude of these context factors. The scale and direction of value differences across the different contexts provide an approximate guide for calibrating benefit estimates for transfer.

The present paper is organised as follows. In section 2 a brief description of the CM technique is provided. Next, details of the questionnaire design and survey administration are given. This is followed by section 4, in which the choice models are described. The results are summarised in section 5 where key findings from the national survey are reported and the benefit transfer test results are examined. Section 6 provides guidelines for undertaking benefit transfer. The present paper concludes with a discussion of how these results can be used to inform regional and national assessments of the non-market benefits associated with natural resource management policies.

2. The choice modelling technique

The CM technique originates from the published 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 (e.g., Adamowicz *et al.* 1994; Blamey *et al.* 2000; Bennett & Blamey 2001). Choice modelling is suited to the role of benefit transfer because it allows value estimates of resource use changes to be disassembled into component values, where the components are attributes of change scenarios. Provided the physical impacts in the source study are similar in type to those at the target site, these attribute values can be transferred to a target site

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and reassembled to produce an estimate of the total welfare impact at the target site.

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 a 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 *status quo* policy and, as such, the levels of attributes for this option are held constant.

By including a financial impost as one of the attributes (e.g., 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:

$$V_{ij} = (\boldsymbol{q_j}, c_j, \boldsymbol{s_i}, \varepsilon_{ij}), \tag{1}$$

where $\boldsymbol{q_j}$ is a vector of outcome attributes, c_j is the cost of the alternative (given by the levy attribute), $\boldsymbol{s_i}$ 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. Therefore, the probability of individual i choosing alternative j is given by:

$$\Pr = \Pr[\{v_{ij}(\boldsymbol{q_j}, c_j, \boldsymbol{s_i}) + \varepsilon_{ij}\} \geq \{v_{ik}(q_k, c_k, s_i) + \varepsilon_{ik}\}] \quad \forall j \neq k. \tag{2}$$

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. This function is known as a random utility model. It is made operational by adopting a particular cumulative density function for the unobserved random component of utility, ε. If the ε's are independently and identically distributed with an Extreme Value Type I (Weibull) distribution, then an individual's probability of choosing alternative j from a total of J possible options is given by a multinomial logit model (McFadden 1974):

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$$\Pr_j = \frac{\exp(v_j)}{\sum_{k=1}^{J} \exp(v_k)}. \tag{3}$$

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.[4]

The estimated utility functions permit the calculation of implicit price estimates for environmental and social improvements. The implicit price for attribute n is given by the marginal rate of substitution between the non-monetary attribute and the financial impost. Therefore, the implicit price (IP) for an attribute n is calculated as follows:

$$IP_n = \frac{\beta_n}{-\beta_\$}, \tag{4}$$

where β_n is the coefficient on the nth environmental or social attribute and $\beta_\$$ is the coefficient on the monetary attribute.

3. Questionnaire design

Three versions of the CM questionnaire were developed, one for each of the three frames (National, Region A and Region B). A common set of attributes was used for all versions and the range of values used for the money attribute were the same for all versions. However, the levels of the social and environmental attributes were different for each version, reflecting the conditions that exist in each frame. The questionnaires were also differentiated from one another by slight variations in the background information that was given to respondents. By necessity, the background information was tailored to fit the issues that are pertinent to each study area.

The regions selected for the present study were the Great Southern Region of Western Australia (GSR) and the Fitzroy Basin Region of Central Queensland (FBR). The environmental degradation issues in these regions are markedly different and there is evidence to suggest that Queenslanders

[4] The Weibull distribution assumption imposes a restriction on the estimation of the Multinomial Logit model known as the Independence of Irrelevant Alternatives (IIA). This means that the unobserved component of utility for one alternative must be independent to the unobserved factors associated with other alternatives. If two alternatives share common features that are embodied in the error terms but not captured by the attributes, a violation of IIA is said to occur. The IIA restriction can be overcome by grouping like alternatives together and estimating a Nested Multinomial Logit Model.

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have different attitudes towards the environment to Western Australians.[5] Therefore, a priori, the CM value estimates obtained for these regions should differ. The case studies were selected so as to provide insights into how the national value estimates would need to be calibrated if they were to be transferred to regions with a range of varying contexts.

The questionnaires were 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. Participants were recruited from a cross section of demographic groups in each of the study locations. The meetings were used primarily to gain an understanding of public awareness of environmental and social issues associated with land and water degradation and to check communication aspects of the questionnaire. The discussions amongst members of the focus groups formed the basis for selecting the attributes used for the CM application.

