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What's appropriate?
Investigating the Effects of Attribute Level Framing and Changing Cost Levels in Choice Experiments

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Table of Contents

Abstract

Choice Experiments w are increasingly used to estimate the values of non-market goods and services. A cost attribute is typically included in a CE questionnaire to enable the estimation of monetary values for changes in the non-market attributes presented. Notwithstanding the central importance of the cost attribute, limited research has been undertaken on the impacts of varying the levels of the cost attribute on respondents' choices in CE surveys. Furthermore, the ways in which the levels of non-market attributes are described to respondents - the 'attribute frame' - may affect value estimates. The challenge for CE practitioners is to identify the 'appropriate' attribute frames and range in cost levels.

In this report, the impacts of changing cost levels, the impacts of describing non-market attributes as absolute levels or in relative terms, and of using positive versus negative contextual descriptions of attribute levels are assessed. These tests were performed using data from a CE on catchment management in Tasmania, Australia. Contrary to *a priori* expectations, including explicit information cues about relative attribute levels in the choice sets is found not to affect stated preferences. The data reveal significant differences in value estimates when attribute levels are described as a 'loss', compared to a 'presence'. Furthermore, comparisons between different split samples provide evidence that respondents' preferences are impacted by changing the level of the cost attribute, with higher levels leading to significantly higher estimates of WTP for one of the three environmental attributes.

1 Introduction

There is an increasing interest in using discrete Choice Experiments (CEs), otherwise known as Choice Modelling (CM), as a stated-preference (SP) technique to estimate values for non-market goods and services. Fundamental to CEs is the use of surveys in which alternative (hypothetical) policy scenarios are described. Respondents are asked to make choices between these alternatives. CE studies have been conducted in fields ranging from health (e.g. Ryan and Wordsworth, 2000) and environmental management (e.g. Hanley et al., 2006) to transportation and infrastructure services (e.g. Hensher and Rose, 2007). The methodology and the survey used to estimate non-market values in a SP study can influence the outcomes and therefore affect both the validity and reliability of value estimates. Validation of methods and results (should) therefore play an important role in SP studies. Many studies have investigated the validity of different SP techniques (see, for example, Bennett et al., 1998, Carlsson and Martinsson, 2001, Grijalva et al., 2002, Johnston, 2006, and Boyle and Özdemir, in press). It has been found that CEs can avoid bias from strategic behaviour and reduce embedding effects (Morrison et al., 1996, Hanley et al., 2001) and that CEs are associated with less hypothetical bias than another popular SP technique; the contingent valuation method (CVM) (Murphy et al., 2005). More recent comparisons between CVM and CE in a health valuation context indicate that the welfare estimates from CE data are significantly higher than estimates from CVM data (Ryan and Watson, In Press, and van der Pol et al., In Press). If CE results are to be used as an input into environmental decision making, research is warranted into what impacts the welfare estimates from CEs and how.

The study setting and wording of the survey questionnaire forms a vital part of any CE. CE studies are context-specific, that is, the results are specific to the study's circumstances. The context of the questionnaire should match the context of the study setting. Setting the appropriate questionnaire design context is critical, in order to estimate the true values respondents hold for the resources under consideration. In this report, three topics related to design context are investigated: the impacts of two prominent issues in attribute framing and the impacts of varying the cost vector, that is, varying the range and magnitude of the levels of the monetary attribute.

1.1 Framing

Framing refers to the context in which choices are made (Rolfe et al., 2002). There is considerable evidence that the framing of questions and the information provided in a survey affects the answers (Ajzen et al., 1996). When using CEs to value non-market goods, it is important to know how respondents' choices are sensitive to the survey context. Not all respondents may have pre-existing preferences for the non-market goods presented in a CE survey. Instead, preferences may be constructed based on the information provided in the survey[1]. In that case, preferences are likely to change with the information provided and with the wording of the questionnaire (i.e. the survey frame), rather than with the nature of the good. It can be argued that framing effects are inherent to SP techniques as these are *contingent* on the information supplied in the survey. Defining the appropriate survey frame is part of all SP surveys and depends on the purpose of the survey, the context of the issue and the requirements of respondents.

Attribute framing occurs when choices are influenced by the way attributes are described to respondents. The particular focus of the study reported here is the framing of attribute *levels*. Different ways of describing attribute levels may impact on respondents' choices, even when attribute levels are identical. The ways in which attribute levels are described will vary with the context of each CE study. Attribute levels may be described qualitatively, for example, as 'low', 'medium' and 'high' (Carlsson et al., 2003). WTP estimates can then be interpreted as the willingness to pay for a discrete change from one qualitative attribute level to another.[2] Levels can also be described quantitatively, for example as 'absolute' quantities (e.g. the number of bird species; Bennett et al., 2008), or as 'relative' quantities (e.g. the percentage of healthy vegetation in a river floodplain; Rolfe and Windle, 2005). WTP estimates are then interpreted as the willingness to pay for a unit change in attribute levels. An example of 'absolute' attribute levels is given in Lockwood and Carberry (1998), who described an attribute of 'remnant native vegetation' as the total area (in hectares) of native vegetation remaining in the study area under alternative policy scenarios. 'Relative' attribute levels would then be defined as the proportion of the total study area with remnant native vegetation.

Bateman et al. (2009) stress that respondents should be able to 'evaluate' the information presented in a non-market valuation survey to avoid anomalies in stated preferences. Survey comprehension may be increased when respondents are given information cues to help them to make choices about unfamiliar goods (Schlapfer, 2008). Such cues can be provided by describing attribute levels using information about absolute quantities of the attributes as well as their relative levels. It is plausible that respondents will be able to easily evaluate information about one absolute level being higher than another, but comparisons to relative quantities will allow respondents to more readily assess the relative scarcity of a good. The ways in which attribute quantities are described will vary with the context of each CE study. Decisions about how to define attribute levels are typically made in consultation with

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[1] See, for example Braga and Starmer (2005), Bateman et al. (2004) or Tversky and Simonson (1993) on context-dependent preferences.

[2] Note that individuals' interpretation of qualitative attributes level can be subjective and may hence differ between survey respondents.

scientists, policy stakeholders and focus group discussions but ultimately remain at the discretion of the analyst. In this study, the impacts of defining attribute levels only as absolute values versus including relative quantities are assessed. We hypothesise that absolute attribute levels are more difficult for respondents to interpret. We expect that the variability in responses will be larger in the absence of information about relative quantities, leading to larger variance in value estimates.

Another source of attribute framing occurs when respondents' choices are influenced by alternative attribute level descriptions, such as in positive versus negative terms (for example 'gain' versus 'loss). The psychology literature predicts framing effects from describing alternatives in either positive or negative terms (Kahneman and Tversky, 1984, Hallahan, 1999). Respondents typically value a change (either gain or loss of a good) in terms of changes from a reference position. Losses from a reference state are valued more highly than gains to the reference state (Knetsch, 2007). As a consequence, asymmetric valuations of gains and losses have been observed in contingent valuation (CV) studies (Horowitz and McConnell, 2002, Tversky and Kahneman, 1991, McDaniels, 1992). In a similar context of 'reference decency, several CE studies have found evidence that values for a decrease in attribute levels from an experienced status quo level are significantly different from values for an increase in attribute levels compared to the status quo (Windle and Rolfe, 2004, Hensher, 2008, and Hess et al., In press). These CE studies used the same contextual formulation to describe changes in attribute levels. In a way, the differences found are related to the disparity observed between willingness-to-pay versus willingness-to-accept measures (Plott and Zeiler, 2005, Loomis et al., 1998, Grutters et al., 2008). To the authors' best knowledge, no CE studies have, however, investigated the impacts on respondents' choices of explicitly formulating attribute level changes in positive or negative terms. Because individuals generally place greater value on losses relative to commensurate gains (Borges and Knetsch, 1998), we hypothesise that respondents will prefer avoiding a 'loss' compared to maintaining a 'presence' of an attribute (Bateman et al., 2009), resulting in higher WTP estimates in the former case.

1.2 Cost anchoring

Anchoring arises when respondents base their answers on the attribute levels provided in the questionnaire, rather than on their own true preferences. In the contingent valuation (CV) literature, this effect is typically observed as a starting point bias. Starting point bias is said to occur when respondents perceive the initial bid levels included in SP questions as a suggestion of 'acceptable' answers and use the proposed bit to develop and/or revise their own 'true' WTP (Mitchell and Carson, 1989). When respondents base their choice on this revised WTP, they are said to anchor their answers on the proposed bid[3]. Ignoring such anchoring effects will lead to biased estimation of the mean and the standard deviation of the WTP (see, for example, Silverman and Klock, 1989, Herriges and Shogren, 1996, Green et al., 1998, Frykblom and Shogren, 2000, and Flachaire and Hollard, 2007).

