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Developing a Questionnaire for Valuing Changes in Natural Resource Management in the George Catchment, Tasmania

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Abstract

A combination of literature review, expert interviews, biophysical modelling and focus group discussions were used to design a Choice Modelling (CM) questionnaire for valuing changes in natural resource management in the George catchment, Tasmania. This report provides details on the questionnaire development, the selection of George catchment attributes and the assessment of attribute levels. The (experimental) design and delivery of the questionnaire are also presented.

1 Introduction

The questionnaire described in this report aims to assess community values and preferences for different natural resource management options in the George catchment, Tasmania. The research is undertaken as part of the EERH Project Theme D: 'Valuing Environmental Goods and Services'.

Water resources in Australian catchments are under increasing pressure to satisfy often conflicting environmental and economic goals. Increased agricultural runoff, 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. However, scientific data on these different impacts are sparse (Gilmour et al., 2005). There is increasing pressure for catchment managers to take ecological, social and economic values into account in decision making processes. To enable an assessment of these different values, catchment managers need data on environmental changes, as well as information on the economic values of catchment conditions.

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 natural resource protection with the economic impacts of changed catchment management. Whereas environmental changes and direct market impacts are relatively easy to monitor, little is known about the non-market values 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.

Figure 1 Location of the George catchment

The research reported here aims to assess the environmental and economic impacts of changed catchment management in the George catchment, in north-east Tasmania (Figure 1). The George catchment is a coastal catchment of about 557 km^2. 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 (22 km^2) 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.

Environmental impacts are evaluated using computer model simulations. The development of the biophysical models for the George catchment will be reported in a separate report (see Landscape Logic Technical Reports series: http://www.landscapelogic.org.au/publications/LL/Technical_Reports.html). The focus of the present report is to outline the design of a choice modelling (CM) questionnaire employed to elicit the non-market values that Tasmanian communities attach to different attributes of the George catchment. The next section gives a general introduction to designing CM questionnaires. Sections three to five are focused on the selection of management scenarios and environmental attributes specifically for the George catchment. Results from a literature review, expert interviews and focus group discussions are reported in these sections. In the sixth section, the experimental design employed in the George catchment valuation survey is presented, followed by a section on survey presentation and delivery. The final section summarises and outlines the future steps in the CM experiment.

2 Choice modelling

A CM experiment comprises of several stages (Table 1). The first five stages of the CM experiment for the George catchment are detailed in this report. The analyst must first identify the issue under consideration and define the ‘status quo’ situation. (Bennett and Adamowicz, 2001: 46). In a CM experiment, the status-quo scenario is typically defined as the level of attributes at some point of time in the future if current policies were to continue. The outcomes of alternative policy scenarios are described by the levels the attributes will have at the same point of 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 features, and should be relevant to both decision makers and respondents to the CM questionnaire. Selecting attributes that are independent of each other[1] allows for the assumption that respondents make complete trade-offs between the attributes[2]. 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 status quo). 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 4 of this report.

An experimental design is used to allocate the different attribute levels to the choice options in each choice set. Constructing choice sets conventionally uses an orthogonal main effects design. Recent design techniques aim to increase design efficiency (see Scarpa and Rose, 2008, for more details). The experimental design for the George catchment survey is presented in Section 6 of this report. Describing the collection of the George catchment questionnaire and its data analysis are beyond the scope of this report and will be published elsewhere.

3 Identifying the issue

The various Rivercare plans for the George Rivers (Rattray, 2001, Lliff, 2002, and Sprod, 2003) provide a first guideline to possible issues and management strategies in the George catchment (Table 2).

[1] That is, a change in the level of one attribute does not influence the level of any other attribute included in the choice set.
[2] Assuming perfectly substitutable attributes provides a computationally convenient choice model. Advanced econometric modelling techniques can be used if attribute independence is not achieved.

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 rivercare	(i) No resources for on ground works (ii) Clear legislation

A team of local and regional experts was interviewed to identify the current threats to natural resources in the George catchment and the strategies that can be undertaken to protect river and estuary conditions. Current NRM strategies are targeted at water quality decline, with an emphasis on reducing nutrient concentrations and *e*-coli in the water. Current management strategies include:

Dairy effluent upgrades
Improved wastewater treatment
Reducing stock access to riparian zones
Planting native vegetation in riparian buffers
Weed removal

Possible threats from forestry activities in the George catchment were discussed with representatives of the Forest Practise Board Tasmania. The main water quality issues associated with forestry practises include 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. It has been observed that chemicals used in forestry activities (Simazine, Sulfometuron Methyl) can reach streams and drainage channels, but no strategies on chemical spraying are included in the FPC.

Local landholders are taking actions to prevent the impacts of farming practises on water quality in the George catchment. Management actions include fencing, recovery of dairy effluent, removing weeds along river banks, using alternative stock watering points and developing riparian buffer zones.

The current catchment threats and possible new management actions need to be plausible and understandable for respondents to the CM questionnaire. Eight focus groups were organised to further discuss the community concerns and NRM strategies identified during the expert interviews[3]. 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 new management actions that can 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).

4 Attribute selection

A key task in any CM 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.

4.1 Review of literature

A first step in identifying possible attributes in 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

[3] 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.

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.

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 shortfinned 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	(i) 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

4.2 Expert interviews

Interviews were conducted with various ecology 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[4] (Appendix 3). Several of these species are impacted by river and estuary conditions. 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 is available.

4.3 Focus groups

A number of potentially important attributes were identified from the literature review and expert interviews. The next step was to seek guidance upon 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.

A general discussion on environmental issues in Tasmania raised concerns ranging from forestry impacts on old-growth forest to water quality. Focusing on the George catchment, most focus group participants considered the area a "beautiful, unique

[4] Rare species are defined as all observed species listed as vulnerable or (critically) endangered.

place". The most important concern in the George catchment that features in the discussions 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 for the environment and industries
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 is the Georges Bay and how its features affect tourism and contribute to local economic development. The Georges Bay is 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 CM questionnaires were pretested during the focus group discussions in February and August. Each version included three attributes of the George catchment (Table 5). The lowest levels of the attributes in Table 5 represent the situation that would happen if no new management strategies are undertaken (the 'status quo'). The questionnaire pretested during the February focus group discussions included a 'fish diversity' attribute (see Appendix 4). This attribute was replaced by the attribute 'native riverside vegetation' in the second draft.

