Ministry for the Environment
Manatū Mō Te Taiao

Option and Existence Values for the Waitaki Catchment

Report prepared for Ministry for the Environment by

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1. Purpose

The task of the Waitaki Water Allocation Board is to prepare a water allocation plan for the whole Waitaki Catchment. The SKM report on a *National Cost Benefit Analysis of Proposals to Take Water from the Waitaki River* identified a lack of information on option and existence values. Having identified that the option and existence values are unknown, the issue that now arises is how significant is this omission – in other words, what is the likely magnitude of these existence (and option) values, and how do they relate to other values established for the river? In addition, how will such values change with variations in flow regimes?

The measurement of existence and option values requires careful attention to economic theory, thorough research planning and execution, and, above all, sufficient resources. This report does not attempt to measure existence and option values. It should be viewed more as a think piece aimed at providing the following:

1. a brief overview of option and existence values as they relate to the Waitaki River
2. a synthesis of any relevant information or studies that might indicate the significance of such option and existence values for the Waitaki River
3. to the extent possible, a prediction of the size of option and existence values relative to other values established for the river
4. a discussion of how such values could be altered by allocation decisions on the river (includes allocation to in-stream uses as well as to activities).

2. Background

In economics, value is based on the preferences an individual attaches to the flow of services associated with a water resource. Addressing the **change** in the flow of services is of particular importance. The maximum amount an individual is willing to pay (WTP) for obtaining a benefit or avoiding a loss reflects the individual's preferences for the gain or loss. The minimum willingness to accept (WTA) measures the compensation necessary for the individual experiencing a loss.

The Waitaki River provides a wide array of services, some of which are currently being used. For example, land, labour and capital (market-priced factors of production) combine with an energy gradient within the catchment to produce electricity. Similarly, land, labour and capital combine with water to produce agricultural products. Both of these outputs are market-priced and measuring the benefits and costs associated with alternative water use is relatively straightforward. However, expenditure to derive benefits from the Waitaki River is not limited to the production of market-valued outputs. For example, anglers spend money on the annual licence required for fishing, along with gear, travel and so on, in order to fish in the river. Similarly, individuals spend money on gear to enjoy white water kayaking. The output (utility enjoyed by individuals and families) is not valued in the market. We refer to these as "use values".

However, some people may place a value on the Waitaki River that is independent of their present use. For example, people may gain utility from the knowledge that the river system is preserved even though they may never visit the site. The SKM report suggests that existing knowledge about this class of values is not sufficient to even provide a qualitative assessment of the proposals considered in the national cost benefit analysis (SKM, 2004). Natural resource values that are independent of individual's present use of the resource are variously termed "existence" and "non-use" values (Freeman, 1993). These values arise from a desire to bequeath environmental resources to one's heirs, a sense of stewardship and a desire to preserve options for the future. Little is known about the qualitative impact of water resource development on existence values. More significantly, no conclusions can be drawn about the **net impact** of each alternative on the flow of environmental services in a qualitative sense. If non-use values are large then ignoring them could result in a misallocation of resources

Non-market valuation methods can provide estimates of environmental impacts in a metric that is consistent with the theoretical underpinnings of cost benefit analysis (CBA). The net present value of each alternative water allocation scenario *i* (NPV_i) is given by

$$NPV_i = \sum_{t=1}^{T} \frac{(B_t^M - C_t^M) + (B_t^{NM} - C_t^{NM})}{(1+r)^t} \qquad \textbf{(1)}$$

Each alternative was assessed over a 30-year time horizon (t = 1, … , 30) using a number of different discount rates (r). The national CBA provides an estimate of efficiency gains in terms of market valued benefits B_t^M and costs C_t^M ; that is, the first bracketed term in the numerator of equation (1). As noted in the SKM report, a more comprehensive estimate would include so-called non-market valued impacts; *viz* the non-market valued benefits B_t^{NM} and costs C_t^{NM} included in the second brackets in the numerator of equation (1). We now turn to an overview of non-market values.

3. Total economic value

Total economic value, as illustrated in Figure 1, provides a convenient framework for organising the different classes of value that might be associated with water resource development in the Waitaki Catchment.

