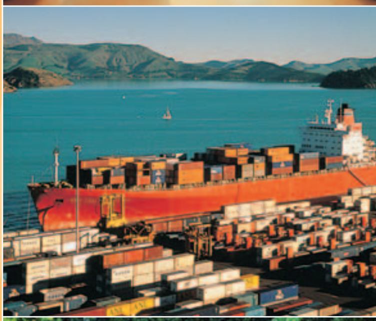

Amenity Values of Spring Fed Streams and Rivers in Canterbury, New Zealand: A Methodological Exploration

Geoffrey N Kerr
Simon R Swaffield

Research Report No. 298
December 2007

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Summary

Groundwater allocation decisions have effects beyond the enterprises and land uses for which water is used. They may influence the quantity, quality and flow of spring fed streams within the catchment, and the in-stream values such as biodiversity, fishing, and recreation. Changes to the streams themselves in turn shape the character and values of the wider stream corridor and the surrounding landscape. Human use and occupation of the land has always changed the character of streams and rivers- that is not new- but the scale of current demands for groundwater, and the speed of land use change based upon groundwater use, set challenges and questions for the way in which spring fed streams and rivers will change in the future.

The Sustainable Groundwater Allocation Research (SUGAR) funded by the Foundation for Research, Science and Technology is aimed at improving knowledge of the relationships between the flow regime of spring fed streams and rivers and its effects, and the development and testing of an improved process of decision making about groundwater allocation. The overall project was developed by Lincoln Ventures Ltd in partnership with Environment Canterbury, Ministry of Agriculture and Fisheries and Ministry for Environment, and is being undertaken by staff from the National Institute of Water and Atmospheric Research, Lincoln University and Harris Consulting. Federated Farmers of New Zealand Inc. is collaborating in the design and implementation of the research.

This report presents results from Objective 4 of the SUGAR project, which was aimed at developing a method to help stakeholders in groundwater management to visualize and then weigh the landscape consequences of different water allocation regimes. It focused specifically upon improving understanding of the way people trade off different amenity outcomes of allocation decisions. The study was undertaken in two stages. Salient attributes of amenity were identified using Q Sort method with a selection of key informants from stakeholder groups. A choice experiment was then undertaken, using images and diagrams of different attributes of streams and stream corridors, which are presented to stakeholders as a set of choices. Analysis of the choices people make identifies the relative significance of the different attributes most affected by different management regimes. This information can then inform the next round of decision making in the wider groundwater allocation process.

The combination of methods successfully identified salient attributes of amenity, and identified the relative weights placed upon these attributes by two key stakeholder groups (farmers and anglers), when faced with a range of possible consequences of changing groundwater allocation regimes. It also identified similarities and differences between stakeholder values, both across and within the two groups involved in the study. The most notable finding was that differences in values between farmers and anglers, taken in aggregate, were less marked than differences between different farmers and between different anglers. This enhances prospects for consensus across user groups.

Chapter 1
Introduction: Research Objective and Approach

1.1 Context: the need for the research

There have been conflicting demands upon New Zealand water resources for many decades. The proposal to raise Lake Manapouri to generate hydroelectricity provided a catalyst for the growth of the New Zealand conservation movement in the 1970s, and since that time contests between economic, recreational, scenic and conservation values and demands upon the allocation of water resources have been evident in most parts of the country. Over the past decade Canterbury has been a particular focus of conflict, due in large part to the rapid increase in the use of groundwater to support agricultural intensification, and its strategic significance for the economic development of the region. However the technical and political resolution of such conflicts has been hampered by uncertainty and lack of knowledge about the underlying hydrological processes, and of the effects of alternative management regimes upon the conditions and values of different aquatic environments.

One aspect that requires attention is the effect of different groundwater management regimes upon recreational and scenic values of the streams and rivers whose flows are linked to groundwater systems. There have been a number of research projects that have investigated the link between river conditions, recreation use and scenic values, but they have been largely focused upon mountain sourced rivers that are being considered for hydro schemes, or from which surface water is to be extracted, or upon urban streams. There is currently little knowledge or understanding about the scenic and recreational values of groundwater sourced streams and rivers in New Zealand.

This paper reports upon a project being undertaken as part of a wider investigation into groundwater allocation. The Sustainable Groundwater Allocation Research programme (SUGAR) is aimed at providing a whole-systems approach to solving water allocation problems. The overall project was developed by Lincoln Ventures Ltd in partnership with Environment Canterbury, Ministry of Agriculture and Fisheries and Ministry for Environment, and is being undertaken by staff from the National Institute for Water and Atmospheric Research (NIWA), Lincoln University, and Harris Consulting. Federated Farmers of New Zealand Inc. is collaborating in the design and implementation of the research. It includes a range of scientific studies undertaken within a wider framework of collaborative decision making.

1.2 Research objectives

Objective 4 of the SUGAR programme is aimed at improved understanding of the relationship between ground water allocation regimes and changes in aesthetic and recreational values of spring-fed streams. These types of values are all included within the definition of 'amenity' in the Resource Management Act. The project's specific objective is to develop and apply methods that identify the attributes of amenity in spring-fed streams and rivers that are valued by selected stakeholders, and to identify the relative weights attached to these attributes, in the context of ground water allocation.

1.3 Approach

The research incorporates two complementary research methods - Q Sort and a Choice Experiment - which have not been combined in this way previously. The initial step in the study was to scope current understanding of amenity values of streams and rivers by reference to existing literature and previous studies in New Zealand. From this a set of values and their corresponding environmental attributes that could potentially be relevant were developed. Next, a set of photographic images that showed a range of river and stream conditions was prepared, selected to demonstrate these values and attributes. These images were taken from the study area (the Selwyn Catchment) that was also being used for the ground water modelling and development of the decision support model within the wider programme.

The approach adopted to identify salient attributes of amenity was the Q method (Brown, 1980). This method provides stimuli such as photographs to respondents in such a way that they are free to express their own view on the topic of research. Typically, about 20 to 30 photographs are sorted in order from those which the respondent likes, approves or judges to have some quality, such as amenity value, to those which they judge to least represent the nominated quality. The photographs are sorted into piles and receive a score corresponding to the pile. The scores are recorded, and quantitative analysis then identifies characteristic and distinctive ways of sorting the photographs, which are common to a number of respondents. These are called factors. While respondents are ordering the photographs, they are also asked to explain why they sort the items in the way that they do. These comments complement the scoring and are used to interpret in detail the factors that are identified in the quantitative analysis. In effect, the Q Sort method is a way of using quantitative methods to assess qualitative judgements.

The output from the Q Sort was a set of amenity attributes that are particularly valued by key stakeholder groups, primarily farmers and recreationists/conservationists. These results were combined with the outcomes of other independent research into Maori cultural values in streams (Tipa and Tierney 2003). The second step was to incorporate these key attributes into a choice experiment.

Choice experiments are a stated preference method in which respondents are asked to choose between several scenarios (three in this case). The scenarios present different combinations of values for salient attributes, primarily derived in this study from the Q Sort. The scenarios are designed to force respondents to make choices between different combinations of attribute conditions. The analysis then derives relative values for the attributes.

In order to ensure that all respondents understand the context in which the choices are framed, the choice experiment was preceded by a briefing session in which all respondents were shown a summary environmental history of the study area. Preparation of this history was a significant task in itself, given the contentious nature of the topic. An illustrated Powerpoint presentation was compiled, that explained the objectives of the study, and then provided an overview of environmental conditions prior to, and during different phases of human occupation. The history included a summary of current knowledge about the functioning of the ground water system, and its relationship with climate and land use. The history was peer reviewed by a range of experts and representatives of stakeholder groups, including tangata whenua.

1.4 Study area

The Objective Four research is intended to develop a method that can be applied throughout New Zealand. However to develop and test the method a case study application is needed, and this report is based upon a study undertaken in the lower part of the Canterbury Plains between Christchurch and Rakaia, focused upon the lower Selwyn River. The Selwyn River rises in the Canterbury foothills and flows across the plains between the Waimakariri River and the Rakaia River before discharging into Te Waihora/Lake Ellesmere. The Selwyn receives rainfall recharge from the foothills and the plains and is also spring-fed in its lower reaches. Between State Highway 1 and Te Waihora there are also a number of wholly spring-fed streams, and the study area was defined as the zone between State Highway 1 and the lake (see Figure 1), where a number of these streams are located. Images for the Q Sort were drawn from both the Selwyn and also the other spring-fed streams in this vicinity. For the choice experiment, the point of reference was the reach of the Selwyn River between Chamberlain's and Coe's Fords.

Chapter 2
Identification of Relevant Attributes of Amenity

2.1 Review of literature and scoping of potential attributes

The first step in the Objective Four research was to identify attributes of stream and river environments that contribute significantly to the amenity of spring-fed streams and rivers. A review of international literature identified a range of potential attributes. This is summarised in Table 2.1.

CVM = Contingent Valuation Method
CE = Choice Experiment
TCM = Travel Cost Method

Table 2.1: Summary of Riparian attributes identified in previous literature

Reference	Method	Attributes
Dunford, Ginn, and Desvousges 2004	Habitat equivalency analysis	• Stream miles • Woody vegetation acres • Herbaceous vegetation acres
Holmes *et al.* 2004.	CVM	• Abundance of game fish • Water clarity • Wildlife habitat in buffer zones • Allowable water uses • Ecosystem naturalness
Carlsson, Frykblom and Liljenstolpe 2003	CE	• Surrounding vegetation • Biodiversity • Fish • Fenced waterline • Crayfish • Walking facilities
Kerr and Sharp 2006	CE	• Water clarity • Km of native fish habitat • Number of native fish species • Streamside vegetation • Channel form
Rolfe & Windle 2005	CE	• Percent of original healthy vegetation left in floodplain • Kilometres of waterways in good health • Amount of unallocated water in reserve • Protection of aboriginal heritage sites • People leaving country areas each year
Hoehn, Lupi and Kaplowitz 2004	CE	• Acreage of drained wetland • Change in public access • Change in wetland type • Change in habitat for reptiles/amphibians • Change in habitat for wading birds • Change in habitat for song birds • Change in habitat for wild flowers
Egan, Herriges, Kling and Downing 2004	TCM	• Secchi depth • Chlorophyll • NH3 + NH4 • NO3 + NO2 • Total Nitrogen

		• Total Phosphorous • Silicon • pH • Alkalinity • Inorganic SS • Volatile SS
Bennett and Morrison. 2001	CE	• Healthy riverside vegetation % • Number of native fish species present • Number of waterbird & other fauna species present • Boatable / fishable / swimmable
Rolfe, Bennett and Blamey 2000	CE	• Income lost to the region ($ million) • Jobs lost in region • Endangered species lost to region • Population size of non-threatened species (1%) • Area of unique ecosystem (1%)
Hatton MacDonald and Morrison 2005	CE	• Scrubland area • Woodland area • Wetland area
Hanley *et al.* 1998	CVM CE	• Woods • Archaeology • Heather moors • Wet grasslands • Dry stone walls
Whitten and Bennett 2001	CE	**Upper South East** • Healthy wetland area • Healthy remnant vegetation area • Threatened species benefited • Ducks hunted **Murrumbidgee River** • Healthy wetland area • % pre 1800 water and woodland birds • % pre 1800 fish numbers • Farmers leaving
Mallawaarachchi *et al.* 2001	CE	• Income in region • Teatree woodlands area • Area of vegetation along rivers and in wetlands
Blamey, Gordon and Chapman 1999	CE	• Reduction in household water use • Use of recycled water • Improvements in river flows • Number of species with habitat loss • Colour of grass in urban areas
Morrison, Bennett and Blamey 1997	CE	• Employment **Gwydir Wetlands** • Wetland area • Waterbird breeding frequency • Number of endangered and protected species **Macquarie Wetlands** • Wetland area • Area of healthy river redgums • Number of waterbirds • Water birds breeding • Water quality
Bennett (nd)	CE	• Native fish abundance ➢ Years of good fishing, ➢ Time driving to good fishing, ➢ Status of endangered species

		• Floodplain vegetation ➢ Diversity ➢ Forest & grassland condition ➢ Weeds • Wetlands ➢ Icon wetlands ➢ Other wetlands • Waterbirds ➢ Diversity of species ➢ Abundance ➢ Driving time to see bird breeding • Algal bloom frequencies ➢ Frequency of mild toxic algal blooms ➢ Frequency of moderate toxic algal blooms ➢ Frequency of severe toxic algal blooms

These studies have tended to emphasise five types of environmental attribute. Species numbers have been the most commonly used, together with the presence and area of different types of vegetation. There are two main approaches to dealing with the characteristics of water; either using water clarity, or some metric associated with chemical composition. Social factors have most typically been dealt with by jobs created or forgone.