3.1 Attribute selection

An objective of the present study was to select attributes that are generic enough to cover a wide range of circumstances – and therefore suitable for benefit transfer – yet specific enough to be meaningful to respondents and relevant for policy. The focus group sessions were used to develop attributes that struck a satisfactory balance between these criteria. In the group sessions, participants were asked to list the environmental factors, experiences and opportunities that they felt were important to protect. People commonly identified factors that imparted use- and non-use values. Definitions for the identified factors (or attributes) were developed in consultation with focus group participants to ensure that they were meaningful to respondents.

Another selection criteria for choosing the attributes was to minimise jointness of provision or interdependence between the attributes. This situation arises when changes in the level of one attribute are perceived by respondents to be related to changes in another. While interdependence is a common feature of environmental systems, every effort was made to choose attributes that would be perceived by respondents to be independent. Respondents were informed in the questionnaire that there are many plausible reasons why attributes could vary independently of one another – for example, native species could be protected by baiting programs to control feral animals, independent to changes in river management or farmland repair.

[5] 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, and Queenslanders have the lowest levels of awareness (ABS 1999a).

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Table 1 Attributes selected for the choice modelling questionnaire

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

After extensive workshopping with the focus groups, five outcome-attributes of land and water degradation were selected for the study, including three environmental attributes, a social impact attribute and a money attribute (table 1). While the interpretation of these attributes will inevitably vary among respondents, steps were taken to improve consistency by carefully describing each attribute. The restoration of waterways for fishing and swimming (Water) and the improvement of countryside aesthetics through the repair of degraded farmland (Aesthetics) were defined as use values. For example, respondents were told that programs to improve countryside Aesthetics would 'make degraded land more attractive by repairing eroded land and protecting native bush'. The emphasis was on visual appearance rather than the non-use aspects of biodiversity protection. Non-use values were represented in the questionnaire by outcomes that protect endangered native species from extinction (Species). A social impact attribute (Social) was included because the focus group discussions indicated that people are 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.

A background information leaflet was produced which contained concise descriptions of each attribute, together with information about the current levels of each attribute. For example, in the national questionnaire respondents were informed that currently 560 native species of plants and animals are listed on the national register as being endangered. It can be argued that native species are not a homogeneous commodity and that there may well be different values for different types of species protected. However, the aim of the present study was to define a set of attributes that could be used to evaluate community trade-offs at a macro level. In practice, if it is found that respondents hold values for native species, a microlevel analysis could be conducted as a follow-up study to get a better understanding of

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values for different categories of species if it was deemed relevant to the policy issue at hand.

3.2 Scenarios

Two types of policy options were presented to respondents for valuation:

1. A *status quo* scenario whereby the current level of investment in environmental programs continues over the next 20 years (at no extra cost to the respondent); and
2. A levy option whereby respondent households would be required to pay an annual levy in return for environmental improvements over and above what could be achieved under the status quo. The levy options ranged between $A20 to $A200 per annum.

Changes in attribute levels resulting from these scenarios were communicated to respondents by measuring all changes relative to a do nothing reference point, defined as the outcomes that would eventuate under a policy of zero investment in the environment. While this is a hypothetical policy, it serves as a benchmark to communicate what improvements are likely to eventuate under alternative levels of environmental expenditure – the *status quo* level and other higher levels funded by a levy. Figure 2 uses the Species attribute as an illustrative example of how the outcomes were measured. In this example, the *status quo* option will ensure 50 additional species to be protected relative to the do nothing scenario. In contrast, selecting the levy option would ensure that 140 species are protected, again relative to the do nothing reference point. Note that all scenarios involve more species

Figure 2 An example of scenario outcomes for endangered species.

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becoming endangered over the 20-year period. Selecting the levy option merely slows down the rise in the number of species that are endangered.

Under the levy option, all of the environmental attributes were defined to improve compared to the *status quo*. However, for the Social attribute, both positive and negative outcomes were formulated. This takes account of the possibility that some types of environmental programs funded by a levy could accelerate the migration of people from country communities (for example, the conversion of farmland into long rotation forestry), while other programs could stem migration losses, relative to the *status quo* case.