- *Use values*: Use value derives from actual use of the water resource. For example, water as an input into dairy production; the energy potential in water to generate electricity; angling and hunting; and so on. As noted earlier, use value necessarily involves the combination of other factors of production with the resource. Use values can be further broken down into:
  - Commercial value, where water is combined with other factors of production and the output sold (eg, milk and electricity)
  - In situ use value, where the services of the water resource are directly (eg swimming) or indirectly (eg hunting) used, but the output (utility in this case) is not marketed
  - Option value, where, although individual's/firm's are not currently using the resource, they might be prepared to pay for the right to use the services of the resource at some later date (Weisbrod, 1964; Freeman, 1993). Option value is not related to current use and is typically used to measure the value attached to future use opportunities. To be consistent, option value need not be exclusively related to "recreational use". For example, dryland farmers in the Waitaki Catchment might be willing to pay for the opportunity to withdraw water from the Waitaki River in the future. Similarly, anglers not currently fishing the Waitaki River might be willing to pay for a future opportunity to fish in the Waitaki River
  - Quasi-option value is a term used to describe the welfare gain associated with delaying a decision when there is uncertainty about the payoffs of alternative choices, and when at least one of the choices involves an irreversible commitment of resources. Quasi-option value stems from the value of information gained by delaying an irreversible decision to develop a natural environment; it is not a value that individuals attach to changes in the natural resource (Freeman, 1993).
- *Non-use values:* These are independent of the individual's present use of the resource and are variously described as "existence value", the value from knowing that a particular environmental assets exists (eg endangered species); and "bequest value", the value arising from the desire to bequeath certain resources to one's heirs or future generations (eg habitat preservation).

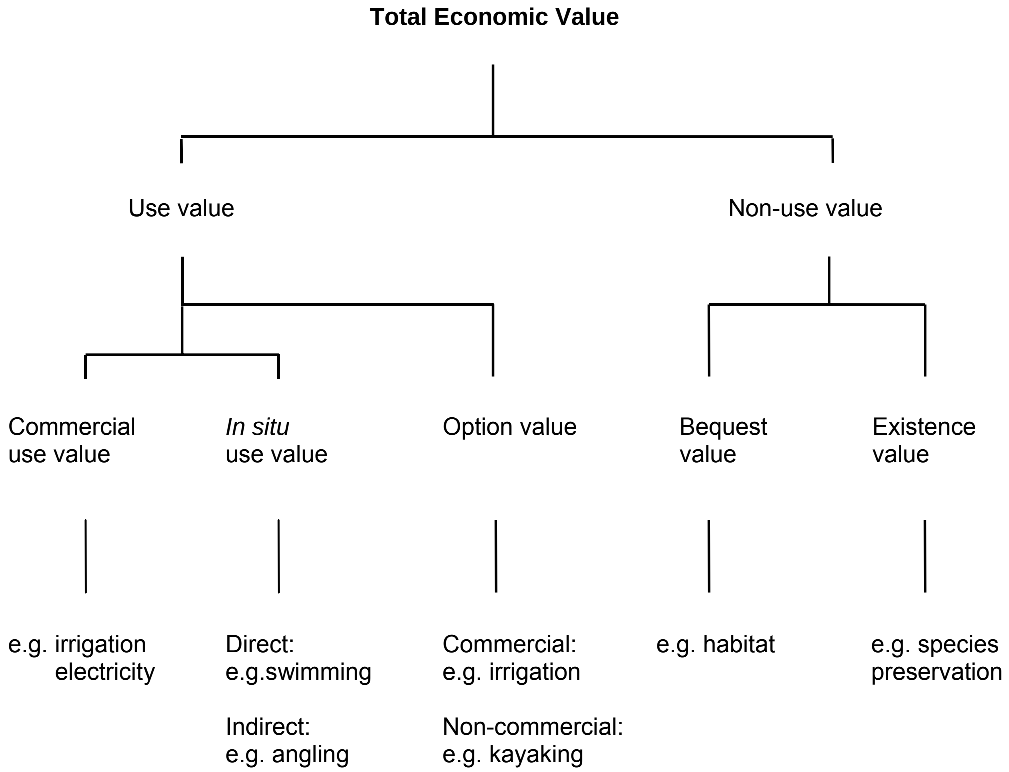

Figure 1. Total economic value

Potential changes to the Waitaki River, whether emanating from hydro-electric energy development, irrigation, natural processes or for other reasons, can result in changes to natural character and to use of the environment. Changes in natural character affect the values that citizens perceive to be embodied in the environment. The signs on existence and recreation use value changes cannot be known *a priori*; they depend upon the nature of the proposed changes. For example, development activities can create or enhance recreational opportunities – or they can destroy them, depending on the type of development and its specific design and operation parameters. Consequently, development activities can reduce or enhance recreation use values (and existence values).

