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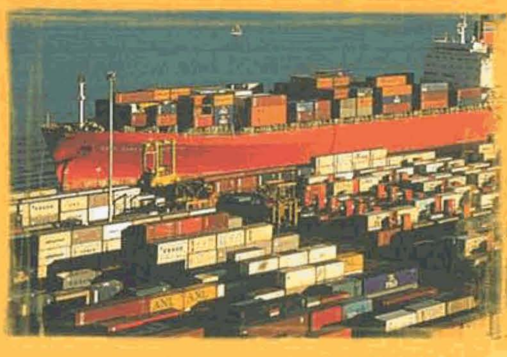

Instream Water Values: Canterbury's Rakaia and Waimakariri Rivers

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Table of Contents

List of Tables

List of Figures

Abstract

This paper reports previously unpublished results from an early study of instream values associated with two Canterbury Rivers, the Waimakariri and the Rakaia. The studies utilised several different approaches to valuation and assessed different types of value. The Rakaia River study estimated recreational use benefits, the value of salmon management, and non-use benefits from protection of instream flows. The Waimakariri River studies measured non-use benefits from protection of instream flows and the benefits from improved water quality.

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Chapter 1
Introduction

Monetary valuation of in-stream aspects of water has been undertaken since the earliest days of New Zealand non-market valuation. Amongst the first ever valuation studies undertaken in this country are Russell Gluck's (1974) investigations of Rakaia River salmon fishery values and Barry Harris' (1981) study of the recreational impacts of pollution in Lake Tutira[1]. Other early water-related studies include Barry Harris' (1983) study of Waikato River pollution and Geoff Kerr's (1985) investigation of existence and use value changes contingent upon proposed hydro-electricity developments on Otago's Kawarau River.

Research undertaken by Ken Leathers, Basil Sharp and Geoff Kerr during 1983-4 at what was then Lincoln College measured Rakaia River fishery values, as well as existence and option values for both the Rakaia and Waimakariri Rivers. The research was commissioned by the National Water and Soil Conservation Organisation (NWASCO) to inform deliberations on a water conservation order on the Rakaia River under investigation at the time[2]. The study resulted in a report to NWASCO, but was never published and the results have not been widely available.

Water management is highly topical, with several investigations currently underway into irrigation and hydro-electricity proposals. Population growth, industrial expansion and agricultural intensification all look likely to contribute to increased demand for water abstraction, while growing environmental concerns emphasise the importance of in-stream values. The recent Rangitata River water conservation order hearing, and the Waitaki River water allocation procedures currently being developed by the Minister of the Environment highlight contemporary concerns about the need for high quality water allocation processes. It is important to have information on values of water in alternative uses to allow quality decisions about water allocation.

This report seeks to make the results of the NWASCO studies available to a contemporary audience. Benefit transfer is a method employed to circumvent the expense and time involved in undertaking original non-market valuation studies. Benefit transfer entails using results from one or more existing non-market valuation studies, usually with adjustments to correct for differences between populations and the environment at different sites, to provide an indicator of the non-market impacts of some environmental change. Publication of non-market valuation study results (and methods) is extremely important to add to the body of studies available for benefit transfer. Already, New Zealand studies are being used for benefit transfer both here (Kaval *et al.*, 2003; Kerr, 2004) and abroad (Shrestha and Loomis, 2001).

The original Rakaia fishery zonal travel cost valuation data have been reanalysed using modern statistical procedures. However, options for data analysis have been somewhat limited because the original data were saved on legacy computer media that can no longer be accessed. Consequently, individual-level data are now unavailable. However, the aggregated zonal data that formed the basis for the original study have survived in hard-copy form and have been reinterpreted. Contingent valuation results are unchanged from the original study.

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[1] An inventory of New Zealand non-market valuation studies is available at www.lincoln.ac.nz/markval
[2] The Rakaia River water conservation order was gazetted in October 1988.

Chapter 2
Case Study Rivers

2.1 Rakaia River

The Rakaia River drains about 65 km of the main divide of the Southern Alps. The river is 140 km long, is braided in its upper reaches, passes through a short gorge, and then flows some 62 km through braided channels to the sea. Total catchment area is 2910 km^2, with over 90% of the catchment area situated above the gorge. Mean annual flow is 200 m^3s^{-1} at the gorge. Peak discharges at the gorge can exceed 4,000 m^3s^{-1} (Stephen, 1972; NCCB, 1983).

The Rakaia River supports a sea-run salmon fishery, which forms the basis of the majority of recreational river use. Like the Rakaia, the other major New Zealand salmon rivers (Waitaki, Rangitata and Waimakariri) are all on the east coast of the South Island. Rakaia River angling activity is highly variable, and is dependent on the fluctuating salmon run and river conditions. Ministry of Agriculture and Fisheries use estimates for the early 1980s range from 30,000 to 70,000 angler-days per year (Tierney *et al.*, 1982). Over the 1994-96 period fishery use was about 35,000 angler-days per year (Unwin and Brown, 1998).

During the early 1980s the Rakaia River was the focus of intense scrutiny because of conflicting proposals to use significant amounts of river water for agricultural irrigation and to preserve the river because of its wild and scenic attributes. Much debate was focussed upon the relative magnitudes of instream and out of stream values of water. Cost benefit analyses of irrigation proposals at that time did not consider instream values, however conservation interests argued that these were significant and should not be ignored.

Loss of the Rakaia River fishery could occur for several reasons, including natural events and human-induced river management activities, possibly as a result of irrigation. This concern prompted investigation of the total value of the recreational salmon fishery. The potential impacts of changes in salmon abundance (rather than complete loss of the fishery), either directly because of fishery management or indirectly because of other river changes, was also of concern at the time, prompting investigation of the relationship between fishery values and salmon abundance.

While salmon angling was the primary impetus for the investigation of recreational use values, other non-market impacts were of concern too. There were concerns about effects of river flow changes on wildlife habitat, particularly for endangered native birds such as the Wrybill Plover, and for the "naturalness of the river environment".

Objectives for studies of the Rakaia River were to (i) measure the value of the recreational fishery, (ii) measure the value of changes in salmon abundance, and (iii) measure the benefits of protecting instream values from further water abstractions, either permanently, or for a five year period.

2.2 Waimakariri River

The Waimakariri River is 151 km long. It is braided in its upper reaches, passes through a gorge of about 25 km, and then flows 61 km to the sea in a braided channel up to 1.6 km wide. Total catchment area is 3564 km^2. Mean annual discharge at the old highway bridge, near the mouth, is 116 m^3s^{-1} (NCCB, 1986).

In its lower reaches the river was used for industrial waste dilution and transport. Industrial wastes, including sewage and waste from meat processing, wool scouring and fellmongery activities were discharged into the Waimakariri River near State Highway One from four major point-source discharges (Knox and Wilson, 1982). This resulted in water quality classed "D", largely because of high faecal coliform and sulphide levels. The effluent outfalls were upstream of areas where significant recreation activities took place. Health risk perceptions caused some recreators to avoid this section of the river.

The Waimakariri River has high levels of use from salmon anglers. However, in contrast to the Rakaia, the Waimakariri River also receives high recreational use from anglers pursuing other fish species, with trout, mullet, kahawai and whitebait fishing also significant. Swimming and sailing are popular near the river mouth. Jet boating is very popular, both in the gorge and the lower reaches. The Waimakariri Gorge hosts the kayak leg of the annual Coast to Coast multi-sport race, which is responsible for significant kayaking activity through the gorge over the summer months. Logan (1987) reports the following North Canterbury Catchment Board estimates of river use.

Table 2.1
Waimakariri River Recreation

Activity	Estimated annual visits
Salmon angling	78,000
Trout angling	64,000
Estuarine fishing	35,000
Jet boating	30,000
Picnicking	25,000
Walking and tramping	20,000
Swimming	14,000
Whitebaiting	13,500
Power boating and water skiing	3,000
Yachting	3,000
Canoeing and rafting	1,200

Objectives for studies of the Waimakariri River were to (i) estimate willingness to pay for an improvement in water quality in the lower river from Class D (suitable for boating and fishing) to Class C (suitable for swimming), and (ii) to measure the benefits of protecting instream values from further water abstractions, either permanently, or for a five year period.

Chapter 3
Methods

The study employed two approaches to non-market valuation; contingent valuation and the zonal travel cost method. It used these two methods to assess several different types of value associated with in-stream water benefits.

The reference population was defined as all households living in those portions of Canterbury bordered by the Conway River (in the north) and the Rangitata River (in the south). Two groups were relevant: households – for measuring non-use values, and anglers – for measuring fishery use values. Households were randomly sampled from the 1981 electoral rolls. Anglers were sampled from whole season fishing licence holders in the region who resided in households not drawn in the household sample.

Data were collected using mail questionnaires and personal interviews. In total, 2020 households received postal questionnaires and 317 individuals were approached for personal interviews. Valuation questions from the various survey instruments are reported in Appendix A.

3.1 Fishery Values

3.1.1 Value of the Rakaia River Fishery

The change in recreational benefits contingent upon complete loss of the Rakaia River fishery was estimated using the zonal travel cost method. Data on individual anglers were obtained using a postal survey that collected information on angler demographics, Rakaia River fishing activity, fishing travel patterns and expenditures on Rakaia River fishing. The data were aggregated into six zones, each with different costs of visiting the river.

3.1.2 Rakaia River Fish Abundance and Fishery Values

The single-site, zonal travel cost approach is not capable of identifying the impacts of changes in resource attributes, such as fish abundance. Consequently, the values of fish stock changes were assessed with the contingent valuation method.

