LANDSCAPE LOGIC
LINKING LAND AND WATER MANAGEMENT TO RESOURCE CONDITION TARGETS

Technical Report No. 8

Developing a non-market valuation survey of natural resource condition

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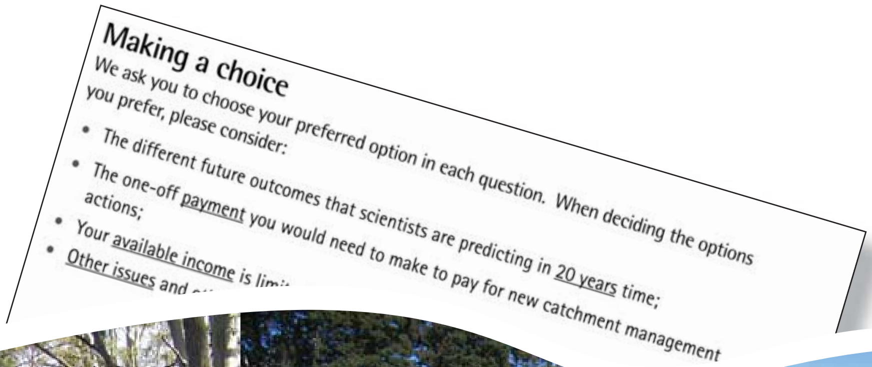
Making a choice
We ask you to choose your preferred option in each question. When deciding the options you prefer, please consider:
- The different future outcomes that scientists are predicting in 20 years time;
- The one-off payment you would need to make to pay for new catchment management actions;
- Your available income is lim...
- Other issues and ...

Australian Government
Department of the Environment, Water, Heritage and the Arts

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LANDSCAPE LOGIC is a research hub under the Commonwealth Environmental Research Facilities scheme, managed by the Department of Environment, Water Heritage and the Arts. It is a partnership between:

- **six regional organisations** – the North Central, North East & Goulburn–Broken Catchment Management Authorities in Victoria and the North, South and Cradle Coast Natural Resource Management organisations in Tasmania;
- **five research institutions** – University of Tasmania, Australian National University, RMIT University, Charles Sturt University and CSIRO; and
- **state land management agencies in Tasmania and Victoria** – the Tasmanian Department of Primary Industries & Water, Forestry Tasmania and the Victorian Department of Sustainability & Environment.

The purpose of Landscape Logic is to work in partnership with regional natural resource managers to develop decision-making approaches that improve the effectiveness of environmental management.

Landscape Logic aims to:

1. Develop better ways to organise existing knowledge and assumptions about links between land and water management and environmental outcomes.
2. Improve our understanding of the links between land management and environmental outcomes through historical studies of private and public investment into water quality and native vegetation condition.

Developing a non-market valuation survey of natural resource condition

By Marit E. Kragt

Summary

Changes in natural resource management in Australian catchments are likely to impact on the non-market values that communities attach to catchment resources, such as recreational, existence and protection values. To support efficient decision making, environmental valuation techniques are needed to quantify the value impacts resulting from changed catchment management. In this report, several approaches to environmental valuation are discussed. Revealed preference techniques include travel cost and hedonic pricing methods, stated preference techniques include contingent valuation and choice experiments.

Stated preference techniques are increasingly being used to estimate non-market values associated with changed environmental conditions in Australian catchments. The study described in this report employs choice experiments to assess community preferences for different natural resource management options in the George catchment, Tasmania. A combination of literature review, expert interviews, biophysical modelling and focus group discussions were used to design a Choice Experiment (CE) questionnaire for valuing changes in natural resource management in the George catchment, Tasmania. This report provides details of the questionnaire development, the selection of George catchment attributes, the determination of attribute levels and the design and delivery of the questionnaire. The results will be presented in a future technical report in this series.

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Contents

Introduction

Water resources in Australian catchments are under increasing pressure to satisfy often conflicting environmental and economic goals. Increased agricultural run-off, the introduction of exotic species, point source pollution and habitat destruction has led to concerns over water quality and ecosystem health in rivers and downstream estuaries. Changes in catchment conditions can have significant economic and social impacts on catchment communities. Catchment managers are likely to require information about environmental value changes in monetary terms to assist them to identify policy investments and to provide justification for catchment management changes (Robinson, 2001b).

Tasmania is not immune to water quality deterioration and the Tasmanian government is committed to protecting the State's water resources, while acknowledging possible conflicting economic, social and environmental objectives (DPIWE, 2005). There is a need to balance the environmental and social benefits of environmental protection with the economic impacts of changing natural resource management. However, there is limited knowledge about the non-market values such as those associated with protecting Tasmanian catchment systems. More information about community preferences for alternative natural resource management (NRM) options is necessary to support efficient decision making.

State and National government agencies make increasing use of environmental valuation studies to estimate the non-market costs and benefits impacted by changed NRM. Examples of such studies include Morrison and Bennett (2004) or Kragt *et al* (2007) who assessed the use and non-use values associated with river health; Whitten and Bennett (2003a) or Bennett *et al* (1998) on the values of wetland protection; and Lockwood and Walpole (1999) or Mallawaarachchi *et al* (2001) for value assessments of remnant vegetation.

Sections 2 and 3 of this report gives an introduction to environmental values and the different valuation techniques available to measure environmental values. Sections 4 to 8 describe the general design theory of valuation questionnaires, the selection of management scenarios and environmental attributes for a case study in the George catchment in Tasmania, the design of a non-market valuation survey for the George catchment, and the presentation and delivery of the survey. The final section summarises the design of a non-market valuation survey and outlines the future steps in this valuation study.

Environmental values

Economists and ecologists have different perspectives about the concept of 'environmental value'. Ecologists view a good or service as valuable when it contributes to the achievement of some system goal. These ecological values are derived from purely ecological functions, can be measured objectively, and can be described using biophysical models. Ecological models tend to disregard human preferences when considering values (Bockstael *et al*, 1995). In neoclassical economics, on the other hand, a good or service has value because it contributes to the maximisation of an individual's utility (Straton, 2006). Such economic values are based on an anthropogenic definition of value. A major criticism by ecologists is that economists are too narrow and anthropocentric in viewing the role and functions of ecological systems (Bockstael *et al*, 1995). While recognising that ecological values often underpin economic values, this report will focus on the economic values of catchment systems.

A change in water quality (or flows) may affect industries operating in the catchment directly through a change in the provision of ecosystem goods and services. Some of these goods may be traded in conventional markets, like fish caught in a river or prawns harvested in an estuary. Information about the effects on the *market values* of river system goods and services can be derived from the analyses of market data (see Section 3.1).

Many benefits generated by ecosystem goods and services, however, are not traded in conventional markets. To obtain a complete picture of the economic value of changes in water quality, additional information is required about the *non-market* values affected, including use values, option values and non-use values (Figure 1).

Use values can be divided into direct and indirect use values. *Direct use values* are associated with direct utilisation of the resource. For a catchment system, such use values can correspond to benefits obtained from visiting natural areas, fishing in the river and other recreational activities. *Indirect use values* include the positive externalities that catchment ecosystems provide, such as water purification, reduced soil degradation, and reduced flood damage.

Option values are values of retaining the option to use a resource in the future. A related concept is *quasi-option value*, which is the value of obtaining better information by delaying a decision that may result in irreversible environmental loss (value of 'future information'). Rolfe and Windle (2005) describe and estimate option values that households hold for reserve water in the Fitzroy Catchment.

Non-use values can be derived without actually utilising the resource. Non-use values include existence value (value derived from knowing that the resource exists), bequest value (value derived from conserving an ecosystem for future generations) and vicarious value (welfare derived from the indirect consumption of an environmental resource through books or other media).

Although the methodology of estimating asset values has been heavily criticised (see, for example, Hueting *et al*, 1998, and Turner *et al*, 1998) there have been many studies attempting to estimate the economic value of ecosystem goods and services (see, for example, Costanza *et al*, 1997, Cork and Shelton, 2000, Asafu-Adjaye *et al*, 2005, and Troy and Wilson, 2006).

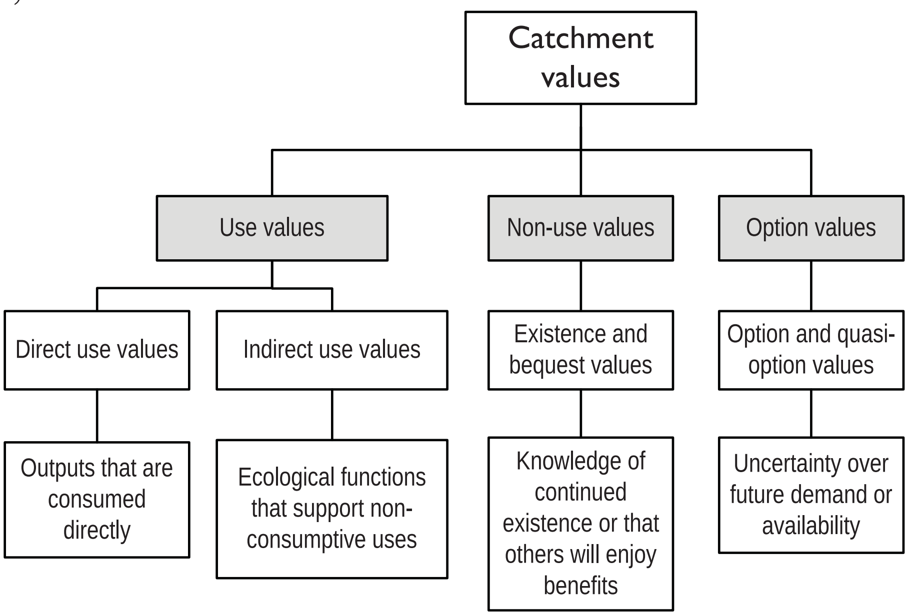

Figure 1. Environmental Values of Catchment Systems.

Environmental valuation techniques

Asset valuation is largely concerned with the value of a given stock of a resource. To support decision making, environmental valuation techniques need to quantify value *changes* resulting from management that affects the quality or quantity of environmental resources. In this section, several of such environmental valuation techniques are discussed.

Market-based valuation

Market based techniques facilitate the estimation of changes to economic values from direct, observable market interactions. In a well-functioning competitive market, prices are direct measures of benefit and costs and can be used as values. The market-value of a natural resource can be monetised based on its value as a factor of production. Using production function approaches, a change in environmental quality can be related to changes in production level or quality. The monetary value of the change in production can then be used to represent the value of the natural resource.