Total Economic Value (TEV) is the sum of all benefits obtained from a resource.

TEV = Use Value + Option Value + Bequest Value + Existence Value

= Use Value + Non-Use Value[1]

Because it is extremely rare for a resource to be completely eliminated because of management actions (although that is possible), TEV normally has little meaning by itself. Most management decisions entail partial changes to the resource, which means that the components of TEV change between states of the world, but may not be zero in any case. Consequently, in a policy context or for application of cost benefit analysis, it is sufficient to know the *change* in TEV between different states of the world.

[1] We include option value under “non-use value” to distinguish it from existing/current “use values”.

Applying the "with/without" criterion to TEV we get

$\Delta TEV = TEV_{\text{With the project}} - TEV_{\text{Without the project}}$

$= (\text{Use Value} + \text{Option Value} + \text{Bequest Value} + \text{Existence Value})_{\text{With the project}}$

$- (\text{Use Value} + \text{Option Value} + \text{Bequest Value} + \text{Existence Value})_{\text{Without the project}}$

$= \Delta\text{Use Value} + \Delta\text{Option Value} + \Delta\text{Bequest Value} + \Delta\text{Existence Value}$

Figure 2 illustrates how components of TEV can be combined and used to examine the economic efficiency of alternative allocation policies. In this example, the net marginal benefits from water abstraction $ΔUV (say, for irrigation) are shown to be balanced against the net marginal *non-use* benefits of leaving water in the Waitaki River (say, for habitat preservation) $ΔIV (Sharp, Kerr and White, 2000). Without this information, we can't draw efficiency conclusions about alternative allocation policies.

The recently completed analysis of Project Aqua and called-in Waitaki submissions provides some insights into community issues (Harte & Comfort, 2004). For example, of the issues listed under "Waitaki called-in applications"; the use values "fisheries" and "recreation" are ranked 1 and 2 respectively, and the non-use value "ecology/ecosystems: in-stream/in-river" was ranked 7. We note that the ranking are based on the number of submissions raising the issue and not on preferences.