Attribute levels were selected based on available information about the current status of each attribute and how these attribute levels could change under different funding programs. Scientists and natural resource managers were consulted to ensure that the various scenario outcomes were feasible. Tables A1–A3 in the Appendix summarise the levels used for each questionnaire and the sources of information used to determine these levels. 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. It is important to note that CM (unlike contingent valuation) does not require precise information about the future level of attributes prior to the techniques' application. All that is required, a priori, for the valuation task is for the selected levels to cover the likely range of possible outcomes.

Each questionnaire consisted of five choice sets with three alternatives per choice set – a constant *status quo* option (A) and two different levy options (B and C) that varied across the choice sets. A sample choice set is contained in the Appendix (figure A1). The levels of the different attributes were combined systematically to make up alternative options according to an experimental design.[6] In order to assist respondents with their choice decisions, approximations of the current levels of each attribute were summarised in the background information pamphlet that accompanied the questionnaire.[7] The alternatives were not labelled with a policy name as the questionnaire aimed to estimate community values for attribute changes rather than specific policies or processes to achieve the outcomes. Previous studies have found that the inclusion of a policy label, such as Revegetation Program, can deflect respondent's attention away from the attribute outcomes by encoding additional information in the label (Blamey *et al*. 1999). Where this is the case,

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

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

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the transferability of attribute values is hampered because the impact values are not captured fully by the attribute set.

3.3 Survey administration

The questionnaire was pretested over two days using a door-to-door, drop off and pick up method. In metropolitan Sydney, 25 households were selected for the pretest. The households were drawn from a broad range of socio-economic strata. The pretests involved a detailed, face-to-face debriefing session after the respondent had completed the questionnaire. Only minor modifications were made to the questionnaire following the pretesting phase as debriefs with the respondent households did not reveal any significant communication problems.

The final version of the questionnaire was administered as a mail-out/mail-back survey in accordance with the research design outlined in figure 1. The national questionnaire was issued to a random sample of households from the national population and households from the main townships within the two case study regions.[8] Albany is the main town of the GSR and Rockhampton is the main town of the FBR. The regional questionnaires were administered to households residing in these towns plus two city samples, which were drawn from the capital cities of the States in which each region was located. Perth and Brisbane are the capital cities corresponding to the GSR and FBR, respectively. The samples were drawn at random from Australia on Disk, a telephone directory database of the Australian population. In total, a sample of 10 800 households was drawn for the study. Table 2 summarises the breakdown of household numbers in each subsample, together with the number of useable responses that were obtained.

The survey was in-field for approximately 6 weeks and reminder cards were sent to those respondents who had not responded within the first two weeks. The overall response rate after allowing for undeliverable mail-outs was 16 per cent, which equated to 1569 completed questionnaires.[9] Response rates around the 20 per cent mark are not uncommon for environmental CM and reflect the complexity of the choice task, particularly when respondents are asked to value non-market goods that are unfamiliar

[8] A single questionnaire was administered to each household in the sample. Therefore, the values estimated in the present study are those of the individuals who filled out the questionnaire on behalf of each household. Hence, the estimates should be interpreted as per household values.

[9] 1079 questionnaires were undeliverable (returned to sender).

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Table 2 Sample sizes and percentage of useable responses

	Questionnaire frame		
Population sample	National	Great Southern	Fitzroy Basin
National	3200 (17%)	–	–
Albany	1200 (17%)	1200 (16%)	–
Rockhampton	1200 (14%)	–	1200 (16%)
Perth	–	1400 (18%)	–
Brisbane	–	–	1400 (13%)

Note: Percentage of useable returns are in parenthesis.

to them.[10] This response rate could also be a reflection of the relatively low order of priority placed on the environment by the Australian community. The Australian Bureau of Statistics (ABS) estimates that only nine per cent of Australians rank environmental problems as their top social issue (ABS 1999a).

In order to diagnose the reason for the low response rate, a follow-up telephone survey of 340 non-respondents was undertaken approximately four months after the survey close-off date. The survey yielded 203 useable replies. The follow-up survey revealed that:

1. Of respondents, 55 per cent said they did not recall receiving the questionnaire, which could be interpreted as a zero level of interest in the subject matter and hence a zero willingness to pay.
2. Of respondents, 20 per cent recalled receiving the questionnaire but did not complete it because they were not interested in the subject matter.
3. The remaining 25 per cent said they received the questionnaire and were interested in the subject material but did not complete it because they were either 'too busy to respond' or 'thought the survey did not ask the right questions'. Of this group, approximately half (47 per cent) said 'yes or maybe' to the idea of supporting an environmental levy.