Choice experiments may also suffer from anchoring effects if different cost-attribute levels, or different ranges in those levels, affect the estimates of implicit prices. Economic theory suggests that models with varying ranges of the cost attribute should produce similar parameter estimates if respondents have stable and well-formed preferences. As long as the cost range used in the survey reflects the distribution of respondents' preferences, a wide versus narrow range or a low versus high range in cost levels should not influence the population average value estimates if the marginal utility of money is constant (a common assumption in CE) (Stevens et al., 1997)[4]. However, given the observed sensitivity to bid levels in CV studies, there is a risk that respondents interpret the proposed levels of the cost attribute in a CE as an indication of the "appropriate" value[5]. In such a case, CEs could suffer from a similar anchoring bias as CV studies.

Notwithstanding evidence of cost anchoring effects in the CV literature (Bateman et al., 1999), there are very few studies that have investigated the effects of varying the levels of the monetary attribute in CEs, particularly in an environmental valuation context. In a study of river health improvements, Hanley et al. (2005) investigated whether WTP estimates in a CE are sensitive to the presented levels of the monetary attribute. A split sample survey was used where only the monetary attribute varied between questionnaire designs. In line with *a priori* expectations, the proportion of respondents choosing the status quo option (no payment, no change in environmental attributes) was significantly higher for the questionnaire design with higher costs compared to the lower cost design. Results indicated that the implicit prices estimates in the low-cost split were lower than the WTP estimates in the high-cost split sample, but these differences were not statistically significant because of the high variability of the WTP estimates in the low-cost split sample. Contrary to Hanley et al. (2005), research by Carlsson and Martinsson (2008) showed statistically significant higher marginal WTP estimates in a CE questionnaire with higher cost levels, as compared to a questionnaire with

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[3] Specifically, an *anchoring effect* occurs when respondents "fasten upon elements of the scenario that are not intended by the researcher to convey information about the value of the good and use them as cues to the good's approximate 'correct value'". *Starting point bias* is said to occur when "the respondent regards an initial value proposed in the survey as conveying an approximate value of the amenity's true value and anchors his WTP around the proposed amount" (Mitchell & Carsson, 1989, pp 240).

[4] Note here that it is of vital importance that the range in cost levels covers the range in preferences in a population.

[5] There is even evidence that survey respondents can anchor their answers to completely arbitrary numbers (Ariely et al., 2003).

lower cost levels. These results indicate the presence of an anchoring effect, but it should be noted that no status quo or 'opt out' alternative was offered to respondents in this study. More in line with the 'traditional' definition of *starting point* anchoring, Ladenburg and Olsen (2006) tested the impacts of the costs proposed in an "Instruction Choice Set" (ICS) on respondents' answers to a CE survey about motorway construction in Denmark. The ICS was an example choice set presented to respondents before the actual choice questions in the survey. To test for starting point anchoring bias, the level of the monetary attribute in the ICS was different between two split samples, but the attributes levels in the subsequent choice sets were identical. The authors found that a significantly higher proportion of respondents in the high cost split sample chose the 'more expensive' option in each choice set, indicating that respondents may anchor their preferences in the payment levels presented in the first choice set. Furthermore, the WTP estimates in the high cost split were significantly higher than in the lower cost ICS. These differences were particularly pronounced for female respondents. The available studies provide no conclusive evidence about the impacts of varying levels of the monetary attribute on WTP estimates.

There is currently limited research on cost anchoring effects in the CE literature and relatively little is known about the impacts of framing attribute level descriptions. This study aims to assess the impacts of cost anchoring and attribute framing in CEs using a split sample survey approach for a case study of the George catchment, Tasmania. This research is part of EERH project Theme D: 'Valuing Environmental Goods and Services'[6]. The next section gives an introduction to the modelling framework used to analyse the CE data. This is followed by a description of the case study area and the survey in section three. In section four to six, the results of the data analyses are presented, followed by a discussion of these results in the final section seven.

2 Modelling framework

Different econometric models can be used to estimate the probability that a particular alternative is chosen from a set of alternatives presented in each choice question (see, for example, Hensher et al., 2005, Alpízar et al., 2001, Bennett and Adamowicz, 2001, and Louviere et al., 2000). In this study, a mixed logit (ML) model specification is used to account for unobserved individual heterogeneity (Hensher and Greene, 2003).

In a ML model, the unobserved component of utility U_{ijt} that individual i derives from alternative j in choice situation t is divided into a part that is correlated across individuals and

[6] This research is a collaboration between the Environmental Economics Research Hub and Landscape Logic, both of which are funded through the Australian Commonwealth Environmental Research Facility.

alternatives η_{ij} and a stochastic part that is independently and identically distributed (iid) over alternative and individuals ε_{ijt}:

$$U_{ijt} = \beta_i '\mathbf{X}_{ijt} + [\eta_{ij} + \varepsilon_{ijt}] \qquad j=0,1,...,J;\ t=1,2,...,T \quad (1)$$

where β_i is a vector of individual specific parameters and $\boldsymbol{X}_{ijt}$ is a vector of observed, explanatory variables; η_{ij} is a random term with zero mean whose distribution varies across individuals and alternatives (Hensher et al., 2005). In a mixed logit model, the analyst needs to define the expected distribution of η_{ij}, such as a normal, lognormal, uniform or triangular distribution (Hensher et al., 2005, Hensher and Greene, 2003). The density of η_{ij} is given by $f(\eta_{ij}|\boldsymbol{\theta})$, where $\boldsymbol{\theta}$ is a vector of the unconditional parameters in the distribution. The conditional probability that alternative j will be chosen by individual i in choice situation t is given by

$$P(j_{it}\left|\mathbf{X}_{ijt}, \beta_i, \theta\right.) = \frac{\exp(\mu \cdot [\beta_i '\mathbf{X}_{ijt} + \eta_{ij}])}{\sum_{j=1}^{J} \exp(\mu \cdot [\beta_i '\mathbf{X}_{ijt} + \eta_{ij}])} \quad (2)$$

where $\mu = \sqrt{\pi^2 / 6 \cdot \sigma_\varepsilon^2}$ is a scale parameter that is included to account for the confounding between the error variance and the estimated parameters (Louviere and Eagle, 2006). The scale parameter is inversely related to the variance σ_ε^2 of the error distribution (Swait and Louviere, 1993). Since all parameter estimates within one estimated model have the same scale, μ is typically normalised to one. Note, however, that comparison of estimated coefficients between different experiments is confounded by the different scale parameters in each model.

An error component term ω was included in the ML model to allow for different patterns of error correlation between alternatives. It was expected that respondents would regard the base alternative in a systematically different manner from the "new management" alternatives (Campbell et al., 2008). Therefore, a shared error component term was included in the utility functions for the two "new management" alternatives but not in the utility function for the no-cost base alternative. This shared random effect introduces error correlation between the new management alternatives, capturing unobserved heterogeneity that is alternative- rather than individual-specific (Greene and Hensher, 2007). The estimated model was thus specified as:

$$\begin{aligned} U(j = base)_{it} &= \beta_i '\mathbf{X}_{ijt} + [\eta_{ij} + \varepsilon_{ijt}] \\ U(j = change1)_{it} &= \beta_i '\mathbf{X}_{ijt} + \omega_{change} + [\eta_{ij} + \varepsilon_{ijt}] \\ U(j = change2)_{it} &= \beta_i '\mathbf{X}_{ijt} + \omega_{change} + [\eta_{ij} + \varepsilon_{ijt}] \end{aligned} \quad (3)$$

In this study, the mixed logit model was combined with a random-effects model, to exploit the panel nature of the discrete responses (Bateman et al., 2008). Panel data models can control for unobserved heterogeneity across the choices made by the same individual, by including an individual specific error term that is correlated across the sequence of choices made by individual i. An added advantage of using a panel data model is to control for omitted and unobserved variables (Campbell, 2007). In a panel data model, the conditional probability of observing a *sequence* of individual choices S_i from the choice sets is the product of the conditional probabilities (Carlsson et al., 2003):

$$S_i(\beta_i) = \prod_t P(j_{it} \mid \mathbf{X}_{ij}, \beta_i, \theta)t \tag{4}$$

In a typical CE, this sequence of choices is the number of choice questions answered by each respondent. The *unconditional* choice probability now is estimated by the integral over all possible values of β_i, weighed by the density of β_i:

$$P_i(\beta_i \mid \mathbf{X}_{ij}, \theta) = \int S_i(\beta_i) \cdot f(\eta_{ij} \mid \theta) d\beta_i \tag{5}$$

This class of models are called *mixed logit* because the choice probability P_{ijt} is a mixture of logits with f as the mixing distribution (Hensher and Greene, 2003). This model accounts for systematic, but unobserved correlations in an individuals' unobserved utility over repeated choices (Revelt and Train, 1998). Because (5) does not have a closed form solution, the ML model is estimated using simulated maximum likelihood methods (Hensher and Greene, 2003).