Table 5 Environmental attributes and their levels included in the draft CM 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

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'.

There is very limited information on fish populations in the George catchment. One survey documents the fish diversity in Georges Bay (Mount et al., 2005), but no quantitative 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.

This fish diversity attribute was identified as one of the most important attributes during the focus group discussions, predominantly as a source of angling and tourism values. However, not all participants believed there was a link between catchment management changes and fish diversity. It was stressed by several participants that fish populations would be better captured in terms of abundance rather than diversity.

Given the importance of the estuary in the George catchment, an explicit estuary attribute is 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, the attributes were perceived as correlated given the habitat seagrass provides for certain fish species. One participant remarked that "if you're getting better fish diversity, than surely seagrass is redundant". Note that some focus group participants in St Helens considered an increase in the area of seagrass positive a "nuisance". When the draft survey included 'native riverside vegetation' rather than 'fish diversity' as an attribute, 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".

Healthy native riverside vegetation is an attribute often used in CM experiments 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 included the attribute in choosing between alternatives.

Because of limited ecological information on threatened species in the George catchment, the attribute was defined as the habitat area for threatened species in the first survey draft. 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. To increase the possibility for benefit transfer, it was desirable to define the attributes in the CM questionnaire in quantitative terms.

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). The quantitative description caused confusion to many focus group participants. It was unclear to respondents whether an increase in the number of threatened species would be positive or negative. The description of the 'threatened species' attribute was therefore changed in the final survey. The attribute is described as the number of different species of rare and native animals and plants that live in the George catchment. The description includes an explicit statement that some species would no longer occur in the catchment (see Appendix 5).

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 decided that seagrass could provide an acceptable alternative as an indicator of water quality. Native riverside vegetation in healthy condition, and rare native plants and animals were important to respondents. These were included as attributes in the questionnaire.

4.4 The payment attribute

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

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

Survey version	Cost attribute description	Levels ($)
Focus groups February	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	0, 20, 50, 100, 200
Focus groups August	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 <u>one-off levy</u> on water 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 Georges catchment. An independent auditor would make sure the money was spent properly.	0, 30, 80, 200, 400, 600

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 5).

5 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 status quo 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 status quo). The current existing level of the attributes was included as one of the alternative future options. Extensive efforts were made to identify scientifically rigorous levels of the attributes and define them in a way that is understandable and acceptable to respondents.

5.1 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 are 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 is presented as the “status quo” scenario. Not all patchy seagrass can become dense seagrass beds because of light availability, suitable substrate, wave energy and tidal currents. Of the current patchy seagrass area, approximately 395ha could become denser, resulting in a “best case” scenario of 815ha of seagrass, or 37% of the total estuary area.

5.2 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” has been defined by 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 is assumed to be impacted by land use, fencing of riparian zones and weed management in the George catchment. Information on land use was sourced from the Bureau of Rural Science (BRS, 2003). It is assumed that the percentage of total land use in the catchment match the percentage of land use adjacent to a stream. The land-use changes that were assessed are detailed in Appendix 2. For each land-use, assumptions were made about the percentage of vegetated area and the ratio of native - exotic species in the riparian zone adjacent to each land use. These assumptions are detailed in Appendix 2. For example, riparian zones in conservation areas are assumed to be densely vegetated (more than 80% vegetation) with mostly native species (more than 70% natives). Note that riparian zones in forested areas are typically densely vegetated but with limited species diversity (Daley, 2008).

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 (see Appendix 2). The "status quo" scenario is based on a decrease in the area of native vegetation (conservation area and native forests), an increase in agricultural areas and limited weed management. In this "worst case" scenario, 35% (40km) of the total river length would have healthy native riverside vegetation. A "best case" scenario based on an increase in conservation area, large-scale weed management and an increase in vegetation density in the riparian zone. Under this scenario, the George catchment would have 81km of native riparian vegetation in good health (or 70% of total river length).

5.3 Threatened species

Whereas 'threatened species' was presented with qualitative levels in the first drafts of the survey, an attempt was made to quantify the number of threatened species in the final questionnaire. Information 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 include 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 3). 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.

The impact of land use changes and changes in riparian vegetation on different species 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).

Table 7 Number of vulnerable and endangered flora and fauna species observed in the George catchment by habitat

Flora		Fauna	
Habitat	**# species**	**Habitat**	**# species**
Heath and woodland (less than three observations)	28	Terrestrial habitat (less than ten observations)	2
Heath and woodland (three or more observations)	17	Terrestrial habitat (more than ten observations)	5
Riparian zone	8	Aquatic sp	1
Wetlands	6	Riparian zone	4
Coastal areas	4	Estuary-birds	4
Marine environment	5	Coastal birds	8
		Other birds	3
		Marine environment	7
Total rare species	**68**		**34**
Total potentially impacted	**43**		**27**

To avoid confusion amongst respondents, only a decline from the current level of threatened species was presented in the CM questionnaire. A number of assumptions was necessary to calculate the number of impacted rare native animal and plant species. Following expert advice, marine species, extinct species and a number of species with only one observation were not included in the calculations, as these were unlikely to be directly impacted by catchment management changes. Excluding marine or extinct species and excluding a number of species with only one observation, the current number of rare native animal and plant species counted in the George catchment is about 80. 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, only 35 species would remain. The number of rare native animal and plant species presented in the CM questionnaire are based on the current situation of 80 observed species and a status quo scenario of 35 rare native animal and plant species in the George catchment.

6 Experimental design

Each choice alternative in the CM experiment for the Georg catchment is composed of alternative levels of the three environmental attributes and the payment attribute. Various authors have studied the impact of presenting respondents with different number of alternative options (see, for example, Hensher et al., 2001, 2004, 2006, Caussade et al., 2005, and Rolfe and Bennett, In Press). In the present study, respondents were presented with three alternative choices in each choice question. The first alternative was always the base alternative, representing the status quo scenario (degradation of all environmental attributes and no payments). Two alternative options represented a protection of the environmental attributes (compared to the status quo) at a certain cost.