We conclude from these results that approximately 75 per cent of non-respondents hold zero values for the environmental improvements stipulated in the CM questionnaire, while the other 25 per cent implicitly place some value on protecting the environment. We assume that the values held by these non-respondents are the same as those held by respondents. The

[10] For instance, Whitten and Bennett (2001) recorded response rates between 22 and 34 per cent in their mail out–mail back CM survey. However, some mail-delivered CM applications have recorded higher response rates. For instance, Bennett and Morrison (2001) were able to achieve response rates of around 40 per cent.

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Table 3 Comparison of sample means to population means

	National	Perth	Brisbane	Albany	Rockhampton
Sample characteristics					
Median age group	45–54	45–54	45–54	45–54	45–54
Per cent male	62	60	64	57	57
Median weekly h/hold income ($A)	700–1000	700–1000	700–1000	500–700	500–700
Per cent with tertiary degree	35	30	35	23	26
Per cent green supporters[a]	24	24	22	27	13
Population characteristics[b]					
Population size (over 15 years)	15 038 339	1 064 190	1 287 004	12 432	46 031
Mean persons per h/hold	2.6	2.6	2.6	2.3	2.5
Median age	35	34	34	37	33
Median weekly h/hold income ($A)	700–800	800–1000	800–1000	500–600	600–700
Per cent male (over 15 years)	49	49	48	46	48
Per cent with tertiary degree	11	12	12	7	8

[a] Defined as respondents that donate money to environmental organisations or are a member of such an organisation. [b] Population means sourced from Australian Bureau of Statistics 2001 census.

results suggest that the value estimates derived from the CM questionnaire could safely be extrapolated to 37 per cent of the population, calculated as the 16 per cent who responded plus the proportion of non-respondents who implicitly hold non-zero, positive values.[11]

3.4 Sample representativeness

It is evident that the survey instrument induced some self-selection bias. For example, the respondent samples contain a significantly higher proportion of males and a higher proportion of people with tertiary qualifications than the population from which the samples were drawn (table 3). While it is clear that the samples are not representative of the population with respect to some socio-economic characteristics, the CM technique allows value estimates derived from the sample to be corrected for this bias. This is achieved by extrapolating benefit function estimates rather than point estimates – such as mean willingness to pay. The inclusion of socio-economic variables in the benefit function 'standardises' the implicit prices.

[11] The total number of non-respondents was 8152. Of this group, the follow up survey suggests that 25 per cent (or 2038) have non-zero values. This proportion, when expressed as a percentage of the total number of delivered questionnaires (9721) is 21 per cent. When this is added to the 16 per cent of people who responded to the survey, the total proportion of the population to which the results can be safely extrapolated is 37 per cent.

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4. Model specification

A nested structure was used to model respondents' choices of alternative options.[12] This structure assumes the respondent makes two separate decisions – an upper level decision to either support an environmental levy or retain the *status quo* (SQ) and, conditional on supporting the levy, a lower level decision which involves the choice between two different levy options. The utility function associated with the upper-level choice was hypothesised to be influenced by the respondent's socio-economic characteristics (Age, Sex, Income), environmental disposition (Green), and whether or not the respondent was confused by the background information (Confuse). Environmental disposition was measured by asking whether the individual was a member of an environmental organisation or donated money to environmental causes. Confusion was measured using a binary variable to indicate whether or not respondents found the background information and survey confusing. 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.[13] Each of these variables is defined in table 4. The utility functions for the upper level alternatives are as follows:

$$V_{\text{levy}} = ASC + \beta_1 Sex + \beta_2 Age + \beta_3 Income + \beta_4 Green + \beta_5 Confuse + \alpha_1 IV_{\text{levy}} \tag{5}$$

$$V_{\text{SQ}} = \alpha_2 IV_{\text{SQ}} \tag{6}$$

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. Therefore, the utility for option j is given by:

$$V_j = \beta_6 Species + \beta_7 Aesthetics + \beta_8 Water + \beta_9 Social + \beta_{10} Cost. \tag{7}$$

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

[13] 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.

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Table 4 Description of individual-specific explanatory variables

Variable	Description
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	The midpoint of the respondent's age category.
Income	The midpoint of the respondent's before-tax household income category.
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.

5. Results

Of those respondents who returned 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. Of respondents, 3 per cent did not complete any of the choice sets and 17 per cent of respondents reported confusion about the survey. 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.