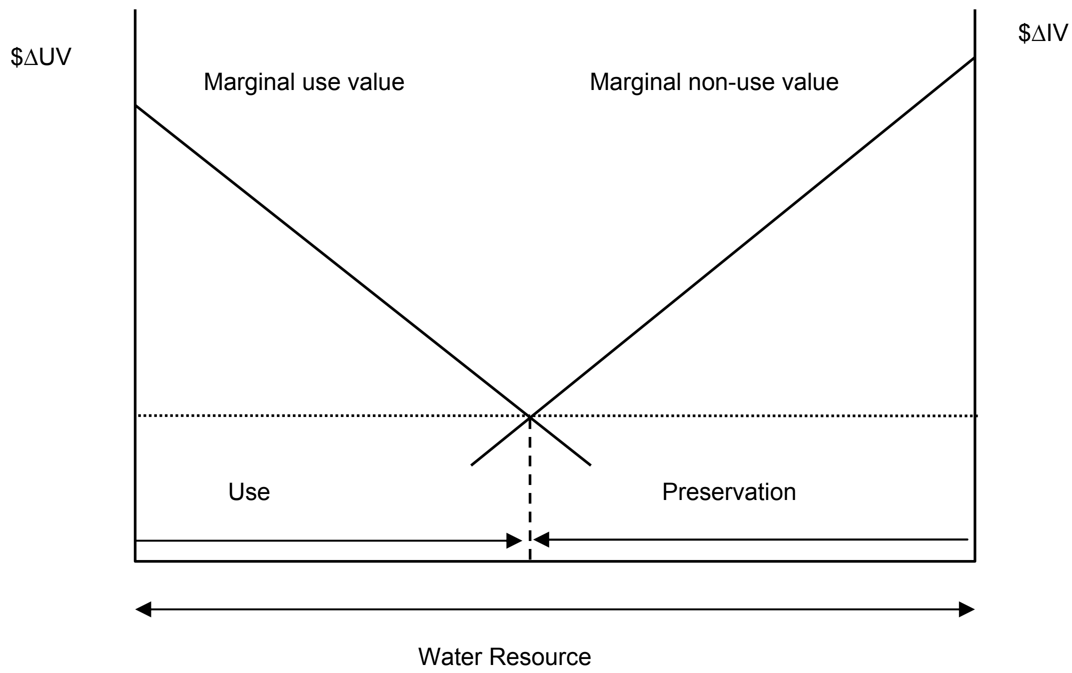

Figure 2: Balancing water use values with non-use values

Valuation methods differ in their ability to measure elements of value. For example, travel cost studies can measure use values, but are unable to measure any other components of TEV. Contingent valuation and other stated preference approaches, on the other hand, are capable of measuring TEV, but are generally unable to identify the values associated with individual TEV components. Recent advances in stated preference methods provide opportunities to separate use and non-use components.

Use value

Use values can derive from market-related activities or non-market activities. These may be extractive or non-extractive. For example, agricultural extraction of irrigation water produces marketed benefits (a use value) that accrue to the farmer as additional profits compared with non-irrigated farming. On the other hand, recreational kayakers are non-extractive users of river water who obtain benefits (a use value) that are not normally captured in a market. Non-commercial recreation bestows benefits that do not pass through a cash register or enter into a balance sheet. Changes in resource management rules have the ability to affect both marketed and non-marketed user values derived from resources.

Recreational use value

Monetisation of recreational use values is based on the premise that people who undertake recreational activities receive benefits from their recreation, despite not having to pay directly for those activities. Monetisation normally entails measurement of how much extra money recreators would be willing to pay, if they had to, in order to continue their recreation activities at current levels under existing conditions. Examination of non-market recreation benefits is beyond the terms of reference for this study. However, recreation benefits can be a major component of total economic value. Kerr (2004) has estimated New Zealand recreation benefits in the order of \$36 per angler-day for freshwater sport fishing and \$21 per recreator-day for other activities. Kerr (2004) estimated total recreational activity on the lower Waitaki River to be in the order of 60,000 recreator-days per year, yielding annual recreation benefits in the order of \$2 million.

Option value

Option value is related to potential, but uncertain, future resource uses and is likely to be small in the presence of close substitutes. For example, if there are no unique biophysical components on the Waitaki then option value is not diminished by changes in the Waitaki River environment. Similarly, when option value is construed as a type of insurance premium in case of future changes in recreational preferences, that insurance policy would have little value if plentiful substitutes were available at low cost or if planned changes to catchment management have little impact on availability of recreational opportunities. Consequently, option values for jet boating might be expected to be significant under a proposal like Project Aqua, which would have dramatically diminished in-stream flows and reduced large flow, braided river jet boating opportunities. On the other hand, provision of another lake in the Waitaki Catchment, which is already well served by lake recreation opportunities, is unlikely to have any significant impact on option values associated with boating.

Existence value

Changes in natural character affect the values that citizens perceive to be embodied in the environment. These changes are independent of use of that environment and are commonly termed “existence values”, “passive use values”, or “non-use values”. In this report the term **existence value** will be used to cover all non use-related benefits. The signs on existence value changes cannot be known *a priori*; they depend upon the nature of the proposed changes and the views of the people doing the valuing. Introduced species provide a good example. Some people are horrified by the ecological damage caused by Himalayan tahr residing in the upper Waitaki Catchment. For these people, tahr have negative existence value. Other people (non-hunters) are delighted by knowledge of the presence of tahr, on the basis that New Zealand tahr may one day be important in preservation of the species, which is endangered in the Himalayas.

Development and mitigation activities can reduce or enlarge existence values. For example wetland drainage for agriculture may reduce existence values, whereas wetland enhancements caused by elevated groundwater levels because of irrigation may increase existence values.

Existence values can be very large, especially when aggregated over a sizeable population. For example, the Exxon Valdez oil spill in Prince William Sound Alaska entailed losses of existence value in the order of several billion dollars (Carson et al, 1994). That case was unusual in that it entailed a very large physical impact in a unique, pristine natural environment that was perceived to have significant value by a large proportion of the whole United States population. On the other hand, small changes in highly altered, non-unique environments with low population densities may not generate any existence value changes.

Existence values can derive from the built environment as well as from the natural environment. Of particular importance are large scale engineering works and items of historical and cultural heritage. The Māori rock art of the lower Waitaki is a notable element in this category. Some people are fascinated by human-made structures and their existence value may exceed the existence value of the natural environment they replace. For example, it is likely that most people value the existence of the Egyptian pyramids and the ruins at Macchu Picchu in Peru more highly than they value the existence of the original natural environments in those locations. In the Waitaki Catchment context, some people may value the existence of large scale engineering works.