River management information needs would be best served by derivation of salmon angling demand, incorporating all possible attributes that affect that demand. Demand for salmon angling can be influenced by a range of factors (Daubert and Young, 1981):

$$\text{Demand} = f[Y, T, E, S(f), C(n,f), Z(n,f)]$$

Where

Y	=	Income
T	=	Tastes
E	=	Experience or skill
S	=	Site attractiveness
C	=	Expected catch
Z	=	Congestion
f	=	River flow
n	=	Number of salmon in the river

Site attractiveness, expected catch and congestion are all likely to be influenced by flow. What is more, the number of salmon in the river is also a function of river flow. However, the absence of scientific research identifying the functional relationships between S, C, Z, n and f means that this demand function cannot be identified. Consequently, an alternative, simplified demand relationship was estimated.

Demand = f[Y, T, E, n]

The contingent scenario presented to survey participants held flow constant. Willingness to pay was explicitly derived by varying only the number of salmon in the river. Salmon abundance was proposed to change because of management interventions designed to "protect, rehabilitate and enhance" Rakaia River salmon stocks. It was left to the respondent to judge his or her potential success with more or fewer fish in the river.

Because flow could affect site attractiveness, congestion and expected catches, this simplified approach does not measure the value of the change in the angling experience because of flow-related (or other causes) changes in salmon abundance.

Two different methods were proposed for paying for these management interventions, a special Rakaia River fishing licence (Questions 12-19) and increases in rates (Questions 20-25). Each respondent was assigned randomly to one of these two payment mechanisms.

3.2 Preservation Values

Preservation value is the sum of existence and bequest values. Existence values arise from the satisfactions of knowing that river habitats, amenities and services are available. Bequest value is the satisfaction that such benefits are protected for future generations.

The contingent valuation method was used to estimate preservation values on both rivers. For the Rakaia River a single postal survey was used to measure preservation values. For the Waimakariri River personal interviews and two different postal surveys were used.

Rakaia River Household Postal Survey A and Waimakariri River Household Postal Survey A were identical, allowing comparison of preservation (and option) values for the two rivers.

Waimakariri River Postal Survey B and the Waimakariri River interviews asked identical valuation questions, allowing comparison of value differences arising because of the data collection method.

Waimakariri River postal surveys A and B differed in several ways. Survey B was undertaken after Survey A and was designed to measure the value of water quality enhancement. In addition, the opportunity was taken to rephrase option price and preservation value questions. These changes are addressed in Section 3.4.

3.3 Option Values

Option <u>value</u> is defined as willingness to pay to postpone action in order to obtain superior information that will allow better decisions to be made in the future. Option value excludes existing use value and can be difficult to measure. Option <u>price</u> is the sum of use, preservation, and option values. In this study the concept of option preservation was embodied in a five-year moratorium on any change to the river environment. The question was posed essentially as the opportunity to postpone a decision with uncertain consequences until a time when the consequences are likely to be better understood.

Option price is the sum of the value of recreational opportunities over the five year period, plus the value of preservation benefits over the five year period, plus the value of the opportunity of making a better decision. For people who are certain that further extraction of river water is the best option (i.e. the benefits from development exceed preservation benefits plus recreation), option price is zero – there is nothing to be learned or otherwise gained from delaying further water extraction. People who are uncertain about the merits of further water extraction may be willing to pay to reduce that uncertainty. Delaying a decision means that recreation and preservation benefits are secured for the five year period.

Option prices were assessed for the Rakaia River in the postal survey and in both postal surveys and the personal interviews for the Waimakariri.

3.4 Postal Survey Instruments

Postal Survey B differed significantly from Survey A. The introduction to contingent valuation in Survey A proposed that hydro-electric power development was a possible source of change to the Waimakariri River. Further, Survey A proposed that additional irrigation from the Waimakariri River could detrimentally affect salmon ranching. Because hydro-electricity development was seen as extremely unlikely and because there was no salmon ranching on the Waimakariri River, and there were no proposals for it, both of these items were excluded from Survey B.

Because mean preservation value and mean option price were so similar for Survey A, there was some concern that respondents may not have been discriminating between the concepts. Survey B attempted to address this potential problem by changes in individual questions, but also by proposing that there were two options: (1) preserving the river forever, and (2) delaying development decision for five years. It was made clear that only one of these two distinct alternatives could eventuate.

3.4.1 Option Price

Whereas Survey A asked respondents what "you" would pay, Survey B clearly identified the household as the unit of payment. In addition, Survey A underlined the word "maximum" when asking for willingness to pay, whereas Survey B did not. Survey A respondents sometimes stated they could see few costs from delaying development and they believed that increases in rates would simply be used for other purposes. They could see no connection between their payment and postponement of development. This concern was addressed by including a statement that "The additional revenues would go solely to research and not to other activities of local bodies".

3.4.2 Preservation Value

The preservation value question in Survey B addressed concerns about ambiguity of the word "you", that could have been interpreted in either the singular (personal value) or the plural (household or family value) in Survey A. Survey B clearly identified the household as the unit of concern and payment.

Survey A proposed "Even if you do not use the Waimakariri yourself, you may get some degree of pleasure from simply knowing that the Waimakariri exists in its present state. This value is in addition to any value you may actually get from using the river yourself." It asked respondents to state their values "to preserve the Waimakariri in its present state, apart from value you may have as a river user" [emphasis in original].

In contrast, Survey B proposed "you may still gain some satisfaction from knowing that the Waimakariri exists as sanctuary for wildlife and a source of recreational enjoyment for others" and simply asked respondents to state their values "to preserve the Waimakariri in its present state."

Survey B also made an attempt to justify why people should pay to preserve the river. It did so by suggesting that "other sources of water would have to be found for development purposes" and that such investigations "would require additional tax revenues."

3.5 Summary

Methodology is summarised in Table 3.1.

Table 3.1
Methodology

Values	Population(s)	Rakaia River	Waimakariri River
Fishing	Canterbury Anglers	**Zonal travel cost method** ▪ Postal survey	na
Change in fish abundance	Canterbury Anglers	**Contingent valuation** ▪ Interviews	na
Water quality	Canterbury Residents	na	**Contingent valuation** ▪ Postal Survey B ▪ Interviews
Preservation value	Canterbury Residents	**Contingent valuation** ▪Postal Survey A	**Contingent valuation** ▪Postal Survey A ▪Postal Survey B ▪Interviews
Option value	Canterbury Residents	**Contingent valuation** ▪Postal Survey A	**Contingent valuation** ▪Postal Survey A ▪Postal Survey B ▪Interviews

3.6 Response Rates

Survey response rates are reported in Table 3.2. "Sample" is the number of surveys mailed out [and not returned as undeliverable] or the number of people asked to complete a personal interview. "Completed" is the number of postal surveys returned and for which an attempt has been made to answer the questions. For interviews, "Completed" is the number of people agreeing to participate. All interviews were usable. However, some postal surveys were incomplete, illegible, or otherwise unusable, so the number of useable surveys is somewhat less than the number of surveys completed. The usable response rate is the ratio of usable responses to the number of surveys mailed out or the number of people asked to participate in interviews.

Table 3.2
Response Rates

Survey	Sample	Completed	Usable	Usable Response rate
Waimakariri Household Postal A	504	334	291	58%
Waimakariri Household Postal B	510	340	317	62%
Waimakariri Household Interviews	150	119	119	79%
Rakaia Household Postal A	498	331	294	59%
Rakaia Angler Postal	507	400	381	75%
Rakaia Angler Interviews	167	139	139	83%

Usable response rates to the three household postal surveys are not significantly different. However, there are significant differences between populations and between methods. Two populations were surveyed about the Rakaia River using postal surveys. The Rakaia Angler postal survey (75%) obtained a significantly better response rate than the Rakaia Household postal survey (59%, Z=5.51).

The difference in response rates between Waimakariri Household interviews (79%) and Rakaia Angler interviews (83%) is not significant. Because two items are changing in this comparison (river, population), it is not possible to draw definitive conclusions, but it appears that interviews moderate the tendency for higher frequency of responses from directly interested groups (anglers) in postal surveys.

When interviews were used for the same target population they obtained significantly better response rates than postal surveys. Waimakariri River Household interviews (79%) were superior to the postal surveys (60%) of the same population (Z=5.31), and Rakaia River Angler interviews (83%) were superior to the postal survey of Rakaia Anglers (75%, Z=2.33).

Chapter 4
Rakaia River Travel Cost Valuation Results

The zonal travel cost method entails choosing zones centred on the recreation facility and comparison of behaviour of recreators within the different zones (Clawson and Knetsch, 1966). The population was divided into six zones for application of the zonal travel cost method in highly aggregated format. A stratified sample was then drawn to minimise expected variance within each zone. The population of anglers surveyed contained 10,220 individuals. Survey data are reported in Table 4.1.

Table 4.1
Angling Data[3]

Zone	1	2	3	4	5	6	Total
Population	9,648	18,791	17,635	240,171	57,752	11,133	355,130
Anglers	481	912	1,029	5,386	2,019	393	10,220
Sample size	62	65	65	71	65	54	382
Annual visits by sample	1,901	994	840	497	313	93	4,638
Total annual visits	14,748	13,947	13,298	37,702	9,722	677	90,094
Zone	**1**	**2**	**3**	**4**	**5**	**6**	**Weighted mean**
Annual visits per capita	1.529	0.742	0.754	0.157	0.168	0.061	0.254
Annual visits per angler	30.7	15.3	12.9	7.0	4.8	1.7	8.82
One-way distance	10km	25km	40km	55km	75km	155km	43.7km
Return VOC/angler	$2.11	$5.29	$8.46	$11.63	$15.86	$32.77	$9.24
Time cost/angler	$0.46	$1.14	$1.83	$2.52	$3.43	$7.09	$2.00
Total cost/angler-visit	$2.57	$6.43	$10.29	$14.14	$19.29	$39.86	$11.23

VOC = Vehicle Operating Cost

The survey revealed that 54% of anglers (5,549 individuals) fish for salmon on the Rakaia[4]. Active Rakaia salmon anglers in the sample averaged 16.25 Rakaia River salmon angling trips each year, which appears to be high compared with other studies of the time[5].