The international review was complemented by three sources within New Zealand. First, the Ministry for the Environment (MfE) has identified a range of Environmental Performance Indicators (EPIs) for freshwater (MfE 1998). Relevant indicators for this study include water clarity, presence of chemicals such as ammonia and nitrates, suitability for bathing, and riparian conditions.

A second key source of potential attributes was the Tangata Whenua Cultural Health Index for streams, also published by MfE (Tipa and Tierney 2003). This report was based upon ethnographic research into tangata whenua values and presents a set of indicators of 'cultural health' as defined by kaumatua and other Maori key informants. The cultural health index includes the following potentially relevant attributes: river shape, water sediment, water quality and safety to drink, flow characteristics, variations and flood, sound, movement, presence and safety of fish, riparian vegetation and conditions, adjoining and catchment uses.

The third New Zealand source of attributes was work being undertaken by Boffa Miskell Partners as part of a related Foundation of Research, Science and Technology (FRST) funded research programme (through NIWA). This work developed methods for the assessment of landscape values of rivers whose resources were likely to be used for water extraction, storage or power generation. The Boffa Miskell study focused primarily upon identifying acceptable flow levels in perennial rivers, and perceptions of thresholds of flow that trigger concern amongst stakeholders about low flow. The reference rivers used were the Halswell, Waikirikiri (Selwyn), Waimakariri, Hurunui and Waipara Rivers. The study included an extensive search of international and New Zealand literature and reports concerning rivers, as well as a number of key informant interviews and workshops, which were used to develop descriptive categories and a vocabulary of river character. The work identified three broad categories of descriptors: attributes of the water course and river channel itself (size/scale, shape, materials, flow, surface texture, sound, appearance); attributes of the riparian edges (landform, land cover, built modifications); and attributes of the wider landscape context (landforms, land cover, built modifications).

These sources were combined to identify a hierarchy of potentially relevant amenity attributes at three scales, summarised in the following table. It highlights *in stream* qualities such as water presence and absence, variability in depth, and clarity; *stream corridor* attributes such as single or multiple channels, and bankside planting; and *contextual* attributes of landscape character and pattern. Also identified were potential amenity values, and management opportunities.

Table 2.2: Potentially salient attributes of amenity

Time frame of change	In stream Attributes	Corridor attributes	Contextual attributes	Recreational and aesthetic values	Management Opportunity
Daily/ seasonal	Presence/ absence of water Variability in depth & Flow Water clarity Water quality	Channel configuration -single or multiple & ephemeral channels	Land use intensity	In stream biodiversity Stream appearance Cultural health Recreational fishing Amenity recreation	Adjustment of extraction regime to seasonal variation
1-5 years		Riparian vegetation type and distribution	Landscape character & amenity	Corridor biodiversity Natural character	Corridor management and enhancement schemes Resource consent conditions
Trends			Landscape structure & pattern	Community identity	Land use policy

In addition to the development of categories based upon existing studies, the empirical conditions in spring-fed streams and rivers within the case study area were also considered. A primary source was an analysis that had been undertaken recently as part of a PhD study by Lincoln University student Nicholas Marchand (2006). This study had included a multivariate analysis of stream conditions, based upon biophysical survey of 50 sample sites, and had identified several representative types of stream condition within the study area.

It became clear that the complexity of landscape and land use-stream and river relationships across the lower plains was too great to encompass within a single choice experiment (the end point target of Objective Four). The decision was made to narrow the focus of the amenity study to rural streams and rivers, and to concentrate upon the in stream and riparian conditions, narrowing down to those attributes which are likely to change significantly under different groundwater management regimes, and where that change is likely to affect aesthetic and recreational values. Consideration of overall changes in landscape character and amenity in the wider landscape associated with use of groundwater was therefore excluded from the study.

The next step was to seek stakeholder guidance upon which attributes were *most* salient. A Q Sort method was administered at several workshops of key informants drawn from the stakeholder organisations.

2.2 Q Method with photographs

The methodology of Q Sort aims to describe the range of distinctive ways (factors) of assessing a set of stimuli (in this case photographs of spring-fed streams and rivers and their corridors), as well as identifying where there is overlap or consensus between the factors. There are two key considerations. First, the stimuli (photographs) should show a wide range of possibilities. Second, the respondent sample needs to include a range of relevant stakeholders in sufficient numbers for some measure of factor stability. Samples in Q Sort are typically smaller than in public opinion surveys which use random samples, and often include between 20 and 60 people. Previous research (Fairweather 2002) has demonstrated that when around a dozen or more people 'load' on a factor, then the factor stabilises. That is to say, however many more people may be interviewed, it is highly unlikely that the main characteristics of the factor will change. Identification of one or more stable factors provides confidence that these ways of evaluating amenity are present in the wider stakeholder group. Furthermore, if a consensus emerges across a number of stable factors about the relative value of particular attributes, then this provides an indication that the evaluation is well grounded in the community. From a technical perspective, the sample needs to be diverse rather than strictly random or totally representative.

In this study the Q Sorts were completed by a non-random sample of respondents, drawn from two broad stakeholder groups:

> (1) Landowners, represented by members of Federated Farmers of New Zealand Inc
> (2) Conservation and Recreational experts and advocates, comprising a number of fishing license holders (drawn from records held by Fish and Game New Zealand), DOC staff, representatives of the Water Rights Trust, and outdoor recreational researchers and planners (including staff from the territorial local authority and consultants with extensive knowledge of public recreational surveys);

A total of 28 key informants participated in the Q Sort survey. Responses from two were not included in the factor analysis, due to errors in the self recording sheets. Hence there were 26 valid responses analysed.

The Q Sorts of all respondents are factor analysed, a process by which similar Q Sorts are identified statistically. The results are presented in a form that shows a typical Q Sort for each factor. This represents the choices of the respondents that contributed to that factor. The purpose of the factor analysis is to identify the main ways that the items are Q Sorted within the sample of respondents, and in nearly all studies these are limited in number, typically about one to five. In this study, there was a significant level of consensus, and a two factor solution accounted for all 26 valid responses. Three and four factor solutions were also investigated and found to provide high levels of explanation. The results are presented as a three factor solution, as this characterises the two dominant factors found in both two and three factor solutions, in addition to providing some insight into a minority but potentially significant interpretation. The two main factors each had 11 respondents. Fairweather's work noted above suggests that they will be reasonably stable, and this is confirmed by the close similarity between these two factors described and those in the two factor solution. For the purposes of this exercise, the results are robust.

The power of the Q method is that it provides a means to understand the underlying way that people think and feel about amenity values, and identifies distinctive types of environmental setting that are regarded as having amenity value. It is important not to confuse Q method with other studies that aim to make inferences about the views held by the population as a whole about particular environmental attributes (e.g. to determine how important statistically is the presence of water, or bush). For that type of research, the focus is on the quantitative characteristics of a random sample of responses. In Q method, quantitative and interpretive analysis is used to identify the qualitative characteristics of people's responses. It does not address the question of how these may be distributed among the population. This was not a relevant question in this methodological study.

The aim of the photograph selection was to provide images of a range of spring-fed river and stream environments in the study area that show different conditions of the stream bed, banks and corridor and featured the range of attributes identified in the scoping exercise. The images are all taken from the Irwell and Selwyn Rivers, between SH1 and Waihora/Lake Ellesmere. The Irwell River is entirely spring-fed, rising near State Highway 1 and running parallel to the Selwyn River down to Lake Ellesmere. The Selwyn River rises in the foothills, and its overall form is determined mainly by surface water flood events. However, the flow in the lower reaches is also influenced by groundwater conditions, and during the majority of the year the regime is essentially that of a spring-fed river.

The character of each river changes notably between State Highway 1 and the lake. Marchand's (2006) work on the Irwell identified 4 types of bankside condition: an incised (and in some parts excavated) seasonal stream through open paddocks; a more sinuous seasonal stream in a wider channel through pasture edged by exotic trees; a highly meandering seasonal stream through willow groves; and a deeper, more permanent channel in the lower reaches, with mixed bankside vegetation. The lower Selwyn displays at least three types: in the stretch crossing State Highway 1 it is a wide, seasonally highly variable, braided river between stop banks; in the mid stretch it is still braided, but more constrained between stop banks that are highly vegetated with willows etc; and in the lower reaches it forms a deep permanent channel between steep banks.

The selection of images for the Q Sort included examples of each of these distinctive types. Where available, images are included with both 'normal' flow and dry channel. On the Selwyn, a couple of high flow conditions are included (these correspond to a 2.2 m^3s^{-1} flood). There are also examples of variations in channel form (straightened and meandering), of different types of bankside vegetation (both exotic and indigenous), and different in stream conditions, with evidence of cattle and recreational vehicles as well as 'pristine' conditions.

Table 2.3 shows the attributes that were used to obtain and select photographs for the Q Sort. The focus was upon providing a wide range of feasible conditions for stakeholders to evaluate.

Table 2.3: Attributes used to obtain and select Q Sort photographs

Setting	Attribute
In Stream	Water clarity and quality Depth and channel cross section Flow duration and reliability [continuous /intermittent] Flow volume [bank full/partial] Flow strength
Riparian	Bank stability Vegetation type [exotic/indigenous] Vegetation height [grass/scrub/trees] Vegetation extent [continuous/intermittent] Ease of access
Corridor	Channel alignment [curvilinear-natural/straight-modified] Channel variety [pools/riffles]

The original photographs for the study were obtained from several sources and of necessity were taken at different times of the year. Light conditions and seasonal vegetation therefore vary. All the images were cropped to achieve a consistent format, and some image editing undertaken to standardise light conditions, remove non typical features that could unduly influence selection, and to provide examples of a wider range of flow conditions. At the key informant workshops, respondents were not able to identify which of the images were edited, but once they were pointed out, respondents expressed a desire for only 'authentic' images to be included in the choice experiment.

Table 2.4 describes the photographs used in the Q Sort. The table distinguishes between photos of the Selwyn River which is both mountain and spring-fed, and the other totally spring-fed stream conditions. There are several 'pairs' where a similar viewpoint is used showing both dry and wet conditions.

Table 2.4: Photographs used in Q Sort

Channel	Water	Vegetation	Recording Number
Mountain and spring fed river (Selwyn)			
Extensive channel	Dry, weedy, shingle	Distant exotic trees	23
Extensive channel	Shallow, shingle	Distant exotic trees	5
Wide channel	Shallow, slow, weedy	Exotic trees	13
Wide channel	Dry, shingle, pools	Exotic trees	22
Wide channel	Shallow, flowing, weedy	Exotic trees	20
Wide channel	Shallow, flowing, clear	Exotic trees & grass	1
Wide channel	Shallow, still, wheel marks	Exotic trees	10
Wide channel	Shallow, flowing, clear	Exotic trees	19
Wide channel	Shallow, flowing	Exotic trees	21
Wide channel	Deep, still	Exotic trees & grass	2
Spring-fed streams			
Shallow channel	Dry	Weedy & grass	3
Shallow channel	Dry	Weedy, exotic trees & grass	4
Narrow channel	Dry	Weedy, exotic trees and shrubs	25

Narrow channel	Dry	Weedy, exotic trees	16
Narrow channel	Deep, flowing	Mixed exotic	7
Narrow channel	Shallow, flowing	Steep grass banks & fences	12
Narrow channel	Deep, slow, clear	Grass	15
Narrow channel	Flowing	Exotic trees & grass	6
Narrow channel	Flowing	Muddy edge, steep grass banks	9
Narrow channel	Deep, still, clear	Aquatic edge vegetation	8
Narrow channel	Slow flow	Weedy	24
Deep channel	Slow	Exotic trees & grass	14
Narrow channel	Deep, still, clear	Exotic trees & distant grass	17
Narrow channel	Deep, still, clear	Flax & exotic trees & grass	18
Narrow channel	Deep, flowing	Weedy, steep grass & pines & fence	11

These photographs were reproduced into identical sets, with each image of a standard size. The photo numbers are for recording purposes, were allocated at random, and do not relate to the photo content.

For each interview, the 30 photographs were spread out on a table, and the respondent was asked to arrange the photographs into piles. The instruction used was as follows:

"Please examine the set of images we have provided and identify the river environments that in your professional opinion as a [farmer/recreational advocate/conservationist] have the highest amenity value. The images are of a range of river and stream environments within the Selwyn District, whose flow regimes may be affected by groundwater conditions."