This technique is attractive as it uses directly observable market prices and output levels. When production revenues and costs are known, a before and after analysis of the producer surplus can provide the value of the environmental change in a relatively straightforward way. Lipton *et al* (1995) use this approach by measuring the reduction in fish catch and increase in variable costs from habitat degradation in Chesapeake Bay.

Production function models depend on the quality of the baseline production function and on accurate measures of environmental change. Limited environmental, ecological and production information can impede application of these techniques. More importantly, the production function approach is limited to natural resources that are used in production processes. When environmental resources are not traded in markets, the production function method generally fails to capture the total value of the resource to society.

Non-market valuation – Revealed preference techniques

When a resource is traded in a competitive market, market prices will give an indication of the value of the goods and services that are used. Production function approaches can be used to derive this economic value. Where markets do not exist, or where there is a failure of the market to value environmental resources, there is a need for techniques that estimate the non-market values of resources.

Two approaches for estimating non-market values can be distinguished: revealed preference techniques and stated preference techniques. Stated preference (SP) techniques involve asking people directly how much they would be willing to pay for a change in an environmental good or service (e.g. contingent valuation and choice experiments). Revealed preference (RP) techniques rely on observable behaviour to deduce monetary values even though the resource is not traded in markets. For the most part, these techniques value the use values associated with a resource. RP techniques include travel cost models and the hedonic pricing method.

Travel costs method

The most commonly applied RP technique is the travel cost method (TCM). This approach uses the relationship between individuals' preferences for recreational sites and their willingness to pay the costs of travelling to the site. Sites can be characterised by environmental attributes like water quality but also by existing facilities and accessibility. Attribute levels vary from site to site, as do the economic costs incurred visiting each site (in terms of varying direct travel expenditures, different travel times, etc.) (Bateman *et al*, 2006a). The choices made by visitors reveal the trade-offs between site attributes and costs.

Where an investment in natural resource management improves the recreational potential of a resource (say through an enhancement of the water quality in a river that is used for swimming or fishing) the TCM estimate the direct use value of the resource by assessing the changes in recreational demand. Using this recreation as a proxy for environmental quality, the demand function enables estimation of the environmental values derived from the site.

There are a couple of examples of studies that estimate the recreational values of healthy rivers in Australia. Thomas (1982) used the TCM to estimate the recreational values of the Murray River Catchment. His results indicated a willingness-to-pay (WTP) of $5.55 (2002 A$) per visit. With approximately 41,800 visitors per year, this led to an annual recreational value of the Murray River of nearly one million dollars. Sinden (1990) used the TCM to analyse the recreational value of 24 sites along the King and Ovens river systems in Victoria. His results showed that the average user was willing-to-pay $22 (1989 A$) per day visit and $37 (1989 A$) per camping visit. Multiplying these estimates by the average number of day-use group visits and camping visit in 1989, the aggregate recreational value of the river systems was more than $1m. Sinden suggested that this aggregate result is likely to be an underestimate of the actual recreational value because not all sites along the river were surveyed. The TCM has more recently been applied by Rolfe and Prayaga (2007) to estimate the value of recreational fishing three major freshwater impoundments in Queensland. Their estimates of individual values ranged from $60 per trip at the Bjelke-Petersen Dam to $904 per trip at the Fairbairn Dam. The authors acknowledged that these estimates were potentially overestimating the values of recreational fishing since they were based on travel costs for the entire trip. When multipurpose and multi-destination issues are considered the values may be lower.

The TCM relies on a number of assumptions, which, if violated, could reduce its validity. Models usually assume single purpose trips to the recreation site. Multi-purpose trips can pose problems because of the need for an arbitrary division of total travel costs (Pearce and Turner, 1992). Another difficulty includes the estimation of travel costs and the inclusion of opportunity costs of travel time. The TCM also ignores potential values that non-visitors hold for a recreation site. Complications equally arise when the environmental quality of not just one, but multiple recreational sites improves. As each site improves, the marginal value of improving the next site declines. This complicates an accurate estimation of total values (Bateman *et al*, 2006a).

Hedonic pricing

The hedonic pricing (HP) technique requires the estimation of the price of a marketed good as a function of its attributes, including non-marketed elements that are of interest (Freeman and Dumsday, 2003). The HP technique is mostly used to measure non-market values associated with property values. Environmental characteristics such as clean air and landscape are captured in the price paid for a property. By comparing the market value of two properties which differ only with respect to a specific environmental attribute, it is possible to extract the implicit price of that attribute. HP techniques can be extended to estimate land values. For example, if rural land prices reflect agricultural production and environmental attributes (e.g. soil quality or biodiversity), land price data could be related to these components using statistical procedures in order to determine the contribution of each component to land value (Freeman and Dumsday, 2003).

The process for estimating a hedonic price function that relates housing or land prices to the quantities of various attributes is reasonably straightforward. Application of the HP technique uses observable market data on property sales and characteristics. However, most environmental attributes will have only small, if any, effects on property values. Buyers and sellers need to be aware of the environmental characteristics, and these need to be included in the price of a property. Even where prices are affected by environmental attributes, it may be difficult to distinguish values using econometric methods because other attributes, many of which are correlated, also influence property prices (NOAA Coastal Services Center, 2006a).

Non-market valuation – Stated preference techniques

A disadvantage of RP techniques is that they do not measure indirect uses or non-use values (e.g. the option value to visit a site in the future or the non-use values of ecosystem services such as water purification or erosion prevention). Stated preference (SP) techniques have been developed to address these shortcomings. SP techniques can be used to estimate use and non-use values for environmental resources. They typically employ questionnaires in which respondents' preferences for various environmental outcomes are identified through construction of a simulated market. Stated preference techniques include contingent valuation and choice experiments.

Contingent valuation

The Contingent Valuation Method (CVM) is a non-market valuation technique that elicits information about environmental values through the use of surveys[1]. In a CVM survey, a hypothetical market is constructed involving an improvement or decline in environmental quality resulting from changed management. Respondents are asked for their willingness-to-pay (WTP) to obtain or avoid the change in environmental quality.

The estimated average WTP captures both use and non-use values of the environmental good in question. Regression analysis of CVM responses can include socio-economic and attitudinal characteristics of respondents. Demand for an environmental resource is usually expressed as:

$$WTP_{ji} = f\,(E_i, X_j, I_j, A_j)$$

where:

WTP_{ji} = the willingness to pay of respondent j for environmental resource i;

E_i = the environmental quality of resource i;

X_j = socio-economic characteristics of the respondent j;

I_j = the income level of the respondent j;

A_j = attitudinal characteristics of the respondent j.

The CVM can be used to estimate the values associated with potential degradation or improvements to environmental resources. The CVM can only consider a one-off change in the environmental resource and is not able to assess values of multiple environmental assets. The incorporation of substitution possibilities or multiple attributes is limited in

CVM, other than through including a statement prior to the CVM question to remind respondents of alternative goods that may serve as a substitute to the environmental resource under consideration.

There are several Australian studies that apply the CVM to estimate non-market values for river condition. Mattinson and Morrison (1985) estimated the WTP for improved water quality through reductions in blue-green algae in the Peel-Harvey Estuary in Western Australia. The value of improved water quality for residents was estimated to range from $27 to $41 (1984 A$). The WTP of visitors to the region was lower at approximately $1.4 (1984 A$). This low estimate for recreationalists could have been caused by the existence of nearby substitute sites. Walpole (1991) carried out a CVM study to analyse the recreational value of sites along the King and Ovens River System, Victoria. The sample sites ranged from parks catering for intensive day and camping use to secluded fishing areas. Benefit values for different sites varied from $7.20 (1989 A$) to $30.30 (1989 A$). Rolfe and Prayaga (2007) used CVM to estimate the marginal values associated with a potential improvement in fishing experience. Their estimates of WTP ranged from $19 to $43 (2003 A$) for three recreational sites in Queensland. The total estimated values of improving catch rates by 20 per cent per annum at each dam were estimated at $0.12m for Bjelke-Petersen, $0.39m for Boondooma and $0.22m for Fairbairn. The authors acknowledged that these estimates may be an overstatement of true WTP if respondents answered to the hypothetical nature of the questionnaire rather than giving a 'true' answer.

Choice experiments

The occurrence of 'hypothetical bias' is a potential problem in using SP surveys to elicit environmental values. Other bias that can arise include strategic bias, where the respondent intentionally understates or overstates his willingness to pay to achieve a desired policy result, or bias resulting from 'yea-saying', where the respondent always agrees to the scenario presented in the survey. Respondents may also protest against the payment vehicle used in the questionnaire if they have an aversion to certain taxes or fees.

The design of the bidding question (open-ended/closed-ended, series of dichotomous choice questions or an iterative bidding question) may influence the respondent's WTP answer. Significant research has gone into methods to overcome bias in CVM surveys. The NOAA panel on Contingent Valuation (Arrow *et al*, 1993) presents guidelines to reduce bias. Other studies aimed at reducing CVM bias have resulted in the development of alternative approaches to SP environmental valuation. One technique that is increasingly used is *Choice Experiments.*

Choice Experiments (CE) require respondents to choose their preferred alternative from an array of alternative choices in a SP survey. A choice question in a CE typically includes several alternatives including a 'baseline' scenario (Figure 2). Each alternative is described in terms of different levels of non-market attributes and a cost attribute. Respondents are asked to choose their preferred option from these scenarios, allowing the researcher to observe the relative importance of the different attributes.

Whereas contingent valuation produces a single value for a given change in environmental quality, choice experiments can provide individual values for the attributes presented in the survey. A CE application may provide estimates of the value of improved water quality, increased fish population, enhanced biodiversity, recreational uses etc.

Data from a CE survey are analysed using non-linear logit regression models, from which values

Suppose the following three options were the only options available for managing the remaining trees of the Desert Uplands. Please indicate which option you prefer by ticking one of the boxes below.

Feature	Option A	Option B	Option C Continued tree clearing
Tree levy (per taxpayer)	$10	$50	$0
Jobs lost in nearby town	10	20	None
Risk to endangered species	medium	low	high
Reduction in numbers of non-threatened species	no reduction	minor reduction	major reduction
Loss of unique landscapes/ecosystems	no change	minor reduction	major reduction
Land degradation	medium	low	high

- ❑ I would choose A
- ❑ I would choose B
- ❑ I would not support either A or B, and would prefer continuation of tree-clearing at current rates (Option C).