An average of 1.98 people shared costs in each vehicle. Modal engine capacity was 2,000 cubic centimetres (CCs) with 69% of vehicles having engine sizes of 2,000 CCs or less. 46% of vehicles were in the 1,600 – 2,000 CC capacity range. The 1982 edition of "Car Operating Costs" (Ministry of Transport, 1982) indicates the cost of running a car in this engine range

[3] Unless indicated otherwise, all money amounts are June 1983 New Zealand Dollars.
[4] Teirney *et al.* (1982) estimated that 5,600 anglers visited the Rakaia each year. Douglass *et al.* (1984) claimed the Rakaia River was visited by 6,000 to 9,000 anglers each season. Unwin (1982) reported total angling use of the Rakaia (including juniors) as: [1978/79, 8,800 anglers]; [1979/80, 6,320 anglers]; [1980/81 7,170 anglers].
[5] Other annual use intensity estimates are provided by Teirney *et al.* (1982) – 10.4 visits per angler; Unwin (1982) – 9.6 to 11.1 days per angler; and Douglass *et al.* (1984) – 8 to 12 visits per angler. Shelby's (1983) on-site sample of anglers made an average of 30 trips per year to the Rakaia (median =20). Simple field samples, as used by Shelby, are over-representative of high frequency users, so Shelby's estimates of average and median trips are expected to be upwardly biased.

to be $0.2114 per kilometre. These figures are similar to those of Sandrey and Simmons (1984), who found 2.3 recreational hunters per vehicle and used a cost of $0.2155 per kilometre.

The following formulae were used to calculate visits per capita and vehicle operating costs for each zone, where i indexes the zone.

$$\text{Visits per Capita}_i = \frac{\text{Visits by Sample}_i}{\text{Sample Size}_i} \times \frac{\text{Number of Anglers}_i}{\text{Population}_i}$$

$$\text{VOC}_i\,(\$\ \text{angler}^{-1}\text{visit}^{-1}) = \frac{2 \times \text{One Way Distance}_i \times \text{Cost/km}}{\text{Number Sharing Costs}} = \frac{2 \times \text{Distance}_i \times \$0.2114\ \text{km}^{-1}}{1.98\ \text{anglers vehicle}^{-1}}$$

$$= \$0.2135\ \text{km}^{-1} \times \text{Distance}_i\ (\text{km})$$

The total annual number of visits predicted was 90,000 (Table 4.1). This estimate of visits is at the high end of other use estimates – e.g. Tierney *et al.* (1982), 58,000 visits; Unwin (1982) 69,000-98,000 angler-days; Douglass *et al.* (1984) 50,000-100,000 angler-days. In the presence of multi-day trips there are fewer visits than angler-days.

The mean distance travelled to fish on the Rakaia was 51.43 kilometres (weighted mean = 43.7 km). Vehicle operating costs for an angler travelling the average distance were $11.03. Weighted vehicle operating cost was $9.24 angler^{-1}visit^{-1}.

A major factor affecting demand for recreation is the time spent reaching the recreation site. Travel time cannot be included as a separate independent variable in highly aggregated zonal travel cost models because of insufficient degrees of freedom. Even if it could be included, time would probably be found to be highly correlated with travel cost and so raise problems in estimation of coefficients. As such, a separate assessment of the value of travel time must be made to enable time to be included in the model.

Cox (1983) suggests that the cost of non-working travel time in New Zealand should be valued at 25% of the average gross income of all workers travelling in leisure time. Cox also recommended "the value of time should be considered invariant with journey length or time". This suggests that visit rate should be considered as a function of total costs, where total costs are the sum of vehicle operating costs and time costs. Average travel time for each zone was calculated by assuming a mean speed of 80kph. Time cost was calculated by multiplying travel time by one quarter of average hourly income ($7.32 - Department of Labour, 1982). Time cost for an average length trip to the Rakaia is $2.35 visit^{-1}. Weighted time cost is $2.00 visit^{-1}. Adding time and vehicle operating costs yields a weighted cost per visit of $11.23 ($13.38 for an average length trip).

Other costs of a fishing trip include: fishing licences and tackle, as well as maintenance of boats, camping gear and other equipment. The average angler had over $1,300 worth of recreational equipment attributable to the Rakaia, and spent about $104.47 per year operating and maintaining this equipment. For most anglers the figures were considerably less than this, the mean being strongly influenced by a few who owned boats or special purpose recreation vehicles. Assuming one already owns a fishing license and tackle it is possible to make a trip to the Rakaia for only the cost of transport ($9.24 angler^{-1}trip^{-1}) and depreciation on fishing tackle ($10.46 angler^{-1}year^{-1}).

While many anglers indicated that they took overnight trips to the Rakaia, few reported use of commercial accommodation. From 381 active anglers surveyed; twelve stayed in the Rakaia camping ground, three stayed in hotels or motels, and only one rented a bach.

The average cost of a day's salmon angling on the Rakaia was $16.31, resulting in annual gross expenditure of $1.47 million.

4.1 Travel Cost Results

The first step of travel cost analysis is to identify the relationship between visit rate and travel cost. Initial investigation was undertaken using OLS regression (Table 4.2, value of travel time = 25% wage rate):

Table 4.2
OLS Models

Model	Linear	Semi-log	Exponential	Double-log
a	1.061	1.913	0.7584	1.265
b	-0.03192	-0.5591	-0.1375	-0.8679
SE_a	0.2703	0.2610	0.1493	0.2403
SE_b	0.01376	0.1022	0.02720	0.1680
Correlation	-0.7856	-0.9416	-0.8179	-0.9050
R^2	0.809	0.947	0.971	0.960
Adjusted R^2	0.574	0.882	0.936	0.910
t_a	3.93	7.33	5.08	5.26
t_b	-2.32	-5.47	-5.05	-5.17
SSE	0.671	0.185	0.101	0.141

The models are defined as:

Linear $V/C = a + b*TC$

Semi-log $V/C = a + b *\log_e TC$

Exponential $V/C = e^{(a + b*TC)}$

Double-log $V/C = e^{(a + b*\log_e TC)} = e^a.TC^b$

Because the number of people living in each zone is non-uniform, OLS models suffer from heteroscedasticity. This is addressed using weighted least squares (WLS), weighting by the square root of zone population (Table 4.3, value of travel time = 25% wage rate).

Table 4.3
WLS Models

Model	Linear	Semi-log	Exponential	Double-log
a	0.6823	1.806	0.8902	1.588
b	-0.02882	-0.5907	-0.1767	-1.174
SE_a	0.3184	0.4626	0.2235	0.3823
SE_b	0.02001	0.1739	0.02816	0.2145
Correlation	-0.9346	-0.9882	-0.8115	-0.9001
R^2	0.639	0.859	0.936	0.900
Adjusted R^2	0.549	0.824	0.747	0.605
t_a	2.14	3.90	3.98	4.15
t_b	-1.44	-3.40	-6.28	-5.47
SSE	18218	7123	3228	5044

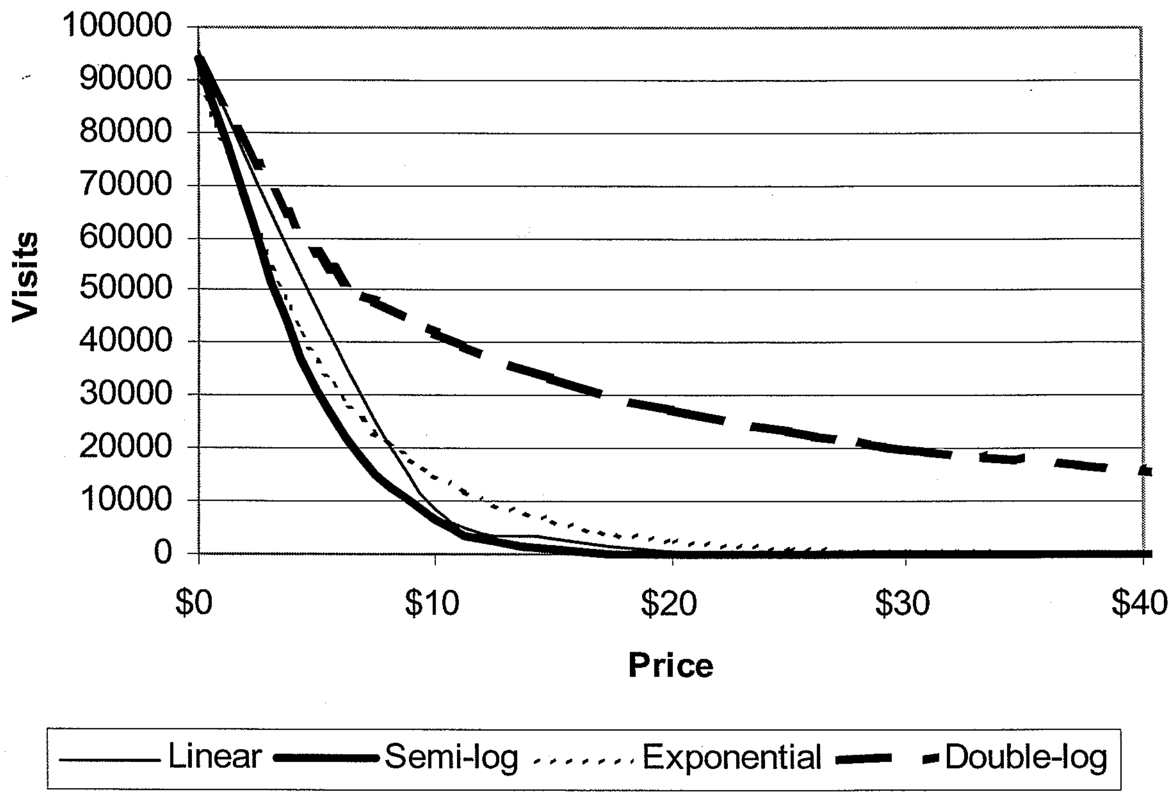
The linear model is likely to be problematic because of the non-significant travel cost coefficient. The semi-log model is a considerable improvement over the linear model. The double-log model is also problematic. While it fits the data well, the travel cost coefficient is not significantly different from -1. This means that the demand curve will have a very thick tail and in some instances will yield infinite consumers' surplus estimates (Table 4.4 and Figure 4.1). This contravention of economic theory rules out the double-log model, leaving the choice between semi-log and exponential models.