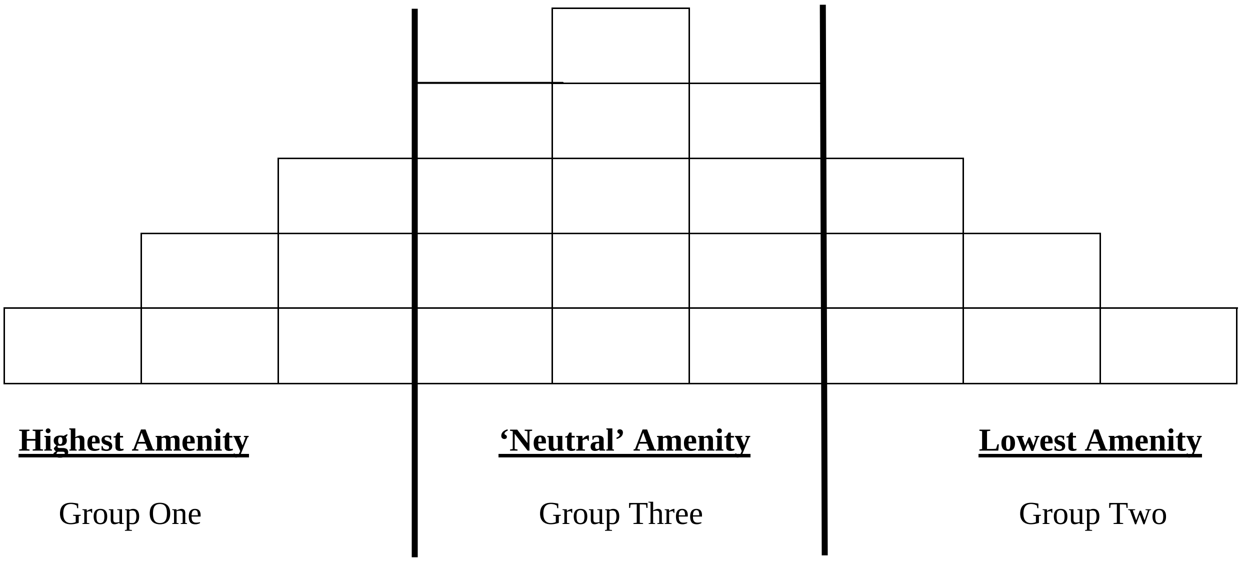
Amenity was defined for respondents as including *recreational use, aesthetic qualities, and other cultural values.*

First, respondents were asked to sort the images into three groups;

- **Group One** with six images of river environments that have highest amenity
- **Group Two** with six images of river environments with lowest amenity
- **Group Three** with the remaining 'neutral' images

Then, they were asked to sort **Group One** of images of 'high' amenity environments into three columns, placing the environment that has the highest amenity in the left hand column, the two environments with the next highest amenity in the second column from the left, and the three remaining images in the third column. **Group Two** of 'low' amenity environments were sorted in the same way, in reverse (so that the environment with the lowest amenity is in the far right hand column, the next two lowest are in the second column from the right, and the remainder in the third column). Finally, the remaining environments in **Group Three** were sorted into three columns - a neutral column in the centre with five images, and columns on either side with four each: The left hand column containing the environments with slightly higher amenity, and the right hand column slightly lower amenity. The Q Sort distribution used by respondents is shown in Figure 2.1.

Figure 2.1: Q Sort distribution



Having ordered the photographs to distinguish between the most and least amenity, respondents were then asked to copy the numbers that are on the images into the corresponding boxes, to provide a summary record of the judgements. They were asked to explain why they had identified particular attributes as either high or low amenity, writing their reasons in a pre formed set of boxes.

Finally they were asked to comment upon how well the images represent the range of spring-fed, streams and river environments in Canterbury, and to identify any important types of environment that had been omitted. Comments upon the way that the river and stream environments were presented were also sought, and aspects of the images provided that did not 'ring true' were identified, with a request for suggestions of how they could be made more authentic.

The key informant workshops were undertaken before and after Christmas 2005. The results were presented at stakeholder and industry workshops and to the stakeholder organisations.

2.3 Factor analysis results

On completion of the workshops, all Q Sorts were coded and then factor analysed. The analysis used the PQ Method and applied Varimax rotation to identify factors with two or more significant loadings on the un-rotated factor matrix (i.e. two or more respondents selected this way of ordering the photographs). See Brown (1980), Fairweather (2002) and Fairweather and Swaffield (2000) for details of factor analysis methods.

As noted above, several factor solutions were tested and a three factor solution is reported here. Factors One and Three accounted for 22 of the 26 valid responses. Eleven respondents loaded significantly onto each of these main factors. There were significant levels of agreement between these two main factors, with a high degree of commonality in the images selected as representing either high or low amenity environments.

The numbers on the following descriptions refer to the random identification numbers allocated to each photograph (see Figures 2.2 to 2.4).

Figure 2.2: Q Sort Factor One

Figure 2.3: Q Sort Factor Two

Figure 2.4: Q Sort Factor Three

In a Q Sort, the most significant choices are those at the two ends of the distribution. The top and bottom loading images for the two factors are described in Table 2.5.

Table 2.5: Highest and lowest amenity images in Factors One and Three

Factor One Highest amenity	**Factor Three Highest amenity**	**Factor One Lowest amenity**	**Factor Three Lowest amenity**
Wide channel/deep still, exotic trees and grass[2]	Narrow channel/deep still /clear, flax & exotic trees & grass[18]	Extensive channel/dry/weedy/shingle, distant exotic trees [23]	Narrow channel/dry weedy, exotic trees and shrubs[25]
Wide channel/shallow flowing, exotic trees[21]	Narrow channel/deep still /clear, aquatic edge vegetation[8]	Shallow channel/dry, weedy & grass [3]	Narrow channel/dry weedy, exotic trees[16]
Wide channel/shallow flowing/ clear, exotic trees[19]	Wide channel/shallow flowing, exotic trees[21]	Narrow channel/dry weedy, exotic trees and shrubs[25]	Shallow channel/dry/weedy, exotic trees & grass[4]

Figure 2.5: Highest and lowest amenity settings in Factors One and Three

When the comments from the respondents about these two factors are analysed, a clear pattern of amenity attributes emerges. Table 2.6 shows the characteristics relating to each of the categories of attributes, derived from the written and verbal descriptions provided by respondents. It also shows the rationale for their choices.

Table 2.6: Six characteristics of selected attributes

Category of attribute		Positive amenity indicator	Negative amenity attribute	Rationale
Channel:	Width	Wide channel		Kayaking opportunities
	Depth	Deep	Shallow	Kayaking
	Profile	Variety along the river/stream*		Quality of experience
	Cross Section	Shallow	Deep, steep banks	Safe access to water
Water:	Presence	Reliability of flow*	Uncertainty of flow	Planning visits
	Volume	Strength of Flow	Stagnant	Fish stocks
	Clarity	Clear*	Weedy/Turbid	Swimming, Fishing
	Quality	Clean*	Polluted	Swimming, Fishing
Bankside vegetation	Trees	Tall		Shade, enclosure, privacy
	Groundcover	Grass		Access
	Type	Indigenous*		Fish stocks along water edge, ecosystem health
			Weedy species	Lack of care
Overall Character	Naturalness	Lack of visible human modification*	Modified channel, structures	Quality of experience
	Management	Cues for Care*	Neglect	Stewardship
		Ease of safe access	Barriers	Use

* Appear in Tangata Whenua Cultural Health Index for Streams (Tipa and Tierney 2006).

2.4 Summary of Q Sort results

Drawing the photograph selections and comments together, it is possible to identify a number of common features. The river and stream environments that were most highly valued for their amenity all had water flows sufficient to fill the stream or river channel, and of sufficient volume to provide visible water movement. The channel cross section was typically (but not always) shallow, enabling ease of access to the water. There was a variety of conditions along the river. There was deep, clear water in the pools, and evidence of healthy aquatic vegetation. They all had bankside vegetation: willows that provided shade to the waters edge, and/or indigenous water edge species, and the banks were managed in a way that enabled easy access. There was no evidence of pollution.

Both spring-fed streams and mountain-fed groundwater influenced rivers (e.g. the Selwyn) were included in the highest amenity category. There was significant seasonal variation across the photographs selected as being of high amenity, which suggests that seasonality *per se* is not a factor. The attributes marked with an asterisk are those that also feature in the Tangata Whenua Cultural Health Index for Streams (Tipa and Tierney 2006). There is a high degree of convergence between the two evaluations.

The environments that were judged to have lowest amenity were those in which the stream or river bed had dried up, with evidence of weeds indicating a long period of no flow conditions. They often included evidence of human modification and/or poor management.

There were also subtle differences between Factors One and Three. Factor One (eleven respondents) focused more upon water clarity and quality, and the ease of access to safe shallow water, with shade trees, indicating a more general concern for recreation. Factor Three (eleven key informants) emphasised the overall naturalness of the environment, indicated by the presence of significant indigenous vegetation, and absence of human modification or intrusion, and appeared to favour deeper water. This suggests a more conservation/game fishing orientation. Aesthetically, Factor One expressed a more picturesque sensibility corresponding to the category described by Newton et al. (2003) as 'cultured nature', whereas Factor Three expressed more of a 'wild nature' aesthetic.

Notably, there was no clear pattern of respondents loading on either Factors One or Three. Both factors included representatives from the main stakeholder groups. For example, Federated Farmers informants were evenly split across the two factors. The numbers involved (eleven in each case) suggests that the factor characteristics are likely to be reasonably stable across a larger group of respondents (and this gains further support from the way the views expressed correspond in general terms to attitudes identified in other studies).

In contrast, Factor Two was distinctively different from both the main factors. There were only two respondents who loaded significantly on this factor, so it must be treated as indicative only. The significant difference was that these two respondents rated accessibility along the river beds very highly, favouring shingle beds that could provide vehicle and foot access, and rating the image with visible tyre marks very highly (this image was rated very negatively by factor three). Images of deep and narrow channels and steep banks were rated most negatively. Factor Two therefore appears to represent a set of interests focused upon recreational use of the river beds using vehicles.

In discussion about the proposed choice experiment with key informants, there were several comments of a general nature frequently expressed. First, a number of comments suggested that it would be important to ensure that the survey portrays a wide range of conditions, including an historical perspective of what the lowland streams and rivers were like before the current phase of groundwater extraction. There was a widely held view that the status quo, as of 2006, was significantly different from the situation in past decades, and should not be the baseline for consideration of values. Second, participants believed that any images used should portray an 'authentic' view of conditions, without any image editing. They also believed that the selection should include more evidence of the use of stream beds and corridors, including uses that caused degradation of water quality (e.g. stock movement), and also evidence of channel modification and/or structures. The third consistent comment was that participants felt that the research, whilst worthwhile, may well be 'too late'. There was a desire for urgency, and a sense of frustration that the situation had been allowed to deteriorate to its current state.

Chapter 3
Choice Experiment and Results

The purpose of this research was to test whether choice experiments could be used to identify the relative importance of river amenity attributes for particular groups of stakeholders. The process was therefore methodological, rather than an attempt to produce values representative of society at large.

The choice experiment process entails reducing the broad set of attributes identified in the Q Sort and developing them into sets of scenarios that form the basis of participant choices. By choosing one scenario over another choice experiment participants reveal that the chosen scenario is expected to provide more utility than any of the other scenarios presented to them. Choice experiments typically ask participants to make a series of choices. The choice scenarios are strategically selected to allow mathematical investigation of the importance of the various attributes in the choices made. A full description of choice experiment methodology is presented by Hensher et al. (2005).

3.1 Choice experiment methodology

Choice experiments entail several procedural steps.

Design

1. Identify options for change and salient attributes
2. Identify alternative attribute levels
3. Define choice sets using a survey design

Data Collection

4. Inform participants of options
5. Participants make choices

Data Analysis

6. Analyse choices to understand preferences

3.2 Attributes

The processes undertaken with key informants, including Q Sort, identified a large number of river-related attributes that participants considered important. The number of attributes that can enter choice experiment scenarios is limited by two factors. Firstly, participants have limited cognitive ability, so it is desirable to keep the number of attributes at a level which enables participants to meaningfully consider the trade-offs being made. Secondly, with a large number of attributes it is not possible to present participants with a complete set of trade-offs. Consequently, a sub-set of all possible scenarios is developed using a statistical design process. Large numbers of attributes require larger designs in order to mathematically estimate preference structures, entailing either that each individual faces a very large number of choices, or there is a large number of participants to allow the range of choices to be varied across participants in a statistically defensible manner. Most environmental choice experiment studies have incorporated 4-8 attributes, although some studies have utilised more.

Attributes chosen for inclusion in the choice experiment were:

- Water flow
- Water quality
- Water clarity
- Streamside vegetation
- Local jobs
- Cost

This appears to be a list of six attributes, 4 relating to physical items and two to economic, but is actually nine attributes. The apparent divergence in number of attributes arises because water flow incorporates four separate attributes, as described below. Nine attributes is at the higher end of the norm for the number of attributes included in this type of study.

Water Flow

Key informants indicated strong concerns about water flow levels. Concerns were raised about the frequency of days without flow, particularly in the summer months, and the levels of flow at times when there is water in the river. Four flow levels were defined:

- no flow,
- low flow,
- moderate flow, and
- flood flow.