Figure 2. Example of a choice set in a CE survey. (Source: Blamey et al, 1997.)

for the different attributes can be derived (Cameron and Trivedi, 2005). These values are expressed as estimates of part-worths (implicit prices) for percentage changes in individual attributes. The implicit prices are derived using the formula:

$$\frac{\beta_{non-market}}{\beta_{cost}}$$

where $\beta_{non\text{-}market}$ is the estimated coefficient of the non-market attribute; and β_{cost} is the estimated coefficient of the cost attribute.

Implicit prices provide a point estimate of the value of a unit change in the attribute. These are marginal values in the sense that they represent the value of a small change in one of the attributes considered in the questionnaire. Such estimates are particularly useful for management decisions where information is required about the value of marginal changes in environmental quality, such as an increase in wetland area or a percentage change in length of streams with healthy riverside vegetation. The implicit price for an attribute is based on the ceteris paribus assumption that the levels of all other attributes are held constant.

Studies by Whitten and Bennett (2003a), Bennett and Blamey (2001) and Blamey *et al* (1999) suggested that CEs are a flexible and cost-effective alternative to CVM. CEs can evaluate multiple policy scenarios and can include both non-use and use values of resources. It is also argued that bias could be reduced in CE applications because the presentation of alternative management options and attributes makes it difficult for respondents to behave strategically.

The CE technique has been used in a number of Australian studies to estimate non-use environmental values. Morrison *et al* (1998) used CEs to estimate the non-use values provided by the Macquarie wetlands, NSW. The authors estimated implicit prices of \$0.04 per km^2 for an increase in wetland area and of \$4.16 per species for an increase in the number of endangered species. Social values associated with losses in irrigation-related employment were also calculated. Another CE application to wetlands is found in Whitten and Bennet (2001b) who estimated the environmental values associated with changed wetland management in the Upper South East of South Australia and Murrumbidgee River Floodplain. Attributes included were the area of remnant vegetation, area of healthy wetlands and native birds and fish species. The Murrumbidgee survey also included as social attribute related to farmers leaving when environmental management is implemented. Blamey *et al* (1999) assessed alternative water supply options in the ACT. The study estimated the welfare impacts of changes from a base scenario to future alternatives with compulsory water restrictions in place. Blamey *et al* (2000) estimated the welfare changes associated with retaining remnant vegetation in central Queensland. More stringent tree clearing restrictions were assumed to lead to increased remnant vegetation but potential loss in income or jobs. Their results show that there is significant support for protecting remnant vegetation. Mallawaarachchi *et al* (2001) also used CEs to estimate the non-use environmental and social values related to protecting natural vegetation for a study of the Herbert River District in North Queensland. The study considered an incentive scheme that would prevent land conversion to cane growing, which would affect regional incomes as well as environmental characteristics. The value of increasing Herbert wetlands and riparian vegetation with 100ha was shown to be \$39.35, the implicit price for a 1000ha increase in tea-tree woodlands was estimated at \$2.56.

Rolfe *et al* (2004) and Windle *et al* (2005) applied the CE technique to investigate landholders' *willingness to accept* payments for restoring riparian buffers in the Fitzroy Basin, Queensland. The study differs from other CE applications in that it focuses on supply rather than on individual willingness to pay. The results from this study provided information on landholders' attitudes that can aid the future design and implementation of market based instruments for riparian conservation.

In the context of river health, several Australian case studies exist. Choice Experiments are especially useful in this context, as it can estimate value changes associated with a range of attributes associated with river conditions. Van Bueren and Bennett (2000) applied CEs as part of the National Land and Water Resources Audit to estimate non-market values associated with land and water degradation in Australia. The length of waterways healthy enough for fishing and swimming was included as one of the attributes in the choice questions. Results indicated that respondents were willing to pay, on average, \$0.08 per household per year for 20 years to restore an additional 10km of waterways. Robinson *et al* (2002) employed the CE technique to estimate value changes associated with an improvement in river water quality in the Bremer River catchment. The study involved a 'citizens' jury' to estimate community WTP. Their results indicated that the implicit price for a 1% increase in riparian vegetation along the river was \$1.47, the implicit price for a 1% increase in aquatic vegetation was \$1.08 and the implicit price estimate for a 1% increase in length of the river with good or very good visual appearance was \$0.37. This study only sampled 23 citizens' jurors, hence extrapolation of the results to a larger population may not be valid because of the small sample size and because jurors were likely to be better informed than the average respondent. The approach by Morrison and Bennett (2004) was also aimed at estimating non-market benefits of river health improvements. Values were estimated for five rivers in NSW (Bega, Clarence, Murrumbidgee, Gwydir and Georges Rivers). Both within-catchment and out-of-catchment populations were sampled. Implicit price estimates for a 1% increase in healthy vegetation ranged from $1.46 to $2.33, for a one species increase in fish species from $2.12 to $7.23 and for an increase of one more fauna species from $0.88 to $1.92. Recreational values were also estimated. The current state of the river was assumed to be only suitable for boating and picnicking. To have the entire river return to being suitable for fishing, respondents were willing to pay between $29.93 to $54.16 as a one-off levy on water rates. To have the entire river return to being suitable for swimming, respondents were willing to pay between $59.98 to $104.07 depending on the sample population and the river considered.

A recent application of CEs in a river health context is described in Bennet *et al* (2006). Their survey was aimed at estimating values for a range of attributes of rivers in Victoria (Goulburn, Gellibrand and Moorabool rivers). Environmental attributes included the percentage of pre-settlement fish species and populations; the percentage of the river's length with healthy vegetation on both banks; and the number of native waterbird and animal species with sustainable populations. A recreational attribute was included to represent water quality. Their sample included respondents in rural within-catchment, urban within-catchment and urban out-of-catchment populations. Respondents were willing to pay $2.19 to $5.56 for a 1% increase in fish species; $2.91 to $5.56 for a unit increase in vegetation; and $3.04 to $22.07 for an increase in the number of native migratory waterbirds and riverine fauna species with sustainable populations in the next 20 years. Recreational values were estimated as the willingness to pay for a 1% increase in the river suitable for primary contact recreation without threat to public health and ranged from $1.64 to $2.12. Respondents' location and the river under consideration were significantly influencing the implicit price estimates for some attributes.

The above examples show that CEs are a versatile environmental valuation technique that can be applied to a range of situations. The technique is capable of estimating use and non-use environmental and social values, associated with currently non-observed impacts from changed natural resource management. CEs are especially useful in cases where management decisions are expected to affect an array of attributes.

The study reported in this paper employs a CE survey to estimate the non-market value impacts of changing natural resource management in the George catchment, Tasmania. The following sections describe the development of the survey and its application.

Designing choice experiment questionnaires

A choice experiment comprises of several stages (Table 1). The analyst must first identify the issue under consideration and define the 'baseline' situation (Bennett and Adamowicz, 2001: 46). In a CE, the baseline scenario is typically defined as the level of attributes at some point in time in the future if current policies were to continue. The outcomes of alternative policy scenarios are then described by the levels that the attributes will have at the same point in time if a policy change were to come about.

The policy scenarios included in the questionnaire should be understandable and plausible to respondents. The presented scenario also needs to be unbiased as to not raise political objections by respondents. The proposed policy scenarios may be described in the choice questions or presented in a separate information booklet or sheet (see Blamey *et al*, 1997 for a discussion on policy labelling).

Table 1. Stages of choice modelling questionnaire development.

1.	Problem identification	Describing the issue at stake. What is the environmental resource that will be considered? What is the current status, threats, involved stakeholders etc.
2.	Policy scenarios	Identifying what management actions could be undertaken to address the issue at stake.
3.	Selection of attributes	Decide on the attributes relevant to the good under consideration including their scope, scale and framing context.
4.	Assigning levels to attributes	The likely levels of the attributes need to be determined for a status-quo scenario and alternative policy scenarios.
5.	Experimental design	Allocating the levels of the attributes to each alternative within the choice sets.
6.	Survey delivery	Choosing the presentation, the sample size and locations and surveying procedure.
7.	Analysing the survey results	Using different econometric models specifically developed to analysing discrete choice data can provide an estimation of the trade-offs respondents make between the attributes

The changes resulting from alternative policies are described by varying levels of different attributes. These attributes can include environmental and socio-economic assets, and should be relevant to both decision makers and respondents to the CE questionnaire. Selecting attributes that are independent of each other[3] allows for the assumption that respondents make complete trade-offs between the attributes[4]. Attributes should also be exogenous to the respondent. That is, attribute levels should not be influenced by respondents' actions directly. All attribute levels should be realistic and related to the policy scenario (for example, one would expect an environmental policy to result in increased environmental quality). The current situation needs to be assessed, as well as the possible environmental status at some point in the future time if no management changes would occur (the baseline). The attribute levels resulting from alternative management actions need to be *quantified* to describe the different future options. Finally, attribute levels must be *described* in a way that is unambiguous and meaningful to respondents. The selection of the attributes important in the George catchment is described in Section 6 of this report.

It is usually infeasible to include all possible combinations of the attributes in a CE questionnaire (the 'full factorial'). The number of alternatives can be reduced by selecting a subset of all possible combinations. An *experimental design* is used to allocate the different attribute levels to the alternatives in each choice set. Constructing choice sets conventionally uses an orthogonal main effects design. Recent approaches to experimental design such as Bayesian techniques aim to increase design efficiency, typically measured in terms of minimum variance-covariance in the estimated parameter matrix (see Scarpa and Rose, 2008, for more details). The experimental design for the George catchment survey employed an efficient design strategy aimed at maximising D-efficiency (see, Rose and Bliemer, 2005, and Rose and Bliemer, 2008).

Identifying the issues in the George catchment

The questionnaire described in this report aims to assess the community values and preferences for different natural resource management options in the George catchment, in north-east Tasmania (Figure 3). The George catchment is a coastal catchment of about 557km². The total length of rivers in the catchment is approximately 113km, with the main rivers being the Ransom and the North and South George Rivers. The George River flows into the Georges Bay estuary (22km²) near the town of St Helens. Land use in the upper catchment is a mix of native forestry and forest plantations along with dairy farming, while the lower catchment is used for agriculture and contains most of the rural and urban residences (DPIW, 2007). Georges Bay has been extensively developed for oyster farming and is intensively used for recreational activities.

The economic valuation study must be aimed at catchment management issues that are important in the George catchment. The various Rivercare plans for the George Rivers (Rattray, 2001, Lliff, 2002, and Sprod, 2003) provided guidelines to possible issues and management strategies in the George catchment (Table 2).