3 The Choice Experiment

The effects of varying attribute frames and cost vectors were tested using data from a discrete CE that was aimed at determining community preferences for alternative catchment management strategies in the George catchment, Tasmania.

The George catchment is a coastal catchment in north-east Tasmania, with several small communities, of which St Helens town (with a population of approximately 2,000; ABS, 2006). Land use in the catchment includes National Parks, agriculture, forestry plantations and State Forests. The rivers in the catchment and Georges Bay estuary are intensively used for recreational activities. The catchment environment is generally in good condition (DPIW, 2007, Davies et al., 2005) but increased clearing of riparian vegetation, stock access to rivers and streams as well as inputs from forestry operations and other human activities have been identified as threats to catchment water quality and estuary health (NRM North, 2008, DPIW, 2005). Natural resource management in the George catchment is aimed at preventing water quality decline and maintaining the ecosystem health of the rivers and estuary (BOD, 2007, Lliff, 2002).

3.1 Developing the CE survey

The CE survey development involved several rounds of consultations with local decision makers, scientists and community members. After identifying science- and policy-relevant attributes in the George catchment, a series of focus group discussions were carried out to refine the attributes that were important to the community. Two preliminary versions of the survey were pretested during these focus groups. The results of eight focus group discussions, along with expert judgement and results from environmental modelling studies were used to identify the attributes and their levels used in the CE survey (Kragt and Bennett, 2008). In the George catchment CE survey, three environmental attributes were described: native riverside vegetation, rare native animals and plant species and seagrass area. A cost attribute was defined as a one-off levy on rates, to be paid by all Tasmanian households during the year 2009.

The final survey material consisted of an introduction letter, a questionnaire booklet and an information poster. The information poster provided information about the George catchment using maps, photos and charts (Appendix 1). Natural resource management in the George catchment, environmental attributes and attribute levels were also described on the poster. The questionnaire comprised four sections. An introductory section contained questions on visitation and activities in the George catchment, plus a question on respondents' perception of current river and estuary quality. The next section explained the choice task at hand, followed by the choice questions. A third section contained questions that aimed to elicit respondents' choice strategies and understanding of the survey. The final section consisted of various socio-economic questions.

The levels of the attributes included in the choice sets reflected the different situations that could occur in the George catchment under different combinations of catchment management actions. Each choice set consisted of a no-cost, no new catchment management base alternative, presented as a likely degradation in catchment conditions in the next 20 years. Two alternative options in each choice set described implementations of new management actions and resulting protection of the environmental attributes (compared to the base alternative). An example choice set is shown in Figure 1 and the description of the attributes can be found in Appendix 2.

3.2 Split sample versions

To enable testing of attribute framing and cost anchoring effects, four different survey versions were developed. A 'standard' (ST) version provided the base for comparing results between versions. In the ST questionnaire, the levels of native riverside vegetation were measured in km, which was explicitly compared to the total length of rivers in the George catchment. The area of healthy seagrass beds was measured in hectares and compared to the total estuary area. The rare species attribute was described as the number of species present in the catchment. The levels of the payment ranged from zero to 400 $. The various levels of attributes in the ST version are shown in Table 1.

Table 1 Attribute levels used in the standard version of the George catchment CE

Attribute	Description of base level	Alternative levels*
Native riverside vegetation	40km - Healthy native vegetation along 40 km on both sides of the river (=35% of total river length)	56, **74**, 84 (km)
Seagrass area	420ha – Seagrass growing in 420 ha of Georges Bay (=19% of total bay area)	560, **690**, 815 (ha)
Rare native animal and plant species	35 species present – Of the current 80, 35 rare species remain (45 rare species no longer live in the George catchment)	50, 65, 80 (number of species present)
Your one-off payment (AU$)	0	30, 60, 200, 400 (AU$)

A second version varied from the standard version only in the description of the seagrass and riverside vegetation attribute levels. Although all questionnaire versions described the total river length and total estuary area on the survey poster, the 'absolute levels' survey (AL) version did not include the percentages of river and estuary area explicitly in the attribute description or choice sets (see Figure 2). This sub-sample was used to test whether respondent's choices are impacted by excluding the relative quantities of the attributes.

Figure 1 Choice set in the ST questionnaire design of the George catchment CE

Question 6

Consider each of the following three options for managing the George catchment.
Suppose options A, F and G are the **only ones** available. Which of these options would you choose?

Features	Your one-off payment	Seagrass area	Native riverside vegetation	Rare native animal and plant species	YOUR CHOICE
Condition now		690 ha (31% of total bay area)	74 km (65% of total river length)	80 rare species live in the George catchment	
Condition in 20 years					Please tick **one** box
OPTION A	$0	420 ha (19%)	40 km (35%)	35 rare species present (45 no longer live in the catchment)	☐
OPTION F	$400	560 ha (25%)	81 km (70%)	65 rare species present (15 no longer live in the catchment)	☐
OPTION G	$400	690 ha (31%)	56 km (50%)	65 rare species present (15 no longer live in the catchment)	☐

Figure 2 Choice set in the AL questionnaire design of the George catchment CE

Question 6

Consider each of the following three options for managing the George catchment.
Suppose options A, F and G are the only ones available. Which of these options would you choose?

Features	Your one-off payment	Seagrass area	Native riverside vegetation	Rare native animal and plant species	YOUR CHOICE
Condition now		690 ha	74 km	80 rare species live in the George catchment	
Condition in 20 years					Please tick one box
OPTION A	$0	420 ha	40 km	35 rare species present (45 no longer live in the catchment)	☐
OPTION F	$400	560 ha	81 km	65 rare species present (15 no longer live in the catchment)	☐
OPTION G	$400	690 ha	56 km	65 rare species present (15 no longer live in the catchment)	☐

A 'rare species' (RA) version of the questionnaire differed from the standard version only in the description of the *levels* of the 'rare native animal and plant species' attribute[7]. This version allows testing of alternative attribute framing on respondents' choices. In the RA version, rare species were defined in terms of 'species lost' rather than 'species present'. Hence, although respondents were presented with a different number, the absolute levels of the number of rare species presented in the George catchment were identical (Table 2). It was expected that respondents would be willing to pay more for "preventing a loss" in species (RA sub-sample) compared to having a certain number of "species present" (ST sub-sample).

Table 2 Levels of the rare species attribute presented in the ST and RA split sample versions

Questionnaire	Description of base level	Alternative levels
ST	35 species present – Of the current 80, 35 rare species remain (45 rare species no longer live in the George catchment)	50, 65, **80** (number of species present)
RA	45 species lost – Of the current 80 rare native species, 45 species no longer live in the George catchment	30, 15, **no loss** (number of species lost)

A fourth 'cost range' (CR) version was developed to test whether respondents anchor their answers to some proposed cost level. This version varied from the standard version only in the levels of the monetary attribute presented. The levels of the payment attribute were based on cost levels used in previous CE studies in Australia and feedback from the focus groups. During the focus group discussions, $600 had been identified as the "absolute maximum" WTP for natural resource management in the George catchment. To avoid a high rate of protest responses from payment levels that would push respondents beyond their maximum

[7] Note that the description of the attribute was identical across split samples.

cost, the levels in the ST and RA versions were scaled by a factor of about 2/3[8]. The levels of the cost attribute in the ST and RA survey versions were 0, 30, 60, 200 and 400 AU$, whereas the payment levels in the CR survey were 0, 50, 100, 300, 600 AU$ (Table 3)Note that the relative differences in cost levels are therefore similar but absolute differences are not. If the suggested cost levels indeed serve as an anchor for respondents' choices, it was expected that the implicit price estimates from the CR survey version would be higher than the estimates from the ST version (Ladenburg and Olsen, 2006).

Table 3 Cost levels used in the ST and CR versions of the questionnaire

Split sample version	Levels of the monetary attribute
Standard survey	0, 30, 60, 200, 400 (AU$)
Cost range	0, 50, 100, 300, 600 (AU$)

3.3 Survey experimental design and administration

A total of 24 choice sets were created using a Bayesian *D*-efficient design (Scarpa and Rose, 2008). Prior information on the expected values of the coefficients was elicited from the results of the questionnaire pretested during focus groups in August 2008. Some combinations in the design were not feasible, for example because one alternative completely dominated the others in the levels of the environmental attributes but not in costs. These combinations were removed from the choice design, leaving a total of 20 choice sets to be included in the questionnaire. The total number of choice sets was divided into four blocks, so that each respondent was presented with five choice questions.