The coefficient of determination (R^2) cannot be used to compare specifications with different forms of the dependent variable. Rao and Miller (1971) provide a technique for the statistical comparison of various functional forms involving comparison of the Sum of Squared Errors (SSE). This test shows both logged dependent variable models to be superior to their linear counterparts. The exponential model provides the best fit for both the OLS and WLS cases.

Table 4.4
Predicted Visits: WLS Models

Price	Linear	Semi-log	Exponential	Double-log
$0	95286	94221	89298	93459
$5	46737	31248	36904	57245
$10	8733	6370	15252	42299
$15	2913	1091	6303	33501
$20	307	0	2605	27650
$25	0	0	1077	23473
$30	0	0	445	20343
$40	0	0	76	15976
$50	0	0	13	13085
$100	0	0	0	6653
$500	0	0	0	1141
$1000	0	0	0	514

Figure 4.1
WLS Demand Curves



4.2 Consumers' Surplus

Consumers' surplus estimates provide measures of benefits from Rakaia River angling. Consumers' surplus is simply the area underneath the estimated aggregate demand curve. Algebraic solutions for consumers' surplus for each of the models are:

Linear model: $CS/visit_i = \frac{-\text{Visit Rate}_i}{2b} = -0.5\left(\frac{a}{b} + TC_i\right)$

Semi-log model: $CS/visit_i = \frac{-b(\text{choke price} - TC_i)}{\text{Visit Rate}_i} - TC_i = \frac{-b\left(e^{-a/b} - TC_i\right)}{(a + b.\ln TC_i)} - TC_i$

Exponential model: $CS/visit_i = -b^{-1}$

Double-log model: $CS/visit_i = -TC_i\,(b+1)^{-1}$ When $b<-1$, otherwise $CS/visit_i = \infty$

Note that consumers' surplus estimates for both the exponential model and the double-log model are dependent only upon the travel cost coefficient, allowing straightforward estimation of confidence intervals. Consumers' surplus estimates and their confidence intervals are reported in Table 4.5. One approach commonly used to address the infinite consumers' surplus problem which arises because of the fat tails associated with the double-log model is truncation of the demand curve. Table 4.5 presents double-log model consumers' surplus estimates with the demand curve truncated at a total visit cost (per angler) of $1000.

Table 4.5
<u>Consumers' Surplus</u>

	Choke price	Expected Visits	CS/ visit	95% Confidence Interval	Annual Site value, 90,000 visits	95% Confidence Interval
OLS						
Linear	$33.24	210,559	$9.91	$2.84 ~ $62.10	$0.89m	$0.26m ~ $5.6m
Semi-log	$30.63	159,193	$7.41	$2.16 ~ $72.63	$0.67m	$0.19m ~ $6.5m
Exponential		122,394	$7.88	$5.19 ~ $11.43	$0.71m	$0.47m ~ $1.0m
Double log		139,192	∞	$57.30 ~ ∞	∞	$5.2m ~ ∞
Truncated Double log*		139,192	$73.76		$6.64m	
WLS						
Linear	$23.67	95,286	$5.44	-$113 ~ $91	$0.49m	$0~ $8.1m
Semi-log	$21.28	94,221	$4.12	$0.81 ~ $355	$0.37m	$0.07 ~ $31.9m
Exponential		89,298	$5.66	$4.28 ~ $8.39	$0.51m	$0.39m ~ $0.76m
Double log		93,459	$67.95	$16.72 ~ ∞	$6.12m	$1.5m ~ ∞
Truncated Double log*		93,459	$35.82		$3.22m	

* Truncated at Total Cost = $1000

Negative consumers' surplus estimates for the linear WLS model arise when the slope coefficient is positive and are simply artefacts of this model's poor fit. As predicted, the double-log model sometimes results in infinite consumers' surplus. The exponential model fits best and produces the narrowest confidence intervals. Linear and semi-log forms provide similar expected benefits to the preferred exponential form. In all cases WLS models produce smaller consumers' surplus estimates than do their corresponding OLS models, although the differences are not statistically significant.

Using the weighted least squares exponential model in Table 4.5, the expected annual recreation value of the Rakaia River to Canterbury anglers in 1983 was in the order of $500,000 - about $6 angler^{-1} visit^{-1}.

Chapter 5
Rakaia River Contingent Valuation Results

5.1 Option Prices and Preservation Values

Usable answers to the option price question were provided by 78% of postal survey respondents. Objections to the question were raised by 7% of postal survey participants, while 15% simply did not answer this question. Of usable responses to the option price question in the postal survey, 47% stated zero willingness to pay (WTP). A near identical pattern of responses was obtained for the preservation value question (Table 5.1).

Table 5.1
Rakaia River Option and Preservation Values
($ per household per year)

Value	Group	Mean WTP	95% Confidence interval	Median	Item response (completed surveys)
OP	Aggregate Households	$17.60	$12.11 ~ $23.09	$2.00	229 (294)
	User Households	$31.10	$18.54 ~ $43.66	$9.96	82 (104)
	Non-user Households	$10.08	$5.59 ~ $14.57	$0.35	141 (190)
	All anglers	$28.95	$8.72 ~ $49.18	-	270 (381)
	Anglers: Salmon	$37.63	$5.82 ~ $69.44	-	160 (212)
	Anglers: Non-salmon	$15.59	$2.73 ~ $28.45	-	107 (165)
PV	Aggregate Households	$17.38	$11.75 ~ $23.01	$1.33	217 (294)
	User Households	$30.93	$18.07 ~ $43.79	$10.05	76 (104)
	Non-user Households	$10.07	$5.21 ~ $14.93	$0.31	141 (190)
	All anglers	$29.82	$10.83 ~ $48.81	-	267 (381)
	Anglers: Salmon	$39.30	$10.10 ~ $68.50	-	159 (212)
	Anglers: Non-salmon	$15.48	$4.11 ~ $26.85	-	105 (165)

OP = Option Price PV = Preservation Value

Response distributions are highly skewed, with the medians being much lower than the 2.5th percentile of the mean in each case. The mean is highly affected by a small number of very high values, with most people stating very low values for option and preservation benefits.

Mean values differ widely between groups. For example, river users' mean WTP is about three times non-river users' mean WTP. Anglers who do not fish for salmon have higher mean WTP than non-users (about the same as aggregate households), while mean WTP for salmon anglers (about $40) exceeds mean WTP for all river users (about $30).

The present value of preservation benefits obtained by aggregating over the 110,000 households in the survey population using a 10% discount rate is in the order of $19 million. On the same basis, present value of option price is in the order of $8 million.

5.2 Option Price

It is notable that in all cases option price and preservation value are nearly identical (e.g. both OP and PV are valued at about $31 by user households, $10 by non-user households, and $30 by anglers). This implies either that people do not place significant value on preservation beyond five years, or there are real benefits to retention of options for the future. Frequently expressed concerns by survey participants about preservation of the river environment for future generations favour the latter explanation.

It could be argued that option price for river users should exceed option price for non-users on the basis that use values are included for existing users. This need not be the case. The option value component of option price may differ markedly between groups. It may be very small or zero for current river users who know they intend to use the river in the future. In that case, option price is simply the annuity associated with the present value of 5 years of future use. On the basis of the travel cost model estimates of $6 benefit per visit and 16 visits per year, the present value at 7% of 5 years use by the average angler is about $420, which yields an annuity of about $29. This is the value of option price estimated here.

5.3 Salmon Abundance

Salmon abundance was addressed in angler interviews. A total of 139 usable interviews were completed.

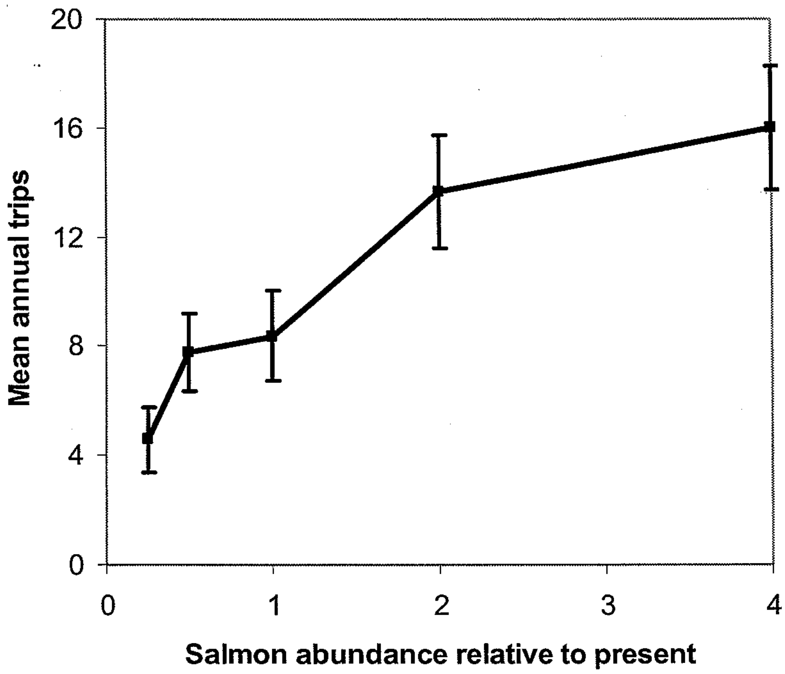
The number of trips anglers expect to take to the Rakaia at different levels of salmon abundance provides a non-monetary indicator of the importance of fish abundance (Table 5.2). This information could be used to re-estimate travel cost models under the different quality scenarios. However, the number of respondents was judged to be too small for reliable application of this approach using the zonal travel cost method. Numbers are probably adequate to utilise these responses in an individual analysis, but the unavailability of individual level data precludes this option.