It should be noted that existence values are measured within the context of alternative water allocation plans *viz* what is measured is the **change** in existence value between two states (alternative plans). Therefore it is important to define what the two states are. The relevant states are with, and without, a **specific** project. The Waitaki River and its environs are in a state of change, so the status quo (as the river is now) may not form a relevant benchmark for with/without analysis of specific development proposals.

4. Benefits transfer

Estimating the so-called “non-market costs and benefits” described in equation (1) using primary research methods such as contingent valuation, the travel cost method or choice experiments is time-consuming and expensive, and cannot be justified for a scoping study of this type. In such instances, existing knowledge from research at other sites can be used in a process known as “benefit transfer”. Benefit transfer entails collection of value estimates from other locations (study sites), being careful to match environments, users and proposed changes as closely as possible. The best matching results are then used as estimates of value at the site under investigation (the policy site). Alternatively, results at study sites can be averaged, or they can be adjusted to reflect better the situation at the policy site.

The three principal methods of transferring benefits from a study site or sites to a policy site (in this case, the Waitaki River) are:

1. *Direct transfer*. In direct transfer, mean values estimated at the study site, or several study sites, are used directly at the policy site, without adjustment to reflect policy site characteristics. For example, it is conceivable that a point estimate of “existence value” benefits associated with habitat preservation in the Waitaki Catchment could be obtained by using the mean, median or range) per capita dollar value from a study undertaken elsewhere in New Zealand and multiplying this value by the number of households affected by Waitaki water allocation. As expected, extremely strong assumptions need to be invoked viz the change in environmental conditions are identical as are population characteristics (preference structure, ethnicity, age, household size, and so on).

2. *Benefit function transfer*. This approach uses the valuation function estimated at the study site as a basis for estimating values at the policy site using policy site parameters (ie, those pertinent to the Waitaki). For example, a study may have estimated a value function for household i, as $WTPi = a + bX + cY + e$; where X = site/good characteristics, Y = respondent characteristics (age, income, ethnicity, etc) and e = statistical error. The estimate of value is obtained by plugging site specific values into the function.

3. *Meta-analysis*. Meta-analysis is another form of valuation function benefit transfer. Regression analysis is applied to the results of other valuation studies completed at many sites to identify statistically the influences of site attributes on value. Meta-analysis has an advantage in that it uses information from a number of studies.

The extensive literature on benefit transfer is in general agreement that the approach can produce large errors – transferred benefits are frequently in disagreement with primary valuation studies carried out at the policy site (Brouwer, 2000; Brouwer & Spaninks, 1999; Vandenberg et al, 2001). Meta-analysis, which uses results from a large number of studies to identify the role of site attributes, is acknowledged as the most accurate benefit transfer approach. Benefit function transfer and point estimate transfer are less reliable, with benefit function transfer typically preferred to point transfer (Brouwer & Spaninks, 1999; Rosenberger & Loomis, 2003; Vandenberg et al, 2001). Typically large errors associated with benefit estimates at study sites warn of the need for caution when transferring simple point estimates. Despite lack of precision, benefit transfer is the only available indicator of non-market values in the absence of a site-specific study. It is an approach that is generally accepted as providing order of magnitude estimates of values that indicate whether further, site-specific valuation work is warranted.

5. New Zealand studies that indicate potential value magnitudes

Methods

Relevant New Zealand case studies have been identified from the New Zealand Non-Market Valuation Database (www.learn.lincoln.ac.nz/markval). In most instances, stated preference studies have been employed to measure community willingness to pay to obtain a specified change in the environment. Typically, the environmental scenarios evaluated entail changes in both use and existence values – assessing the changes in total value and not providing any way to identify the relative significance of existence values in the total.

Each study has been reviewed to identify the nature of the items valued, the time of the study, the group whose values have been measured (individuals, households, etc), and the estimated values. This information has been entered into a spreadsheet to allow the disparate values to be converted to a common basis for comparison. No attempt has been made to evaluate the quality of the individual studies. To provide indicative net present values the following parameters have been assumed: two adults per household, one million households, 10 percent discount rate. All values have been converted to December 2003 equivalents using the all groups' consumers' price index.