In order to achieve a representative sample of Tasmanian households, but within the practical limits of this study, the survey sample was restricted to the two largest population centres in Tasmania (Hobart and Launceston) and the local community around the town of St Helens. Each location was divided into multiple smaller local sampling units, stratified to cover the complete sample location and a range of community types. A random sample was taken from these areas, using a 'drop off/pick up' method[9] with the assistance of local service clubs. Surveyors received a training session and detailed instructions on the sampling locations and procedures. The questionnaires were collected between November 2008 and March 2009.

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[8] Using rounded number in the cost levels was considered appropriate to reduce survey complexity and negative reactions from respondents.

[9] This method involved surveyors to visit randomly selected households within each stratified sampling unit with the request for survey participation. When the householder agreed to participate, a copy of the questionnaire was left behind and arrangements were made to pick up the completed survey booklet at a convenient time

4 Descriptive statistics

A total of 1,432 surveys was distributed, of which a total of 933 (65%) were returned. A series of χ^2-test were conducted to compare the sample characteristics across locations and questionnaire versions. These indicated significant differences in the population characteristics between the urban respondents in Hobart and Launceston and the local population in St Helens. Because of low response rates and to avoid confounding the results from different underlying population characteristics, only the urban samples are included in the analysis reported here. The interested reader is referred to Kragt and Bennett (Kragt and Bennett, 2009) for more information about the local sample characteristics.

Respondents who consistently chose the base alternative because they protested against paying a government levy were not included in the analysis. This resulted in a total of 811 useable surveys (Table 4). Because not all respondents answered all the choice questions, the total number of choice observations available for analysis was 3,482.

Table 4 Number of respondents and available choice observations by survey design

Design	Respondents (#)	Choice observations (#)
Standard version	321	1,344
Absolute levels version	151	693
Rare species version	137	602
Cost range version	202	843
Total	**811**	**3,482**

Testing the equivalence between the sample and the Tasmanian population statistics (ABS, 2007) shows that the income, education, gender and age distribution in the sample was significantly different from the State average. The main difference with the average Tasmanian population is the high average income, the higher proportion of respondents with a university education and the over-representation of women in the sample. The sample is therefore not representative of Tasmanian households and care should be taken when interpreting the results in light of the wider population. The mean descriptive statistics of the sample are presented in

Table 5Table 5. The number of visits to the George catchment was included in the analysis. Respondents had, on average, visited the region 2.6 times in the 5 years before filling out the survey. An attitudinal variable that captures the level of agreement with the survey information was also included. This variable was measured as respondent's agreement with the information presented on the poster on a 5-point Likert scale where 1=strongly disagree and 5=strongly agree.

Table 5 Descriptive statistics of George catchment survey sample

Variable	Unit	Mean	Std.	Min	Max
Income	Annual household income (‘000 $, before taxes)	76.78	44.52	7.5	210
Education	Respondent education (yrs)	13.50	2.20	8	18
Gender	=1 if respondent is male	0.38	0.49	0	1
Age	Respondent age (yrs)	45.93	14.59	18	91
Visit	Visits to the George catchment (# in past 5 yrs)	2.59	3.53	0	25
Agree*	Agreement with survey information	3.63	0.70	1	5

* Measured on a 5-point Likert scale where 1 = strongly disagree and 5 = strongly agree.

5 Attribute framing results

Mixed logit (ML) models were estimated in LIMDEP 9.0 (Econometric Software, 2007) using Halton draws with 500 replications (Train, 2000). In this section, the model results on comparing the AL and RA survey split samples are reported. The results of the cost anchoring analysis are reported in Section 6.

Model specifications investigated several distributional assumptions for the choice attributes (for example, fixed or log-normally distributed coefficients), the inclusion of a range of socio-demographic variables, various specifications of heteroskedastic or correlated random parameters as well as the specification of heteroskedasticity in the latent error component. The results of the preferred model are reported in Table 6. The coefficients of interest in this analysis are the population averaged parameter estimates on the choice attributes. Therefore, a parsimonious model including only university degree as a dummy variable was included to correct for possible bias originating from the relatively highly educated sample. Other socio-economic or behavioural variables were not significant in more than one of the split sample models and so were not included in the models reported.[10] All the choice attributes were included as random parameters to account for variation in respondents’ preferences towards the four choice attributes. Following Greene et al. (2006), a constrained triangular distribution was used for the random cost parameter, to ensure a negative sign on each individual’s cost parameter. It was not desirable to so constrain the distributions on the environmental attributes, as respondents may have positive or negative preferences towards the attributes. Normal distributions were therefore defined for the environmental attributes. Other distributional forms, or specifying one or more of the environmental attributes as fixed attributes, did not lead to significantly better models.

[10] All models are available upon request from the authors.

As shown in Table 6, all attribute parameters have the expected signs. The cost-coefficient is negative and significant in all models, indicating a disutility from higher levels in the cost attribute, *ceteris paribus*. The parameters of the environmental attributes are positive, indicating that respondents derive positive utility from higher levels in vegetation, rare species and seagrass. The positive and significant standard deviations for the random parameters cost, vegetation and species indicate individual heterogeneity in preferences for these attributes. The standard deviation for the seagrass random parameter is only significant in the ST sub-sample.

An alternative specific constant (ASC) for the 'new-management' alternatives was positive and significant in the all models, indicating a preference of respondents towards protecting the George catchment that is not captured by the covariates in the model. The coefficient on education was positive, indicating that respondents with some university education were more likely to choose new environmental management actions, *ceteris paribus*. The latent error component is positive and significant in all models. This shows that there is significant unobserved error correlation between the two new-management alternatives that is individual, rather than choice-specific. The positive and significant sign on the error component also means that there is significantly more unobserved variation in the perception and substitutability between the new-management alternatives, compared to the base option (see Scarpa et al., 2007 for similar findings).

The most noteworthy differences across the sub-sample models are the significance of the seagrass and riverside vegetation attributes. The parameter estimate on seagrass is only significant in the AL questionnaire version, in which the percentage of the estuary covered by seagrass beds was not explicitly described in the choice sets. Riverside vegetation is significant at the one percent level in the ST and AL sub-samples, while it is significant at the ten percent level in the RA version of the questionnaire.

Table 6 Mixed logit model results for ST, AL and RA analysis

	ST (standard)		AL (absolute levels)		RA (loss in species)	
Variable	Parameter	t-value	Parameter	t-value	Parameter	t-value
Random parameter means						
Costs ($)	-0.011***	-13.47	-0.017***	-9.30	-0.011***	-7.28
Seagrass (ha)	0.001	1.60	0.004***	3.88	0.001	0.59
Vegetation (km)	0.044***	5.16	0.063***	4.23	0.025*	1.80
Rare species (#)	0.070***	7.31	0.095***	6.58	0.106***	6.25
Random parameter standard deviations						
Cost	0.012***	13.73	0.017***	9.30	0.011***	7.28
Seagrass	0.004***	4.15	0.001	0.23	0.001	0.33
Vegetation	0.052***	4.76	0.078***	4.85	0.042***	2.59
Rare species	0.100***	8.39	0.076***	4.55	0.103***	5.55
Standard deviation of the latent error component	2.225***	4.73	4.279***	4.07	1.494**	2.03
Non-random parameters						
ASC (=1 for change alternatives)	1.395***	2.95	3.388***	2.79	1.303**	2.00
University educ (0/1)	1.393***	2.74	-0.729	-0.57	2.928***	2.85
Log-likelihood	-1069.15		-474.11		-404.66	
Choice observations N	1419		693		602	
Adjusted - $\rho^{2\,(a)}$	0.252		0.278		0.275	
AIC	2158.3		968.2		829.3	
BIC	2210.9		1013.6		873.3	

Note: ***, **, * = significance at 1%, 5% and 10% level. (a) Against a constant-only model; *AIC = -2·(LL-#par) ; BIC = -2·LL + #par·ln(N)*

5.1 Attribute framing effects

The first set of hypotheses to be tested in this report are the null hypotheses of equal parameters estimates between the ST version of the survey and each of the other two 'attribute framing' survey designs:

$$H_0 : \beta_{ST} = \beta_{RA} \qquad \text{and} \qquad H_0 : \beta_{ST} = \beta_{AL}$$

Because of the confounding effect of the scale parameter μ, the estimated parameters from Table 6 cannot be compared directly. In order to enable a comparison of the parameters, a grid search was conducted to estimate the ratio of the scale parameter (Swait and Louviere, 1993) where the scale parameter for the ST version was constrained to one. The null hypothesis of equal parameter estimates can then be tested using regular likelihood ratio tests:

$$LR = -2[LL_{pooled} - (LL_{ST} + LL_{RA})]$$

and $$LR = -2[LL_{pooled} - (LL_{ST} + LL_{AL})]$$

where LL_{pooled} is the log-likelihood of the pooled model in which one sample has been rescaled by the estimated ratio of scale parameters, and LL_{ST}, LL_{RA} and LL_{AL} are the log-likelihoods of the separately estimated models. The *LR*-statistic is χ^2-distributed with $(k+1)$ degrees of freedom, with *k* the number of restrictions in the models. Hence four additional models were tested: two pooled models without rescaling the RA or AL data, and two pooled models in which the RA or AL data had been rescaled. The relative scale parameter that maximised the log-likelihood in the pooled ST-RA model was 1.09, and the relative scale parameter in the pooled ST-AL model was 0.88. This supports our hypothesis that the error variance in the AL version of the questionnaire is larger than the error variance in the ST version. The error variance in the RA sub-sample was smaller than the error variance in the ST sub-sample, which makes intuitive sense as people were expected to more strongly prefer avoiding a 'loss' in species than to maintain a 'presence'. The results of these models and test results are reported in Table 7.