As part of the present study a team of local and regional experts was interviewed to identify the threats to natural resources in the George catchment and the strategies that could be undertaken to protect river and estuary conditions. Current NRM activities are targeted at improving native vegetation and curbing water quality decline, with an emphasis on reducing nutrient concentrations and e-coli in the water:

- Recovery of dairy effluent
- Improved wastewater treatment
- Reducing stock access to riparian zones
- Planting native vegetation in riparian buffers
- Removing weeds along river banks.

Possible threats from forestry activities in the George catchment were also discussed with representatives of the Forest Practise Board Tasmania. The main water quality issues associated with forestry practises included erosion and chemical contamination. The Forest Practise Code (FPC, Forest Practices Board, 2000) targets erosion by recommending a 10m to 40m buffer zone along streams, to reduce sediment runoff when harvesting in plantations and native forests. The FPC also includes guidelines for

Table 2. Community concerns in the Upper George River. (Source: Rattray, 2001.)

Objectives	Threats
Good water quality	(i) Uncontrolled stock access
	(ii) Former mining activities
	(iii) Septic tanks and dairy effluent
A good looking river	(i) Weeds along the river
	(ii) Too much unnaturally placed rock
	(iii) Litter
Ample water for irrigation	(i) Drought
	(ii) Increase in irrigators
	(iii) Lack of water storages
Recreation opportunities	(i) Lack of community parks
	(ii) Fences and weeds preventing river access
Community controlled river-care	(i) No resources for on ground works
	(ii) Clear legislation

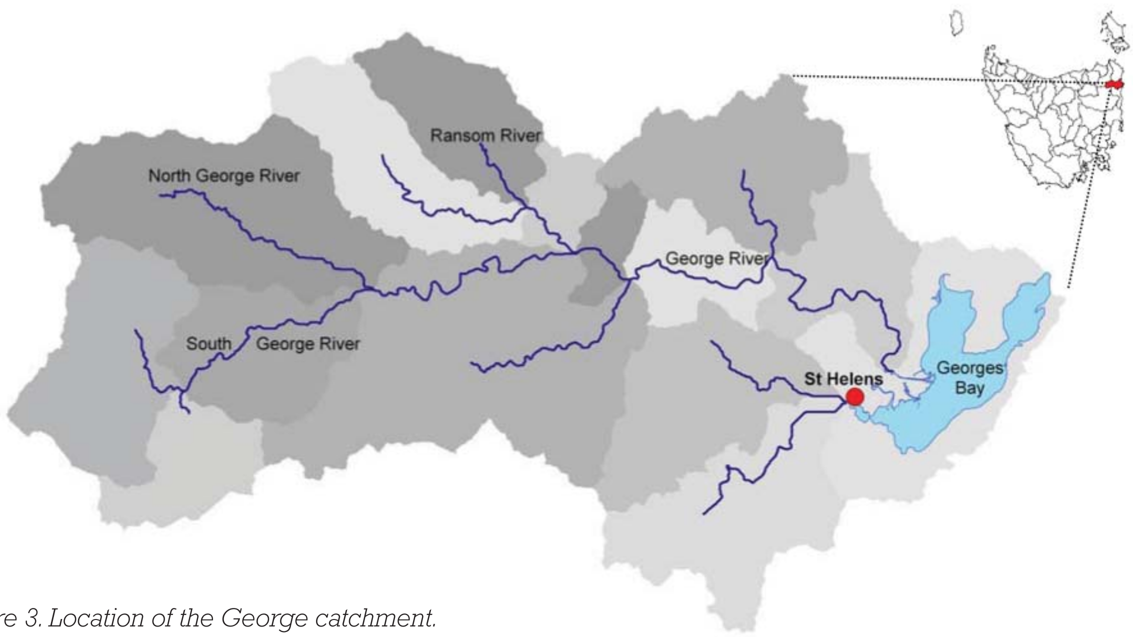

Figure 3. Location of the George catchment.

logging procedures and responsible application of chemicals (Forest Practices Board, 2000)

The current catchment threats and possible new management actions need to be plausible and understandable for respondents to the CE questionnaire. Eight focus groups were organised to further discuss the community concerns and NRM strategies identified during the expert interviews[5]. The most notable factors that were believed to affect water quality in the George catchment were septic tanks, forestry runoff and agricultural practises. Participants generally agreed with the identified catchment threats and that more management actions should be undertaken to protect the catchment.

The most important threats identified in the George catchment are clearing of riverside vegetation; stock access to rivers; sedimentation of rivers; runoff from agriculture and forestry and pollution from sewage and urban areas. These practises may reduce the area of native riverside vegetation, water quality and animal and plant populations in the George catchment in the next 20 years time. Possible new management actions to protect the George catchment environment include weed removal and planting native riverside vegetation; limiting stock access to rivers; managing pollution from agriculture and forestry; and improved sewage treatment. The impacts of new management actions are described by changed levels of the environmental attributes (see following sections).

Selecting attributes for the CE questionnaire

A key task in any CE exercise is the selection of the attributes, and their levels, used to describe the impacts of alternative policy scenarios. The attributes chosen to describe the change should be relevant to both decision makers and respondents to the questionnaire. Determining which attributes are relevant in the George catchment involved an extensive literature review, discussions with Tasmanian scientists and focus group meetings.

Review of literature

A first step in identifying possible attributes was a literature review of existing non-market valuation studies of environmental changes in river catchments. These included recreational studies, contingent valuation studies and choice experiments of rivers, lakes and estuaries (Appendix 1). There are a few studies that include chemical characteristics or water clarity as indicators of water quality (for example, Johnston et al, 2002a, Kerr and Sharp, 2003, Egan et al, 2004, and Holmes et al, 2004). Most valuation studies, however, use ecological indicators to reflect water quality and catchment conditions. The literature review showed that valuation studies on catchment conditions tend to emphasise five types of attributes:

1. Threatened species or birds
2. Native fish species
3. Healthy riparian vegetation
4. Wetland areas
5. Recreational values associated with fishing, boating and swimming

The review of valuation studies was complemented by a review of policy documents related to river and estuary water quality. The 2001 draft Rivercare Plan (Rattray, 2001) identifies some general issues that the local community may be concerned about (see Section 3). Further attributes of the George catchment are identified in McKenny and Shepherd (1999) and DPIW (2005) (Table 3).

A final source of information on George catchment attributes is the Break O'Day NRM Survey 2006 (BOD, 2007). Results from this survey indicate that residents and ratepayers in the municipality place great value on the variety of natural assets in the area, "for their inherent natural function, as well as scenery and recreation opportunities" (BOD, 2007). Clean water and streams in the George catchment and the Georges Bay are regarded key assets in the region.

Expert interviews

Interviews were conducted with various ecological experts to discuss environmental attributes of importance in the George catchment. Special attention was paid to identifying potential 'icon' species in the catchment. Representatives of *Birds Tasmania* were interviewed regarding the importance of the George catchment for birds. From a bird-watchers point of view, there are minimal significant bird attributes in the George River catchment. The high number of visitors to the area is likely to be more disruptive to bird populations than water quality changes. Meetings with the Threatened Species Unit at DPIW revealed a number of rare species in the George catchment[6] (Appendix 2). Several of these species are impacted by river and estuary conditions.

Table 3. Community and State Technical values for the George catchment. (Sources: McKenny and Shepherd, 1999, and DPIW, 2005.)

Water value	Specific asset concerns
Ecosystem protection	(i) Maintaining existing riparian zone in catchment streams
	(ii) Maintaining suitable in-stream habitat for birds and Green and Gold tree frogs
	(iii) Maintain water quality
	(iv) Improve erosion control
	(v) Maintain sufficient habitat and flows for spotted galaxias, common jollytail, lampreys, brown trout, freshwater flathead, and long and short-finned eels
	(vi) Maintaining fish stocks, including the rare Australian grayling
	(vii) Protecting seagrass areas in Georges Bay
	(viii) Protect St Helens Wax Flower
	(ix) Protection of modified ecosystems in Georges Bay from which edible fish, shellfish and crustacea are harvested
Consumptive use	Securing adequate water quality for drinking water supply at St Helens
Recreation	(i) Protecting water quality and quantity for swimming
	(ii) Maintaining and improve angling values
Agricultural water	(i) Securing water for irrigational usage and stock watering
	(ii) Providing a fair system of water allocation
Aesthetics	(i) Maintain visual quality
	(ii) Maintain reasonable flows over St Columba falls
	(iii) Maintain and improve riparian zone quality
	(iv) Improve riparian weed control
	(v) Maintain undisturbed status of headwaters

Of special importance is the Davies' waxflower, which is endemic to the George catchment. Interviews with Tasmanian experts on river health provided valuable information about the conditions of the rivers in the George catchment and its attributes. Flow and structural habitat, rather than river water quality, were identified as the most important parameters influencing native fish populations. To the experts' knowledge, no assessment of fish abundance in the rivers or estuary in the George catchment was available.

Focus groups

A number of potentially important attributes were identified from the literature review and expert interviews. The next step was to seek guidance on which attributes were considered most important by stakeholders. Focus group discussions were organised in Hobart, Launceston and St Helens during which the environmental concerns in the George catchment were discussed. Most focus group participants considered the George catchment area a "beautiful, unique place". The most important environmental concern in the George catchment was water quality. Safe drinking water, the bacterial quality of river water and treatment of sewage were all considered extremely important by focus group participants, particularly the local community in St Helens. Other issues mentioned included native animals, pristine beaches and preserving some natural areas in the catchment such as St Columba falls and the Blue Tier (Table 4).

Table 4. Environmental attributes and concerns in the George catchment identified during focus group discussions, February and August 2008.

Water supply consistent with the needs of the environment and industry.
Chemical quality of drinking water.
Native animal populations.
Oyster quality.
Conserving coastal areas and beaches
Natural beauty of the region (naturalness of the rivers; St Columba falls; Blue Tier)
Georges Bay.

Another prominent attribute was the Georges Bay and how its features affect tourism and contribute to local economic development. The Georges Bay was considered a "very valuable asset", providing resources for many local operators. The focus group participants stressed the value of the Georges bay for recreational fishing and oyster production.

Two draft questionnaires were pretested during the focus group discussions in February and August. Each version included three attributes of the George catchment (Table 5). The levels of the attributes in Table 5 represent preliminary estimates

Table 5. Environmental attributes and their levels included in the draft questionnaires for the George catchment.