Table 5.2
Rakaia Fishing Trips by Salmon Abundance

Rakaia River Salmon Abundance	Mean annual trips	Standard error of the mean	Ratio to existing	N
4x Present ≈60,000 fish	15.98	1.15	1.91	123
2x Present ≈30,000 fish	13.64	1.06	1.63	131
Existing ≈15,000 fish	8.37	0.85	-	139
0.5x Present ≈8,000 fish	7.79	0.73	0.93	129
0.25x Present ≈4,000 fish	4.57	0.60	0.55	125

This information is depicted graphically in Figure 5.1, along with 95% confidence intervals. Salmon abundance is likely to have a significant effect on fishing activity, which is expected to double with four times the original fish abundance, and to halve at one quarter original fish abundance. It should be noted that increased fish abundance is likely to bring new entrants to the fishery, so total use will go up by more than the ratios for increases in fish abundance in Table 5.2.

Figure 5.1
Impacts of Salmon Abundance on Visit Frequency



Whereas most respondents readily provided responses about **what they would do** if salmon numbers changed, many respondents had difficulty nominating **money values** for changes in salmon abundance. There were 34 usable responses to the rates vehicle and 33 usable responses to the licence vehicle (i.e. a total of 48% of all anglers interviewed). Most respondents felt comfortable with the concept of paying to **increase** salmon numbers. However, there was some apprehension about paying to **restore** present salmon numbers, or to **prevent** a decline in salmon abundance. Two major problems occurred.

1. Anglers believed it was **unfair** for them to have to pay to correct a situation that was not of their making. An attempt was made to circumvent this problem by proposing that natural disasters (flood through spawning grounds, disease, river mouth blockage, etc.) could be responsible for the decline. Some anglers refused to consider these options and were insistent that human actions would be the causes for future decreases in salmon abundance. Consequently, they refused to pay anything – even though the uncompensated change would still occur (i.e. fishery quality would decline) and their utility would be less than the maximum attainable with management intervention.

2. Some anglers refused to **believe** that salmon numbers could be returned to existing levels after a decrease in abundance and were unwilling to pay anything.

Both these cases are instances of respondents refusing to believe the contingent scenario presented to them. Consequently, their responses have been excluded from analysis. After deletion of these cases and irrational responses (declining willingness to pay for greater fish numbers) only 50% of responses received to the salmon abundance valuation questions remained. Annual dollar values for changes in salmon abundance are reported in Table 5.3.

Table 5.3
Values of Changes in Salmon Abundance
($ per angler [licence] or per household [rates] per year)

Group	Vehicle	Mean WTP	95% Confidence interval
4x Present	Rates	$27.62	$14.02 ~ $41.22
	Licence	$13.46	$8.03 ~ $18.89
2x Present	Rates	$17.27	$8.84 ~ $25.70
	Licence	$8.94	$5.53 ~ $12.35
0.5x Present	Rates	$21.59	$8.56 ~ $34.62
	Licence	$7.55	$3.90 ~ $11.20
0.25x Present	Rates	$26.32	$12.54 ~ $40.10
	Licence	$9.55	$5.45 ~ $13.65
4x-2x Present	Rates	$10.35	$3.41 ~ $17.29
	Licence	$4.51	$1.10 ~ $7.92
0.25-0.5x Present	Rates	$4.74	$1.31 ~ $8.17
	Licence	$2.00	$0.47 ~ $3.53

For each of the four suggested changes in fish abundance, mean willingness to pay for the rates vehicle exceeds that for the licence vehicle at the 98% confidence level or better. This result does not imply payment vehicle bias. Whereas the fishing licence payment vehicle required each adult angler to purchase a licence, rates are paid on a household basis. The average number of anglers in an angling household is, by definition, more than one. Consequently, maximum willingness to pay via special licence fees is expected to be less than maximum willingness to pay via household rate increases. An average of two anglers per angler-household would explain the approximate two to one ratio of willingness to pay observed in Table 4.3. The number of anglers per angler-household is unknown, but is unlikely to be as high as 2. For example, the North Canterbury Fish and Game Region sold 6,561 adult whole season licences in the 2003/04 season, of which an estimated 10% were to people living at the same address (Millichamp, *pers. comm.*). The region also sold 2,264 family licences, suggesting that there were about 8,500 households with at least one adult angler. Assuming three anglers per family licence there would be an average of 1.57 anglers per angler-household with an adult licence holder present. Two anglers per family licence would lower this statistic to 1.31 anglers per household. In each case it was not possible to refute the hypothesis that the mean for the rates vehicle was different to 1.3 times the mean of the fishing licence payment vehicle.

Estimates of value for changes in salmon abundance based upon licence vehicle responses are reported in Table 5.4, on the basis of 5,500 different anglers fishing the Rakaia River each year.

Table 5.4
Aggregate Values of Changes in Salmon Abundance

Change	Total Annual WTP (thousands)	95% Confidence interval (thousands)
Increase salmon abundance to 4x Present	$74	$44 ~ $104
Increase salmon abundance to 2x Present	$49	$30 ~ $68
Increase salmon abundance to 4x Present from 2x Present	$25	$6 ~ $44
Restore current abundance from 0.5x Present	$42	$21 ~ $62
Restore current abundance from 0.25x Present	$53	$30 ~ $75
Restore salmon abundance to 0.5x Present from 0.25x Present	$11	$2 ~ $19

The values in Table 5.4 are suspect because of the low numbers of respondents, and bias in the sample. Whereas the postal survey revealed an average of about 16 Rakaia fishing trips per year for active Rakaia River anglers (Table 4.1), the anglers interviewed here had an average of only 8.4 trips per year (Table 5.2). Anglers responding to the fish abundance valuation are unlikely to be representative of all anglers. These low use-intensity anglers may obtain lower benefits from the fishery than the average Rakaia River angler.

The weighted least squares exponential travel cost model (Table 4.5) estimates per trip surplus of about $6. Mean annual consumer surplus of Rakaia River angling for the anglers who provided usable answers to the fish abundance question is then about $48 (mean of 8.4 trips per angler). If, as hypothesised above, this sample is biased towards low benefit anglers, mean benefit will be somewhat less than $48 per angler per year.

These figures suggest that doubling salmon stocks would increase benefits for existing anglers by 20% or more. Similarly, and noting anglers' reticence to pay for something they perceive to be unfair, if salmon abundance were to decline to one quarter of the existing level then the fishery would lose about 20% or more of its value. The relatively small percentage changes in value compared to the changes in salmon abundance are not inconsistent with the multiple attributes of fishing trips, including catching other species, enjoying the river environment, and other benefits from fishing trips such as getting away from home, enjoying the company of friends, and so on.

This point is emphasised in NCCB (1983, Volume 4, p.68):

> "It should not be assumed, however, that the primary motivation of the salmon angler is catching large numbers of fish on every visit to a salmon river. With North Canterbury anglers only averaging 3.6 salmon per season, this is obviously not the case (Aukerman and Davison, 1980). Even the expert anglers participating in the fishability experiment, who had an average of 21 years experience, caught not more than an average 10.4 salmon during their best recent season. For these anglers, and it seems for others as well (Aukerman and Davison, 1980), the desire to go salmon angling has more to do with the possibility of good catches, the use of skill to achieve those catches, and the experience of being "out-of-doors" in a natural environment."

Unwin (1982) reports that 62% of Rakaia River salmon anglers didn't catch any fish in the 1979/80 season, with 65% of salmon caught by 12% of the anglers. The average annual catch was 1.34 salmon per angler for the whole season, requiring an average of 7 to 9 days fishing per fish caught. Such a low success rate and the highly skewed distribution of angling harvest suggest that harvest is not the primary motivating factor for most anglers.

Chapter 6
Waimakariri River Contingent Valuation Results

Results for the three contingent valuation surveys undertaken on the Waimakariri River are presented in Table 6.1.

Table 6.1
Waimakariri River Contingent Valuation Results

Group	Survey	Mean WTP	95% Confidence interval	Median	Item response (completed surveys)
Option Price					
Aggregate	Interview	$9.80	$6.45 ~ $13.14	$2.33	103 (119)
	Postal A	$17.05	$11.27 ~ $22.82	$2.38	220 (291)
	Postal B	$15.00	$7.15 ~ $22.85	$1.54	213 (317)
Users	Postal A	$11.86	$8.04 ~ $15.68	$4.65	101 (134)
	Postal B	$18.10	$7.66 ~ $28.54	$4.50	158 (218)
Non-users	Postal A	$21.45	$11.31 ~ $31.59	$1.25	119 (157)
	Postal B	$6.09	$1.63 ~ $10.55	$0.19	55 (99)
Preservation Value					
Aggregate	Interview	$10.05	$6.78 ~ $13.32	$3.00	103 (119)
	Postal A	$27.34	$14.11 ~ $40.57	$4.77	218 (291)
	Postal B	$16.86	$9.23 ~ $24.48	$4.73	220 (317)
Users	Postal A	$15.69	$10.89 ~ $20.49	$5.35	101 (134)
	Postal B	$20.71	$10.77 ~ $30.65	$5.17	167 (218)
Non-users	Postal A	$37.39	$13.19 ~ $61.59	$1.75	119 (157)
	Postal B	$4.72	$2.16 ~ $7.28	$0.30	53 (99)
Water Quality					
Aggregate	Interview	$16.19	$10.31 ~ $22.06	$5.41	103 (119)
	Postal B	$13.66	$10.91 ~ $16.72	$4.88	241 (317)
Users	Postal B	$16.21	$12.70 ~ $19.72	$5.36	184 (218)
Non-users	Postal B	$5.46	$2.17 ~ $8.75	$0.46	57 (99)

6.1 Comparison of Option Price and Preservation Value

Option price and preservation value are extremely similar for most items. The only major difference in point estimates arises from Postal Survey A, in which Non-users' preservation value is nearly double their option value. However, this difference is not significant.