The χ^2-test value for the RA model against the ST model is 10.52. As this is lower than the χ^2-critical value, we cannot reject the null hypothesis of equal parameter estimates between the standard and 'rare species' versions of the questionnaire. To ensure that this conclusion was not a result of differences in scale, a second likelihood ratio test was conducted to test the pooled model with scaling, against the pooled model without rescaling the RA data. The χ^2 value of this test is 1.86, not providing enough evidence at the 5% significance level to reject the null hypothesis of parameter equivalence (Table 7). Hence, it cannot be concluded that preferences are significantly different between the ST and RA data. Using the same test procedure to compare the 'absolute levels' model against the ST base model provides insufficient evidence to reject the null hypothesis of parameter equivalence at the five percent significance level: ($\beta_{ST} = \beta_{AL}$).

Table 7 Pooled model results and likelihood ratio test for equivalence of parameters of ST, RA and AL models

Variable	Pooled ST-RA (no scaling)	Pooled ST-RA (with scaling)	Pooled ST-AL (no scaling)	Pooled ST-AL (with scaling)
Random parameter means				
Costs ($)	-0.012***	-0.011***	-0.013***	-0.013***
Seagrass (ha)	0.001	0.001	0.002***	0.002***
Vegetation (km)	0.040***	0.039***	0.051***	0.053***
Rare species (#)	0.084***	0.083***	0.079***	0.083***
Random parameter standard deviations				
Cost	0.012***	0.012***	0.013***	0.013***
Seagrass	0.004***	0.004***	0.004***	0.004***
Vegetation	0.056***	0.055***	0.056***	0.057***
Rare species	0.112***	0.106***	0.084***	0.087***
Non-random parameters				
ASC (=1 for change alternatives)	1.285***	9.380*	2.137***	-8.589
University educ (0/1)	1.658***	1.653***	0.981	1.088*
Error component (sd)	1.258***	1.410***	3.811***	3.806***
Scale parameter		-7.590		11.808*
Log-likelihood	-1480.00	-1479.07	-1549.79	-1550.24
n	2,021	2,021	2,112	2,112
χ^2-test value	10.52	1.86	13.97	-0.91

Note: ***, **, * = significance at 1%, 5% and 10% level.

5.2 Implicit price estimates

An alternative way to test whether the respondents' preferences are influenced by the frame of the attribute levels is to compare the implicit price estimates across models. The marginal willingness to pay (WTP) for each environmental attribute was calculated using parametric bootstrapping from the unconditional parameter estimates using 1,000 replications (Krinsky and Robb, 1986). The results are shown in Table 8. The marginal WTP estimates are positive and significant for the riverside vegetation and the rare species attributes in all split samples. Seagrass is significant at a 10% significance level in the ST and ABS version.

Table 8 Mean marginal willingness to pay estimates (95% confidence interval in parentheses)

Attributes	ST version			RA version			AL version		
Seagrass (ha)	0.104*	(-0.02	0.23)	0.053	(-0.13	0.23)	0.239***	(0.12	0.36)
Riverside vegetation (km)	3.969***	(2.45	5.48)	2.265**	(-0.21	4.73)	3.708***	(1.98	5.51)
Rare species (#)	6.310***	(4.61	8.08)	9.779***	(6.63	13.1)	5.591***	(3.88	7.34)

Note: ***, **, * = significance at 1%, 5% and 10% level.
95% confidence intervals based on the 5^{th} and 95^{th} percentile of the simulated WTP distribution.

As shown in Table 8, the confidence intervals between the implicit price estimates overlap for all attributes. A formal test[11] for statistical differences in WTP estimates was conducted, based on the convolution approach proposed by Poe et al. (2005, 1994). As indicated by the p-values reported in Table 9, there are no significant differences in WTP estimates at the five percent level for any of the choice attributes between the ST and AL samples. There is not enough evidence to conclude that the exclusion of explicit information about changes in relative quantities of attributes leads to different welfare estimates.

The WTP estimates for seagrass and riverside vegetation are not significantly different between the RA and ST sub-samples. However, the estimate for the rare species attribute is significantly higher in the RA sample, where species are described as 'species lost' compared to 'species present'.

Table 9 Poe *et al* (1994) test for equivalence of WTP estimates*

	ST vs AL version		ST vs RA version	
Attribute	p-value	90% confidence interval	p-value	90% confidence interval
Seagrass (ha)	0.070	(-0.04 0.30)	0.310	(-0.17 0.27)
Riverside vegetation (km)	0.396	(-2.52 2.09)	0.107	(-1.19 4.70)
Rare species (#)	0.269	(-1.65 3.12)	0.028	(0.11 7.36)

* p-values for a one-sided t-test of statistical insignificant differences with the WTP estimates from the base ST sub-sample

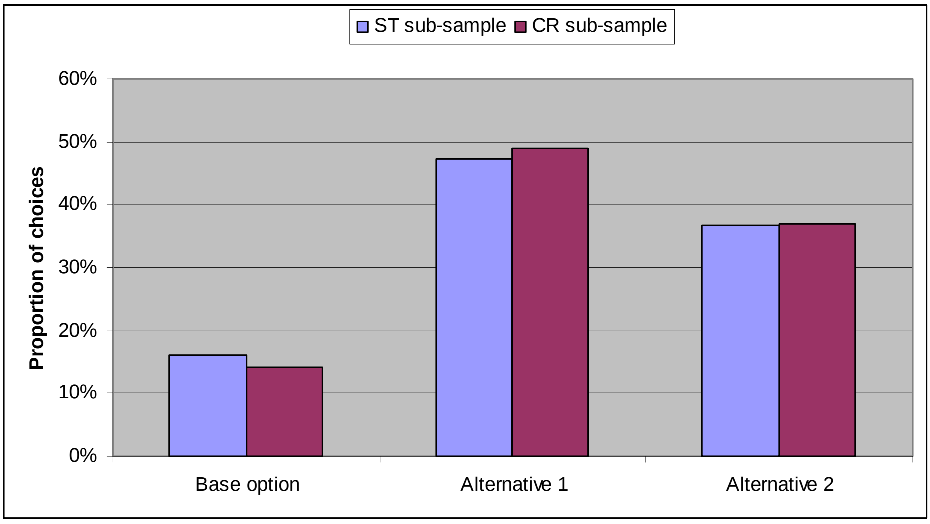
6 Cost anchoring results

A first test of differences between the ST and CR questionnaire versions is an analysis of protest responses. It was expected that the higher cost range in the CR questionnaire would lead to a higher rate of protests. The proportion of respondents protesting against the payment was 10.6 percent in the ST survey sample and 12.9 percent in the CR sample. This is not a significant difference across the split samples (p = 0.512).

In each choice set, a no-cost base option and two 'new management' alternatives were included. It was expected that a higher proportion of respondents would choose the base-option in the higher cost range version as an opt-out to avoid paying the higher levy. However, the choice data revealed no significant differences in the proportion of choices for the no-cost base option between the ST and CR questionnaire versions (Figure 4; p = 0.18).