Attribute	Description	Levels
Fish diversity[a]	Different fish species in rivers and estuary	Few, Average, Large, Very large
Area of native riverside vegetation[b]	km of native vegetation in healthy condition within 30m on each side of the rivers	51, 63, 74, 86
Seagrass area[a,b]	Hectares of seagrass in Georges Bay	550, 620, 690, 740
Threatened species[a]	Areas in the George catchment with threatened species that rely on good water quality: Davies' Wax Flower, Glossy Hovea, Green and Gold Frogs and Freshwater Snails	None, Small, Moderate, Abundant
Threatened species[b]	Number of threatened species (such as Davies' Wax Flower, Glossy Hovea, Green and Gold Frogs and Freshwater Snails)	50, 65, 75, 85

a Discussed during the four February focus groups in Hobart and St Helens
b Discussed during the four August focus groups in Launceston and Hobart

of the situation that would occur if no management would be undertaken. The baseline scenario therefore shows a decline in attribute levels. The attribute levels used in the draft questionnaires were used to gauge respondents' opinions about the plausibility of the scenarios. After pilot testing the questionnaire, the attribute levels were further refined based on biophysical modelling and expert opinion (see Section 7).

The discussions showed that some respondents were seeking an attribute to capture general catchment condition ('biodiversity' or 'ecosystem health'), rather than a specific fish population or threatened species attribute. Participants in St Helens were interested in an attribute that would capture 'general water quality'.

Fish populations were identified as one of the most important attributes during the focus group discussions, predominantly as a source of angling and tourism values. However, there is very limited quantitative information on fish populations in the George catchment. One study documents the fish diversity in Georges Bay (Mount et al, 2005), but no data on fish abundance were found, even after extensive literature research and interviews with the DPIWE Fisheries Management branch. When asking scientists about their projection of WQ impacts on fish abundance, one of them literally said "I can not and do not want to give you any numbers; it would just be hand waving''. The hesitation of experts to provide quantitative assessments of fish populations instigated the choice for qualitative descriptions on fish diversity in the first survey draft. However, it was stressed by several participants that fish populations would be better captured in terms of abundance rather than diversity.

Because of the limited data on fish populations, the attribute was replaced by 'native riverside vegetation' in the second draft. Healthy native riverside vegetation is an attribute often used in CEs of river health (see, for example, Morrison and Bennett, 2004, and Bennett et al, 2006). Native riverside vegetation was included as an attribute in the August survey draft. The attribute was defined as 'native riverside vegetation in healthy condition consisting of mostly native species. This definition of riverside vegetation did not give rise to any discussion. Most participants considered the attribute important in choosing between alternatives.

Given the importance of the estuary in the George catchment, an explicit estuary attribute was included in the questionnaire. Seagrass area is often used by decision makers as an indicator of estuary water quality (Crawford, 2006, Scanes et al, 2007). There is a well established relationship between water quality and turbidity and the extent of seagrass beds in Australian estuaries (Walker and McComb, 1992, Abal and Dennison, 1996). Seagrass beds further provide important habitat for many aquatic animals. Seagrass area has also been used as an attribute in previous choice modelling studies (Johnston et al, 2002a, Windle and Rolfe, 2004), making it an attractive attribute for future benefit transfer exercises. Reactions to seagrass area as an attribute were mixed. When both the area of seagrass and fish were included in the survey (February focus groups), the attributes were perceived as correlated given the habitat seagrass provides for certain fish species. When the draft survey included 'native riverside vegetation' (August focus groups), the reactions to the seagrass attribute were positive. It was considered a feasible attribute of George catchment condition, with one respondent stating that ''seagrass is an important indicator of water quality in the Bay''.

Although fish abundance would provide a meaningful attribute to respondents, the possible confounding effects between the use-values of fish, and the limited scientific data on fish populations in the George catchment challenges its use as an attribute in this questionnaire. It was therefore decided to use seagrass as an indicator of water quality.

The attribute of threatened species was defined as 'the habitat area for threatened species' in the first survey draft because no quantitative information had been found at that stage. Focus group participant reacted positively to this formulation. The protection of threatened species was important to participants (''for future generations''). Note that not all participants were familiar with the specific species included in the questionnaire. However, it is desirable to define the attributes in the questionnaire in quantitative terms to enable a comparison with other CE studies. The attribute was therefore defined as the ''number of threatened species'' observed in the George catchment in the August draft of the questionnaire (see Table 5). Information on threatened species in the George catchment was derived from the Natural Values Atlas (NVA, Department of Primary Industries and Water, 2008). The attribute was described as ''the number of different species of rare and native animals and plants that live in the George catchment'' (see Appendix 3).

The payment attribute

A good deal of time was devoted to choosing a payment vehicle and payment levels that would be acceptable to survey respondents. Different specifications were tested during the focus group discussions (see Table 6). During the February

Table 6. Cost attributes included in the draft questionnaires for the George catchment.

Survey version	Attribute description	Levels ($)
February draft	Your one-off payment. The money to pay for management changes would come from all the people of Tasmania, including your household, through a one-off payment into a trust fund specifically set up to fund management changes in the Georges catchment. 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 water rates collected by the Tasmanian Government during the year 2009.	0, 20, 50, 100, 200
August draft	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 Georges catchment. An independent auditor would make sure the money was spent properly.	0, 30, 80, 200, 400, 600

focus groups, several participants stated that they had not considered the payment in making their choice between alternative options. Payment levels were therefore increased in the next draft questionnaire, triggering a much stronger reaction to the cost attribute. Nearly all August focus group participants stated that they included the cost attribute in answering the choice questions, with some participants making their choice primarily on the money attribute, and others making a trade-off between costs and the amount of change in the environmental attributes.

There was little debate about the description of the payment vehicle during the eight focus groups. Most respondents supported a one-off levy to protect the George catchment (''perfectly acceptable''). Some participants wanted to know who would manage the money, so an 'independent auditor' was included in the description. One participant remarked that water rates would not be an appropriate payment vehicle as not all households pay water rates in Tasmania. It was therefore decided to describe the payment as a general one-off levy on rates. To stress the lump-sum character of the payment, the one-off levy is underlined in the final survey text (Appendix 3).

Defining attribute levels

The levels of the attributes included in the choice sets reflect the different situations that could occur in the George catchment in 20 years time under alternative NRM strategies. The levels of the attributes were determined through a combination of literature review, expert interviews, biophysical modelling and focus group discussions. Scenarios of different ways to manage the George catchment provided possible changes in attribute levels. The baseline scenario was presented as a degradation in catchment conditions in the next 20 years. Alternative future options all consisted of improved natural resource management and resulting protection of the environmental attributes (compared to the baseline). The levels of the attributes that are currently observed in the catchment were included as one of the alternative future options. Extensive efforts were made to identify scientifically credible levels of the attributes and define them in a way that was understandable and acceptable to respondents.

Seagrass

The extent of seagrass beds in the Georges Bay was assessed using seagrass monitoring data and GIS mapping techniques. The area of seagrass in the Georges Bay has increased over the last couple of years, indicating that water quality in the Bay is currently in good conditions. A deterioration of water quality (especially increased turbidity) is expected to decrease seagrass area.

Baseline data on seagrass extent in the Georges Bay were derived from Mount et al (2005). The seagrass beds measured in 2005 consist of dense seagrass areas (approximately 420ha) and areas with more patchy seagrass (approximately 530ha). Patchy seagrass areas were counted as 50% 'full' seagrass beds, resulting in a current area of approximately 690ha of seagrass in Georges Bay, or 31% of the total estuary area. If all patchy seagrass beds were to disappear due to increased turbidity or other factors, approximately 420ha of seagrass would remain. This area was presented as the baseline scenario. The maximum area with dense seagrass beds is limited by light availability, suitable substrate, wave energy and tidal currents. It was estimated that a "best case" scenario would result in 815ha of healthy seagrass beds, or 37% of the total estuary area.

The attribute levels included in the CE questionnaire provide an estimated *range* of possible seagrass area in the Georges Bay. These estimates are *not* modelled projections of changes in seagrass beds due to different management. Improved information on water quality changes, the impacts of water quality on seagrass health and information on the hydrodynamics in Georges Bay is required to link catchment management to a certain area of seagrass beds.

Riparian vegetation

The measure used to present native riverside vegetation was "the total length of rivers in the George catchment with healthy native riverside vegetation along both sides of the river". Healthy native riverside vegetation was defined as having more than 80% vegetated area within the 30m zone along the river, consisting for at least 70% of native species.

The scenario changes for riparian zone management are based on local observations, information in the George Rivercare Plans (Lliff, 2002, Sprod, 2003, Rattray, 2001), guidelines in the Forestry Practise Code (Forest Practices Board, 2000) and expert opinion. All assumptions and scenarios have been reviewed by forestry practitioners, riparian ecologists and the local NRM officer. The length of healthy native riverside vegetation was assumed to be impacted by land use, fencing of riparian zones and weed management in the George catchment. The total length of the riparian zone with healthy native vegetation is based on a total stream length of 113km. The current length of healthy riparian vegetation is approximately 74km, or 65% of the total river length in the George catchment. A decrease in conservation areas and native forests, combined with limited weed management and riparian buffers, was estimated to reduce the length of healthy native riverside vegetation to 35% (40km) of the total river length. An increase in conservation area, large-scale weed management and an increase in vegetation density in the riparian zone, was estimated to result in 81km of native riparian vegetation in good health in the George catchment (or 70% of total river length).

A full description of the land use change scenarios will be provided in a future research report in this series, when the results of the Bayesian Network developed as part of this study will be reported.

Threatened species

Data on the number of threatened species in the George catchment was derived from the Natural Values Atlas (NVA, Department of Primary Industries and Water, 2008). Threatened species included all species listed as vulnerable or endangered. A total number of 68 threatened flora species and 34 threatened fauna species have been observed in the George catchment (Appendix 2). The list of threatened species was discussed with flora and fauna experts at the DPIW Threatened Species Unit. The experts agreed that the NVA provides the most up-to-date and accurate information on threatened species in Tasmania.

Estimating the impact of changed natural resource management in the George catchment was based on the habitat requirements of each species. Flora species were divided into 'heath and woodland species', 'riparian species', 'coastal species' and 'marine species'. Threatened fauna species observed in the George catchment were divided into birds, aquatic, riparian and terrestrial species (Table 7).

A number of assumptions were needed to estimate the number of impacted rare native animal and plant species. Following expert advice, not all species were included in the 'total potentially impacted species', as some were unlikely to be directly impacted by catchment management changes. Marine species, extinct species and a number of species with only one observation were not counted in the total number of rare native animal and plant species in the George catchment, leading to a total of about 80 species.