6.2 Comparison of Users' and Non-users' Responses

Differences in item means for users and non-users responding to Survey A are not significant (Table 6.2). However, Survey B has produced significantly different responses for all measures [option price, preservation value, water quality], with non-users being willing to pay substantially less than river users in each case.

Table 6.2
<u>Comparison of Users' and Non-Users' Responses</u>

Group	Waimakariri Users' Mean WTP	Waimakariri Non-Users' Mean WTP	Z	P(Z)
Option Price				
Postal Survey A	$11.86	$21.45	1.74	0.083
Postal Survey B	$18.10	$6.09	2.07	0.038
Preservation Value				
Postal Survey A	$15.69	$37.39	1.72	0.085
Postal Survey B	$20.71	$4.72	3.05	0.002
Water Quality				
Postal Survey B	$16.21	$5.46	4.38	0.000

6.3 Comparison of the Two Postal Surveys

Survey B obtained significantly different responses than Survey A from respondents who did not use the Waimakariri River. Mean preservation value and mean option price were both substantially less for this group in Survey B (Table 6.3). There were no significant differences in responses for Waimakariri River users, or for aggregate population responses.

Table 6.3
<u>Comparison of Postal Survey Values</u>

Group	Survey A Mean WTP	Survey B Mean WTP	Z	P(Z)
Option Price				
Aggregate	$17.05	$15.00	0.41	0.681
River users	$11.86	$18.10	1.10	0.271
River non-users	$21.45	$6.09	2.72	0.007
Preservation Value				
Aggregate	$27.34	$16.86	1.35	0.179
River users	$15.69	$20.71	0.89	0.373
River non-users	$37.39	$4.72	2.63	0.009

There is a notable contrast between the differences in responses to the two surveys by river users and river non-users. For both variables, river users have offered higher values in Survey B, although these differences are not statistically significant. However, river non-users have provided dramatically lower values in Survey B. The difference in mean values for non-users is highly significant. One possible reason for this changed behaviour of non-users is their lower item response rate for Survey B (Table 6.4), a decline in the order of 20%. River users' response rates did not change significantly between the two surveys. The dramatic decline in users' response rates for Survey B suggests there is something in the revised question format that they found objectionable, or that they could not understand. The similarity of changes in response rates for the option price and preservation value questions suggests that the problem may arise in the introductory material.

Table 6.4
Waimakariri River Postal Survey Item Response Rates

Group	Survey A	Survey B	Z	P(Z)
Option Price				
Users	75%	72%	0.60	0.550 (2 tailed)
Non-users	76%	56%	3.38	0.000 (1 tailed)
Preservation Value				
Users	75%	77%	0.26	0.792 (2 tailed)
Non-users	76%	54%	3.69	0.000 (1 tailed)

6.4 Comparison of Postal Survey and Interview Results

Interview responses could not be disaggregated into user/non-user groups, so comparisons are limited. There are no significant differences for responses collected by the two different approaches using the same questions (Table 6.5).

Table 6.5
Comparison of Postal Survey and Interview Mean WTP Values

Group & Value	Interview	Postal Survey B	Z	P(Z)
Aggregate Option Price	$9.80	$15.00	1.19	0.233
Aggregate Preservation Value	$10.05	$16.86	1.61	0.108
Aggregate Water Quality	$16.19	$13.66	1.91	0.057

Chapter 7
Discussion and Conclusions

7.1 Comparison Between the Waimakariri and Rakaia Rivers

Table 7.1 reports option prices and preservation values for the Rakaia and Waimakariri Rivers.

Table 7.1
Comparison of Mean Option and Preservation Benefits

Group	Waimakariri Mean WTP	Rakaia Mean WTP	Z	P(Z)
Option Price				
Aggregate	$17.05	$17.60	0.14	0.892
Users	$11.86	$31.10	2.87	0.004
Non-users	$21.45	$10.08	2.01	0.044
Preservation Value				
Aggregate	$27.34	$17.38	1.36	0.174
Users	$15.69	$30.93	2.18	0.030
Non-users	$37.39	$10.07	2.17	0.030

Similarity in aggregate option prices for the two rivers arises despite substantial differences for sub-groups. Mean option price for Rakaia River users is nearly three times mean option price for Waimakariri River users, with the difference having strong statistical significance. Waimakariri River non-users' mean option price is twice that of Rakaia River non-users. Again, the difference between means is highly significant.

While Waimakariri River aggregate preservation value is about 50% more than the same value for the Rakaia River, the difference is not statistically significant. As with option prices, Rakaia River users' preservation values substantially (and significantly) exceed Waimakariri River users' preservation values. Non-users' preservation values for the Waimakariri River are nearly four times those for the Rakaia River.

It is notable that Rakaia River users' mean non-use values for the Rakaia River significantly exceed those of Rakaia River non-users. This outcome is not unexpected. River users may be more aware of the existence and significance of positive attributes of the river environment because of added familiarity with the environment. However, the opposite relationship is observed on the Waimakariri River. There, Waimakariri River non-users' mean option and preservation values are about twice those of Waimakariri River users, although the difference is not significant (Table 6.2). While the questions used in the two surveys are somewhat different, and therefore are not directly comparable, it should be noted that Waimakariri River Postal Survey B yielded the same result as the Rakaia survey - with users willing to pay significantly more than non-users.

7.2 Comparison of Rakaia and Rangitata River Angling Benefits

Kerr and Greer (2004) used an individual, single site travel cost approach to estimate recreational angling use benefits from the Rangitata River. Their study, undertaken in the year 2000, estimated benefits per angler per trip in the range $18 - $45 [June 1983$], with the smallest lower bound 95% confidence interval from all of their models being $10 per angler per trip [June 1983$]. With the preferred exponential weighted least squares model yielding benefits in the range $4 - $9 per angler per trip [June 1983$] for Rakaia River angling, the Rangitata River appears to provide higher angler benefits than the Rakaia River.

However, care should be exercised in making such comparisons. Angling activity is responsive to fish abundance, so travel cost models applied in different years can yield substantially different value estimates. Kerr and Greer's (2004) Rangitata River travel cost study estimated benefits based on trips made in an "average" year, whereas the Rakaia River study used information on trips in the 1982/83 season, which was regarded as poor[6].

Further, travel cost models require assumptions and modelling choices made by the analyst. These must be identical to provide a valid comparison. The two studies varied in several ways, summarised in Table 7.2.

Table 7.2
Comparison of Rakaia and Rangitata Travel Cost Studies

Attribute	Rakaia	Rangitata
Travel time value	25% of average hourly income	35% of average hourly wage rate
Costs	Variable vehicle operating costs	(i) Fuel costs (ii) Variable vehicle operating costs
Substitutes and complements	Excluded	Included
Statistical model	Exponential	Negative binomial
Aggregation	Zonal	Individual

It is not possible to predict the effects that the different statistical models or the level of aggregation might have on value estimates. Use of a higher value of travel time on the Rangitata deflates benefit estimates relative to the Rakaia (Kerr and Greer, 2004, p.146). Inclusion of substitutes and complements in the Rangitata River model substantially increased benefit estimates. Kerr and Greer's (2004, p.145) full variable cost model which included substitutes and complements estimated benefits at $45 [June 1983$] per angler per trip, compared to $18 [June 1983$] per angler per trip from the model without substitutes and complements). Kerr (2001) reports that the Rangitata River model produces angler benefit estimates of $18 [June 1983$] per angler per trip using the same assumptions as the Rakaia River model wherever possible (i.e. using the same assumptions about travel time, costs, substitutes and complements).

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6 The number of salmon caught in the Glenariffe trap in 1983 was 1578 (NCAS, 1983), compared with 2883 in 1979, 1529 in 1980, 2426 in 1981, and an average of 1877 over the period 1965-1982 (Unwin and Davis, 1983). This information and the low numbers of redds led NCAS (1983, p.52) to the conclusion that "1983 has not been a good spawning year for the Rakaia, with returning adult numbers below average". Low fish numbers were compounded by difficult fishing conditions, further reducing catches (AAS, 1983).

7.3 Water Quality Benefits

Sheppard *et al.* (1992) used dichotomous choice contingent valuation to measure the benefits of improving water quality in the lower Waimakariri River from D grade to C grade, arriving at annual household willingness to pay estimates of $47 - $67 [June 1983$]. The Sheppard data have been reanalysed by Kerr (2000), who fitted a wide variety of functional forms to responses and obtained a very broad range of mean benefit estimates. Kerr's (2000) point estimates of mean WTP were in the order of $60 per annum [June 1983$], while his lowest 95% confidence interval lower bound was $43 [June 1983$]. The Sheppard dichotomous choice values substantially exceed the $10 - $22 [June 1983$] open ended estimates derived here. The ratio of dichotomous choice value (Sheppard, 1992) to open-ended value (this study) is about 4. This ratio is greater than average, but is not unusual in other studies (Boyle *et al.*, 1996; Brown *et al.*, 1996).

Medians show a similar difference. Kerr's (2000) modelling of the Sheppard data produced medians in the order of $23 per annum [June 1983$]. The lowest 95% confidence interval lower bound was $14 [June 1983$], significantly more than the $5 median obtained here.