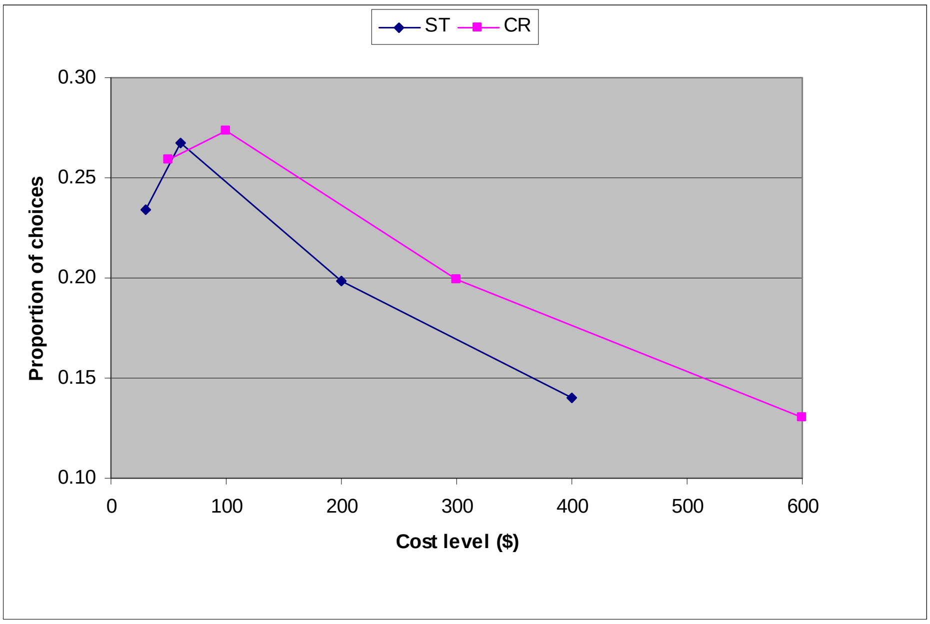
[11] As shown in Poe et al. (1994), comparing confidence intervals between groups is not an appropriate test because it relies on distributional assumptions about WTP that may not be satisfied.

Figure 3 Proportion of choices for the no-cost base option and the 'new management' alternatives



The choice data were further inspected based on the choices by the levels of the cost attribute. Bid-acceptance curves for both survey versions are shown in Figure 4. The figure shows choice sensitivity to the relative cost levels within each sub-sample, with acceptance rates declining with increasing cost levels. However, no statistical significant difference is present between the proportions of respondents who chose the $600 option in the CR sub-sample compared to the proportion of respondents choosing the $400 option in the ST sub-sample. This indicates some insensitivity to the absolute price levels.

Figure 4 Bid-acceptance for ST and CR questionnaire versions at different levels of the cost attribute



6.1 Model results

ML model specifications were estimated in Limdep 9.0 using Halton draws with 500 replications (Train, 2000). Similar model estimation procedures as described in Section 5 were followed, with the final model specification reported in Table 10.

As shown in Table 10

Table 10, all attribute parameters have the expected signs. The cost-coefficient is negative and significant for both sub-samples, indicating a disutility from higher levels in the cost attribute, *ceteris paribus*. The parameters on the environmental attributes are positive, indicating that respondents derive positive utility from higher levels in riverside vegetation and rare species. Note that the parameter estimate on seagrass is not significantly different from zero. However, this insignificance is irrelevant if the random parameter has an associated standard deviation estimate that is significant (Hynes et al., 2008). Given the positive and significant standard deviation for all random parameters, there is considerable unobserved heterogeneity in preferences towards the choice attributes. The standard deviation on the seagrass attribute is not significant in the high cost questionnaire, indicating that seagrass may be better specified as a fixed parameter. Additional models were therefore tested where the parameter on seagrass was modelled as a non-random parameter in the utility function. These specifications did not lead to better model fit ($\chi^2_{LR\text{-}test}$= 6.0 for ST and $\chi^2_{LR\text{-}test}$= 8.5 for CR model) therefore the final reported models include seagrass as a random parameter.

Table 10 Mixed logit - random effect model results for ST-CR sub-samples

	ST questionnaire		CR questionnaire	
Variable	Parameter	S.E.	Parameter	S.E.
Random parameter means				
Costs ($)	-0.011***	0.001	-0.007***	0.001
Seagrass (ha)	0.001	0.001	0.001	0.001
Vegetation (km)	0.041***	0.009	0.029**	0.011
Rare species (#)	0.072***	0.010	0.084***	0.012
Random parameter standard deviations				
Cost	0.011***	0.001	0.007***	0.001
Seagrass	0.003***	0.001	0.003	0.002
Vegetation	0.051***	0.010	0.044***	0.012
Rare species	0.094***	0.012	0.067***	0.013
Non-random parameters				
ASC (=1 for change alternatives)	-9.781***	2.444	-13.10***	3.629
Education (yr)	0.435***	0.135	0.502***	0.186
Visitation (# visits)	-0.041	0.081	0.276**	0.134
Agree (1-5) [(a)]	1.686***	0.411	2.473***	0.608
Standard deviation of the error component	2.034***	0.383	3.186***	0.536
Log-likelihood	-1006.57		--599.66	
n [(b)]	1,344		843	
Adjusted - ρ^{2} [(c)]	0.254		0.271	
AIC	2037.14		1223.32	

Note: ***, **, *= significant at 1%, 5% and 10% level. [(a)] measured on a 5-point Likert scale where 1 = strongly disagree and 5 = strongly agree. [(b)] Note that the number of ST choice observations is lower in the ST-CR comparative analysis because not all respondents answered the visitation and agreement questions. [(c)] Against a constant only model of LL_{ST}= -1364.8, LL_{CR}= -839.03.

An alternative specific constant (ASC) for the change alternatives was negative and significant, capturing a mean tendency for respondents to select the no-cost base alternative over the new-management alternatives. However, the significance of the latent random error component indicates that there is considerable heterogeneity across the utilities respondents derive from the new-management alternatives in both the ST and CR models. Similar to the models reported in Section 5, education was statistically significant in both sub-sample models. The coefficient on education was positive, indicating that respondents with higher education were more likely to choose new management actions. The number of visits to the George catchment was also included in the analysis, to allow for differences in preferences between respondents who visit the region and those who do not.[12] The coefficient on visitation was positive and significant in the CR model[13], indicating that respondents who visit the region more often are more likely to choose for environmental protection measures. Agreement with the poster information is highly significant in explaining choice probabilities in both the ST and CR survey samples. These results show that respondents who agree with the survey information are more likely to support new environmental management in the George catchment.

6.2 Anchoring effects

One of the hypotheses to test this report is whether the parameter estimates across the two models are equal. In order to enable a comparison of parameters, a grid search was conducted to estimate the ratio of the scale parameter (Swait and Louviere, 1993) where the scale parameter for the ST version was constrained to one. The relative scaling parameter was estimated to be 0.846, which implies that the error variance in the CR version of the questionnaire is larger than the error variance in the ST version (since μ is inversely related to the variance of the error term). The data from both survey versions was pooled and two additional models were estimated: one 'naively' pooled model where all parameters have the same scale, and a 'scaled' model in which potential differences in the variance of responses were controlled for by rescaling the CR data and estimating an additional term on the relative scale parameter. The results of these models and test for equivalence are reported in Table 11.

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[12] Contrary to the RA and AL sub-samples, visitation and agreement were significant in the CR survey version, which is why these variables are included in the comparative analysis here.
[13] Note that no statistical differences were found in visitation rates between split-samples.

Table 11 Pooled model results and likelihood ratio test for equivalence of parameters between ST and CR sub-samples

Variable	Pooled ST-CR (no scaling)	Pooled ST-CR (with scaling)
Random parameter means		
Costs ($)	-0.009***	-0.010***
Seagrass (ha)	0.001*	0.001*
Vegetation (km)	0.037***	0.040***
Rare species (#)	0.072***	0.077***
Random parameter standard deviations		
Cost	0.009***	0.010***
Seagrass (ha)	0.003***	0.004***
Vegetation	0.035***	0.035***
Rare species	0.075***	0.077***
Non-random parameters		
ASC	-11.33***	-21.91***
Education (yr)	0.491***	0.524***
Visitation (#)	0.041	0.030
Agree	2.050***	2.308***
Latent error component (sd)	3.789***	3.882***
Scale parameter		10.538**
n	2,187	2,187
Log-likelihood	-1613.56	-1610.27
χ^2-test value	8.07	6.58

Note: ***, **, * = significance at 1%, 5% and 10% level.

The χ^2-test value for equal parameters in the CR model against the ST model is 8.07. The null hypothesis of equal parameter estimates between the two versions can therefore not be rejected $\beta_{ST} = \beta_{CR}$. To ensure that this result is not a consequence of equal scale parameters, a second test was performed for the 'scaled' pooled model against the 'naively' pooled model. The null hypothesis of equal scale parameters is rejected with $\chi^2_{test} = 6.58$. This implies that the error variance in the CR version is significantly larger than the error variance in the standard survey version: $\sigma_{CR}^2 > \sigma_{ST}^2$. Hence respondents in the CR sub-sample are less 'certain' in their choices than those in the ST sub-sample. These results contrast with findings by Hanley et al. (2005), who conclude that the error variance in respondents' choices is smaller in a split sample with higher cost levels.