Attributes were reported as the number of days of flow at particular levels.

On the basis that management can do little, if anything, about the frequency of floods, three flow levels are relevant over two time periods. Summer was defined as December through March (inclusive), with 112 non-flood days. The rest of the year was termed winter and comprised 190 non-flood days. In either of these periods there are two independent flow levels. Given the fixed number of days in summer the number of days at one flow level (say no flow) is the total number of days in the period minus the sum of days at other flow levels. Consequently, flows required four attributes, each taking three levels. Days of no flow and days of moderate flow were included in the design – days of low flow was a residual. Low flow days were included in the choice information given to participants in order to clarify the choices that they were making. However, number of low flow days did not form part of the experimental design (Table 3.1).

Table 3.1: Flow attribute levels

	Summer	Winter
No flow days	α	δ
Low flow days	$112 - (\alpha+\beta)$	$190 - (\delta+\varepsilon)$
Moderate flow days	β	ε
Total (excludes high flow)	112	190

Water Pollution

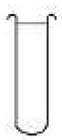
Key informant concerns were clearly focussed on safety aspects of water quality, with the primary concern being bathing safety. This attribute took two levels: *safe to swim* and *not safe to swim*, defined by ANZECC (2000) guidelines. Safety for swimming was reported using simple icons in the choice sets.

Clean

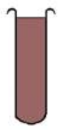
Polluted

Water Clarity

Photographs were used to convey the difference between turbid and clear water. The photographs were matched to icons that were reported in the choice sets. As with water quality, it was stressed that the water would not always be clear, but the choice was between “predominantly clear” and “predominantly murky”.



Clear



Murky

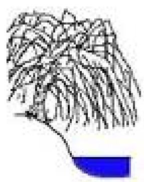
Streamside Vegetation

Historical changes illustrated a broad range of possibilities that could become the predominant form of riparian vegetation. Four different types were included qualitatively:

- exotic shade trees,
- grass,
- native vegetation, and
- gorse.

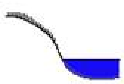
These attributes were illustrated with photographs and were reported in the choice sets using stylised icons.

Shade trees



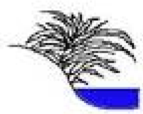
Tall exotic bank-side shade trees

Grass



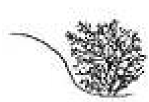
Turf grass on banks

Natives



Indigenous water edge plants

Gorse



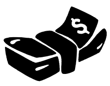
Gorse in the stream bed

Local Jobs

While local employment levels were not an attribute of the river environment, it was decided to include them to avoid bias. Key informants expressed concerns that changes in river management could affect local employment. Failure to control employment in the experimental design left the opportunity for participants to make their own assumptions about employment impacts. If employment was of concern, then failure to account for this effect would result in biased coefficient estimates for other attributes.

Cost

Inclusion of a cost attribute is essential to allow estimation of monetary values of other attributes. The current lack of information on management activities necessary to obtain the specified attribute levels, or their costs, was stressed to participants. It was suggested that individual households could face increased costs from alternative management outcomes in a number of ways, including employment for management activities, such as vegetation management, impacts on agriculture and other commercial water users, employment impacts consequent to recreational use effects, and effects on local and regional council rates. Participants were asked to assume the stated costs would occur for their household, and to make their choices accordingly. Icons were used to help draw attention to the cost attribute.

None	**$50** 	**$100** 
No extra cost to your household	$50 extra cost to your household each year	$100 extra cost to your household each year

3.3 Experimental design

The attributes included in the design are (Table 3.2):

Table 3.2: Attribute levels

Four-level attribute	1. Streamside vegetation	(Trees, Grass, Gorse, Natives)
Three-level attributes	2. No flow days: Summer 3. Moderate flow days: Summer 4. No flow days: Winter 5. Moderate flow days: Winter 6. Employment 7. Cost	(7, 17, 27) (10, 20, 30) (0, 15, 30) (90, 110, 130) (-25 Jobs, No change, +25 jobs) (None, $50, $100)
Two-level attributes	8. Water pollution 9. Water clarity	(Clean, Polluted) (Clear, Murky)

The same base-case profile appeared in each choice event. A fractional factorial design was used to derive 27 alternative profiles. Each survey participant was faced with 27 choice events, each of which included the base case, as well one of the 27 fractional factorial profiles. In addition, a third alternative was included - chosen randomly from the same set of 27 profiles. An example of a final choice scenario is presented in Figure 3.1.

Figure 3.1: Example of a choice scenario

CHOICE 1

		Base	A	B
Summer flows (Average days)	No Flow	27 days	27 days	17 days ↓↓
	Low Flow	75 days	65 days ↓↓	75 days
	Moderate Flow	10 days	20 days ↑↑	20 days ↑↑
Winter flows (Average days)	No Flow	15 days	30 days ↑↑↑	15 days
	Low Flow	65 days	50 days ↓↓↓	65 days
	Moderate Flow	110 days	110 days	110 days
Water clarity (except during floods)				
Water pollution				
Riverbank vegetation is mostly ...		Shade trees	Gorse	Natives
Change in local employment		None	25 fewer jobs ↓	25 more jobs ↑
Extra cost to your household each year		None	$100	$50

3.4 Pre-tests

The introductory presentation and survey methodology were tested on two groups of volunteers (N=13) in November and December 2006. Pre-test group membership had some overlap with the two target stakeholder groups, but included people who were neither anglers nor farmers. Pre-tests were undertaken anonymously and entailed frank discussion about the nature of the information conveyed to participants, the manner in which it was presented, the ways choices were framed, the alternative methods used to depict changes, and choice task difficulty.

One pre-tester was suspicious of the research agenda and refused to participate in the valuation process. Pre-testers saw no need to add or delete attributes. They found the presentation stimulating and enjoyed the valuation process. Prior concerns about the large number of choices made by each participant proved unfounded. The first pre-test group, which was aware of the intention to ask 27 choice questions in the survey, was given an opportunity to quit after nine questions, but requested the opportunity to complete all 27 choices. Similarly, the second group was given an opportunity for a coffee break after each set of nine choices, but chose to proceed immediately. In each case the 27 choices were made in about 20 minutes. The first choices took a few minutes each, but participants soon learned the nature of the process and subsequent choices were made much more quickly.

As a result of the pre-tests several changes were made, but these were of a minor nature. They were:

- Correction of typographical errors
- Streamlining of the presentation
- Clarification of the research agenda
- Changes in icons depicting changes in flow
- Changes in attribute levels

The survey design, recruitment and data collection processes were approved by the Lincoln University Human Ethics Committee.

3.5 Recruitment and data collection

Recruitment entailed a two-stage process. Choice experiment participants were recruited by mail in the first instance, but low response instigated a second round of data collection in which further participants were recruited by the two stakeholder agencies.

A letter of invitation to participate in the choice experiment was sent to each of 400 randomly selected Federated Farmers branch members in the vicinity of the study area and a further 400 North Canterbury Fish and Game members.

As inducements to participate, refreshments and a $20 petrol voucher were offered to each person who attended a meeting. Participants could choose one of three different venues and four times. Participation rates were considerably lower than expected, with only 6 anglers and 19 farmers attending the four meetings (Table 3.3). Consequently, a further round of data collection was instigated. Representatives of the two stakeholder agencies emailed and telephoned their members to recruit participants for further data collection events held at the Fish and Game offices in Christchurch and at the Darfield Recreation Centre in May 2007. This boosted the sample to 17 anglers and 32 farmers.

Table 3.3: Data collection events

Venue	Date	Time	Anglers	Farmers	**Total**
Riccarton Library	23 April 2007	7pm	3	1	4
Beckenham School	24 April 2007	7pm	2	1	3
Lincoln University	26 April 2007	noon	1	7	8
Lincoln University	26 April 2007	7pm	0	10	10
Fish & Game Office	17 May 2007	6pm	11	0	11
Darfield Recreation Centre	22 May 2007	7:30pm	0	13	13
Total			**17**	**32**	**49**

Each meeting commenced with refreshments and brief introductions. A presentation lasting approximately one hour was then made by the researchers. The presentation was designed to illustrate the changing nature of the environment under study, the role that humans have had in continually changing that environment, and the prospects for further change in the future. In order to forestall participant conclusions about who is to blame for undesirable catchment attributes the presentation provided some scientific information that illustrated the variable and changing nature of climate, the uncertain nature of sources and flows of groundwater, and uncertainties about how groundwater and surface water flows are related. A brief outline of the presentation is reported in Appendix 2.

At the conclusion of the background presentation participants were introduced to the choice framework. This introduction entailed illustration of each of the attributes and how they could be combined to form a final description of the river environment. First the base case was illustrated, then other options were introduced and the choice task explained. In each meeting people were offered the opportunity to clarify their understanding of the choice questions. The few questions that were raised showed good understanding of the process.

The 27 choice questions were answered concurrently by everyone in the room. Each person recorded their response by ticking their preferred option on an individual choice record sheet. This meant the process could proceed only as fast as the slowest person chose to go for each choice. In each case the 27 choices were made in about 20 minutes. Respondents also provided a limited amount of personal data. Anonymity was maintained throughout.

3.6 Participant characteristics

The objective of this study was methodological; it was developed as a trial of the ability of choice experiments to provide information that summarises stakeholder group members' preferences about stream amenity attributes. The study was not designed to provide values representative of the wider community. Further, the people who attended the meetings are not a representative cross-section of each of the organisations the attendees represented. Consequently, the results should not be interpreted to be representative of either group or of society at large. Participant characteristics are shown in Table 3.4.

Table 3.4: Participant characteristics

	Anglers	Farmers
Number attending	17	32
Males	100%	91%
Average age	49 years	55 years
New Zealand European	94%	100%
Live	81% Christchurch	88% farms
Fished for trout in last year	100%	16%
Visited Lower Selwyn River in last year	63%	75%
Average personal income	\$50,000-\$70,000	\$50,000-\$70,000
People in household 15 years & older	2.23	2.63

Both groups were almost exclusively male and consisted predominantly of older people. Only one person did not describe themselves as New Zealand European. Most anglers lived in Christchurch City. The 12% of farmers who did not live on farms most frequently lived on lifestyle blocks or a house in the country.

3.7 Results

Analysis of choice experiment results entails fitting mathematical models to explain the choices made. The underlying rationale is that people will choose the choice that they expect will be of most benefit to them. The individual's estimate of the utility to them of each outcome is a function of the levels of each of the attributes and some randomness.

The analyst specifies a mathematical function that describes total benefit (utility) from any combination of attributes. Estimated utility is dependent upon the form of the function fitted, the level of the attributes, and the estimated model coefficients. The form of uncertainty assumed about the choices people make determines the nature of the mathematical model fitted. The most common function utilised in this type of analysis is the Multinomial Logit Model (MNL), utilising a linear utility function. The MNL assumes identically distributed Gumbel error terms for each of the choice alternatives. This model was used for initial investigation of responses from both stakeholder groups (Table 3.5).

Table 3.5: Estimated utility functions

	Anglers MNL	Anglers LCM	Farmers MNL	Farmers LCM
Class 1				
Base case constant	0.4104	-0.5514	-0.2402	-0.06119
1 Summer no-flow day	-0.08676***	-0.02873	-0.03601**	-0.05690***
1 Summer low-flow day	-0.01710	-0.04339**	-0.01074	-0.03371**
1 Winter no-flow day	-0.04421***	-0.04167**	-0.01140	-0.02082**
1 Winter low-flow day	-0.004947	0.003956	0.002864	-0.001856
Clear water	1.177***	2.363***	0.6641***	1.027***
Safe to swim	1.731***	3.866***	1.975***	2.781***
Grass	-0.5521*	0.8268	0.2752	0.8715**
Natives	0.2627	1.063**	0.08972	0.5092
Gorse	-0.7520**	-2.335***	-1.297***	-0.8905*
Jobs	0.008652*	-0.02215**	0.03351***	0.02117***
Cost	-0.004079	-0.01295**	-0.01614***	-0.02282***
Class 2				
Base case constant		0.6654		-1.080*
1 Summer no-flow day		-0.1407***		-0.001812
1 Summer low-flow day		-0.02033		0.005863
1 Winter no-flow day		-0.1089***		-0.01987
1 Winter low-flow day		-0.03091***		-0.006255
Clear water		0.6182**		-0.03526
Safe to swim		0.6217**		1.250***
Grass		-1.236***		0.5664
Natives		-0.1249		0.3727
Gorse		-0.9610**		-1.864***
Jobs		0.009222		0.07752***
Cost		-0.0005723		-0.01839***
P(Class1)		0.6668***		0.7608***
Observations	486	486	810	810
McFadden's Rho^2	.220	.366	.311	.376
χ^2 LCM vs MNL		136.62***		99.38***
(DoF)		(13)		(13)

* P < 0.1, ** P< 0.05, *** P< 0.01

The simple MNL assumes that everyone within a stakeholder group has similar preferences. One response to differences between individuals is to fit a model to each individual's choices. The individual model approach requires a very large number of choices by each individual and comes at high computational cost. A more pragmatic approach has been adopted here to modelling potential respondent heterogeneity using Latent Class Models (LCM: Swait 1994).