It is usually infeasible to include all possible combinations of the attributes in a CM questionnaire (the 'full factorial'). The number of alternatives can be reduced by selecting a subset of all possible combinations. This selection process should lead to an unbiased survey, meaning that the levels of attributes and their combinations have an equal probability of being included in the choice set. Analysts need to decide on an experimental design strategy to combine the attribute levels into alternatives and choice sets. The design strategies employed can significantly influence the precision of the estimates and welfare measures (Lusk and Norwood, 2005). Increasing design efficiency can reduce survey costs by reducing the sample size needed to attain a given level of accuracy (Scarpa et al., 2007). Two different design strategies can be used to construct choice sets: the first one based on probability balanced designs, not using any prior information on parameters, and the second one based on increasing design efficiency by making assumptions about the sign or relative size of the parameters (Scarpa and Rose, 2008). The first design strategy typically results in orthogonal experimental designs, where all attributes are statistically independent from one another. The main motive to use an orthogonal design is that it will result in uncorrelated parameters in a (linear) regression model (Carlsson and Martinsson, 2003). However, as several authors have noted (Rose and Bliemer, 2005, Bliemer et al., 2007, Ferrini and Scarpa, 2007, Rose and Bliemer, 2008), orthogonal designs may not be efficient when complex non-linear models are used to analyse discrete choice data.

Different efficiency criteria have been suggested to measure design efficiency. The basic premise of most criteria is to maximise the expected precision of the parameter estimates $\hat{\beta}$. A criterion that is often employed is *D*-optimality:

$$\min\{\det(\Omega(\beta, x_{sj}))^{1/K}$$

where β is a vector of parameters, x is a matrix of attribute levels, s = 1,2,…,S choice sets, j = 1,2,…J alternatives in each choice set, K is the number of parameters to estimate and Ω is the asymptotic variance-covariance matrix of $\hat{\beta}$. Other criteria of efficiency include *A*-optimality, measured by minimising the *trace* of matrix Ω, and *C*-optimality, which is aimed at minimising the variance in some function of the model parameters. *D*-optimality was chosen as the efficiency criterion for this study, because it provides more information than using the *A*-error and is computationally less burdensome than using *C*-optimality.

To calculate the information a specific design conveys, some information is required on the expected values of β. The researcher can typically make some prior assumptions about the sign of the parameter estimates. To increase design efficiency, *prior* values of β can be elicited from survey pretests. These prior estimates may not give a precise estimate of the final βs. One can use a Bayesian design to account for the uncertainty in the prior parameter estimates. This simply involves including the distribution over β (π_β) into the calculation of the efficiency criterion:

$$\min E_\beta\left[\{\det(\Omega(\beta, x_{sj}))^{1/K}\right] = \int_{\Gamma^K} \{\det(\Omega(\beta, x_{sj}))^{1/K}\, \pi_\beta d\beta$$

where Γ is the number of draws from the assumed distribution over the parameter estimates π_β.

In developing the survey instrument for valuing changes in the George catchment, a conventional main effects fractional factorial orthogonal design was used in the draft questionnaires, which were pretested during the focus group discussions. The survey responses from the August focus groups were analysed in NLOGIT4.0 using a multinominal logit model specification:

$$U_j = ASC + \beta_{Cost} \cdot Cost + \beta_{Sea} \cdot Seagrass + \beta_{Ripveg} \cdot RipVeg + \beta_{Spec} \cdot ThrSpecies + \beta_{Inc} \cdot Income$$

where *ASC* = 1 for the status quo option and zero for the two alternative options. The model generated significant parameter estimates for the cost and riverside vegetation attributes of -0.004 (0.001) and 0.03 (0.016) respectively[5]. These parameter estimates were incorporated in the efficient design strategy for the final survey. Seagrass and threatened species were not significant. It is unclear at this stage whether seagrass will be perceived as a positive attribute. The description of threatened species gave rise to confusion, producing the insignificant estimate on threatened species. Zero priors were therefore used for the seagrass and threatened species attributes.

A total of 24 choice sets were generated with the aim of minimising the *D*-error. Some combinations of the choice set design were not feasible, for example if one alternative completely dominated the other in the levels of the environmental attributes but not in costs. These combinations were removed from the choice design, leaving a total of 20 choice sets to be included in the questionnaire. It is recognised

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[5] Standard error in parentheses

that removing choice sets will affect design optimality, but feasible choice sets were considered more important than a mathematically optimal experimental design.

Asking each individual to answer 20 choice sets may be too demanding for respondents. Although the ‘optimal’ number of choice sets that can be presented in a CM experiment is debatable (see, for example, Hensher, 2006b), five choice sets was considered a reasonable number in the present study. The George catchment questionnaire includes five choice sets in each survey booklet, which means that four respondents are needed to answer the full array of 20 choice sets.

7 Presentation and collection

The CM questionnaire for the George catchment consists of an introduction letter, a survey booklet and 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 provides 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 5. During the focus group discussions, participants’ reactions to the amount of information on the poster were mixed. Some participants requested more scientific background information or references to source data, while others criticised the poster as including too much complicated information. It became clear that reducing the amount of text and straightforward formulation of the questions and information is vital. Several changes were made to the wording of the initial questionnaires to provide less and unambiguous information. On the final poster, the impacts of current natural resource management and possible new management actions are summarised in dot-points. Respondents are referred to further sources if they require more information. Some focus group participants questioned the focus on the George catchment as opposed to other catchment areas in Tasmania. The George catchment has been described as a case-study area and the final survey includes a reminder of other catchments in Tasmania.

The poster describes the attributes and their levels in the George catchment (see Table 9). The draft questionnaires phrased the status quo scenario as “what will happen in 20 years time if we do nothing?” This produced protest reactions during the focus group discussions and was perceived as a “greeny bias” by some participants. The status quo scenario was therefore 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 is composed of four sections. An introductory section contains 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 explains the choice task at hand, followed by the five choice questions. A third section contains questions that aim to elicit the motives for respondents' choices and assesses respondents' understanding of the survey. The final section consists of various socio-economic questions.