Parameter estimates for each of the seven nested logit models describing the data relationships emerging from different combinations of questionnaire frame and population sample are reported in table 5. All seven models exhibit a satisfactory goodness of fit, with Likelihood Ratio Indices (LRI) ranging between 0.17 and 0.27. In the majority of models, the environmental attributes (Species, Aesthetics 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, indicating 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

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Table 5 Parameter estimates

Model	1	2	3	4	5	6	7
Frame	National	National	National	GSR	FBR	GSR	FBR
Population	National	Albany	Rockhampton	Albany	Rockhampton	Perth	Brisbane
Model statistics							
N (choice sets)	2329	860	720	765	818	1046	823
Log Likelihood	–2182.04	–809.84	–639.17	–681.09	–803.16	–976.78	–761.39
LRI	0.23	0.20	0.24	0.27	0.17	0.23	0.23
Lower level choice equation							
Species	5.49E–03**	2.38E–03*	2.88E–03*	1.29E–02**	4.26E–03	1.13E–02**	1.72E–02
Aesthetics	6.05E–08**	1.84E–07**	2.05E–07**	1.51E–06**	8.10E–07**	1.24E–06**	1.11E–06**
Water	6.33E–05**	4.59E–05	7.58E–05**	1.30E–03**	1.04E–03**	8.05E–04**	6.71E–04**
Social	–6.93E–05**	–9.47E–05**	–6.76E–05**	–4.59E–04**	–1.15E–03**	–6.34E–04**	–8.78E–04**
Cost	–8.13E–03**	–8.77E–03**	–1.04E–02**	–8.24E–03**	–5.14E–03**	–8.89E–03**	–8.54E–03**
Upper level choice equations							
ASC	–2.85E–01	–1.87E–01**	2.76E+00**	–1.65E+00**	1.28E+00**	2.54E+00**	2.39E+00**
Sex	–3.04E–01**	5.01E–01**	–6.52E–01**	4.26E–01**	–7.11E–01**	–2.43E–01	–2.89E–01*
Age	7.06E–03*	–1.56E–02**	–3.23E–02**	1.42E–02*	–8.14E–03	–3.83E–01**	–4.47E–01**
Income	1.92E–05**	8.54E–06**	1.76E–05**	2.94E–05**	7.08E–06**	–5.71E–03	9.65E–02**
Green	2.43E–01*	5.13E–01**	5.82E–01	1.47E+00**	1.77E–01	–1.39E–01	–3.22E–01
Confuse	–6.49E–01**	–6.92E–01**	–1.01E+00**	–9.11E–01**	–6.09E–01**	–3.62E–01*	omitted
Inclusive value parameters							
IV *status quo*	1	1	1	1	1	1	1
IV levy	3.43E–01**	3.84E–01**	1.97E–01	2.13E–01	2.19E–01	0.3595**	0.0618

* indicates significance at the 10% level, ** indicates significance at the 5% level; GSR, Great Southern Region of Western Australia; FBR, Fitzroy Basin Region of Central Queensland.

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Table 6 Attribute implicit prices (A$/household/year) derived from the national model

Attribute	Units	Mean implicit price	95% confidence interval
Species	$A per species protected	0.67	0.47–0.88
Aesthetics	$A per 10 000 ha restored	0.07	0.02–0.14
Water	$A per 10 km restored	0.08	0.04–0.16
Social	$A per 10 persons leaving	–0.09	(–0.11)–(–0.07)

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.

4.1 Implicit prices

Attribute implicit prices estimated using the national model are reported in table 6, together with a 95 per cent confidence interval for each estimate. The confidence intervals were calculated using a technique developed by Krinsky and Robb (1986). The results indicate that, on average, respondent households are willing to pay 67 cents per annum over the next 20 years for every species that is protected from extinction. Improvements in landscape aesthetics are valued at 7 cents per 10 000 ha of countryside restored, while a similar amount (8 cents) is estimated as the value for the restoration of each 10 km of waterway. The implicit price of social decline is a 9-cent cost for every 10 people that leave country areas. These estimates assume non-diminishing values for additional improvements in attribute levels. While a non-linear relationship would be expected, at least beyond a certain level of improvement, transforming the data to allow for non-linearity did not improve the model fit. Therefore, it is concluded that implicit prices are constant for changes in the attributes over the range of levels used in the choice sets.