Different land uses were assumed to provide different habitat areas for rare species, with land use directly impacted on woodland flora, riparian flora, terrestrial fauna and some bird species. Further impacts may occur through habitat connectivity, water quality and changes in the amount of native riparian vegetation. Habitat connectivity was assumed to primarily affect fauna species that need habitat corridors for their existence. Changes in native riparian vegetation and degradation of water quality would directly affect the habitats of riparian and wetland species. Water quality degradation would further affect estuary-dependent birds. Under a ''worst case'' scenario of an increase in urban areas, low habitat connectivity, less than 40km of riparian vegetation and poor water quality, 35 species would remain. The attribute levels presented in the CE questionnaire were based on the current number of observed species (80) and a baseline scenario of 35 rare native animal and plant species in the George catchment.

Table 7. Number of vulnerable and endangered flora and fauna species observed in the George catchment by habitat. (Source: Natural Values Atlas – see Appendix.)

Flora		Fauna	
Habitat	**# species**	**Habitat**	**# species**
Heath and woodland (one observation)	22	Terrestrial habitat (between two and ten observations)	2
Heath and woodland (between two and six observations)	14	Terrestrial habitat (more than ten observations)	5
Heath and woodland (six or more observations)	10	Aquatic sp	1
Riparian zone	8	Riparian zone	4
Wetlands	7	Estuary-birds	4
Coastal areas	4	Coastal birds	8
Marine or extinct species	3	Other birds	3
		Marine species or less than two observations	7
Total rare species	**68**		**35**
Total potentially impacted	**43**		**27**

Survey presentation and collection

The CE survey for the George catchment consisted of an introduction letter, an information poster and a survey booklet. The introduction letter outlined the purpose of the survey and provided the contact details of the researchers involved in the study. A poster separate from the survey booklet provided information about the George catchment using maps, photos and charts. Professional graphic designers were employed to produce high quality information posters and booklets. The final versions of the poster and booklet are shown in Appendix 3. During the focus group discussions, it became clear that limiting the amount of text and straightforward formulation of the questions and information was vital. Effort has therefore been made to provide information in a simple and unambiguous fashion. The introductory letter and information in the survey were worded in a manner to increase the trust of (particularly local) respondents that the research is independent, anonymous and purely scientific.

The poster presented the attributes and their levels in the George catchment (see Table 9). The baseline scenario was described by the levels of the attributes that are ''likely to occur in 20 years time without new management actions'' on the final poster.

The survey booklet was composed of four sections. An introductory section contained questions on visitation and activities in the George catchment, plus a question on the respondent's perception of current river and estuary quality. The next section explained the choice task at hand, followed by the five choice questions. A third section contained questions that were aimed at eliciting the motives for respondents' choices and assesses respondents' understanding of the survey. The final section consisted of various socio-economic questions.

Each choice set in the CE for the George catchment was composed of three alternative options that differed in terms of the levels of the three environmental attributes and the costs. The first alternative was always the base alternative, representing a degradation of all environmental attributes and no costs. Two alternative options represented a protection of the environmental attributes (compared to the baseline) at a certain cost Figure 4 shows an example of a choice question. Each survey booklet included five of these questions, resulting in five choice observations per respondent.

The George catchment survey was distributed to a random selection of Tasmanian households. To test for differences in preferences between communities

Figure 4. Example of a choice set in the George catchment CE.

Question 4

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

Features	Your one-off payment	Seagrass area	Native river-side vegetation	Rare native animal and plant species	YOUR CHOICE
Condition now		690 ha (31% of total bay area)	74km (65% of total river length	80 rare species live in the George catchment	
Condition in 20 years					**Please tick one box**
Option A	$0	420ha (19%)	40km (35%)	35 rare species present (45 no longer live in the catchment)	
Option B	$60	815ha (37%)	81km (70%)	50 rare species present (30 no longer live in the catchment)	
Option C	$30	690ha (31%)	74km (65%)	65 rare species present (15 no longer live in the catchment)	

within and outside the catchment, sampling sites included Hobart, Launceston and St Helens (Table 8). Two urban out-of-catchment sampling sites were used, as it is expected that Launceston households may be more familiar with the George catchment because of its relative proximity to Launceston compared to Hobart. In each sampling location, 480 questionnaires were distributed.

Table 8. Sampling locations for George catchment survey.

Sampling location	Urban/ rural	Proximity to George catchment
St Helens	Rural	Within catchment
Launceston	Urban	Outside catchment (approx 160km)
Hobart	Urban	Outside catchment (approx 250km)

A 'drop-off/pick-up' method was used to collect the survey. This method involves surveyors to visit randomly selected households with the request for survey participation. When the householder agrees to participate, a copy of the questionnaire is left behind and arrangements are made to pick up the completed survey booklet at a convenient time. Local service clubs assisted in the survey distribution in Hobart, Launceston and St Helens, for a fixed fee per completed questionnaire returned. The surveyors received a short training session and detailed instructions on the sampling locations and procedures. It was anticipated that administering the survey via a 'drop-off/pick-up' method would enable a conversation between surveyors and respondents to further clarify the survey goals if required.

The questionnaires were collected in November and December 2008. Notwithstanding research efforts to present the questionnaires in an unbiased scientific manner, preliminary results indicated that natural resource management in the George catchment has been a controversial issue, which may have limited response rates to the environmental valuation survey. There were significant concerns of Tasmanian communities that water pollution in the catchment is affecting drinking water quality and oyster quality in the Georges Bay. Particularly local surveyors had difficulties collecting completed questionnaires because respondents did not want to be associated with the ongoing natural resource management disputes in the catchment.

To increase the representativeness of the survey sample, a second sampling wave was carried out in March 2009. Results of the survey collection process and the statistical analyses of respondents' answers are expected mid 2009, and will be detailed in an upcoming report in this series.

Conclusion

Stated preference techniques are increasingly used to estimate non-market values associated with changed environmental conditions in Australian catchments. In this report, a number of non-market valuation techniques are reviewed.

The study described in this report employed choice experiments to assess community preferences for different options of natural resource management in the George catchment, Tasmania. A combination of literature review, expert consultation and focus group discussions was used to develop a CE survey. Appropriate policy scenarios and attributes were identified and several draft versions of the survey were scrutinised.

The expert interviews and focus group discussions validated water quality and condition of the George catchment as important to Tasmanians. The George catchment was considered a special place that warrants payments for natural resource protection. The Georges Bay was a most prominent feature in the catchment, often as a source of tourism, fishing and oyster values.

Environmental attributes that were used to represent water quality and the condition of the George catchment condition included seagrass area, rare native plants and animals and riverside vegetation. Table 9 shows the description and the levels of the attributes in the final version of the questionnaire.

The George catchment CE survey was administered in Hobart, Launceston and St. Helens between November 2008 and March 2009. Statistical and econometric analysis of the survey results and outcomes will be reported in a subsequent Technical Report in this series.

Table 9. Description and levels of the attributes in the final George catchment questionnaire ('standard version').

Attribute	Description	Levels
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.	40, 56, 74, 84 (km)
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.	35, 50, 65, 80 (number of species present)
Seagrass area	Seagrass generally grows best in clean, clear, sunlit waters. Seagrass provides habitat for many species of fish, such as leatherjacket and pipefish.	420, 560, 690, 815 (ha)
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.	0, 30, 60, 200, 400 ($)

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Appendix 1 – Summary of water quality and catchment valuation studies

Reference	Valuation technique*	Location	Attributes	Payment vehicle
Bennett, Morrison and Blamey (1998)	CVM	Tilley Swamp and Coorong, SA	• Tea tree area • Habitat provision and feeding area for water birds	Addition to income tax
Morrison, Bennett and Blamey (1998)	CE	Macquarie Wetlands, NSW	• Wetland area (km^2) • Frequency of waterbird breeding (every x years) • # endangered and protected species • Irrigation related employment (# of jobs)	One-off levy on water rates in 1998
Blamey, Gordon and Chapman (1999)	CE	ACT drinking water supply	• Improvements in river flows • # of rare and endangered species with habitat loss • Appearance of urban environment • Restrictions on household water use (%) • Use of recycled water	Household water costs
Mallawaarachichi *et al* (2001)	CE	Herbert River catchment, QLD	• Area of tea tree woodlands • Area of vegetation along rivers and wetlands • Regional income from cane production	Annual environmental levy on land rates
Whitten and Bennett (2001d)	CE	Wetlands in Upper South East, SA	• Area of healthy wetlands • Area of healthy remnants • # of threatened species • # of ducks hunted	One-off levy on income
Whitten and Bennett (2001d)	CE	Murrumbidgee River Floodplains, NSW	• Area of healthy wetlands • # of native birds • # of native fish • # of farmers leaving	One-off levy on income
Johnston *et al* (2002a)	TCM	Peconic Estuary System, NY	• Clean water (physical measures of water quality) • Recreational fish catch rates	Travel costs
Johnston *et al* (2002a)	CE	Peconic Estuary System, NY	• Farmland area (acres) • Area of undeveloped land (acres) • Wetland area (acres) • Shell fishing areas (acres) • Eelgrass areas (acres)	Annual program costs per household
Robinson, Clouston and Suh (2002) [Robinson, 2002 #206]	CE	Bremer River catchment, QLD	• Length of river with riparian vegetation (%) • Length of river with aquatic vegetation (%) • River appearance (% good)	Levy on council rates
Carslsson, Frykblom and Liljenstolpe (2003)	CE	Wetlands in south Sweden	• Surrounding vegetation type • # of rare species • Fish conditions • Fenced waterline • Crayfish • Walking tracks and other facilities	Total costs
Kerr and Sharp (2003)	CE	Auckland region waterways, NZ	• Water clarity • # of native fish species • km of native fish habitat • Native stream-side vegetation • Channel form	Regional council rates
Egan, Herriges and Kling (2004)	TCM	Iowa Lakes	• Secchi depth (m) • Chlorophyll (μg/l) • Total nitrogen (mg/l) • Total phosphorus (μg/l) • Inorganic suspended sediment (mg/l) • Volatile suspended sediment (mg/l)	Price of lake visit
Holmes *et al* (2004)	CVM	Little Tennessee River, NC	• Abundance of game fish • Water clarity • Wildlife habitat • Allowable water uses • Ecosystem naturalness	Local sales tax