7.4 Conclusions

This study provided an important development in identifying the significance of non-market values for water allocation in New Zealand. The value estimates appear to be low compared to more recent studies that have benefited from subsequent theoretical and practical developments and which have used more sophisticated versions of the contingent valuation and travel cost methods.

Of note is the relative importance of use and non-use values. The present value of Rakaia River angling was in the order of $5 million and increasing the salmon run to four times the base level would have increased angling benefits by less than $1 million. In contrast, the present value of Rakaia River preservation benefits was in the order of $19 million and the present value of option price was about $8 million. Preservation values for the Waimakariri River were of a similar scale, $11 million to $30 million present value, depending on data collection method. Present value of Waimakariri River option price fell in the range of $4 million to $8 million, again depending on data collection method, while the proposed water quality improvement had a present value in the $15 million to $18 million range.

While these results may not be precise, and could be biased, it appears that biases are towards under-estimation of true values. The potential for such biases warn against indiscriminate benefit transfer of the estimates derived here. However, while they lack precision, the estimated values indicate that Canterbury residents placed a significant value on protection of instream amenities that should not be ignored in contemporary water allocation decisions.

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Appendix: Survey Instrument Valuation Questions

Rakaia River: Household Postal Survey

4. Several developments have been planned for the Rakaia, including irrigation and hydro-electric power schemes. These may create positive effects such as extra jobs and increased income for Canterbury, but may also negatively affect recreational uses of the Rakaia, wildlife habitats, and salmon ranching, which may also be able to provide extra jobs and income. It is not known what the effects will be. Once developments are made their effects are usually irreversible.

Suppose the decision on development can be postponed. This will allow continued use of the Rakaia while reliable scientific information is gathered. This information will allow a better informed decision to be made as to whether or not these developments will be in the community's best interest.

One way of collecting funds to pay for necessary investigations would be to increase rates paid to local bodies. An increase in rates would mean an increase in rents charged by landlords.

What is the maximum you are willing to pay annually in extra rates or rent to postpone making a decision on irrigation development of the Rakaia for five years? By this time more information will be available, allowing a better informed decision to be made.

5. The Rakaia is one of several rivers in Canterbury that could be nominated for preservation under the new "Wild and Scenic" river legislation. Even if you do not use the Rakaia yourself, you may get some degree of pleasure from simply knowing that the Rakaia exists in its present state. This value is in addition to any value you may get from actually using the river yourself. (For example many taxpayers are willing to support government spending to preserve the existence of the near extinct flightless birds, the Takahe and the Kakapo, even though they never expect to encounter one themselves.) Preserving the river also means it would be available to future generations.

What is the maximum you are willing to pay annually in extra rates or rent to preserve the Rakaia in its present state, apart from any value you may have as a river user?

4. Several developments have been planned for the Waimakariri, including irrigation and hydro electric power schemes. These may create positive effects such as extra jobs and increased income for Canterbury, but may also negatively affect recreational uses of the Waimakariri, wildlife habitats, and salmon ranching, which may also be able to provide extra jobs and income. It is not known what the effects will be. Once developments are made their effects are usually irreversible.

Suppose the decision on development can be postponed. This will allow continued use of the Waimakariri while reliable scientific information is gathered. This information will allow a better informed decision to be made as to whether or not these developments will be in the community's best interest.

One way of collecting funds to pay for necessary investigations would be to increase rates paid to local bodies. An increase in rates would mean an increase in rents charged by landlords.

What is the maximum you are willing to pay annually in extra rates or rent to postpone making a decision on irrigation development of the Waimakariri for five years? By this time more information will be available, allowing a better informed decision to be made.

5. The Waimakariri is one of several rivers in Canterbury that could be nominated for preservation under the new "Wild and Scenic" river legislation. Even if you do not use the Waimakariri yourself, you may get some degree of pleasure from simply knowing that the Waimakariri exists in its present state. This value is in addition to any value you may get from actually using the river yourself. (For example many taxpayers are willing to support government spending to preserve the existence of the near extinct flightless birds, the Takahe and the Kakapo, even though they never expect to encounter one themselves.) Preserving the river also means it would be available to future generations.

What is the maximum you are willing to pay annually in extra rates or rent to preserve the Waimakariri in its present state, apart from any value you may have as a river user?

Waimakariri River: Household Postal Survey Version B

All rivers in New Zealand are classified according to standards of water quality and these standards are enforced by Regional Water Boards. The present water quality standard for the Waimakariri, 'class D', prohibits excessive pollution, but does not ensure against risks to human health.

The water quality of the Waimakariri is influenced by the disposal of wastes from freezing works and related industries. Sometimes during the summer months when the river's flow is low, the concentration of waste material in the water can be hazardous to human health. Under these conditions river recreation below the Main South Road Bridge, including the estuary and nearby ocean beaches, can be affected. This area is a popular location for swimming, fishing, sailing, wading, diving, etc. for many Canterbury families.

Raising the river's present quality standard from 'class D' to 'class C' would eliminate the present health risk. Water quality improvement however can be expensive. Funds would be needed for research on pollution control, for assistance to companies who adopt new control technologies, and for enforcing compliance with the new water quality regulations. If local body rates were increased to fund the water quality improvement, it is likely that landlords would pass this increase on to their tenants in the form of higher rents. In other words almost everyone would contribute to the improvement.

5. **What is the maximum amount in extra rates (rent) your household would pay annually to raise the water quality standard of the Waimakariri from 'class D' to 'class C'?** (This level of improvement would eliminate the health risk to recreational users. The additional rates paid would go solely to water quality research and pollution control measures)

As you may know, the Waimakariri is being considered for future irrigation development. Irrigation would have positive effects such as new jobs and increased income for the region, but may also negatively affect present recreational uses of the river and its habitat for wildlife. At present, the positive effects of development and the negative effects of on the environment are not adequately understood. Once developments are undertaken their effects are usually irreversible.

Decision makers have to decide between competing uses. Basically, there are two alternatives to development going ahead:

Option A: postpone the decision and obtain more information.
Option B: preserve the river in its present state.

First consider Option A.

Suppose decisions on development could be postponed until more information becomes available. Present recreational uses of the river would continue, while scientific research was carried out to provide a more reliable basis for future decisions. This additional research could cost the tax payer money through increased rates, paid to the responsible local bodies. Rents would also increase since landlords would pass on the rate increase to their tenants.

We would like you to express the Waimakariri River's value to your household in terms of the extra rates (or rent) you would be willing to pay annually to postpone development decisions for five years.

6. **Our household would pay annually a maximum of $_______ in additional rates (or rents) to postpone decisions on the Waimakariri development for a period of five years.** (The additional revenues would go solely to research and not to other activities of local bodies).

Now consider Option B.

The Waimakariri could be preserved in its present state under the new "Wild and Scenic river" legislation. This action would preclude any further development, and preserve the river for present and future generations.

Even if you or members of your household are not present users of the river, you may still gain some satisfaction from knowing that the Waimakariri exists as sanctuary for wildlife and a source of recreational enjoyment for others. For example, many tax payers willingly support government spending to preserve the existence of the near extinct flightless birds – the Kakapo and the Takahe – even though they realise that they may never actually see one themselves.

If the Waimakariri was preserved as a "Wild and Scenic River" however, other sources of water would have to be found for development purposes. Such new investigations, for example looking into groundwater resources and the use of other rivers, would require additional tax revenues.

7. Provided that the extra revenue collected was solely for water research purposes, **What is the maximum your household would pay annually in additional rates (or rents) to preserve the Waimakariri in its present state?**

Waimakariri River: Household Personal Interviews

All rivers in New Zealand are classified according to standards of water quality and these standards are enforced by Regional Water Boards. The present water quality standard for the Waimakariri, 'class D', prohibits excessive pollution, but does not ensure against risks to human health.

The water quality of the Waimakariri is influenced by the disposal of wastes from freezing works and related industries. Sometimes during the summer months when the river's flow is low, the concentration of waste material in the water can be hazardous to human health. Under these conditions river recreation below the Main South Road Bridge, including the estuary and nearby ocean beaches, can be affected. This area is a popular location for swimming, fishing, sailing, wading, diving, etc. for many Canterbury families.

Raising the river's present quality standard from 'class D' to 'class C' would eliminate the present health risk. Water quality improvement however can be expensive. Funds would be needed for research on pollution control, for assistance to companies who adopt new control technologies, and for enforcing compliance with the new water quality regulations. If local body rates were increased to fund the water quality improvement, it is likely that landlords would pass this increase on to their tenants in the form of higher rents. In other words almost everyone would contribute to the improvement.

5. **What is the maximum amount in extra rates (or rent) your household would pay annually to raise the water quality standard of the Waimakariri from 'class D' to 'class C'?** (This level of improvement would eliminate the health risk to recreational users. The additional rates paid would go solely to water quality research and pollution control measures)

As you may know, the Waimakariri is being considered for future irrigation development. Irrigation would have positive effects such as new jobs and increased income for the region, but may also negatively affect present recreational uses of the river and its habitat for wildlife. At present, the positive effects of development and the negative effects of on the environment are not adequately understood. Once developments are undertaken their effects are usually irreversible.

Decision makers have to decide between competing uses. Basically, there are two alternatives to development going ahead:

Option A: postpone the decision and obtain more information.
Option B: preserve the river in its present state.

First consider Option A.

Suppose decisions on development could be postponed until more information becomes available. Present recreational uses of the river would continue, while scientific research was carried out to provide a more reliable basis for future decisions. This additional research could cost the tax payer money through increased rates, paid to the responsible local bodies. Rents would also increase since landlords would pass on the rate increase to their tenants.

We would like you to express the Waimakariri River's value to your household in terms of the extra rates (or rent) you would be willing to pay annually to postpone development decisions for five years.

6.	**Our household would pay annually a maximum of $_______ in additional rates (or rents) to postpone decisions on the Waimakariri development for a period of five years.** (The additional revenues would go solely to research and not to other activities of local bodies).