The implicit prices provide a basis for assessing the size of benefits associated with a package of environmental improvements or, alternatively, the cost associated with a decline in environmental quality or rural population at the national level. For illustrative purposes, table 7 outlines a particular scenario involving improvements in waterway health, countryside aesthetics and species protection. Using the implicit price estimates, the changes are valued at $A174.40 per household each year for 20 years. Assuming the value estimate can be safely extrapolated to 37 per cent of the population, the aggregate benefit of the improvements is $A471 million per year, based on an Australian household population of approximately 7.2 million.

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Table 7 Aggregate benefits from a package of national environmental improvements

Attribute	Change by 2020	Attribute implicit price	Annual value of change (A$/hhold)
Water	12 000 km restored	$A0.008 per km	$A96.00
Aesthetics	4.5 million ha rehabilitated	$A7.00 per million ha	$A31.50
Species	70 species protected	$A0.67 per spp.	$A46.90
Total			$A174.40

4.2 Benefit transfer tests

As outlined in Section 1, five benefit transfer tests were performed to gain an insight into how values change across different populations and frames of reference. The tests comprised paired comparisons of implicit prices estimated using selected model pairs from the diagram in figure 1.

4.2.1 Benefit Transfer Test 1: consistency of values across different populations for attributes in the national frame

This test examines the influence of population effects on values. It tests for the equivalence of values across regional and national populations for attributes in the national frame. The three relevant sets of implicit prices are sourced from the following models:

- Model 1 – the national sample and frame
- Model 2 – the Albany sample and national frame
- Model 3 – the Rockhampton sample and national frame

The implicit prices estimated from each of the three models are compared in figure 3. The error bars represent the 95 per cent confidence intervals. Attribute values are deemed to be equivalent if the error bars overlap, signifying no statistical difference. For example, the values for Water and Social are not statistically different across the samples because the error bars associated with each attribute value overlap. However, it is found that the national sample of respondents value Species significantly higher than the two regional samples. Aesthetics is valued significantly lower by the national sample relative to the Albany sample but the values held by Rockhampton respondents for this attribute are not statistically different to those of the national sample. We can conclude from these results that values are dependent on the population sampled, at least for some attributes.

4.2.2 Benefit Transfer Test 2: transferability of estimates from a national to regional context

This test examines whether the implicit prices estimated for attributes in the national context are equivalent to those obtained in the regional case studies.

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Figure 3 Attribute implicit prices examined under Benefit Transfer Test 1.

Table 8 Scaling factors for calibrating the national estimates for transfer to a regional context

Attribute	Scaling factor
Species	×2
Aesthetics	×20–25
Water	×20–25
Social	×6–26

Unlike Benefit Transfer Test 1, both frame and population vary in this comparison. The implicit prices under examination are derived from the following models:

- Model 1 – the national sample and frame
- Model 4 – the Albany sample and GSR frame
- Model 5 – the Rockhampton sample and FBR frame

The test results show that attribute values estimated in the regional contexts are significantly higher than those estimated in the national context – by a factor of 2–26 times, depending on the attribute in question (figure 4). The magnitude of value difference provides a guide to the scaling adjustments that would need to be made if the national estimates were transferred to a regional context (see table 8 for scaling factors). At least three reasons could be responsible for the different value estimates. The case studies differ from the national study in terms of the respondent's frame of reference, the population sampled and the scope of changes presented for valuation.

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Figure 4 Attribute implicit prices examined under Benefit Transfer Test 2.

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. It could also be the case that people identify more closely with changes occurring in their local district compared to changes at the national level. Alternatively, a scope effect could be responsible for the value differences given that larger changes were presented to respondents in the national study. However, this test does not allow firm conclusions to be drawn about the predominant cause of the differences. Benefit Transfer Test 3, the next test to be reported, serves to disentangle framing effects from population differences so that the influence framing can be assessed in isolation.

4.2.3 Benefit Transfer Test 3: The relative importance of framing

This test examines the equality attribute values in a regional and national context, estimated using separate samples drawn from the same regional population. The objective of the test is to gauge the extent of the framing effect, holding population constant. Implicit prices are sourced from the following models:

- Model 2 – Albany sample and national frame versus
- Model 4 – Albany sample and GSR frame

and

- Model 3 – Rockhampton sample and national frame versus
- Model 5 – Rockhampton sample and FBR frame

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Figure 5 Attribute implicit prices examined under benefit transfer test 1.

The test results indicate that respondents have significantly higher values when attributes are framed in a regional context (figure 5). The scale of differences is similar to the findings from Benefit Transfer Test 2, which suggests that framing effects (because of scope or context differences) are the primary cause of the differences rather than population effects.