The George catchment survey has been distributed to a random selection of Tasmanian households. To test for differences in preferences between communities 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. It is anticipated that using local surveyors may result in higher response rates. The surveyors received a short training session and detailed instructions on the sampling locations and procedures. The questionnaires were collected in November 2008. Results of the survey collection are not yet available at the time of writing, but will be reported in future publications.

8 Conclusion

A non-market valuation survey instrument has been developed to assess community preferences for different options of natural resource management in the George catchment, Tasmania. A combination of literature study, expert consultation and focus group discussions provided useful insights to developing the CM questionnaire. 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 is considered a special place that warrants payments for natural resource protection. The Georges Bay is a most prominent feature in the catchment, often as a source of tourism, fishing and oyster values. The significance of the Georges Bay may indicate that respondents think about the estuary instead of the whole catchment when answering the questionnaire. The final survey stresses the importance of both rivers and estuary as characteristics of catchment condition to reduce potential bias.

Environmental attributes that used to represent water quality and the condition of the George catchment condition were explored in the literature, through interviews with experts and policy makers and discussed during focus group discussions. The environmental attributes included in the George catchment questionnaire are seagrass area, rare native plants and animals and riverside vegetation. Table 9 shows the description and the levels of the attributes in the final 'standard version' of the questionnaire. Additional questionnaire versions have been used to test for the impacts of alternative descriptions and levels on respondents' choices. A next research report in this EERH Report series will provide details on the split sample tests incorporated in the George catchment survey.

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	0, 30, 60, 200, 400 ($)

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

A final note on the George catchment involves the recent history of uncertainty and disputes about drinking water quality and oyster deaths in Georges Bay. Water quality proves to be a sensitive issue within the local community that may limit response rates to an environmental valuation survey. The introduction letter and information in the survey have been worded as to increase the trust of locals that the research is independent, anonymous and purely scientific. It is anticipated that administering the survey via a ‘drop off/pick up’ method will enable a conversation between surveyors and respondents to further clarify the survey goals if required.

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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

Reference	Technique*	Location	Attributes	Payment vehicle
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)	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 streamside vegetation Channel form	Regional council rates

Reference	Technique[*]	Location	Attributes	Payment vehicle
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
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

Reference	Technique*	Location	Attributes	Payment vehicle
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.* (2006)	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

Reference	Technique*	Location	Attributes	Payment vehicle
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 – Assumptions in native riparian vegetation assessment

Land use change scenarios for native riparian vegetation assessment

Scenario	Conversion assumptions*
Increased conservation area	A maximum of 20% of all current agricultural lands and forestry plantations is be turned into conservation area
Conversion of agriculture to forestry plantations	A maximum of 40% of all current agricultural lands is converted into forestry plantations
Conversion of native vegetation to forestry plantations	A maximum of 40% of all current native production forest and a maximum of 13% of all current conservation area is converted into forestry plantations
Increase in agricultural areas	A maximum of 20% of all current forestry plantations, a maximum 40% of all current native production forest and a maximum of 13% of all current conservation area is converted into agriculture
Increase in urban areas	A doubling in size of the St Helens urban areas, and an expansion of other existing urban area by a maximum of 40%

* These scenarios are based on viability of different areas for different land uses, taking land tenure, soil structure, elevation and existing land use into account. As 20% of the conservation area is under protected land tenure, a maximum of 13% of existing conservation area can be converted.

Native riparian vegetation scenario outcomes

Scenario	Land use	Conservation	Grazing	Irrigation	Urban	Production forest	Forestry plantation	Total
Current situation	Land use as % of total catchment	30	15	1	1	45	5	
	Total riverside length (km)	37.3	17.0	1.1	1.1	50.9	5.7	**113**
	Riverside zone with healthy native vegetation (%)	80	30	20	10	70	50	
	Length of healthy native riparian vegetation (km)	29.8	4.9	0.2	0.1	35.7	2.8	**73.5**
Status quo	Land use as % of total catchment	20	47	1	1	27	4	
	Total riverside length (km)	22.6	53.1	1.1	1.1	30.5	4.5	**113**
	Riverside zone with healthy native vegetation (%)	80	10	10	10	40	40	
	Length of healthy native riparian vegetation (km)	18.1	5.3	0.1	0.1	12.3	1.8	**37.7**
Best case scenario	Land use as % of total catchment	37	12	1	1	45	4	
	Total riverside length (km)	41.8	13.6	1.1	1.1	50.9	4.5	**113**
	Riverside zone with healthy native vegetation (%)	80	60	40	10	70	70	
	Length of healthy native riparian vegetation (km)	33.7	7.9	0.4	0.1	35.8	3.2	**81.1**

Appendix 3 – 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
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

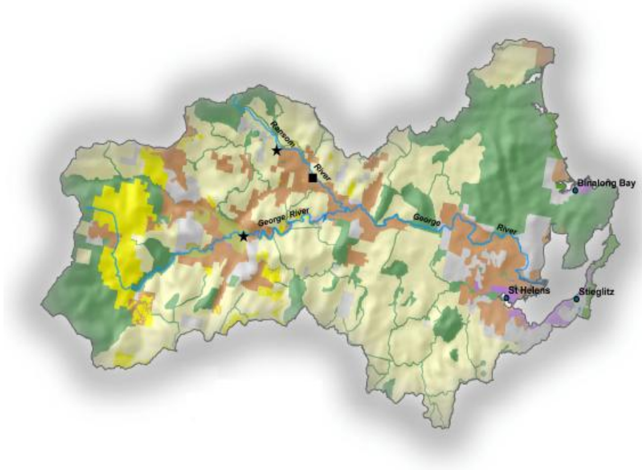
* e = endangered, j/c = species under Japan-Australia and/or China-Australia migratory bird agreement, r= rare, v = vulnerable, x = extinct

Appendix 4 – Draft questionnaire, February 2008

River and estuary condition in the George Catchment

George Catchment

Rivers and Georges Bay



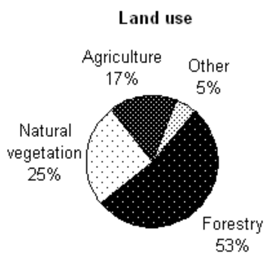
The George Catchment (557 km^2) is located in north-eastern Tasmania

The main rivers in the catchment include the George River (54 km), Ransom River, Groom River, Power Rivulet, and Golden Fleece Rivulet

The George River flows into the Georges Bay estuary (22km^2) at the town of St. Helens (population of about 2000)

Land use in the catchment is dominated by forestry, natural vegetation and agriculture

The estuary is used mostly for recreation (fishing, swimming, boating) and oyster farming



Catchment management

Land use in the George Catchment can affect the condition of the rivers and estuary. For instance, urban developments, agricultural practices and forestry management can cause soil erosion and water pollution.