Now consider Option B.

The Waimakariri could be preserved in its present state under the new "Wild and Scenic River" legislation. This action would preclude any further development, and preserve the river for present and future generations.

Even if you or members of your household are not present users of the river, you may still gain some satisfaction from knowing that the Waimakariri exists as sanctuary for wildlife and a source of recreational enjoyment for others. For example, many tax payers willingly support government spending to preserve the existence of the near extinct flightless birds – the Kakapo and the Takahe – even though they realise that they may never actually see one themselves.

If the Waimakariri was preserved as a "Wild and Scenic River" however, other sources of water would have to be found for development purposes. Such new investigations, for example looking into groundwater resources and the use of other rivers, would require additional tax revenues.

7.	Provided that the extra revenue collected was solely for water research purposes, **What is the maximum your household would pay annually in additional rates (or rents) to preserve the Waimakariri in its present state?**

The use of Waimakariri River water for irrigation may be of considerable benefit to Canterbury. A large irrigation scheme would create several hundred new jobs and increase farm production by $10 million or more annually. All households in the region would benefit from this growth in economic activity. The annual income benefit could be as much as $100 per average Canterbury household. This level of development however would likely have negative effects on recreational uses and river amenities. The extent of these losses is not known.

Suppose the income benefit from irrigation would be $100 per year for your household.

8a. **Do you think irrigation development should go ahead?**

8b. If "yes" or "don't know"
How low would the income benefit have to fall for your household to say no to the development?

8c. If "no" or "don't know"
How high would the income benefit have to rise for your household to say yes to the development?

5. About how many trips per year do you normally take for salmon fishing on the Rakaia?

If none, ask:

6. If salmon numbers in the Rakaia River increased significantly so that, on average, anglers caught more fish, would you consider taking up salmon fishing on the Rakaia?

[If no, go to question No. 26]

7. On average about how many salmon do you catch in a normal fishing season?

The future levels of salmon numbers in the Rakaia are uncertain. Better management of the fishery and the increase of commercial salmon farming may increase salmon numbers. Similarly, numbers may increase due to the effects of fishing at sea, closure of the mouth, disease, the use of water for irrigation or other causes. Presently, about 15,000 salmon return to the river each year, of which about 5,000 are caught by anglers.

If salmon numbers increased some people would probably gain more enjoyment from salmon fishing and would take more trips.

8a. **Given that you presently take ______ trips on average per year, how many trips would you take if improved fishery management increased salmon numbers to 30,000 fish per year?** (i.e. double present numbers).

8b. If no positive change, probe reasons.

9a. **How many trips would you take if salmon numbers could be increased to 60,000 per year?**

9b. If no positive change from 8a, probe reasons.

It is conceivable that Rakaia salmon numbers could also drop in the future. This would probably decrease the fishing enjoyment of some anglers.

10a. **How many trips would you take if there were 8,000 salmon returning each year** (About half that of today)?

10b. If no negative change, probe reasons.

11a. **How many trips would you take if there were 4,000 salmon returning each year** (About ONE quarter of present numbers)?

11b. If no negative change, probe reasons.

Water and fishery management efforts are not free. They must be financed by those who stand to gain from them, and they can be expensive. Regional water boards, acclimatisation societies and other local bodies will require revenue to support the necessary research and enforcement efforts to ensure that fishery objectives are met and adhered to.

RESPONDENTS WERE RANDOMLY ASSIGNED TO EITHER

1) **THE FISHING LICENCE GAME (QUESTION 12), OR**
2) **THE RATES GAME (QUESTION 20).**

FISHING LICENCE GAME

One possibility to protect or enhance Rakaia salmon stocks would be to designate the river a special fishery management unit or district. A special Rakaia fishing licence, separate from the national licensing system, would be issued to entitle holders exclusive access to the Rakaia. In other words, a regular acclimatisation society licence holder would not be allowed to fish the Rakaia unless he or she also purchased the "Special Rakaia Licence". The revenues collected via the special licensing system would be devoted solely to the protection, rehabilitation and enhancement of the river's salmon fishery. While the special licence entitles the holder to fish the Rakaia, it would not be valid outside the Rakaia River Management District.

12a **Given that last year's general licence was $20, what is the maximum amount you would be willing to pay for a "Special Rakaia Licence" in the next angling season?**

12b If zero, probe reasoning.

13 **In addition to purchasing this "Special Licence", would you also purchase the general licence?**

By increasing fishery management efforts, such as the rearing and release of smolts into the river, it is possible to increase numbers of salmon returning to the Rakaia each year. This work is expensive, but any work done will have benefits for the Rakaia salmon angler <u>only</u>.

14a You mentioned that you would pay $_____ for a special licence under present conditions (recall that present numbers average 15,000 fish per year, with about 5,000 caught by anglers). **Would you be willing to pay more if salmon stocks could be increased (with certainty) to 30,000 returning fish per year?**

14b If yes: iterate amounts to obtain maximum bid.

14c If no: probe reasoning.

15a **Would you be willing to pay more (reference the maximum bid above) for the special licence if salmon stocks could be enhanced (with certainty) to 60,000 fish per year?**

15b If yes: iterate amounts to obtain maximum bid.

15c If no: probe reasoning.

In the absence of concerted fishery management efforts salmon stocks could decline. This could happen because of natural causes such as disease or blockage of the mouth.

16a Suppose salmon numbers were to drop to about half their present numbers (from 15,000 to 8,000 fish). **Would you be willing to pay more** (reference the initial bid) **for the special licence to ensure that the necessary research and management was carried out to maintain present salmon stocks?**

16b If yes: iterate amounts to obtain maximum bid.
16c If no: probe reasoning.

17A Suppose that salmon numbers were to drop to ¼ their present number (i.e. from 15,000 to 4,000). **Would you be willing to pay more than** (reference maximum bid) **to ensure that salmon stocks were maintained at their present level?**

17b If yes: iterate amounts to obtain maximum bid.
17c If no: probe reasoning.

18 A "Special Licence Fee" is one means of collecting revenue for protection and management of the Rakaia salmon fishery. **Can you think of any other methods, for example increasing rates paid by the general public, that might be better (or worse)?**
Please explain.

If salmon stocks decline as a result of river developments, one might argue that some form of compensation was due, to the extent that the loss affected individuals personally.

19 **If, because of developments on the river the salmon stocks were reduced to 4,000 fish** (i.e. ¼ present numbers), **what minimum amount of cash compensation would make you equally well off?**

Probe to assist the respondent to arrive at either a minimum lump sum or a minimum annual payment.

END OF FISHING LICENCE GAME

RATES GAME

By increasing fishery management efforts, such as the rearing and release of smolts into the river, it is possible to increase numbers of salmon returning to the Rakaia each year. This work is expensive.

20a WOULD YOU BE WILLING TO PAY MORE IN ANNUAL RATES IF SALMON STOCKS IN THE RAKAIA WERE DOUBLED FROM PRESENT NUMBERS? (Recall that present numbers average 15,000 with about 5,000 caught by anglers).

20b If yes: iterate amounts to obtain maximum bid.
20c If no: probe reasoning.

21a WOULD YOU BE WILLING TO PAY MORE (Reference the maximum bid above) IN EXTRA RATES IF SALMON STOCKS COULD BE ENHANCED (WITH CERTAINTY) TO 60,000 FISH PER YEAR?

21b If yes: iterate amounts to obtain maximum bid.

21c If no: probe reasoning.

In the absence of concerted fishery management efforts salmon stocks could decline. This could happen because of natural causes such as disease or blockage of the mouth.

22A Suppose that salmon numbers were to drop to about half their present numbers (i.e. from 15,000 to 8,000 fish). WOULD YOU BE WILLING TO PAY MORE IN ANNUAL RATES TO ENSURE THAT THE NECESSARY RESEARCH AND MANAGEMENT WAS CARRIED OUT TO RESTORE SALMON STOCKS TO THEIR PRESENT LEVEL?

22b If yes: iterate amounts to obtain maximum bid.
22c If no: probe reasoning.

23A Suppose that salmon numbers were to fall to 1/4 their present numbers (i.e. from 15,000 to 4,000). WOULD YOU BE WILLING TO PAY MORE THAN (reference previous bid) TO ENSURE THAT SALMON STOCKS WERE MAINTAINED AT THEIR PRESENT LEVEL?

23b If yes: iterate amounts to obtain maximum bid.
23c If no: probe reasoning.

24 Raising rates to property owners is one way of collecting revenue for protection and management of the Rakaia salmon fishery. CAN YOU THINK OF ANY OTHER METHODS, FOR EXAMPLE FISHING LICENCE FEES, THAT MIGHT BE BETTER (OR WORSE)?
Please explain.

If salmon stocks decline as a result of river development, one might argue that some form of compensation was due, to the extent that the loss affected individuals personally.

25 If, because of development on the Rakaia River salmon stocks were reduced to 4,000 fish (i.e. ¼ their present number), WHAT MINIMUM AMOUNT OF COMPENSATION WOULD MAKE YOU EQUALLY WELL OFF?

Probe to assist the respondent to arrive at either a minimum lump sum or a minimum annual payment.

END OF RATES GAME

RESEARCH REPORTS

251 **Environmental Beliefs and Farm Practices of New Zealand organic, Conventional and GE Intending Farmers.**
Fairweather, John R., Campbell, Hugh R., Tomlinson, Craig J. and Cook, Andrew J. 2001

252 **An Assessment of the Economic Costs of Relapsing-Remitting Multiple Sclerosis in the Canterbury/Westland Region of New Zealand.**
Jackson, Diana., Tomlinson, Craig J., Fairweather, J. and Donaldson, I. 2001

253 **Research on the Consequences of Converting to Organic Production: A Review of International Literature and outline of a Research Design for New Zealand.**
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