Reference	Valuation technique*	Location	Attributes	Payment vehicle
Kerr, Sharp and Leathers (2004)	TCM	Rakaia River, NZ	# of salmon in the river	Fishing licence and rates
Kerr, Sharp and Leathers (2004)	CVM	Waimakariri River, NZ	# of salmon in the river	Rates
Morrison and Bennett (2004)	CE	Five rivers, NSW	• % of healthy vegetation and wetlands • Recreational sites good enough for picnic, boating, fishing or swimming • # of native fish species • # waterbirds and other fauna	One-off levy/ tax on water rates
Owens and Simon (2004)	CE	Coastal waters, CA	• % of waters good for swimming • % fish and shellfish safe for human consumption • % habitat to support a diversity of aquatic life	Federal taxes
Windle and Rolfe (2004)	CE	Fitzroy basin, QLD	• Amount of healthy vegetation left in floodplains • Healthy waterways (km) • Protection of Aboriginal cultural heritage sites • Health of the river estuary (%)	Increase in local rates (one-off or annual for a 20 year period)
Rolfe and Windle (2005)	CE	Fitzroy basin, QLD	• Amount of water kept in reserve • People leaving the area (#/year) • Protection of Aboriginal cultural heritage sites	Annual levy through rate payments for 20 years
Bateman *et al* (2006b)	CVM	River Tame, UK	• Fishing • Plants and wildlife • Boating and swimming	Annual / monthly council tax
Bennett *et al* (2006)	CE	Three rivers, VIC	• % pre-settlement fish species and populations • Healthy riverside vegetation (% of river's length) • # native waterbird and animal species • % of river suitable for primary contact recreation	Compulsory one-off payment to a trust fund
Hanley, Wright and Alvarez-Farizo (2006)	CE	River Wear and River Clyde, UK	• Ecology: range of fish species, water plants, insects and birds • Aesthetics: no litter or some litter in the river • River banks: banks with plenty or few trees and plants and only natural or some erosion	Water rates
Massey, Newbold and Gentner (2006)	TCM	Coastal bays, Maryland	• Total fish catch • Bag limit • Minimum size limit	Trip costs
Colombo, Clatrava-Requena and Hanley (2007)	CE	Two catchments in Spain	• Landscape changes • Surface and ground water quality • Flora and fauna quality • # of agricultural jobs created • Area of project execution (km^2)	Tax
Rolfe and Prayaga (2007)	TCM	Three freshwater dams, QLD	Improvement in recreational fish catch rates	Fishing licence fee
Carslsson, Kataria and Lampi (2008)	CE	Marine Environment, Sweden	• # of endangered species • Oil and chemical discharges • Catch and growth of fish stock • # of fishermen at risk of losing their job	Annual costs to each household
Carslsson, Kataria and Lampi (2008)	CE	Lakes and Streams, Sweden	• # of endangered species • % of lakes suitable for swimming • % of cultural assets in water/at coast	Annual costs to each household

* CVM = contingent valuation method, CE = choice modelling experiment, TCM = travel cost method

Appendix 2 – Rare species observations in the George catchment

Table 10. Rare flora species observed in the George catchment (DPIW, 2008).

Species name	Common name	Status*	Habitat type
Stenopetalum lineare	narrow threadpetal	e	Coastal
Lachnagrostis robusta	tall blowngrass	r	Coastal
Xanthorrhoea arenaria	sand grasstree	v	Coastal
Hierochloe rariflora	cane holygrass	r	Forest and riparian
Anogramma leptophylla	annual fern	v	Heath, Heathy woodlands
Caladenia congesta	blacktongue finger-orchid	e	Heath, Heathy woodlands
Caesia calliantha	blue grasslily	r	Heath, Heathy woodlands
Hibbertia rufa	brown guineaflower	x	Heath, Heathy woodlands
Cynoglossum australe	coast houndstongue	r	Coastal
Scutellaria humilis	dwarf scullcap	r	Heath, Heathy woodlands
Pentachondra ericifolia	fine frillyheath	r	Heath, Heathy woodlands
Brachyscome sieberi var. gunnii	forest daisy	r	Heath, Heathy woodlands
Senecio velleioides	forest groundsel	r	Heath, Heathy woodlands
Deyeuxia densa	heath bentgrass	r	Heath, Heathy woodlands
Senecio squarrosus	leafy fireweed	r	Heath, Heathy woodlands
Bunodophoron notatum	lichen	e	Heath, Heathy woodlands
Zieria veronicea subsp. veronicea	pink zieria	e	Heath, Heathy woodlands
Thelymitra antennifera	rabbit ears	e	Heath, Heathy woodlands
Hovea tasmanica	rockfield purplepea	r	Heath, Heathy woodlands
Pterostylis squamata	ruddy greenhood	r	Heath, Heathy woodlands
Calystegia soldanella	sea bindweed	r	Heath, Heathy woodlands
Xanthorrhoea bracteata	shiny grasstree	v	Heath, Heathy woodlands
Glycine microphylla	small-leaf glycine	v	Heath, Heathy woodlands
Spyridium parvifolium var. molle	soft dustymiller	r	Heath, Heathy woodlands
Austrodanthonia induta	tall wallabygrass	r	Heath, Heathy woodlands
Phyllangium divergens	wiry mitrewort	v	Heath, Heathy woodlands
Arthropodium strictum	chocolate lily	r	Heath, Heathy woodlands
Scleranthus brockiei	mountain knawel	r	Heath, Heathy woodlands
Calandrinia granulifera	pygmy purslane	r	Heath, Heathy woodlands
Pultenaea mollis	soft bushpea	v	Heath, Heathy woodlands
Brachyloma depressum	spreading heath	r	Heath, Heathy woodlands
Corunastylis nuda	tiny midge-orchid	r	Heath, Heathy woodlands
Lobelia rhombifolia	tufted lobelia	r	Heath, Heathy woodlands
Austrostipa blackii	crested speargrass	r	Heath, Heathy woodlands
Caladenia filamentosa	daddy longlegs	r	Heath, Heathy woodlands
Orthoceras strictum	horned orchid	r	Heath, Heathy woodlands
Pterostylis grandiflora	superb greenhood	r	Heath, Heathy woodlands
Caladenia caudata	tailed spider-orchid	v	Heath, Heathy woodlands
Cyrtostylis robusta	large gnat-orchid	r	Heath, Heathy woodlands
Desmodium gunnii	slender ticktrefoil	v	Heath, Heathy woodlands
Hibbertia virgata	twiggy guineaflower	r	Heath, Heathy woodlands
Microtidium atratum	yellow onion-orchid	r	Heath, Heathy woodlands

Species name	Common name	Status*	Habitat type
Plantago debilis	shade plantain	r	Heath, Heathy woodlands
Acacia siculiformis	dagger wattle	r	Heath, Heathy woodlands
Acacia ulicifolia	juniper wattle	r	Heath, Heathy woodlands
Caustis pentandra	thick twistsedge	r	Heath, Heathy woodlands
Conospermum hookeri	tasmanian smokebush	v	Heath, Heathy woodlands
Baumea articulata	jointed twigsedge	r	Lagoons
Lotus australis	australian trefoil	r	Lagoons
Ruppia megacarpa	largefruit seatassel	r	Marine
Pomaderris elachophylla	small-leaf dogwood	v	Riparian
Baumea gunnii	slender twigsedge	r	Riparian
Hovea corrickiae	glossy purplepea	r	Riparian
Phebalium daviesii	davies waxflower	e	Riparian
Caladenia pusilla	tiny fingers	r	Rocky outcrops
Bolboschoenus caldwellii	sea clubsedge	r	Saltmarsh, wetlands
Lepilaena preissii	slender watermat	r	Saltmarsh, wetlands
Triglochin minutissimum	tiny arrowgrass	r	Saltmarsh, wetlands
Schoenus brevifolius	zigzag bogsedge	r	Saltmarsh, wetlands
Sporobolus virginicus	salt couch	r	Saltmarsh, wetlands
Lepilaena patentifolia	spreading watermat	r	Saltmarsh, wetlands
Utricularia australis	yellow bladderwort	r	Saltmarsh, wetlands
Villarsia exaltata	erect marshflower	r	Saltmarsh, wetlands
Lepidium pseudotasmanicum	shade peppercress	r	Woodlands
Lepidosperma viscidum	sticky swordsedge	r	Woodlands
Blechnum cartilagineum	gristle fern	v	Woodlands
Hibbertia calycina	lesser guineaflower	v	Woodlands
Euphrasia collina subsp. deflexifolia	eastern eyebright	r	Woodlands

* e = endangered, r= rare, v = vulnerable, x = extinct

Table 11. Rare fauna species observed in the George catchment (DPIW, 2008).

Species name	Common name	Status*	Habitat type
Accipiter novaehollandiae	grey goshawk	e	Other birds
Aquila audax	wedge-tailed eagle	e	Other birds
Beddomeia tasmanica	hydrobiid snail (terrys creek)	r	Riparian
Dasyurus maculatus	spotted-tailed quoll	r	Terrestrial
Dermochelys coriacea	leathery turtle	v	Marine
Diomedea cauta	shy albatross	v	Coastal
Diomedea exulans	wandering albatross	e	Marine
Haematopus fuliginosus	Sooty Oystercatcher	j/c	Coastal
Haematopus longirostris	Pied Oystercatcher	j/c	Coastal
Haliaeetus leucogaster	white-bellied sea-eagle	v	Estuaries
Heteroscelus brevipes	Grey-tailed tattler	j/c	Coastal
Hoplogonus bornemisszai	bornemissza's stag beetle	e	Terrestrial
Hoplogonus simsoni	simson's stag beetle	v	Terrestrial
Hoplogonus vanderschoori	vanderschoor's stag beetle	v	Terrestrial
Hydrobiosella sagitta	caddis fly (st. columba falls)	r	Riparian
Lathamus discolor	swift parrot	e	Other birds
Limosa lapponica	Bar-tailed goodwit	j/c	Estuaries
Litoria raniformis	green and golden frog	v	Riparian
Mirounga leonina	southern elephant seal	e	Marine
Numenius madagascariensis	eastern curlew	e	Estuaries
Nycticorax caledonicus	Nankeen Night Heron	j/c	Coastal
Pachyptila turtur subsp. subantarctica	fairy prion southern sub-sp	e	No impact assessed
Perameles gunnii	eastern barred bandicoot	v	Terrestrial
Prototroctes maraena	australian grayling	v	Aquatic
Pseudemoia rawlinsoni	glossy grass skink	r	Riparian
Pseudomys novaehollandiae	new holland mouse	e	Terrestrial
Sarcophilus harrisii	tasmanian devil	e	No impact assessed
Sternula albifrons	little tern	e	Coastal
Sternula caspia	Caspian Tern	j/c	Estuaries
Sternula nereis	fairy tern	j/c	Coastal
Tasmanipatus barretti	giant velvet worm	r	Terrestrial
Thinornis rubricollis	Hooded Ploover	v	Coastal
Thylacinus cynocephalus	thylacine	x	No impact assessed
Tyto novaehollandiae	masked owl (tasmanian)	e	No impact assessed
Vombatus ursinus	common wombat		No impact assessed

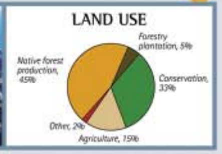
* e = endangered, j/c = species under Japan-Australia and/or China-Australia migratory bird agreement, r= rare, v = vulnerable, x = extinct

Appendix 3 – Final CE questionnaire for the George catchment environmental valuation study

NATURAL RESOURCE MANAGEMENT IN THE GEORGE CATCHMENT

South George River at Evenden

Georges Bay



Native riverside vegetation

Ransom River at Pyengana

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 animals and plant species, can reduce the risk of erosion and provides shelter for livestock.