Current land management practices may lead to a worsening of river and estuary conditions in the future. Changing the way in which the land is managed could improve the condition of the George River and Georges Bay.

Ransom River at Sweet Hills

Current management issues

Clearing riparian vegetation

Unrestricted stock access to rivers

Erosion from roads and riverbanks

Runoff from agriculture and forestry

Sedimentation of rivers

Pollution from sewage and urban areas

Dairy farming in the upper catchment

Erosion from unrestricted stock access

Impacts

Reduced water quality

Loss of habitat for threatened species

Reduced fish populations and diversity

Loss of riverside vegetation

Reduced oyster growth and quality

Reduced seagrass areas

Fencing to protect riverside vegetation

New management strategies

Managing stock access to rivers through fencing and alternative watering points

Planting riverside vegetation

Reducing pollution from agriculture, forestry and roads

Reducing urban stormwater runoff

Stabilising river banks

FEATURES OF THE GEORGE CATCHMENT

Please use this information when answering questions 4 to 8

Fish diversity

Reduced environmental quality in the river can lead to reduced fish diversity in the George River and Georges Bay.

Georges Bay*

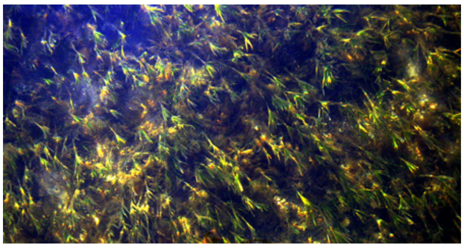
A) What will happen in 20 years time if we do nothing?

FEW	Less than 30 different fish species in rivers and estuary

B) What will happen in 20 years time if we do something?

AVERAGE	30 - 40 different fish species in rivers and estuary
LARGE	40 - 50 different fish species in rivers and estuary
VERY LARGE	More than 50 different fish species in rivers and estuary

Seagrass area and density



Seagrass beds in clear, sunlit waters

Seagrass generally grows best in clear waters and is important for the spawning and growing of fish like leatherjacket and pipefish.

A) What will happen in 20 years time if we do nothing?

550 ha	**Decline** in seagrass in Georges Bay from 690 ha to 550 ha

B) What will happen in 20 years time if we do something?

620 ha	**Decline** from 690 ha to 620 ha
690 ha	Remain at **current** levels of 690 ha
740 ha	**Increase** from 690 ha to 740 ha

* Photo courtesy of Wanderer Photographics, St Helens

Threatened species

Threatened species in the George Catchment that rely on good water quality include Davies' Wax Flower, Glossy Hovea, Green and Gold Frogs and Freshwater Snails.

Davies' Wax Flower

A) What will happen in 20 years time if we do nothing?

NONE	Less than 3 areas with Davies' Wax Flower and Glossy Hovea Less than 5 areas with Green and Gold Frogs and Freshwater Snails

B) What will happen in 20 years time if we do something?

SMALL	3 – 8 areas with Davies' Wax Flower and Glossy Hovea 5 - 12 areas with Green and Gold Frogs and Freshwater Snails
MODERATE	8 - 15 areas with Davies' Wax Flower and Glossy Hovea 12 - 25 areas with Green and Gold Frogs and Freshwater Snails
ABUNDANT	More than 15 areas with Davies' Wax Flower and Glossy Hovea More than 25 areas with Green and Gold Frogs and Freshwater Snails

Your one-off payment

Taking action today to change management in the George Catchment would involve higher costs.

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.

River and estuary condition in the George Catchment
A survey of your preferences

Dear respondent,

I would like to invite you to be part of a survey about catchment management strategies in the George Catchment. You have been randomly selected for this **independent** survey.
Your views and opinions on this topic are important. Your answers to this questionnaire will inform the Tasmanian Government on how people value river and estuary condition. By being part of this survey, you can help decide how the George Catchment is managed in the future.

Any adult member (18 years or older) of your household can complete this survey. Please answer the questionnaire on behalf of all members of your household.

You don't need to know about management in the George Catchment to do this survey. There are no right or wrong answers – we are interested in your opinions. We anticipate that it should take no more than 20-30 minutes to complete the questionnaire.

Along with the questionnaire, there is a poster with information about the George Catchment.

We ask that you look at the poster before completing the questionnaire.

This research has been approved by the Human Ethics Committee of the Australian National University, protocol 2007/2237. **Your answers will be anonymous and strictly confidential**. Consent to participate in this study is implied by completing the questionnaire.

Thank you very much for taking part in the survey! If you have any questions or concerns about the conduct of this research, please feel free to contact Marit Kragt on 02 6125 4670 or email: marit.kragt@anu.edu.au or Professor Jeff Bennett on 02 6125 0154 during business hours. Please contact the ANU Human Ethics Officer, Ms Yolanda Shave, on 02 6125 7945 if you have additional ethical concerns.

Marit Kragt
February 2008

All responses will be stored securely. Overall results may be published, but will not be linked to individual information. Only researchers working on this project will have access to the data.

The George River and Georges Bay

We would like to know how familiar you are with the rivers and estuary in the George Catchment.

Question 1
Have you visited the George Catchment in the last 5 years?

☐ Never visited → Go to question 3

☐ Visited once

☐ Visited between once 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 visited the George Catchment, which of the following things did you do? (Tick all that apply)

☐ Fishing in the rivers

☐ Fishing in the bay

☐ Collecting shellfish

☐ Birdwatching

☐ Boating

☐ Swimming

☐ Walking

☐ Camping

☐ Sightseeing

☐ Other, please specify ____

Question 3
How would you describe the condition of the George Catchment environment? (Please tick one)

☐ Very poor ☐ Quite poor ☐ Average ☐ Good ☐ Very good

What do you think?