6.3 Value estimates

The next hypothesis test involves a comparison of the implicit price estimates across the ST and CR models. The marginal willingness to pay for each environmental attribute was estimated from the unconditional parameter estimates using the WALD procedure in Limdep. 95% confidence intervals were calculated using parametric bootstrapping with 1,000 replications (Krinsky and Robb, 1986). The results are shown in Table 12

Table 12 Marginal willingness to pay estimates and Poe *et al* (1994) test for equivalence of WTP

Attributes	ST version		CR version		p-value of equivalence	
Seagrass (ha)	0.09*	(-0.03 - 0.21)	0.12	(-0.16 - 0.40)	0.39	(-0.27 - 0.33)
Riverside veg (km)	3.71***	(2.19 - 5.21)	4.22***	(0.94 - 7.48)	0.39	(-2.99 - 4.01)
Rare species (#)	6.48***	(4.77 - 8.26)	12.25***	(8.59 - 15.8)	0.00	(1.63 - 9.89)

Note: ***, **, * = significance at 1%, 5% and 10% level. 95% confidence intervals in parentheses based on the 2.5th and 97.5th percentile of the simulated WTP distribution.

The marginal WTP estimates are positive and significant at the 1% level for the riverside vegetation and the rare species attributes in all split samples. Seagrass is significant at the 10% level of significance in the ST sample only. The confidence intervals around the WTP estimates are wider in the CR sample. This shows larger variance in WTP estimates in the CR sample compared to the ST survey sample.

Conform to *a priori* expectations, the implicit prices estimated in the CR version are higher than the ST version for all environmental attributes (Table 12 12). A test for statistical differences in WTP estimates was conducted, based on the convolution approach proposed by Poe et al. (2005, 1994). Results from this test show no significant differences in marginal WTP estimates for seagrass and riverside vegetation between the two sub-samples (Table 12Table 8). Only the estimated WTP for rare species is significantly higher in the CR sub-sample compared to the ST sub-sample. These results provide only partial support that an upward shift in the levels of the cost attribute provides respondents with a value anchor.

7 Discussion

The way in which respondents' make their choices in CE surveys will be affected by the context of the survey. Whereas several studies have investigated the impacts of varying the choice set context on respondents' choices (see, for example, Hensher, 2006b, Caussade et al., 2005, Breffle and Rowe, 2002, and DeShazo and Fermo, 2002), there are few studies that have explored alternative ways to frame (non-market) attribute levels in a CE and the possible impacts on value estimates.

7.1 Attribute framing

In this study, the effects of different formulations of attribute levels were explored, using results from a CE survey developed to assess community preference for natural resource management in the George River catchment, Tasmania.

The first issue that was examined was the impact of including both absolute and relative descriptions of attribute levels for the ‘seagrass area’ and ‘riverside vegetation’ attributes. Two questionnaire versions were administered; one included the absolute quantities of the attributes as well as the relative attribute levels compared to the total estuary area and total length of rivers, while the second questionnaire version described the absolute quantities only. Previous studies have found that survey respondents need information cues to help them make choices about unfamiliar goods (Schlapfer, 2008). It was therefore expected that the exclusion of relative attribute levels would make the information less instructive to respondents. However, results from mixed logit-random effect models do not provide evidence to show conclusively that preferences are significantly affected when information cues in the form of relative quantities are excluded. Although respondent’s uncertainty in choice is higher in the sample without relative attribute level descriptions (as indicated by a scale parameter that is less than one), it cannot be concluded that welfare estimates are different between sub-samples.

Information was provided on the survey poster about the total length of rivers in the George catchment and total area of the estuary. It is therefore possible that respondents used this knowledge to evaluate the relative changes in attribute levels, even without being explicitly informed. These results strengthen confidence in the validity of the CE results and the applicability of the CE methodology to value non-market changes.

A third questionnaire version was used to explore two different ways to describe attribute levels for a ‘rare native animal and plant species’ attribute. In the standard version of the questionnaire, the species attribute was described as the ‘number of species present’ in the catchment, while the third version described the attribute levels as ‘species lost’. It was expected that ‘species lost’ would lead to a stronger reaction towards the rare species attribute than in the standard survey version. Our findings indicate a smaller error variance in the ‘species lost’ survey, which makes intuitive sense as people were expected to more strongly prefer avoiding species ‘loss’ than maintaining species ‘presence’. Furthermore, the data show significant differences in the willingness to pay for rare species. The implicit price per species is significantly higher when the rare species attribute is described as a loss. Similar to findings reported in the CV literature (McDaniels, 1992, Tversky and Kahneman, 1991), this suggests that describing the level of a CE attribute in terms of 'loss' rather than 'presence' will increase the importance of that attribute in respondents' decisions.

The study setting and wording of the survey questionnaire forms a vital part of any CE. The context of the CE questionnaire should match the context of the study setting. The challenge for CE practitioners is to choose 'relevant' attributes and define an 'appropriate' attribute frame. The relevance of attributes will depend on both the policy and scientific contexts of the study. The management changes considered by decision makers should have plausible impacts on the chosen attributes, and those impacts need to be measurable from a scientific perspective. Setting the appropriate questionnaire frame is also critical, in order to estimate the true values respondents hold for the resources under consideration. The attributes and attribute levels presented in a CE questionnaire must be *described* in a way that suits the policy and scientific contexts and that is unambiguous and meaningful to respondents. CE practitioners need to be aware that particular attribute frames may influence respondents' choices and that alternative representations of attribute levels may affect how respondents comprehend the survey information. Focus group discussions and careful pretesting of CE surveys is essential to assess respondents' reactions to different ways of presenting attribute levels. If WTP estimates vary systematically according to methodological factors, there will be implications for benefit transfer studies. CE practitioners need to ensure that the physical context between "source" and "target" study area are consistent when using benefit transfer (Morrison and Bergland, 2006). The evidence provided in this report stresses the additional importance of providing comparable methodological contexts between applications.

7.2 Cost anchoring

Of particular importance to environmental valuation studies is the impact of changing the levels of the *cost* attribute on respondents' preferences. Previous work by Ladenburg and Olsen (2006) and Carlsson and Martinsson (2008) found significant differences between subsamples that were presented with different cost-levels. In contrast, Hanley *et al* (2005) concluded that varying the levels of the monetary attribute did *not* impact WTP estimates between subsamples.

In this study, a split sample was administered, in which the cost attribute levels were higher than the levels used in the standard version of the survey. It was expected that a higher proportion of respondents would choose the no-cost 'opt-out' alternative in the high cost split sample. Furthermore, we expected that the levels of the cost attribute might serve as an 'anchor' to respondents about the 'correct' payment for management changes.

Contrary to Hanley et al. (2005), no evidence was found of differences in the proportion of respondents who chose the no-cost base option over costly environmental management alternatives between the 'standard cost' (ST) and 'high cost' (CR) questionnaire versions. Further analysis of the choice data revealed that the probability of choosing a certain option decreases with increasing costs, indicating choice sensitivity to the cost levels in a CE survey. However, there were no significant differences in the proportion of highest bid acceptance between the ST and CR survey. This may indicate that respondents are more sensitive to relative, rather than absolute cost levels.

The main hypothesis tested in this study is that respondents might "anchor" their choice on the proposed levels of the cost attribute by interpreting the costs as a hint for a "reasonable" payment for management changes (Frykblom and Shogren, 2000). The higher levels of the cost attribute in the CR survey sub-sample would then have indicated a higher value for the George catchment environment. However, results showed that the estimated taste parameters were not significantly different between the ST and CR survey versions. The scale parameters varied significantly between survey versions. Although it was expected that higher cost levels would invoke 'stronger' (more decisive) reactions in respondents, the error variance was larger in the CR sample. Similar to findings by Mørkbak et al. (2009), these data thus show that respondent's uncertainty associated with the expected utility of an alternative was larger for the CR version of the questionnaire.

The implicit price estimates are higher in the CR sub-sample for one of the attributes. Therefore, only partial support is provided for the hypothesis that respondents anchor their choices on the levels of the cost attribute.

Given the inconclusive results in the CE literature about the impact of cost levels on respondents' choices and subsequent estimates of WTP, it is important to deliberate on why and how cost levels may affect respondents' choices. Anchoring provides a partial explanation for these findings. Other explanations could be choke price bias, yea-saying or because respondents have unstable preference structures.