Condition now

74 km – Healthy native vegetation along 74 km on both sides of the river (≈65% of total river length)

What is likely to happen in 20 years time without new management actions?

40 km – Healthy native vegetation along 40 km on both sides of the river (≈35% of total river length)

Sources: DPIW Conservation of Freshwater Ecosystem Values Project; www.rivers.gov

Rare native animal and plant species

Davies' Wax Flower

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.

Condition now

80 species present - 80 different species of rare native animals and plants live in the George catchment

What is likely to happen in 20 years time without new management actions?

35 species present - Of the current 80, 35 rare species remain (45 rare species no longer live in the George catchment)

Sources: DPIW Natural Values Atlas; www.dpiw.tas.gov.au/threatenedspecies

Seagrass

Seagrass beds

Seagrass generally grows best in clean, clear, sunlit waters. Seagrass provides habitat for many species of fish, such as leatherjacket and pipefish.

Condition now

690 ha - Seagrass growing in 690 ha of Georges Bay (≈31% of total bay area)

What is likely to happen in 20 years time without new management actions?

420 ha - Seagrass growing in 420 ha of Georges Bay (≈19% of total bay area)

Sources: Bringing back the Bay (Mount, 2006); Marine and Freshwater Research (47: 763–771); www.environment.gov.au/soe/1996/publications

BACKGROUND

- The George catchment (55,700 ha) is located in north-eastern Tasmania
- Land use in the catchment is mostly forestry, conservation and agriculture
- There are about 113 km of major streams in the catchment. The largest are the North and South George Rivers
- The George River flows into the Georges Bay (2,200 ha) at the town of St. Helens; a popular holiday destination with a local population of about 2,000 (Census 2006)
- The Georges Bay is used for oyster farming and recreation (fishing, swimming, boating)

MANAGEMENT INFORMATION

The way in which the George catchment is managed affects the condition of the rivers and bay. For instance; agricultural practices, forestry managment and urban developments can cause soil erosion and water pollution. **A continuation of current management will harm the health of the rivers and bay in the George catchment.** Changing the way in which the catchment is managed would protect the condition of the rivers and Georges Bay.

Dairy farming in the upper catchment

Current catchment management

- Clearing riverside vegetation
- Stock access to rivers
- Sedimentation of rivers
- Runoff from agriculture and forestry
- Pollution from sewage and urban areas

Source: Break O'Day NRM Survey (2006)

Erosion from unrestricted stock access

Impacts of current practices

- Loss of native riverside vegetation
- Reduced water qualitiy in rivers and bay
- Reduced fish populations and fish diversity
- Loss of habitat for threatened species
- Reduced oyster growth and quality
- Reduced seagrass area in Georges Bay

Sources: North-Eastern Rivers review (Koehnken, 2001); Annual Waterways Monitoring Report (DPIW)

Fencing to protect riverside vegetation

Possible new management actions

- Weed removal and planting native riverside vegetation
- Limiting stock access to rivers through fencing and alternative watering points
- Managing pollution from agriculture and forestry
- Improved sewage treatment

Sources: NRM North (http://www.nrmtas.org/); George Rivercare Plans (2002, 2003)

There exist different management actions that could help protect the George catchment. Future outcomes may vary depending on the combination of management actions that is undertaken

Rare native animal and plant species are listed as vulnerable or (critically) endangered (http://www.dpiw.tas.gov.au)

STA

THE AUSTRALIAN NATIONAL UNIVERSITY

Natural Resource Management in the George Catchment

A SURVEY OF YOUR PREFERENCES

The George catchment - Rivers and Bay

We would like to know how familiar you are with the George catchment

Question 1

Have you visited the George catchment in the last 5 years?

- ☐ Never visited → go to Q3
- ☐ Visited once
- ☐ Visited between one and 10 times
- ☐ Visited more than 10 times
- ☐ I live permanently in the George Catchment
- ☐ I own a holiday house in the George Catchment

Question 2

When you were/are in the George catchment, which of the following things did/do you do? (tick all that apply)

- ☐ Fishing in the rivers
- ☐ Fishing in the bay
- ☐ Collecting shellfish
- ☐ Bird watching
- ☐ Swimming
- ☐ Walking
- ☐ Camping
- ☐ Diving or snorkelling
- ☐ Other, please specify ....

Question 3

a) Think about the rivers in the George catchment. Which box do you think best describes the condition of the rivers in the George catchment? (please tick one box)

☐	☐	☐	☐	☐	☐
Don't Know	Very Bad	Quite Bad	Neither Good nor Bad	Quite Good	Very Good

b) Think about the bay in the George catchment. Which box do you think best describes the condition of the Georges Bay? (please tick one box)

☐	☐	☐	☐	☐	☐
Don't Know	Very Bad	Quite Bad	Neither Good nor Bad	Quite Good	Very Good

What do you think?

In each question 4 to 8, we ask you to make a choice between alternative future options for managing the George catchment. The George catchment and some future management actions are described in the poster.

Options

- Option A is the same in each question 4 to 8. This option shows the catchment condition that is likely to occur in 20 years time if current catchment management continues. This option involves no new management actions and no costs to you
- Options B to K involve combinations of new management actions. These actions are likely to affect the future condition of the George catchment
- The impacts that new actions will have in 20 years time are predicted by scientists and described by:
  - > Seagrass area
  - > Native riverside vegetation
  - > Rare native animal and plant species

Costs

- 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

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Making a choice

We ask you to choose your preferred option in each question. When deciding the options you prefer, please consider:

- The different future outcomes that scientists are predicting in 20 years time;
- The one-off payment you would need to make to pay for new catchment management actions;
- Your available income is limited and you have other expenses;
- Other issues and other catchments in Tasmania may also need your payments.

Important note

The questions are hypothetical but they are based on current scientific knowledge. The answers you provide will be important for decisions about future catchment management.

- Please consider the questions carefully and make your choices as if they were real
- Some of the outcomes may seem unrealistic to you. However, all the outcomes are possible. They come from a wide range of possible combinations of management actions
- Please answer each question independently of the other questions

Please answer all questions from 4 to 8
Consider each question separately
You may find it useful to refer to the information on the poster

Question 4

Consider each of the following three options for managing the George catchment.
Suppose options A, B and C 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 B	$200	560 ha (25%)	74 km (65%)	50 rare species present (30 no longer live in the catchment)	☐
OPTION C	$400	560 ha (25%)	56 km (50%)	65 rare species present (15 no longer live in the catchment)	☐

Question 5

Consider each of the following three options for managing the George catchment.
Suppose options A, D and E 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 D	$30	560 ha (25%)	74 km (65%)	80 rare species present	☐
OPTION E	$30	815 ha (37%)	74 km (65%)	65 rare species present (15 no longer live in the catchment)	☐

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	690 ha (31%)	81 km (70%)	50 rare species present (30 no longer live in the catchment)	☐
OPTION G	$200	690 ha (31%)	74 km (65%)	50 rare species present (30 no longer live in the catchment)	☐

Question 7

Consider each of the following three options for managing the George catchment.
Suppose options A, H and I 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 H	$400	815 ha (37%)	74 km (65%)	80 rare species present	☐
OPTION I	$60	690 ha (31%)	56 km (50%)	80 rare species present	☐

Question 8

Consider each of the following three options for managing the George catchment.
Suppose options A, J and K 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 J	$200	560 ha (25%)	56 km (50%)	80 rare species present	☐
OPTION K	$200	815 ha (37%)	81 km (70%)	65 rare species present (15 no longer live in the catchment)	☐

We would like to understand how you made your choices in Questions 4 to 8

Question 9

When answering questions 4 to 8, did you always choose option A (no costs, no new management actions)?

☐ Yes ☐ No → **go to Q10**

If you always chose option A, which of the following statements best describes your main reason for doing so? (please tick one box only)

☐ I support current catchment management (in the George catchment)

☐ I don't believe that new management actions will be implemented

☐ I support new management actions, but the payments are too expensive

☐ I support new management actions, but I am not the one who should pay for it

☐ I object to paying a government levy

☐ I didn't know which option was best, so I stayed with the current situation

☐ Some other reason (please specify)

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→ **go to Q11**

Question 10

When choosing to support new management actions (options B to K), which of the following statements best describes your main reason for doing so? (please tick one box only)

☐ I always chose the new actions option that had the lowest payment

☐ I was looking to preserve at least the condition of the catchment now

☐ I was looking for the largest area of seagrass

☐ I was looking for the longest length of native riverside vegetation

☐ I was looking for the largest number of rare native animal and plant species

☐ Some other reason (please specify)

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Question 11

In making your choices in questions 4 to 8, were **all the features** (costs, seagrass, vegetation and species) equally important to you?

☐ No ☐ Yes → **go to Q12**

Please tick the feature(s) you took into account when making your choice (tick as many as apply)

☐ Costs

☐ Seagrass area

☐ Native riverside vegetation

☐ Rare native species

Endnotes

1. For detailed information about the CVM technique, see Mitchell and Carson (1989).
2. Bennett and Blamey (2001) give a detailed description of the choice modelling approach to environmental valuation.
3. That is, a change in the level of one attribute does not influence the level of any other attribute included in the choice set.
4. Assuming perfectly substitutable attributes provides a computationally convenient choice model. Advanced econometric modelling techniques can be used if attribute independence is not achieved.
5. Four focus group discussions were organised in Hobart and St Helens in February 2008, and a further four were organised in Launceston and Hobart in August 2008.
6. Rare species are defined as all observed species listed as vulnerable or (critically) endangered.