In questions 4 to 8, we ask you to make some choices between **alternative future options** for managing the George Catchment. Management in the catchment can affect the water quality and condition of the rivers and estuary.

Alternative management strategies will have different impacts on threatened species, fish populations and seagrass areas in the rivers and Georges Bay. The management strategies and features of the George catchment are described in the poster you received with this questionnaire.

Options and costs

Option A is the same in each choice question. This option represents the condition of the George River and Bay that would occur in 20 years time if current catchment practises would continue. This option involves no costs and <u>no new management initiatives</u>.

All of the other options (B to K) involve changes in catchment management. These changes would affect the future condition of the George Catchment.

Changed catchment management would involve higher costs. The money to pay for the changes would come from you and all other Tasmanian households through a one-off payment into a trust fund specifically set up to fund new management strategies in the George Catchment.

Making a choice

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

The different outcomes that scientists are predicting for the options in 20 years time;

The estimated one-off payment needed to finance new catchment management initiatives;

Your available household income and other expenses; and

Other issues that you may care about.

Important note

The questions are hypothetical but they are based on current scientific knowledge. Your answers will provide decision makers with important information for managing the George Catchment.

Please consider the questions carefully and make your choices as if they were real.

Some of the catchment management outcomes may seem unrealistic to you. However, all the outcomes are possible. They come from a wide range of possible management changes. Just choose your most preferred option in every question.

Please answer each question **independently** of the other questions.

Before answering questions 4 to 8, it is important that you go over the poster provided.

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

Question 4

Please carefully consider each of the following three options for the Georges River and Bay. Suppose that Options A, B and C are the only ones available. Which one would you choose?

Features	Your one-off payment	Fish diversity	Seagrass	Threatened species populations
Condition now		LARGE	690 hectares	SMALL
Condition in 20 years				
OPTION A *No new initiatives*	$0	FEW	550 ha	NONE
OPTION B	$20	FEW	690 ha	MODERATE
OPTION C	$200	VERY LARGE	740 ha	MODERATE

Which of these options would you choose?

☐ Option A

☐ Option B

☐ Option C

☐ Not sure

The next four questions are similar to the previous one, except that the levels of the features in the options for change are different in each question. Remember to consider each question separately.

Question 5

Please carefully consider each of the following three options for the Georges River and Bay. Suppose that Options A, D and E are the only ones available. Which one would you choose?

Features	Your one-off payment	Fish diversity	Seagrass	Threatened species populations
Condition now		LARGE	690 hectares	SMALL
Condition in 20 years				
OPTION A *No new initiatives*	$0	FEW	550 ha	NONE
OPTION D	$100	AVERAGE	550 ha	ABUNDANT
OPTION E	$50	LARGE	740 ha	NONE

Which of these options would you choose?

☐ Option A

☐ Option D

☐ Option E

☐ Not sure

Question 6

Please carefully consider each of the following three options for the Georges River and Bay. Suppose that Options A, F and G are the only ones available. Which one would you choose?

Features	Your one-off payment	Fish diversity	Seagrass	Threatened species populations
Condition now		LARGE	690 hectares	SMALL
Condition in 20 years				
OPTION A *No new initiatives*	$0	FEW	550 ha	NONE
OPTION F	$20	AVERAGE	690 ha	NONE
OPTION G	$200	FEW	620 ha	ABUNDANT

Which of these options would you choose?

☐ Option A

☐ Option F

☐ Option G

☐ Not sure

Question 7
Please carefully consider each of the following three options for the Georges River and Bay. Suppose that Options A, H and I are the only ones available. Which one would you choose?

Features	Your one-off payment	Fish diversity	Seagrass	Threatened species populations
Condition now		LARGE	690 hectares	SMALL
Condition in 20 years				
OPTION A *No new initiatives*	$0	FEW	550 ha	NONE
OPTION H	$200	VERY LARGE	620 ha	SMALL
OPTION I	$50	LARGE	550 ha	MODERATE

Which of these options would you choose?

☐ Option A

☐ Option H

☐ Option I

☐ Not sure

Question 8

Please carefully consider each of the following three options for the Georges River and Bay. Suppose that Options A, J and K are the only ones available. Which one would you choose?

Features	Your one-off payment	Fish diversity	Seagrass	Threatened species populations
Condition now		LARGE	690 hectares	SMALL
Condition in 20 years				
OPTION A *No new initiatives*	$0	FEW	550 ha	NONE
OPTION J	$100	VERY LARGE	550 ha	SMALL
OPTION K	$50	FEW	740 ha	NONE

Which of these options would you choose?

☐ Option A

☐ Option J

☐ Option K

☐ Not sure

We would now like to ask you some further questions about the management options for the George Catchment.

Question 9

When answering Questions 4 to 8, did you always choose option A (no new initiatives)?

☐ Yes

☐ No → Go to question 10

If you answered "yes", which of the following statements most closely describe your reason for doing so? (Please tick one box only)

☐ I prefer if no new catchment management initiatives are undertaken

☐ I support changes in management, but could not afford payments of any amount

☐ I support changes in catchment management, but object to having to pay for it

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

☐ Some other reason (please specify)

____

____

Question 10

Please indicate how strongly you agree or disagree with each the following three statements (please tick the one option that is closest to your view).

1. I found answering questions 4 to 8 confusing

☐ Strongly Agree ☐ Agree ☐ Neither Agree nor Disagree ☐ Disagree ☐ Strongly Disagree

2. I <u>understood</u> all the information on the information sheet

☐ Strongly Agree ☐ Agree ☐ Neither Agree nor Disagree ☐ Disagree ☐ Strongly Disagree

3. I <u>agreed with</u> the scenarios presented on the information sheet

☐ Strongly Agree ☐ Agree ☐ Neither Agree nor Disagree ☐ Disagree ☐ Strongly Disagree

Question 11

Could you give us some insights into the way you made your choices in Questions 4 to 8?

Did you consider **all the outcome features** in each option?

1. Tick the features you looked at when making your choice (tick as many as apply)

   ☐ Costs

   ☐ Fish

   ☐ Seagrass

   ☐ Threatened species

   ☐ I looked at **all** the features in each option

2. Tick the features you ignored completely when making your choice (tick as many as apply)

   ☐ Costs

   ☐ Fish

   ☐ Seagrass

   ☐ Threatened species

Did you look at the **levels** of all the features in each option?