4.2.4 Benefit Transfer Test 4: consistency of values across case study regions
This test examines whether attribute values differ between the two case study regions. Whilst the same set of attributes are evaluated in each case study, the frame in which these attributes 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 socio-economic variables included in the utility functions but attitudinal differences remain unaccounted for. The test was performed using implicit prices from the following models:

- Model 4 – Albany sample and GSR frame versus
- Model 5 – Rockhampton sample and FBR frame

The implicit prices for these models are shown in figure 5. The results show that values are significantly different between the two case studies for some attributes. Respondents from Rockhampton hold significantly higher values for social impacts in their local region relative to the values held by Albany respondents. Conversely, Species is not valued by Rockhampton respondents in the FBR but is considered a significant attribute by Albany

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respondents in the GSR. Interestingly, these value disparities do not occur when these attributes are embedded in a national frame (see figure 3). It appears that some attributes are viewed in a different light when respondents are asked to consider attribute trade-offs at a local level. The results of this test also demonstrate that the value estimates obtained in one region do not necessarily reflect community values in a different region, although there is a degree of consistency for some attributes.

4.2.5 Benefit Transfer Test 5: consistency of values across city and regional respondents

The purpose of this test is to examine whether regional respondents have different values for attributes in their local area to urban dwellers in the State capital city. This is another test of population effects because the frame is fixed but population is allowed to vary. Implicit prices from the following models are compared:

- Model 4 – Albany sample and GSR frame versus
- Model 6 – Perth sample and GSR frame

and

- Model 5 – Rockhampton sample and FBR frame versus
- Model 7 – Brisbane sample and FBR frame.

The implicit prices are compared in figure 6. The test results show that implicit prices for the environmental attributes are statistically equivalent for regional and city households. While the direction of results is for values to be lower in the city samples (suggesting lower use values), this difference is not statistically significant. The results imply that it is safe to aggregate environmental values from respondents in regional areas to city populations within the same State. Importantly, there is no evidence of values declining with distance from either of the case study regions. Parochialism does not appear to have played a significant role in influencing values in the regional communities. In the case of social impacts, Rockhampton respondents have significantly higher values for this attribute than Brisbane city households – indicating that local residents of Rockhampton have greater concerns about the prosperity of their region than city people. The same trend was not evident in the GSR study.

6. Benefit transfer guidelines

The results of the benefit transfer tests demonstrate that community values for environmental and social attributes are dependent on the context in which changes are made and the population for whom the impacts are relevant.

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Figure 6 Attribute implicit prices examined under benefit transfer test 5.
GSR, Great Southern Region of Western Australia; FBR, Fitzroy Basin Region of Central Queensland.

Therefore it is critical to ensure the value estimates selected for assessing a particular policy are suitable for the policy context. The following guidelines apply:

1. For environmental policies that have an Australia-wide impact, the national model value estimates (Model 1) should be used and aggregated to the national household population – as per the example provided in the present paper.
2. In situations where the impacts of a policy are limited to a particular region within a single State (or possibly spanning two adjoining States), the national value estimates from Model 1 should be scaled up using the scaling factors in table 8. The scaling adjustment is required to reflect the higher values attached to attributes in a regional frame – where there are no other parallel improvements (substitutes) being carried out in other regions. The benefits should only be aggregated to households residing in the same State(s) as the region where the changes are expected to occur.
3. As an example of national-to-regional transfer, consider the case of a proposal to redress land and water degradation in a region in New South Wales (table 9). Under the proposal, 20 000 ha of rural land will be rehabilitated, 160 km of waterways will be restored, three additional species will be protected and 50 additional people will leave the region each year because of the proposal involves lower farming intensities. To

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Table 9 Transfer and calibration of national value estimates to assess a regional policy

Attribute	Change by 2020	Calibrated national prices	Regional prices	Annual value of impact ($A/hhold)
Water	160 km restored	($A0.008) × 20	$A0.16 per km	$A25.60
Aesthetics	20 000 ha rehabilitated	($A0.07) × 20	$A1.40 per 10 000 ha	$A2.80
Species	3 species protected	($A0.67) × 2.	$A1.34 per species	$A4.02
Social	50 people leaving p.a.	(–$A0.09) × 6	$A0.54 per 10 persons	$A2.70
Total				$A29.72

value these impacts, the national value estimates are scaled up to fit the regional context, which produces a total annual benefit of $A29.72 per household.