It is common for people to feel more affinity for proximate resources, implying that existence values may decline with distance. Similarly, recreation use benefits, and therefore option values, are known to decline with distance. If these non-use values decline with distance, then it is not possible to use local and regional studies as a basis for national existence value estimates. Doing so would result in exaggeration of true national benefit changes. Despite this problem, local and regional studies have been used here as the basis for extrapolation to the nation in order to obtain an indication of upwardly biased estimates – to provide an "upper bound" estimate.

Many of the studies address existence values associated with proposed changes directly affecting rivers. Several of the others address water-related matters. Most of the river-related studies address specific stream attributes. Harris' (1984) Waikato River study and both the Sheppard et al (1993) and Kerr, Sharp and Leathers (2004) Waimakariri studies valued the impacts of pollution. The other Waimakariri River studies (Kerr, Sharp, & Leathers, 2004), the Rakaia River studies (Kerr, Sharp, & Leathers, 2004), and the Ashburton River study (Lynch & Weber, 1992) valued river flows. The Auckland streams study (Kerr & Sharp, 2003) addressed several specific stream attributes.

Two studies have taken a national perspective: Kerr's (1985) study of Kawarau River values and Greer and Sheppard's (1990) study of funding for biological control of *clematis vitalba*. The latter study was unique amongst the cases studied in that it addressed a once-only payment – it also generated the smallest household value of all studies reviewed ($7 per household per year, NPV = $72 million). The remainder are about evenly split between local and regional studies. Table 1 reports the main elements of the case studies.

Table 1a. New Zealand existence value studies: National level studies

Author(s)	**Study population**	**Item valued**	**$ per house hold per year**	**NPV**
Kerr	NZ households	Prevent Kawarau River hydro-electricity development	$197	$1967 million
Greer & Sheppard	NZ voters	Research into biological control of Clematis Vitalba	$7	$72 million

Note: All money values have been adjusted to December 2003 values using the consumers' price index

Table 1b. New Zealand existence value studies: Regional level studies

Author(s)	Study population	Item valued	$ per house hold per year	NPV
Harris	Households in 4 main Waikato urban centres	Prevent **Waikato River** pollution returning to 1960s quality	$93	$928 million
Kerr, Sharp & Leathers	Canterbury households*	Prevent **Waimakariri River** irrigation development for 5 years	$37	$155 million
		Preserve the **Waimakariri River** in its existing state	$42	$421 million
		Improve **Waimakariri River** water quality from D to C standard	$34	$346 million
	Canterbury households* that use the Waimakariri	Prevent **Waimakariri River** irrigation development for 5 years	$45	$187 million
		Preserve the **Waimakariri River** in its existing state	$51	$512 million
		Improve **Waimakariri River** water quality from D to C standard	$40	$401 million
	Canterbury households* that do not use the Waimakariri	Prevent **Waimakariri River** irrigation development for 5 years	$15	$63 million
		Preserve the **Waimakariri River** in its existing state	$12	$117 million
		Improve **Waimakariri River** water quality from D to C standard	$14	$135 million
Kerr, Sharp & Leathers	Canterbury households*	Prevent **Rakaia River** irrigation development for 5 years	$44	$182 million
		Preserve the **Rakaia River** in its existing state	$43	$430 million
	Canterbury households* that use the Rakaia	Prevent **Rakaia River** irrigation development for 5 years	$77	$321 million
		Preserve the **Rakaia River** in its existing state	$77	$766 million
	Canterbury households* that do not use the Rakaia	Prevent **Rakaia River** irrigation development for 5 years	$25	$104 million
		Preserve the **Rakaia River** in its existing state	$25	$249 million
Beanland	Manawatu-Wanganui Region households	Payment of a special rate to lease and preserve Aorangi-Awarua forest (on private land)	$11	$113 million
Lynch	Canterbury households (excludes Ashburton)	Preserve **Ashburton River** flows	$70	$703 million
Lock	Manawatu-Wanganui Region households	Payment into a Manawatu-Wanganui possum control fund	$88	$879 million
Mortimer, Sharp & Craig	Auckland households	Maintain current conservation activities on Little Barrier Island	$45	$454 million

Note: All money values have been adjusted to December 2003 values using the consumers' price index