"Latent Classes correspond to underlying market segments, each of which is characterised by unique tastes" (Louviere et al. 2000). The LCM is an extension of the MNL model that assumes that respondents can be a member of one of a predetermined number of classes. There are now two mathematical estimation problems: allocating people to classes and modelling preferences within each class. LCMs use a type of MNL model to allocate individuals probabilistically to classes. Consequently, the LCM can be likened to solving several MNL models simultaneously.

MNL models fit well, but LCM offers significant improvements, as indicated by the highly significant χ^2 statistics in Table 3.5. Quality of model fit is indicated by McFadden's Rho^2. A bigger Rho^2 indicates a better fit. However, Rho^2 cannot be interpreted as the percentage of variance explained. The Rho^2 scores reported here approximate R^2 in linear regression of about 0.50 ($Rho^2 = 0.220$) to 0.75 ($Rho^2 = 0.376$), based on the equivalences reported in Hensher at al. (2005). These models are exceptionally good fits for this type of data.

3.8 Significant attributes

The base case levels for qualitative attributes are moderate flows and shade trees, which have been ascribed zero utility. Consequently, the coefficients reported in Table 3.5 report values for the specified attributes relative to moderate flows and shade trees. The negative signs on no-flow days and low-flow days (where significant) indicate that moderate flows were preferred to either of these outcomes.

Only two attributes have significant coefficients for all groups analysed. Gorse provided disamenity for all groups, whilst having water in which it was safe to swim was valued positively by all groups. Clear water was valued positively by all groups except farmers in Class 2. Similarly, an increase in local employment was valued positively by all groups except anglers in Class 2.

It is notable that cost is not significant for anglers as a whole, or in Class 2. Cost is significant for anglers in Class 1, and for both farmer groups.

Table 3.6 summarises how each group (on average) perceived each attribute.

Table 3.6: Overall values

	Farmers	Anglers
Summer flows	• Didn't like complete loss of flow. • Preferred moderate flows to low flows, but the difference wasn't significant.	• Didn't like complete loss of flow. • Preferred moderate flows to low flows, but the difference wasn't significant.
Winter flows	• Not significant.	• Didn't like complete loss of flow. • Preferred moderate flows to low flows, but the difference wasn't significant.
Water Clarity	• Very significant. • Much preferred clear water.	• Very significant. • Much preferred clear water.
Water pollution	• Very significant. • Unpolluted water is about 3 times as valuable as clear water.	• Very significant. • Unpolluted water is about 1.5 times as valuable as clear water.
Riverbank vegetation	• Grass, natives and shade trees are valued similarly. • Gorse is disliked quite a bit.	• Grass, natives and shade trees are valued similarly. • Gorse is disliked, but not as intensely as it is disliked by farmers.
Local employment	• Prefer more jobs to less. • Very significant, but don't place a high value on jobs.	• Not significant.

There are few qualitative differences between the two stakeholder groups. Both groups preferred higher summer flows, clear water and water safe for swimming. Neither group likes gorse and both groups view grass, native plants and shade trees similarly. The differences that do occur are the positive values put on jobs by farmers and on higher winter flows by anglers. Whilst these two groups are quite similar in a qualitative sense, there are quantitative differences between their preferences that will be addressed later.

The LCM results indicate that there are significant differences in preferences within the stakeholder groups. Differences for two classes of anglers are summarised in Table 3.7.

Table 3.7: Angler preferences

	Anglers: Class 1	Anglers: Class 2
Summer flows	• Complete loss of flow not significant. • Moderate flow preferred to low flow.	• Don't like low flows or no flows. • No flow days have twice the impact of low flow days.
Winter flows	• Didn't like complete loss of flow. • Preferred moderate flows to low flows, but the difference wasn't significant.	• Don't like low flows or no flows. • No flow days have three times the impact of low flow days.
Water Clarity	• Very significant. • Prefer clear water. •	• Prefer clear water.
Water pollution	• Very significant. • Unpolluted water is about 1.5 times as valuable as clear water.	• Prefer unpolluted water. • Similar value to water clarity.
Riverbank vegetation	• Grass and shade trees similar. • Prefer natives. • Dislike gorse.	• Dislike grass and gorse.
Local employment	• Prefer fewer jobs to more, but not highly valued.	• Not significant.

While the number of anglers participating in the study was low, these differences as a whole are highly significant. The study was not designed to investigate reasons for the differences, and none were revealed in discussion with participants. The analysts did not know of these differences until after data analysis was complete, so there was no opportunity to enter discussions on these points.

The non-significance of cost for Class 2 anglers may have occurred because of insufficient variation in the cost attribute relative to other attributes. Water clarity, water quality and the presence of gorse seem to be particularly salient attributes for these anglers. The negative value on jobs for Class 1 anglers is also something of an anomaly. Possible reasons may include perceived change in political power as the number of people dependent on water use increases, or some perceived causal link between the number of local workers and the ability to maintain river amenity. Again, there was no opportunity to explore these hypotheses or to investigate other possible causes of these unexpected outcomes.

As with anglers, farmers fell into two distinct groups, with 75 per cent belonging in Class 1. Differences between these farmer groups are summarized in Table 3.8.

Table 3.8: Farmer preferences

	Farmers: Class 1	Farmers: Class 2
Summer flows	• Don't like low flows or no flows. • No flow days have twice the impact of low flow days.	• Not significant.
Winter flows	• Didn't like complete loss of flow. • Preferred moderate flows to low flows, but the difference wasn't significant.	• Not significant.
Water Clarity	• Very significant. • Much preferred clear water.	• Not significant.
Water pollution	• Very significant. • Unpolluted water is about 3 times as valuable as clear water.	• Strong preference for unpolluted water.
Riverbank vegetation	• Natives & shade trees similar. • Prefer grassy banks. • Don't like gorse.	• Grass, natives and shade trees are valued similarly. • Don't like gorse.
Local employment	• Prefer more jobs to less. • Very significant, but don't place a high value on jobs.	• Prefer more jobs to less. • Very significant, but don't place a high value on jobs.

The differences between the two classes of farmers are reasonably striking. Both classes of farmer preferred water that was safe to swim in, more jobs, and lower costs. They both disliked gorse. Class 1 farmers also wished to maintain river flows and expressed clear preferences for clear water and for grassy banks or natives in preference to exotic shade trees. These preference structures may indicate a strongly production-focused approach on behalf of Class 2 farmers, in contrast to Class 1 farmers (the great majority in our sample) who were concerned about non-productivity related environmental attributes as well.

3.9 Values

Ratios of attribute coefficients yield marginal rates of substitution that indicate the rates at which people would trade off amenity attributes. Table 3.9 presents the relative values of attributes by setting the value of improvement in water quality from polluted (not safe for swimming) to unpolluted (safe for swimming) at 100 points. The values of other attributes are then compared to the value of unpolluted water. For example, unpolluted water is worth about twice as much to anglers (100 ÷ 43 = 2.3) as avoiding gorse in the riverbed.

Table 3.9: Value indices

Attribute	Anglers' Index Base: Unpolluted	Farmers' Index Base: Unpolluted
Unpolluted	100	100
Avoid Gorse	43	66
Clear Water	68	34
Avoid one summer day without flow	5.0	1.8
Avoid one winter day without flow	2.6	-
One local job	-	1.7
$1.00	-	0.8

It is not possible to directly compare value indices for farmers and anglers. However, it is clear that they have different patterns. For example, anglers value water clarity (index = 68) more highly than avoiding gorse (index = 43). The ratio of values is 68 ÷ 43 = 1.6. The same ratio for farmers is 34 ÷ 66 = 0.5, showing that farmers value gorse avoidance more highly than they value water clarity. Farmers are not concerned about loss of winter flows, whereas anglers do not place significant value on jobs.

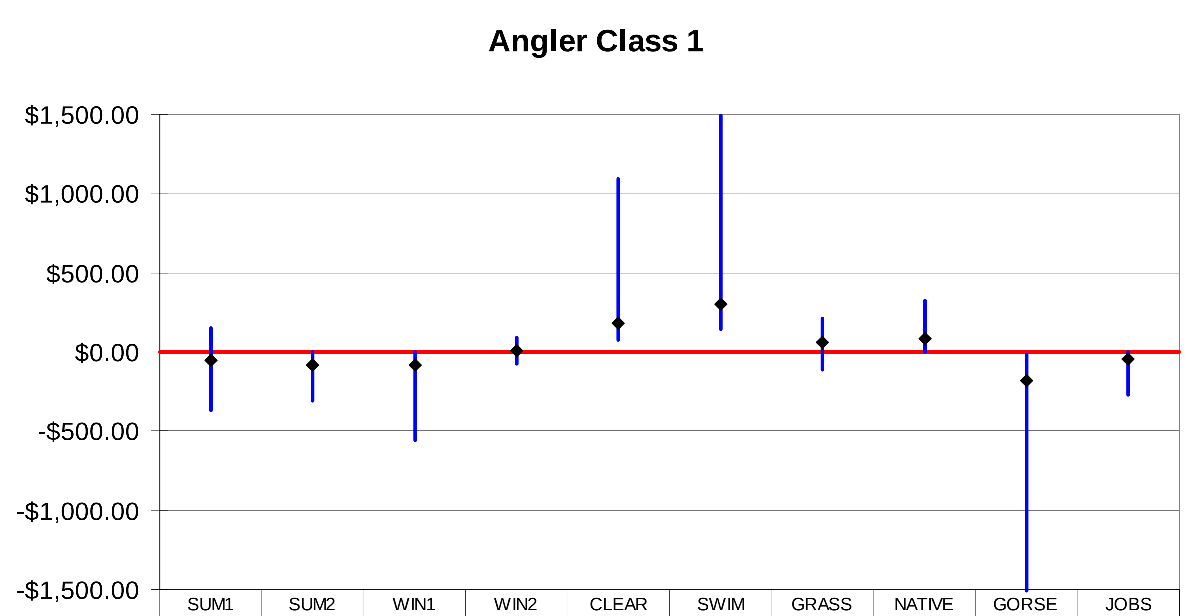
3.10 Money values

Money estimates of value are derived by dividing attribute coefficients by the negative of the cost coefficient. Figures 3.2 – 3.4 show money value estimates for two farmer classes and one class of angler. No money values are significant for angler Class 2, so results are not reported for that group. Figure 3.5 compares 95 per cent confidence interval estimates for the three items with significant differences between groups. Figure Eleven presents a summary of all mean money values that are significantly different from zero.

In order to accommodate scale differences in money values between different attributes the values of flow days and jobs have been multiplied by 25 in Figures 3.2 – 3.5. Consequently, SUM1 is the value of 25 days without flow in the period December through March, relative to the value of moderate flow for those 25 days. The negative values on SUM1 indicate that participants preferred moderate flows to no flows.

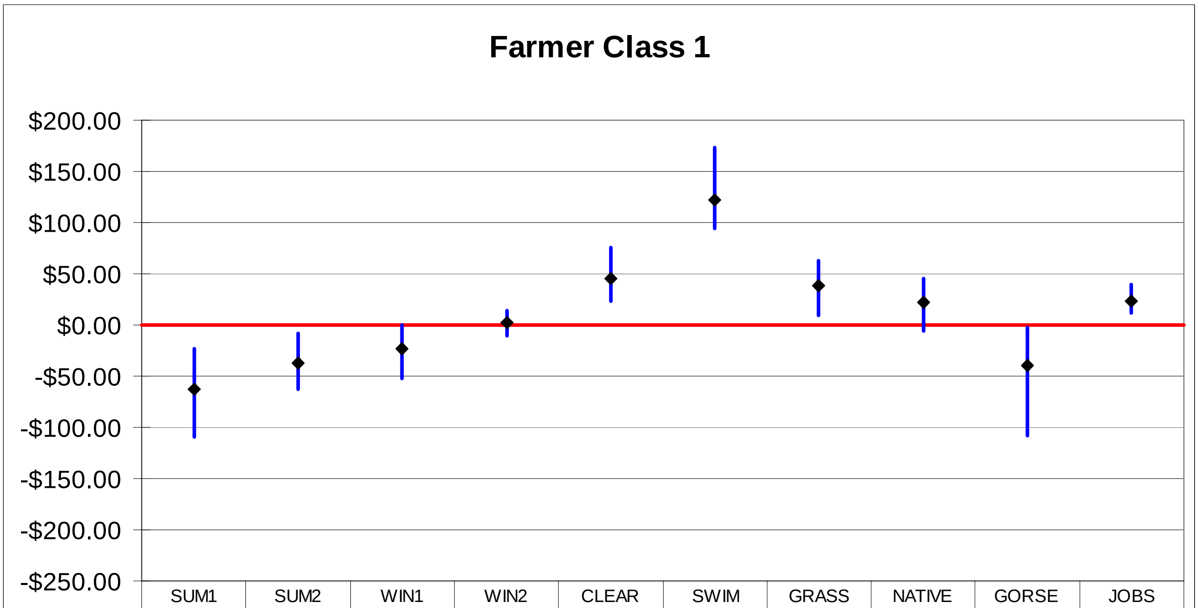
Confidence intervals for money value estimates have been derived using a Monte Carlo procedure (Krinsky and Robb, 1986). Attribute coefficients were randomly drawn from their correlated distributions a large number of times and a distribution of money values was generated. Tails of these distributions were truncated to yield confidence intervals. Six hundred replicates were drawn for the LCMs.