4. The national estimates serve as a base source of value estimates, which can be adjusted to fit different policy frames. Naturally, value estimates from the regional case study models would be a better source of estimates for assessing policies that were specifically targeted at those regions.
5. If multiple regional policies are to be implemented, and each policy affects a similar set of attributes, it would be inappropriate to assess these separately using the scaled up value estimates and to add up the benefits to arrive at a total national benefit. This would ignore the influence that regular embedding has on peoples' preferences. The correct course of action would be to use the national value estimates (Model 1) and aggregate these to the relevant household population.
6. The transfer tests provide guidance on the geographical extent of the market or how widely the values should be extrapolated. The results suggest that values for regional impacts can be extrapolated to city populations as values were found to be statistically equivalent for the two population types. This result is perhaps a result of the generic nature of the attributes selected for the present study because other research has found that values are sensitive to parochialism displayed by local populations (Rolfe *et al.* 2000) and that use values tend to be lower for populations living at distance from the site of interest (Sutherland and Walsh 1985; Pate and Loomis 1997).

7. Conclusion

The present study provides policy makers with estimates to make a first pass assessment of the non-market values associated with land and water degradation in Australia. The implicit prices estimated using the CM technique allows policy analysts to examine a wide range of different scenarios

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by packaging up the unit values according to the attribute changes that are expected to take place as a result of a proposed resource use change. The values should be regarded as order of magnitude type estimates for evaluating broad regional and national policies – not specific management plans at a local level.

The benefit transfer tests demonstrate how important it is to take account of framing and population characteristics when transferring value estimates. 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.

It is clear that the challenge of benefit transfer is greatest when source values are required for evaluating welfare impacts at a localised level where values are highly dependent on the context in which the environmental outcomes are embedded. For example, the present study found that populations from different States have similar values for attributes in the national context but in the regional context the values are markedly different – at least for some of the attributes investigated. Further research is needed to understand the limits of benefit transfer and what options are available for improving its validity.

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Appendix

Figure A1 Example of a choice set used in the choice modelling questionnaire.

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Table A1 Attribute levels used for the national choice modelling questionnaire

Attribute	Current level	Information source for current level	20 years outcome under *status quo*	Range 1	Range 2	Range 3
Species	560 endangered	EA (1996). Estimate does not include vulnerable and threatened species.	50 protected	70	140	200
Water	15 000 km degraded	EA (1996). Also, 30% of waterways (SCARM 1999) are estimated to be in extremely poor condition	1000 km restored	5000	8000	10 000
Aesthetics	12 million ha degraded or unprotected	PMSEIC 1999)	4 million ha rehabilitated	6 million	8 million	10 million
Social	8000 people leaving annually	ABS (1999b) Estimate based on the 20 Statistical Local Areas in Australia that suffered the highest decline in population in 1998/1999	15 000	5000	10 000	20 000

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Table A2 Attribute levels used for the Great Southern choice modelling questionnaire

Attribute	Current level	Information source for current level	20 years outcome under *status quo*	Range 1	Range 2	Range 3
Species	120 endangered	State Salinity Council (2000).	25 protected	35	70	100
Water	800 km degraded	State Salinity Council (2000).	100 km restored	250	500	800
Aesthetics	1 million ha degraded or unprotected	Approximately 0.5 million ha is salt-affected land (State Salinity Council 2000). The other 0.5 million ha constitutes eroded land and unprotected remnant vegetation on private property.	250 000 ha rehabilitated	500 000	750 000	1 million
Social	520 people leaving annually	ABS (1999b). Calculated by summing the population loss in 1998/1999 across all Statistical Local Areas in the Upper and Lower Great Southern Statistical Divisions.	1500	500	1 200	2000

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Table A3 Attribute levels used for the Fitzroy Basin choice modelling questionnaire

Attribute	Current level	Information source for current level	20 years outcome under *status quo*	Range 1	Range 2	Range 3
Species	20 endangered	FBA (1998). Only includes vascular plants and fauna.	5 protected	10	15	20
Water	1000 km degraded	Queensland EPA (1999).	100 restored	500	800	1000
Aesthetics	1 million ha degraded or unprotected	Estimate refers to the area of remnant vegetation on private land that remains unprotected, plus areas affected by soil erosion (SCARM 1999).	250 000 protected	500 000	750 000	1 million
Social	450 people leaving annually	ABS (1999b). Calculated by summing the population loss in 1998/9999 across all Statistical Local Areas in the Fitzroy Statistical Division.	1200	450	1 000	1500

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