3. Tick the features for which you required a minimum level when making your choice (please specify)

   ☐ Fish at a minimum level of few / average / large / very large diversity

   ☐ Seagrass at a minimum level of 550 / 690 / 740 ha

   ☐ Threatened species populations none / small / moderate / abundant

Thanks! Now, some questions about yourself

We also need to ask some questions about you. This ensures that our sample is representative and allows us to identify which people prefer which management strategy. **This study is anonymous and confidential.** All data collected will only be used for the purpose of the current study, and will not be passed to anyone else.

Question 12

What is your age? ________________________ years

Question 13

What is your sex? ☐ Male ☐ Female

Question 14

How many people live in your household? (Please include the number of adults and children supported by your household)

Adults ___________________ Children (17 years or under) ________________

Question 15

What is your postcode? _________________________

Question 16

What is the highest level of education you have obtained (until now)?

☐ Never went to school

☐ Primary only

☐ Junior / year 10

☐ Secondary / year 12

☐ Diploma or certificate

☐ Tertiary degree (post-graduate)

☐ Other (please specify) _______________________________

Question 17

Are you a member of an environmental organisation? (e.g. WWF, ACF)

☐ Yes

☐ No

Question 18
Are you, or is a member of your close family, associated with the farming industry?

☐ Yes

☐ No

Question 19
Are you, or is a member of your close family, associated with the forestry industry?

☐ Yes

☐ No

Question 20
To the best of your knowledge, please indicate the total combined income **before taxes** earned by all members of your household last year. As for all your answers, information provided here is **strictly confidential**.

☐ Under $7,800 (under $300 per fortnight)

☐ $7,800 – $12,999 ($301 – $500 per fortnight)

☐ $13,000 – $20,799 ($501 – $800 per fortnight)

☐ $20,800 – $31,199 ($801 – $1200 per fortnight)

☐ $31,200 – $41,599 ($1201 – $1600 per fortnight)

☐ $41,600 – $51,999 ($1601 – $2000 per fortnight)

☐ $52,000 – $67,599 ($2001 – $2600 per fortnight)

☐ $67,600 – $83,199 ($2601 – $3200 per fortnight)

☐ $83,200 – $103,999 ($3201 – $4000 per fortnight)

☐ $104,000 or more (more than $4001 per fortnight)

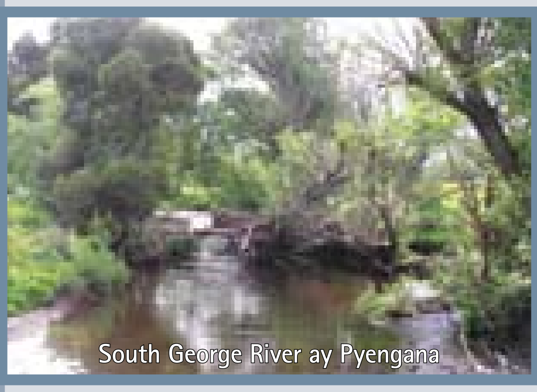
☐ Don’t know

Thank you for your time! Your effort in completing this survey is very valuable to us.

If you have any other comments about the survey that might be important, please use the next blank page to inform us.

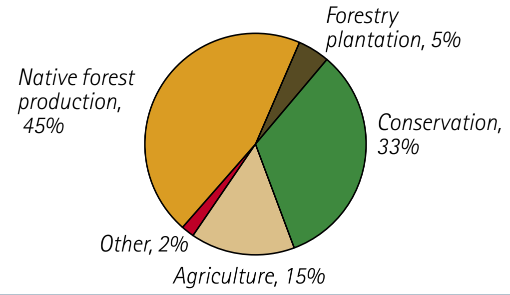
Appendix 5 – Final questionnaire, November 2008

NATURAL RESOURCE MANAGEMENT IN THE GEORGE CATCHMENT


South George River ay Pyengana


Georges Bay

LAND USE




Healthy native vegetation


Ransom River at Sweets Hill

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

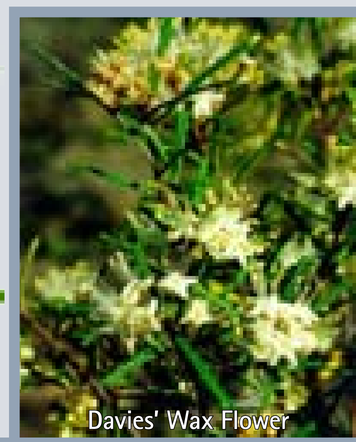
Condition now

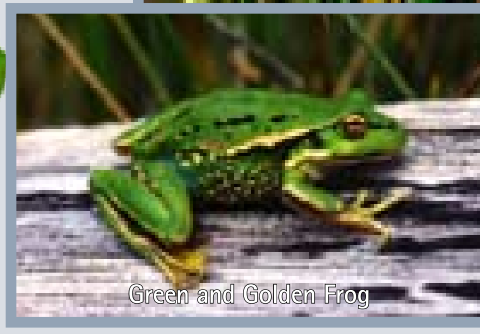
74 km – Healthy native vegetation along 74 km on both sides of the river (=65% of total river length)

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


Davies' Wax Flower


Green and Golden Frog

Rare native animal and plant species[2]

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.

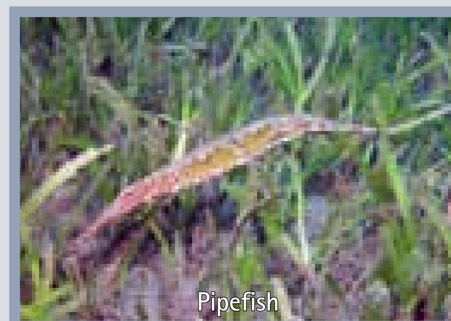
Condition now

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


Pipefish


Seagrass beds

Seagrass

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)

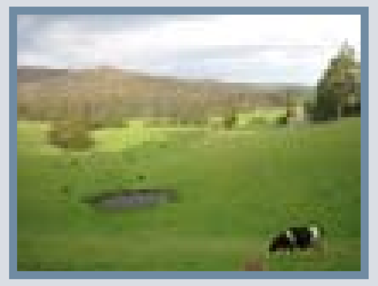
Sources: Bringing back the Bay (Mount, 2005); Marine and Freshwater Research (47: 763-771); www.environment.gov.au/soe/1996/publications.