Figure 3.2: Money value 95 per cent confidence interval estimates, Angler Class 1



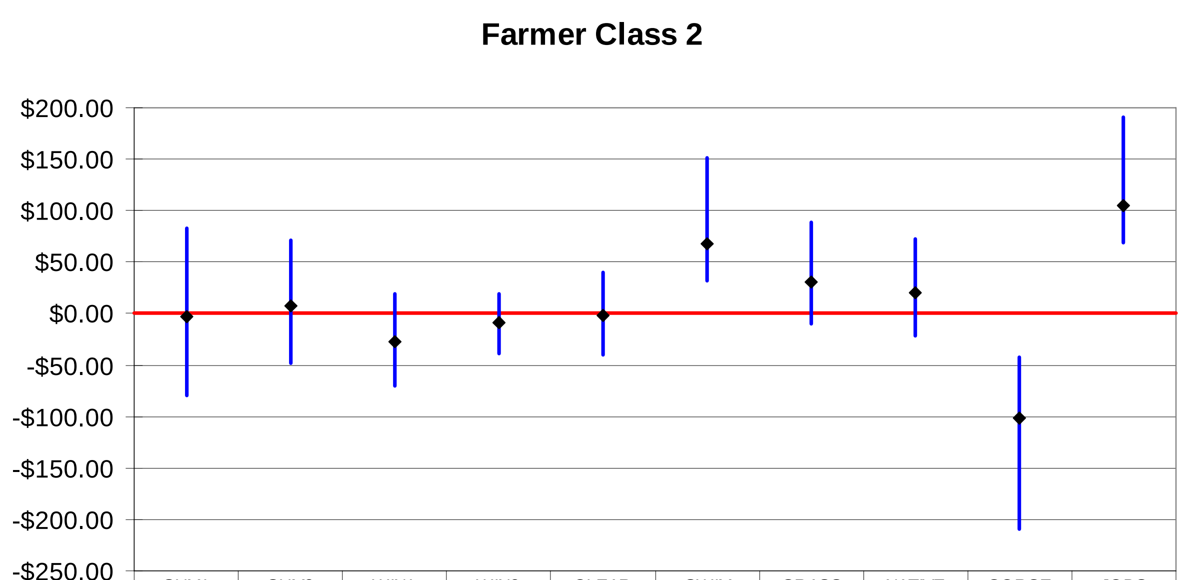
	SUM1	SUM2	WIN1	WIN2	CLEAR	SWIM	GRASS	NATIVE	GORSE	JOBS
High 95%	$154.03	-$3.61	-$2.87	$89.66	$1,093.47	$1,494.24	$212.44	$325.48	-$18.13	-$0.08
Low 95%	-$368.28	-$311.47	-$554.93	-$78.63	$73.48	$145.69	-$109.98	-$1.70	-$1,503.93	-$270.94
◆ Expected	-$55.48	-$83.78	-$80.45	$7.64	$182.53	$298.58	$63.86	$82.09	-$180.37	-$42.76

Figure 3.3: Money value 95 per cent confidence interval estimates, Farmer Class 1



	SUM1	SUM2	WIN1	WIN2	CLEAR	SWIM	GRASS	NATIVE	GORSE	JOBS
High 95%	-$23.69	-$8.64	-$0.30	$13.68	$75.09	$172.82	$62.38	$44.97	-$2.56	$39.90
Low 95%	-$109.09	-$63.21	-$51.81	-$9.95	$23.54	$94.48	$8.76	-$5.25	-$107.59	$11.20
◆ Expected	-$62.34	-$36.93	-$22.81	$2.03	$44.99	$121.88	$38.19	$22.31	-$39.02	$23.19

Figure 3.4: Money value 95 per cent confidence interval estimates, Farmer Class 2.



	SUM1	SUM2	WIN1	WIN2	CLEAR	SWIM	GRASS	NATIVE	GORSE	JOBS
High 95%	$83.31	$70.93	$18.96	$18.66	$40.39	$151.08	$88.90	$71.90	-$42.61	$190.40
Low 95%	-$79.98	-$48.45	-$70.05	-$39.37	-$40.30	$31.75	-$9.40	-$21.75	-$209.09	$68.57
◆ Expected	-$2.46	$7.97	-$27.02	-$8.51	-$1.92	$67.98	$30.80	$20.27	-$101.38	$105.41

Figure 3.5: Money value 95 per cent confidence interval estimates for items with significant differences. F1 = Farmer Class 1, F2 = Farmer Class 2, A1 = Angler Class 1

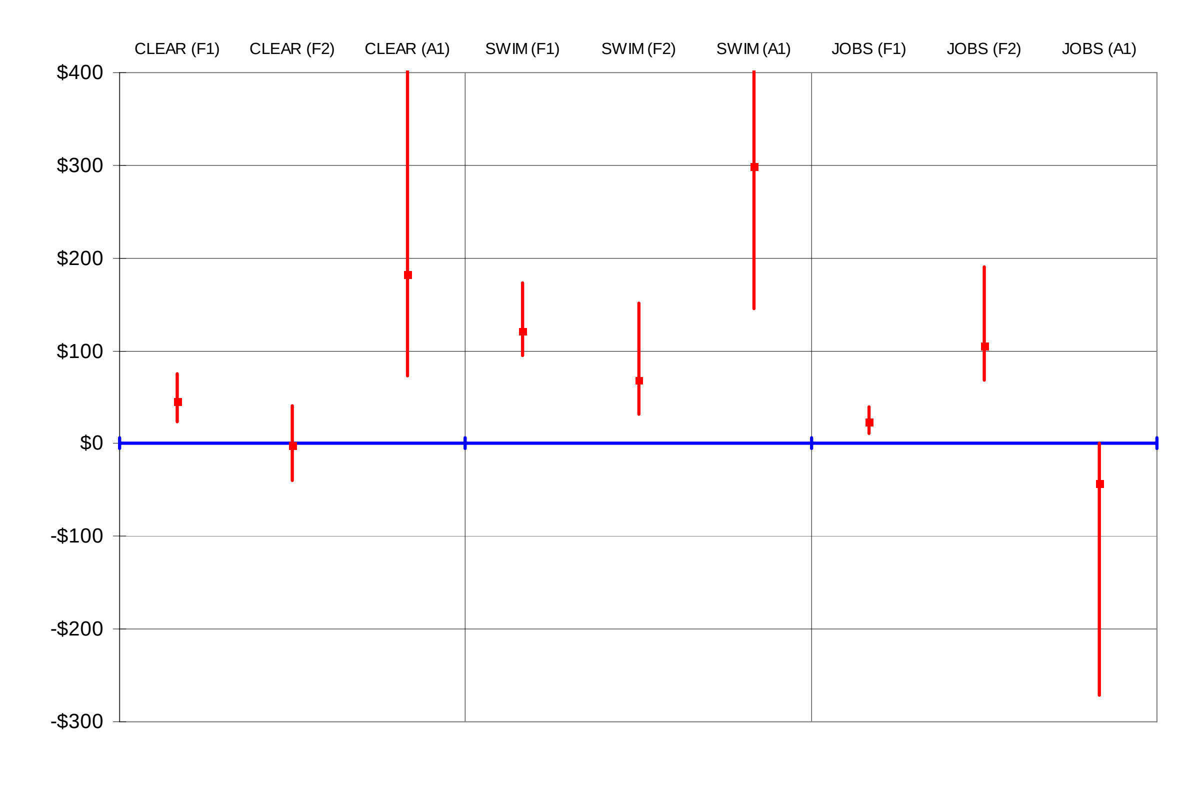
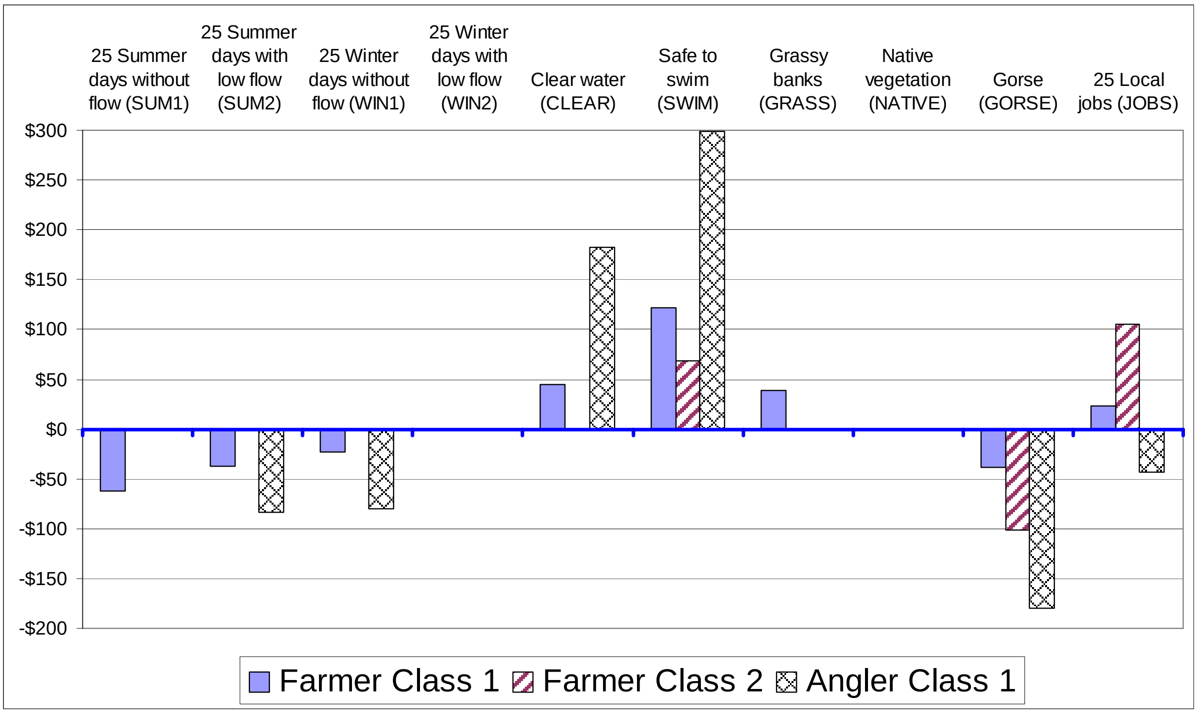


Figure 3.6: Significant mean money value estimates.



Small sample sizes generally preclude meaningful statistical comparison of value differences between groups. However, three items indicate significant results (Table 3.4). The non-overlapping 95 per cent confidence intervals for clear water show that clear water is worth significantly more to anglers than to either class of farmer. Results for the money values of jobs are more stark. Anglers value jobs negatively, whereas both farmer classes value them positively. However, Farmer Class 2 values jobs significantly more highly than Farmer Class 1. Results are not so clear cut for water pollution. The two farmer classes have statistically similar money values. The values for anglers are higher, however 95 per cent confidence intervals show some overlap. Overlapping confidence intervals do not preclude significant differences in means at the same confidence level. When tested using the Krinsky & Robb procedure, mean willingness to pay for clean water is significantly higher for anglers than for either class of farmer at the 95 per cent confidence level.

Figure 3.6 reinforces earlier conclusions about qualitative similarities across groups. Farmer Class 1 has very similar preferences to Angler Class 1, except for a difference in sign on local jobs. Anglers' money values are, on average, higher than those of Farmer Class 1, whether the attributes are valued positively (CLEAR, SWIM) or negatively (flows). However, note that complete loss of summer flow is valued negatively by Farmer Class 1, whereas it is not significant for anglers.

Chapter 4
Discussion and Conclusion

4.1 Methodology

There were several methodological dimensions to the study. The main innovations were the combination of Q Sort and Choice experiments, and the application of Choice Experiments to a complex setting with variable river flows. The study also included minor but interesting aspects, such as conducting the Q Sort as a group workshop, and the use of the environmental history as the introduction to the Choice Experiments. These aspects are discussed under two headings: The Combined Approach, and the Choice Experiment.