Respondents' choices may have been insensitive to changes in the cost vector because their maximum WTP (respondent's choke price) was not reached for a significant proportion of respondents in either of the split samples. Around 14 percent of respondents choose the highest cost option in both the ST and CR survey versions (Figure 4). Given the significant impacts of changing the maximum cost levels found by Mørkbak et al. (2009), setting the 'appropriate' cost levels warrants careful consideration. To avoid hypothetical bias in survey responses, cost levels should be realistic and reflect the relevant (policy) context of the study. But cost levels should also be high enough to ensure that respondents consider the monetary attribute in making their choices. In the present study, careful pretesting and focus-group discussions were used to determine respondents' maximum WTP for changes in George catchment natural resource management. The maximum price was set at a level that was considered high enough to reach respondents' choke prices for the management changes proposed, but not so high to make the cost levels implausible. That would have led to hypothetical bias or a high rate of protest responses. Future research should weigh an increase of the maximum cost level presented in the survey against the plausibility of those costs.

Insensitivity to the absolute price levels could also be due to 'yea-saying' effects, in which respondents always agree to support environmental management options, regardless of their true preferences. Yea-saying may be socially motivated, when the respondent aims to please the interviewer by expressing an opinion considered desirable, or internally motivated, when respondents seek to express their held values (a form of strategic behaviour) (Blamey et al., 1999). It has been argued that CEs are associated with less hypothetical bias than contingent valuation, and that CEs can avoid bias from strategic behaviour (Morrison et al., 1996, Murphy et al., 2005). Given that respondents filled out the CE survey in confidence, at their leisure and in the comfort of their own home, no incentive to please an interviewer should have been present in this survey setting. Furthermore, an increase in the cost vector will have no impact on respondents' choices if yea-saying effects are present, meaning that WTP estimates will always increase when higher cost levels are used. Since significant differences were only found for the WTP estimates for one out of three attributes, yea-saying is unlikely to be the main driver of these findings.

Finally, it is possible that respondents have unstable preference structures for unfamiliar products like environmental goods and services. Setting the 'right' survey context is crucial, especially if preferences are (partly) formed by the survey frame, or 'discovered' (Braga and Starmer, 2005) during the surveying process. When valuing non-market goods, it is particularly difficult to determine the costs respondents may be willing to pay. Focus group discussions and careful pretesting are therefore essential to assess respondents' reactions to different cost levels. The range in 'appropriate' cost-levels will be different for each CE survey, varying with the good under valuation and the study context. The range in levels of the cost attribute should be wide enough to cover the possible preferences of all respondents. Consideration also needs to be given to setting a maximum cost level that is high enough to reach respondent's choke price for the management changes proposed.

The design and execution of future CE studies should be aimed at minimising the biases discussed above. Further research is needed to investigate the effects of varying cost levels on respondent's choices. There is scope for future research that is aimed at analysing the reasons for respondent's choice behaviour and their reactions to different cost vectors in various choice settings. Studies that compare different types of goods and additional model specifications that incorporate respondents' choice behaviour may provide further insights into the impacts of varying cost vectors on value estimates.

Further research is required to investigate effects of attribute level framing and varying cost levels on respondents' choices. In the survey employed in this study, information has been collected about respondents' reasons for choosing new-management alternatives, as well as information on respondents' attendance to the choice attributes. Further scrutiny of the data-set is proposed to reveal potential differences in respondents' choice behaviour between the standard version and the split samples of the questionnaire. Additional model specifications, for example models that account for non-linearities in preferences towards attribute levels, or models that incorporate respondents' choice behaviour, will be estimated to provide further insights in the impacts of attribute level framing and cost anchoring on value estimates.

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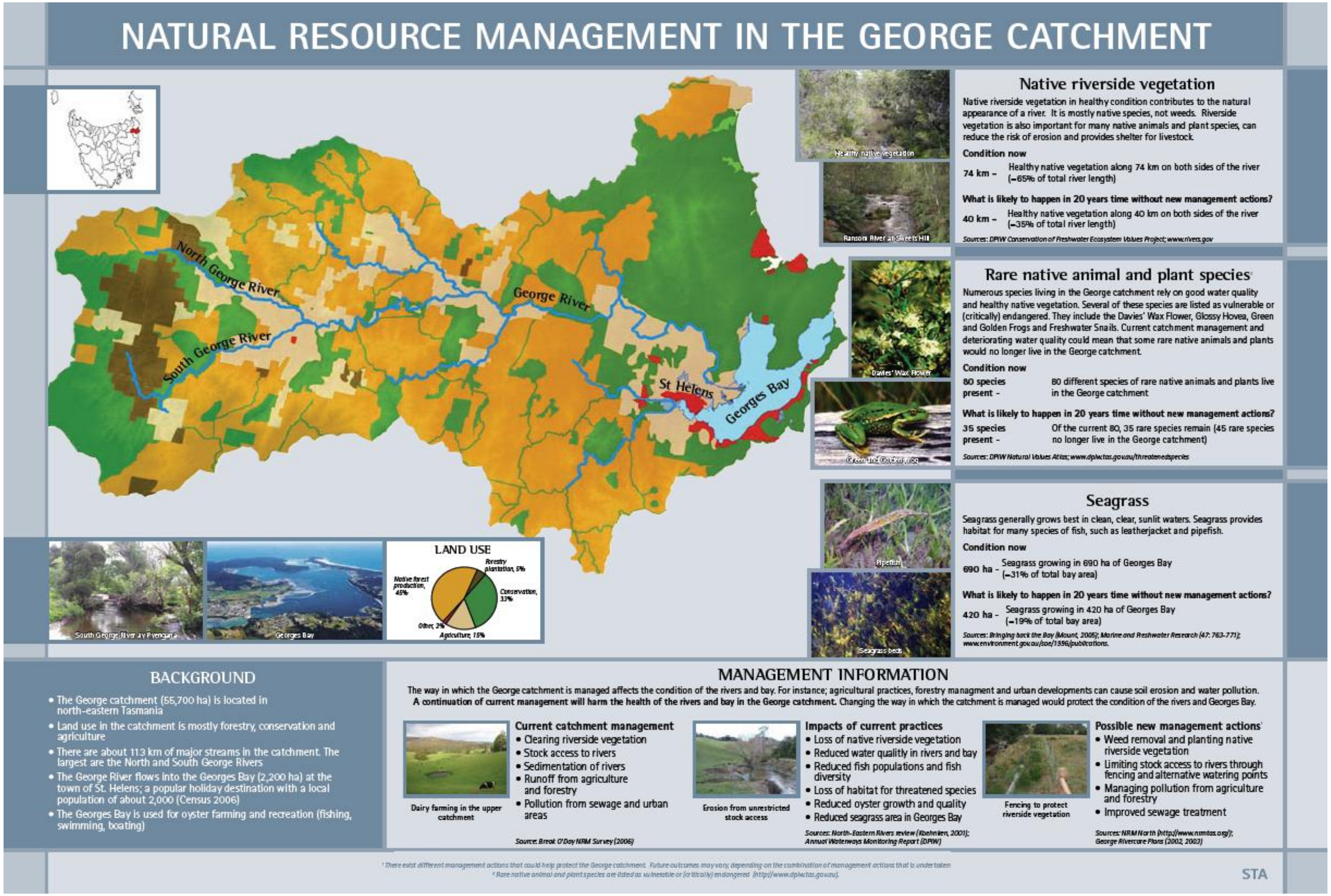
Appendix 1 Information poster included in the George catchment CE



Appendix 2 Attribute description in the George catchment CE

Attribute	Description
Native riverside vegetation	Native riverside vegetation in healthy condition contributes to the natural appearance of a river. It is mostly native species, not weeds. Riverside vegetation is also important for many native animal and plant species, can reduce the risk of erosion and provides shelter for livestock.
Seagrass area	Seagrass generally grows best in clean, clear, sunlit waters. Seagrass provides habitat for many species of fish, such as leatherjacket and pipefish.
Rare native animal and plant species	Numerous species living in the George catchment rely on good water quality and healthy native vegetation. Several of these species are listed as vulnerable or (critically) endangered. They include the Davies' Wax Flower, Glossy Hovea, Green and Golden Frogs and Freshwater Snails. Current catchment management and deteriorating water quality could mean that some rare native animals and plants would no longer live in the George catchment.
Your one-off payment	Taking action to change the way the George catchment is managed would involve higher costs. The money to pay for management changes would come from all the people of Tasmania, including your household, as a one-off levy on rates collected by the Tasmanian Government during the year 2009 The size of the levy would depend on which new management actions are used The money from the levy would go into a special trust fund specifically set up to fund management changes in the George catchment An independent auditor would make sure the money was spent properly