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

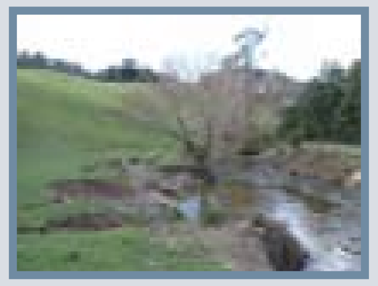
The way in which the George catchment is managed affects the condition of the rivers and bay. For instance; agricultural practices, forestry managment and urban developments can cause soil erosion and water pollution. **A continuation of current management will harm the health of the rivers and bay in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

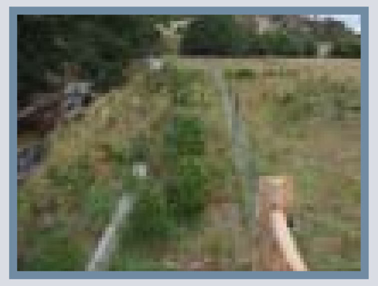
Source: Break O'Day NRM Survey (2006)


Erosion from unrestricted stock access

Impacts of current practices

- Loss of native riverside vegetation
- Reduced water quality 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[1]

- 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)

[1] 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

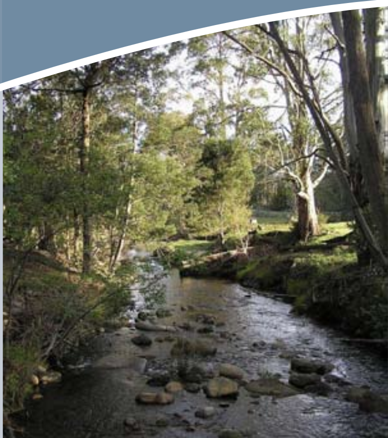
[2] Rare native animal and plant species are listed as vulnerable or (critically) endangered (http://www.dpiw.tas.gov.au).

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

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 <u>main</u> 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)

....

....

....

....

→ **go to Q11**

Question 10

When choosing to support new management actions (options B to K), which of the following statements best describes your <u>main</u> 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)

....

....

....

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

Question 12

Thinking about the information presented on the poster, please indicate how strongly you agree or disagree with each of the following three statements. Tick the one option that is closest to your view

I *understood* all the information on the poster:

☐ Strongly Disagree ☐ Disagree ☐ Neither Agree nor Disagree ☐ Agree ☐ Strongly Agree

I *agreed* with the information presented on the poster:

☐ Strongly Disagree ☐ Disagree ☐ Neither Agree nor Disagree ☐ Agree ☐ Strongly Agree

I found answering questions 4 to 8 *confusing*:

☐ Strongly Disagree ☐ Disagree ☐ Neither Agree nor Disagree ☐ Agree ☐ Strongly Agree

Thanks!

In this last section, we would like to ask you some questions about yourself. This will help us understand why respondents' opinions may differ

Please be assured that your answers are anonymous and all information collected is confidential

Question 13

What is your age? .... years

Question 14

What is your gender? ☐ Male ☐ Female

Question 15

How many people live in your household, including yourself? (please count separately the number of adults and children supported by your household)

Adults .... Children (17 years or under) ....

Question 16

What is your postcode? ....

Question 17

What is the highest level of education you have obtained (until now)?

- ☐ Never went to school
- ☐ Primary
- ☐ Junior / year 10
- ☐ Secondary / year 12
- ☐ Diploma / trades certificate
- ☐ College / University degree (e.g. BSc, BA)
- ☐ Post-graduate degree (e.g. MSc, PhD)
- ☐ Other (please specify)

....

Question 18

Are you a member of an environmental organisation? (e.g. Wilderness Society, Greenpeace etc.)

☐ Yes ☐ No

Question 19

Are you, or a member of your close family, associated with the fishing/aquaculture industry?

☐ Yes ☐ No

Question 20

Are you, or a member of your close family, associated with the farming industry?

☐ Yes ☐ No

Question 21

Are you, or a member of your close family, associated with the forestry industry?

☐ Yes ☐ No

Question 22

Annual household income - please indicate the approximate total **combined income** (before taxes) earned last year by all members of your household. The ranges between brackets are fortnightly income

As for all your answers, information provided here is **strictly confidential**!

- ☐ Under $7,800 (under $300)
- ☐ $7,800 – 12,999 ($300 – 499)
- ☐ $13,000 – 18,199 ($500 – 699)
- ☐ $18,200 – 25,999 ($700 – 999)
- ☐ $26,000 – 33,799 ($1000 – 1299)
- ☐ $33,800 – 41,599 ($1300 – 1599)
- ☐ $41,600 – 51,999 ($1600 – 1999)
- ☐ $52,000 – 62,399 ($2000 – 2399)
- ☐ $62,400 – 72,799 ($2400 – 2799)
- ☐ $72,800 – 88,399 ($2800 – 3399)
- ☐ $88,400 – 103,999 ($3400 – 3999)
- ☐ $104,000 – 129,999 ($4000 – 4999)
- ☐ $130,000 – 155,999 ($5000 – 5999)
- ☐ $156,000 – 181,999 ($6000 – 6999)
- ☐ $182,000 – 207,999 ($7000 – 7999)
- ☐ $208,000 or more ($8000 or more)
- ☐ Don't know

Thank you for your time! Your effort in completing this survey is very valuable to us

If you have any other comments about management in the George catchment or about this survey that might be important, please use the space on the back cover to write them down

If you have any questions or concerns about the conduct of this study, please feel free to contact Marit Kragt on 02 6125 4670 or Professor Jeff Bennett on 02 6125 0154 during business hours or email: marit.kragt@anu.edu.au. Please contact the ANU Human Ethics Officer, Ms Yolanda Shave, on 02 6125 7950 if you have additional ethical concerns.

All responses will be stored securely. Overall results may be published, but will not be linked to individual information. Only researchers working on this project will have access to the data.