4.2 The combined approach

Typically, choice experiments are designed using key informants, focus groups and informal discussion about salient attributes. In this study, given the complexity of the situation being investigated, and its political sensitivity, it was decided to follow a more transparent and formal approach to identifying salient attributes. A series of questions had to be addressed:

What are the potentially relevant attributes of amenity?
What attributes are salient to stakeholders?
What attributes could be modelled in the choice experiment?
What are the relative values assigned to these by stakeholders?

As described in Chapter Two, the process started by reviewing a wide range of literature and sources, and identified a large number and variety of possible attributes that could contribute to the amenity of spring-fed streams and rivers. Q Sort was then used to identify the salient attributes for stakeholders. Q Sort is ideally suited to narrowing down such variety, as one of its normal design parameters is to present respondents with a wide range of possibilities. Even here, the study progressed through several phases of classification and tightening of focus to narrow down the possibilities to the 25-30 conditions that can be presented in a Q Sort.

The Q Sort itself used photographs taken within the study area, selected to provide examples of settings that demonstrated the range of attributes and conditions that had been identified as most relevant. The photos were presented to key informant workshops in which the briefing was collective but the responses were individual, followed by a group discussion. This approach aimed to achieve efficiencies of delivery (by holding workshops with 15-20 participants at a time) whilst retaining the sensitivity of having individual responses, and the richness of collective discussion. In individual Q Sort surveys the interviewer typically records comments made during the sorting process. In the workshop situation a record sheet was self-administered by participants, and this appeared to work well. The only disadvantage was that when two respondents misinterpreted the instructions for ordering the response, the mistake was not recognised until the analysis stage, and their sorts had to be discarded. In an individually administered survey this would have been picked up at the time. Another variation required was that in a group workshop the lead investigator needed to focus upon managing the discussion, and an assistant was used to record the commentaries being made by respondents. Overall, however, the workshop approach appeared to be a very effective way to use the technique.

The next challenge was to identify the attributes that could be usefully modelled in a choice experiment. The outcome of the Q Sort was identification of a number of salient attributes, some of which could be easily expressed as a set of finite conditions. The most difficult attribute to express was variation and reliability in water flow, requiring a way to offer choices with different levels and durations of flow. Finally, as discussed below in more detail, it was necessary to incorporate these attribute conditions within a choice experiment that could be undertaken by a range of stakeholders.

Administering the choice experiment required that stakeholders were well informed about the choices they faced. At the time the study commenced, however, the science was becoming highly politicised, and there was intense debate about the extent and validity of knowledge about the ground water resource. Consequently, a presentation of the environmental history of the study area was prepared, based upon material from a wide range of sources. This presentation covered both the current state of knowledge about groundwater processes, as well as the history of land use development. The aim was to place current choices within a longer historical context. In order to ensure credibility for the presentation, it was peer reviewed by a number of experts from different sectors, including tangata whenua, participating organisations and a project liaison group consisting of scientists, environmental management agency representatives, site users and other interested parties.

Overall, the combination of methods had several advantages. It was iterative and allowed refinement and incremental development of understanding as work progressed through the stages. Both Q Sort and choice experiment are relatively ‘naturalistic’ approaches, that allowed respondents to make holistic judgements based upon their understanding and interpretation of the issues, and this ensured a rich and open process. The techniques used have allowed statistical analysis based upon a relatively small number of respondents, and have identified clear patterns of response. Another advantage of the combined techniques was the way they made the selection of attributes more transparent and responsive to stakeholders, and provided some measure of triangulation within the overall investigation.

The main drawback of the combination of techniques was the additional time required to progress through two phases of investigation. Both methods used photos to represent environmental conditions, and this has its own strengths and limitations. The limited overall budget also meant that the sample size was small, and limits the extent to which the results can be generalised. However this is not a product of the methodology - the use of group workshops would enable sample numbers to be expanded quickly if funding were available.

The choice experiment phase of the study was successful in that it estimated statistical models that explained a very high proportion of the observed responses. All of the attributes that were included in the choice experiment were significant for some of the participants – some were significant for all participant groups. Apart from the unexpected negative value on local employment for one group of anglers, all attribute coefficients were signed consistent with prior expectations. People wanted more water in the river, they wanted clear water that was safe to swim in, they favoured more employment, and they didn’t like paying more. The non-significance of the cost attribute for some anglers suggests the need to include higher cost values for this attribute to increase its salience.

Despite the low numbers of participants from each stakeholder group it was possible to identify two discrete sets of preferences within each group. Most marked were the differences between different farmers. One group provided responses consistent with a very utilitarian perspective, while the majority of farmers also held strong preferences for the state of the stream *per se*. The vast improvement in model fit from taking account of heterogeneity within groups attests to the importance of addressing intra-group heterogeneity.

A much bigger sample was anticipated. However, it proved exceedingly difficult to recruit participants. Meeting locations and times were selected to be as convenient as possible for members of the stakeholder groups. Letters of support from the relevant stakeholder agencies (Fish & Game New Zealand and Federated Farmers) were included in the invitations, along with a promise to pay $20 to each participant to offset their expenses. One possibility is that the monetary inducement may not have been significant enough to entice participants - another is that they were simply not interested in the issue. Subsequent studies conducted by the authors, which offered to pay schools (rather than individuals) $50 for each participant have been very well subscribed, providing some evidence in support of alternative framing of the monetary inducement and encouragement for continuation with group-based applications of choice experiments. The outcome is that the small sample sizes and biased selection from within the stakeholder groups mean the results reported here cannot be generalised to wider populations.

Just as the results can not be generalised to other populations, they cannot be generalised to other streams. The section of the Selwyn River that formed the basis for the case study is somewhat unique, being an ephemeral, gravel-bottomed river that is fed by both spring and surface flows and is widely used for streamside and water-contact recreation, including sport fishing. Values for little-used spring-fed streams in the same locality could be substantially different.

Despite the limitations of the sampling, the choice experiment approach has proven itself to be capable of identifying patterns of preferences about amenity attributes for stakeholder groups. The observed differences within groups provide a starting point for investigating the underlying beliefs and values held by various actors, and for informing policy makers about the directions, magnitudes and differences in preferences within relevant communities about management of aquatic environments.

4.3 Substantive findings

Both the Q Sort and choice experiments revealed a bimodal pattern of response. Whilst there was substantial agreement across stakeholders about the most salient attributes of amenity, there were distinct differences in the relative weights assigned to these attributes. However, the differences did not, for the most part, follow functional interests - that is to say, the biggest differences were not between farmers and recreationists / conservationists. Rather, there appeared to be two different ways of looking at the issues.

The Q Sort identified the following positive amenity attributes: channel width, depth, variety, and shallow cross section; reliability of clean, clear and strongly flowing water; tall bank-side trees with grass below, indigenous water edge plants, safe access and overall naturalness with lack of visible structures, but signs of care.

Within this overall pattern, one type of response placed most weight upon attributes that were most closely aligned to recreation, such as water clarity and safety, and ease of access to shallow water with shade trees; whilst the other tended to emphasise attributes more closely aligned with biodiversity and game fishery, such as overall naturalness, and deeper water.

There are similarities between these patterns of response and the patterns found in other environmental Q Sorts in New Zealand, which suggest that most people express one of two positions - the first is a preference for ‘cultured’ nature, the second, for ‘wild’ nature (Newton, Fairweather and Swaffield 2002). As noted above, the numbers loading on the two main factors (eleven each in Factors One and Three) are close to the level at which Fairweather (2005) argues there is factor stability. That is, the patterns are unlikely to change significantly however many more respondents are interviewed. Furthermore, the similarity between these amenity results for spring-fed streams and rivers, and other findings previously reported for other New Zealand environments (Swaffield and Fairweather 2003) provide additional confidence in the validity of the findings, despite the small sample size and exploratory nature. Consequently, the Q Sort phase of the research has revealed amenity values that are likely to be found in wider New Zealand society, as well as in the stakeholder groups surveyed.

A small minority of respondents favoured ease of access along the riverbed, indicating an interest in 4WD exploration. The evidence of 4WD use was seen as a strongly negative attribute by the majority. The Q Sort did not discriminate between different duration and reliability of water flow - this was a major focus of the choice experiment.

The choice experiment produced some substantial (and significant) estimates of monetary value. Most notable is water quality. All groups positively valued improvement in water quality from unsafe for swimming to safe for swimming. For this attribute, the lowest expected annual value per household in the group valuing this attribute least (the production-focussed Farmer Class 2) was about $68. The same group had the lowest 95% confidence lower bound of about $32 per annum. For other groups mean values are higher (Angler 1, $299; Farmer 1, $122). These values are not representative of the stakeholder groups, or of the wider community, so care must be taken in extrapolation. However, the magnitude of these values and the number of people who could share them are sufficient to signal strong community interest in enhanced water quality. A study of these values in the broader community could be extremely helpful in providing understanding of community willingness to invest in water quality improvements.

While there does not appear to be a great deal of interest amongst survey participants in replacing existing riparian vegetation with natives, strong values were expressed for avoiding the invasion of gorse into the riverbed.

Two findings are worthy of closer investigation. While both farmer classes valued jobs highly, Angler Class 1 valued local jobs negatively. The reason for this unexpected result is not immediately apparent. One possible reason for that response is that more people in the local community would place more direct pressure on the fishery – more anglers competing for fish and for space on the riverbank. Another possible reason is that anglers view increased local employment placing more indirect pressure on the resource through demands for irrigation water or other extractive uses. If this were the case, it would result in confounding between the flow attributes and the employment attribute. In either case, the anglers have not valued “employment” *per se*, but have instead valued the implications arising from increased employment. In that case, employment is a “causally prior attribute” (Blamey et al. 1998). This suggests the need for design changes in future surveys of this type.

The other surprising result, tempered by the small sample size, is the non-significance for Anglers in Class 1 of loss of additional days of summer flow in the river. Farmer Class 1 and Angler Class 2 groups both placed significant negative values on this attribute. One possibility is that anglers in Class 1 viewed the loss of additional days of flow as being not significant because they believe the fishery is essentially ruined once there are any days without flow. This could have important implications for flow management and deserves further investigation.

4.4 Relationship between Q Sort and choice experiment findings

Both the Q Sort and Choice Experiment appeared to identify a broadly similar pattern of response in the identification and evaluation of amenity values, but both surveys also noted a subtle bi modal difference of emphasis, within this overall pattern. This raises two questions. How similar *are* the Q Sort and Choice Experiment results overall? And, is there any similarity or difference in the bi modal patterns?

The Q Sort findings emphasised the value of clear flowing water, with either wide and shallow channels (in the mountain fed Selwyn river) or narrower and deep channels (in the wholly spring fed streams), and bank-side vegetation that included shade trees, some grass, and indigenous water-edge plants. It identified dry weedy water courses as having lowest amenity value. The Choice Experiment identified water quality and clarity as having particular value, reinforced the negative evaluation of weeds, particularly gorse, and added greater understanding of the significance of variation in flow. It revealed that additional days of summer flow are more highly valued than winter flows by all stakeholders, (although not all stakeholders placed value on additional winter flows). In terms of relative values, water purity was most highly valued, while both water clarity and absence of gorse are well valued (with some differences in emphasis between stakeholder groups). This reinforces the findings that farmers, anglers, conservationists, and recreationists all value high quality water, a mix of indigenous and picturesque bank-side conditions, and continuity of summer flow. Hence the overall patterns of the two phases of survey are consistent.

What of the detailed and more subtle nuances found within the two surveys? In the Q Sort, the two main factors (Factors One and Three) differed in the way that respondents placed emphasis upon the naturalness of the setting and the ease and safety of access. However this distinction did not correspond to any systematic difference in the interests of the respondent - farmers were well represented in both groups, for example. In the Choice Experiment, on the other hand, whilst the difference between the two ways of responding were also subtle, there did appear to be a difference in the way that farmers evaluated the attributes, compared with members of Fish and Game. Here, the distinction between perspectives was more closely tied to interests - with the Fish and Game members tending to place higher value on water clarity and extra flow days than farmers, who placed emphasis upon absence of gorse, and lesser weight upon extra flow days. It is also noteworthy that economic benefit trade offs were valued at a relatively low level by farmers (with a local job equivalent to an additional day of summer flow), and not at all by anglers/recreationists.

The distinctions emerging from the Choice Experiment were therefore more based upon material interests, than appeared to be the case in the Q Sort. Or, to put it another way, sectoral interests were more significant in valuing attributes, than in their initial identification. As a consequence, the characteristics of the different patterns of response at each stage were also different - the Q Sort patterns reflecting underlying world views (Newton et al. 2002), whilst the Choice Experiment responses expressed more immediate interests. This difference could be considered significant in determining future use of the two techniques.

4.5 Management implications

There are several possible management implications of these findings. The most significant issue is the significance of additional days of flow within a periodic flow regime. At first sight, the relative values attached to each additional day's flow seem quite low, compared with the values attached to other attributes such as water clarity. However, total amounts are not insignificant. The anglers' group valued each additional summer day of flow at 5.0, against a base of 100 for unpolluted water, which means that 20 days additional flow over the 180 days of summer equate in value to unpolluted water all year.

How do different attributes balance up in terms of management priority? It would seem that for both groups of stakeholders, maintenance of water quality and clarity, controlling gorse, and maximising summer flow occurrence (but not volume) are high priorities. For anglers, the attributes associated with water and stream corridor are infinitely more valuable than the economic benefit of additional local jobs. For farmers on the other hand, economic benefits of each additional local job are valued at 1.7, or $2. In comparative terms, 60 additional jobs would offset the value of unpolluted water, and as few as 20 jobs would offset the value of clear water. This reveals what is intuitively apparent, that different sectors value economic growth differently against natural resource conservation. The resolution of this difference cannot be technical- it must be political.

4.6 Future research

There are two potential research implications, one methodological, the other substantive. A key methodological question is whether the values of additional days are constant as they increase, or decrease, or whether additional days increase or drop in relative value after a certain threshold. In other words, is the valuation of periodic flows linear or non-linear? Similarly, are additional jobs all of equal value? Or does the value of jobs change as the aggregate number increases? It would be very helpful to undertake a second series of choice experiments designed to tease out the nature of the value curve for the attributes.

The main substantive research opportunity is to utilise the methods established here to undertake a wider and more representative investigation of the amenity values of spring-fed streams and rivers recognised by stakeholder groups and communities within Canterbury.

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Appendix 1
Example of Q Sort Recording Sheet

Sustainable Groundwater Allocation Research
Federated Farmers – Key Professional Informants Workshop

Introduction

There is growing demand upon groundwater resources for a range of uses. Abstraction of groundwater may affect the flow regimes of spring-fed streams and rivers. Changes in flow regime influence the biophysical attributes of the stream bed, margins and corridor, and this in turn may affect a range of socioeconomic, ecological and cultural values and functions of the rivers.

The Sustainable Groundwater Allocation Research (SUGAR) funded by the Foundation for Research, Science and Technology is aimed at:-

- improving knowledge of the relationships between the flow regime of spring fed streams and rivers and its effects, and
- the development and testing of an improved process of decision making about groundwater allocation.

The overall project was developed by Lincoln Ventures Ltd in partnership with Environment Canterbury, Ministry of Agriculture and Fisheries and Ministry for Environment, and is being undertaken by staff from NIWA, Lincoln University and Harris Consulting. Federated Farmers Inc is collaborating in the design and implementation of the research.

Objective Four – investigating amenity effects

Objective Four of the SUGAR programme investigates the relationship between stream flow and the aesthetic qualities, cultural values and recreational uses of the affected rivers - aspects commonly described as amenity.

Dr Geoff Kerr and Professor Simon Swaffield of Lincoln University have been subcontracted to undertake the investigation into river amenity, and this workshop is a preliminary part of that work, intended to help us design the research instrument.

Today, we seek your advice as professional farmers representing Federated Farmers to help us identify the stream and river attributes that are likely to be considered by stakeholders to be particularly important in terms of river amenity. The results of this scoping workshop will inform the design of a formal survey of stakeholders in 2006.

The approach we would like to adopt is to share with you a set of images we have prepared that illustrate different types of river and stream environments. The images have been collected from spring-fed streams and rivers in the Selwyn District, whose flow is significantly influenced by the ground water conditions. They show a range of conditions, under different flow regimes. Some of the images have been edited to remove or reduce the effect of factors that are not influenced by stream flow (e.g., season). Others have been edited to illustrate a range of flow conditions.

We seek your advice on three issues. First, which of the river environments we have illustrated have the highest and lowest amenity, from a farmer's perspective? Second, what biophysical attributes most influence their amenity? Third, how well do the images represent the range of spring-fed river environments you would expect in Canterbury, and their different characteristics?

We intend to tackle these questions in a series of exercises that are set out in the following sheets.

We are most grateful to you for agreeing to help us in designing our research.

The information you provide will be anonymous, and will only be used in aggregate form. It will influence the design of the survey that will be carried out in 2006.

We will provide you with feedback on the advice provided today, so that you have opportunity to comment further if you wish.

We do ask you as research collaborators to treat the details of today's workshop in confidence. This is because we will be approaching other farmers next year to participate in the formal survey, and we need to ensure that they are not influenced by your comments to us today.

We acknowledge with thanks the use of photographic and other material supplied by Boffa Miskell Ltd, and Nicholas Marchand, a PhD candidate at Lincoln University, drawn from related research into spring-fed streams and rivers and river flow regimes. We also acknowledge helpful advice we have already received from Ali Undorf-Lay and Peter Fleming.

<u>Step One: Identifying river environment with high and low amenity</u>

Please examine the set of images we have provided and identify the river environments that in your professional opinion as a farmer have the highest amenity value. The images are of a range of river and stream environments within the Selwyn District, whose flow regimes may be affected by groundwater conditions.

For the purposes of this research, Amenity includes *recreational use, aesthetic qualities, and other cultural values.*

First, sort the images into three groups;

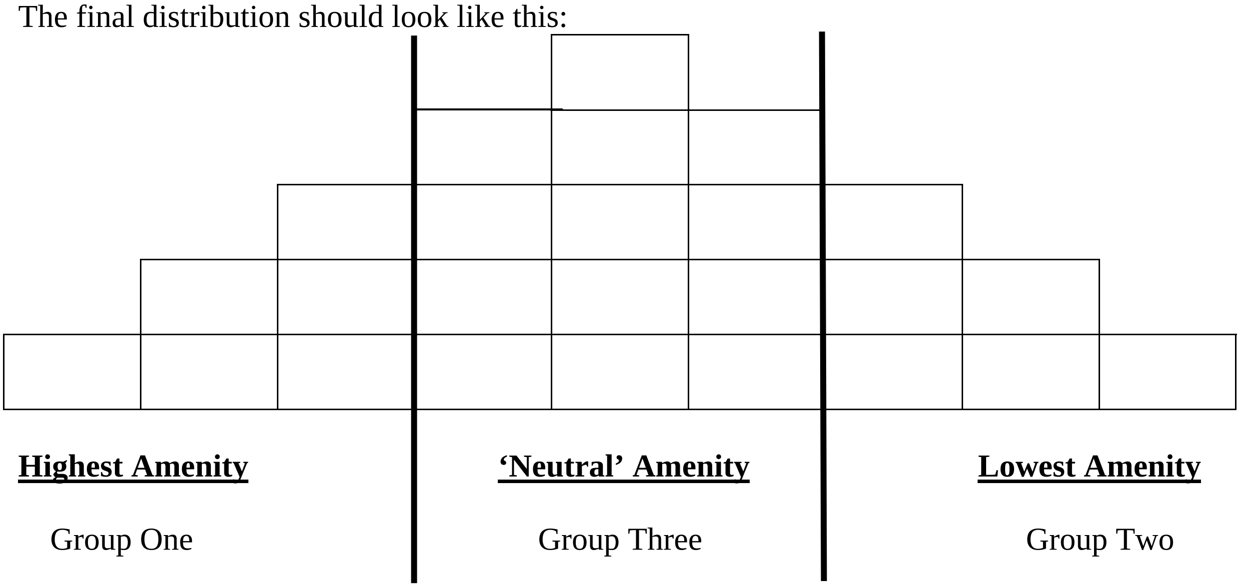
- **Group One** with six images of river environments that have high amenity
- **Group Two** with six images of river environments with low amenity
- **Group Three** with the remaining ‘neutral’ images

Now, sort **Group One** of images of ‘high’ amenity environments into three columns, placing the environment that has the highest amenity in the left hand column, the two environments with the next highest amenity in the second column from the left, and the three remaining images in the third column.

Next, sort **Group Two** of ‘low’ amenity environments in the same way, in reverse (so that the environment with the lowest amenity is in the far right hand column, the next two lowest are in the second column from the right, and the remainder in the third column).

Finally, sort the remaining environments in **Group Three** into three columns - a neutral column in the centre with five images, and columns on either side with four each; the left hand column containing the environments with slightly higher amenity, and the right hand column slightly lower amenity.

The final distribution should look like this:



<u>Highest Amenity</u> — Group One

<u>‘Neutral’ Amenity</u> — Group Three

<u>Lowest Amenity</u> — Group Two

Now please copy the numbers that are on the images you have sorted into the corresponding boxes above.(This gives us a summary record of your judgements).

Please turn to page four

<u>Step Two: Identifying the attributes that contribute to amenity</u>

Please look carefully at the environments that you have selected as having the highest amenity (Group One at the left hand end of the distribution).

In the following boxes, please note the attributes of these river environments that lead to you rate them so highly.

Highest Amenity	Next highest	Next highest

Please turn to page five

Now please look at the environments that you have selected as having the lowest amenity (Group Two at the right hand end of the distribution)

Please note the attributes that lead you to rate them so low.

Next lowest	Next lowest	Lowest Amenity

Please turn to page six

Step Three: Evaluating the images we have used

Please look carefully at the images we have provided. In your professional opinion, how well do these images represent the range of spring-fed, streams and river environments in Canterbury?

Are there any important types of environment that we have omitted?

Now, please look at the way we have represented these environments. Are there any aspects of the images provided that does not 'ring true'? How could they be made more authentic?

Please turn to page seven

Finally please make any further comments that you would like to contribute about the attributes of the spring-fed streams and rivers in the Selwyn District that are particularly important to their amenity, and how we illustrate these qualities in our research.

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Thank you very much. We appreciate your help.

Please provide us with a postal address to which we can send feedback on today's workshop.

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Appendix 2
Introductory Presentation Topics

- **Formation of the Canterbury Plains**
- **Groundwater hydrology**
- **Age & source of groundwater**
- **River profile & processes**
- **Aquifer discharge**
- **Spring fed stream and river characteristics**
- **Lake Ellesmere Te Waihora**
- **Indigenous vegetation of lower plains**
- **Tangata Whenua**
- **1850-60s Early European farming**
- **The wheat boom 1870s**
- **Water races 1870s onwards**
- **Acclimatisation societies 1880s onwards**
- **Drylands mixed farming 1900s onwards**
- **Recreational uses**
- **Flood management**
- **Intensification & diversification 1980s**
- **Restoration projects**
- **Groundwater irrigation**
- **Aquifer / river relationship**
- **Global climate trends**
- **Regional climate trends: rainfall 1928-2003**
- **Seasonality of river flow**
- **Linking climate & aquifer levels**
- **Increasing groundwater abstraction**
- **Aquifer recharge & discharge: recent trends**
- **Catchment & groundwater management**
- **What's the agenda?**
- **Our method**
- **An example**
- **Amenity attributes**
    - **Flow**
    - **Water clarity**
    - **Water quality**
    - **Bankside vegetation**
    - **Local employment**
    - **Extra cost to your household**
- **Choice questions**

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279 The Economic contribution of Four Biotechnologies to New Zealand's Primary Sector
Kaye-Blake, William, Saunders, Caroline, Emanuelsson, Martin, Dalziel, Paul, and Wreford, Anita 2005

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Cook, Andrew J. and Fairweather, J.R. 2005

281 Nanotechnology – ethical and social issues: Results from New Zealand Focus Groups
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Greer, Glen 2006

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Roberts, Mere, Frank, Wero, and Clarke, Liliana 2006

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Gouin, Daniel-M 2006

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Saunders, Caroline, Barber, Andrew, and Taylor, Greg 2006

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Hunt, Lesley and Fairweather, John 2006

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Kaye-Blake, W., Saunders, C. and Ferguson, L. 2007

297 Comparative Energy and Greenhouse Gas Emissions of New Zealand's and the UK's Dairy Industry
Saunders. C.M. and Barber, A. 2007

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145 Papers Presented at the 4th Annual Conference of the NZ Agricultural Economics Society. Blenheim 1997

146 Papers Presented at the 5th Annual Conference of the NZ Agricultural Economics Society. Blenheim 1998

147 Papers Presented at the 6th Annual Conference of the NZ Agricultural Economics Society. Blenheim 2000

148 Papers Presented at the 7th Annual Conference of the NZ Agricultural Economics Society. Blenheim 2001

149 Papers Presented at the 8th Annual Conference of the NZ Agricultural Economics Society. Blenheim 2002

150 Papers Presented at the 9th Annual Conference of the NZ Agricultural Economics Society. Blenheim 2003

151 Papers Presented at the 10th Annual Conference of the NZ Agricultural Economics Society. Blenheim 2004

152 Papers Presented at the 11th Annual Conference of the NZ Agricultural Economics Society. Blenheim 2005