* Canterbury households situated between the Conway and Rangitata rivers

Table 1c. New Zealand existence value studies: Local level studies

Author(s)	Study population	Item valued	$ per house hold per year	NPV
Fahy & Kerr	Otago University second year economics students	Research into prevention of albatross chick fatalities at Taiaroa Head albatross colony	$54	$542 million
Lynch	Ashburton District households	Preserve **Ashburton River** flows	$118	$1180 million
Sheppard et al.	Christchurch Households	Improve **lower Waimakariri River** water quality from D to C standard	$138	$1379 million
Lambert, Saunders & Williams	Dunedin City households	Upgrade Dunedin sewage disposal to water	$63	$634 million
		Upgrade Dunedin sewage disposal to land	$89	$895 million
Moore	Horeke, Tapeka & Russell households	New community sewerage schemes	$73	$730 million
Williamson	Auckland City households	Orakei Basin water quality	$11	$113 million
White, Sharp & Kerr	Waimea Plains households	20% reduction in Waimea Plains groundwater extraction	$203	$2033 million
Kerr & Sharp	North Shore households	Stream channel rehabilitation	$59	$588 million
		Stream clarity	$67	$669 million
		Streamside vegetation	$21	$213 million
		Loss of one native fish species	$11	$112 million

Note: All money values have been adjusted to December 2003 values using the consumers' price index

The highest value per household ($203 per year) was produced by a local study, which addressed values associated with reduced groundwater extraction on the Waimea Plains in Nelson (White, Sharp, & Kerr, 2001). This figure was nearly matched ($197 per household per year, NPV = $2 billion) by the national study of values associated with proposed Kawarau River hydro-electricity developments (Kerr, 1985).

The column headed NPV reports the (absolute) net present value of existence benefit changes assuming that values can be extrapolated to the whole country[2]. The magnitudes of the entries in the NPV column indicate the potential significance of non-market values. The Ashburton River study estimated preservation values both for Ashburton ($118 per household per year) and for the rest of Canterbury ($70 per household per year). The smaller regional values support the hypothesis that existence values decline with distance. Aggregating that regional figure over all Canterbury households indicates (largely non-use) NPV benefits from preservation of Ashburton River flows in excess of $70 million. The NPV of flow protection on the Waimakariri River for Canterbury households is in the order of $60 million.

For the studies in Table 1, existence values are generally confounded with use values. Changes in river attributes such as flow, pollution levels and even impoundment, can affect the amenity gained from activities such as boating, fishing, picnicking and walking. Amenity users may have higher existence values than others because of their familiarity with and affinity for the amenity. Disentangling use and existence values may be impossible. It may also be of little importance. A high use river (for example) may produce recreation use value benefits in the order of $2 million

[2] This approach is biased (recall the earlier warning), but yields an extreme upper bound on national values.

per annum, yielding NPV in the order of $20 million. This may be small in comparison to total value changes as indicated by the NPV column in Table 1.

The suite of studies undertaken on the Waimakariri and Rakaia Rivers by Kerr, Sharp and Leathers (2004) provides some information that helps to understand the likely impact of river use on existence values. Those studies instructed respondents to concentrate on non-use values in constructing their responses to contingent valuation questions. There is no way to know how well respondents followed this instruction. If river users could not successfully undertake this separation of values then users' responses may include elements of use value. Confounding with use values does not occur for non-users of the rivers. However, non-users' option and quasi-option values may not be zero, so while it is possible to gain an indication of differences between use and non-use values, it is still not possible to isolate existence value. The Rakaia and Waimakariri river studies consistently produced non-use value estimates that were larger for river-user households than for non-user households (Table 2).

Table 2. Mean (and median) non-use values by population

River	Population	Prevent irrigation development for 5 years	Preserve River at the status quo	Improve water quality from D to C standard
Rakaia	Aggregate	$44 ($5)	$43 ($3)	
	Non-users	$25 ($1)	$25 ($1)	
	Users	$77 ($25)	$77 ($25)	
	Anglers	$72	$74	
Waimakariri	Aggregate	$37 ($4)	$42 ($12)	$34 ($12)
	Non-users	$15 ($1)	$12 ($1)	$14 ($1)
	Users	$45 ($11)	$51 ($13)	$40 ($13)

Note: Estimates are $ (December 2003) per household per year

Application to all Canterbury households of non-users' values for preserving the rivers at their status quo conditions yields lower bound annual non-use benefits to the region of about $3.7 million (Rakaia) and $1.8 million (Waimakariri). True regional values are likely to exceed these figures because river users probably have higher existence values than non-users. National values would be higher again.

Study designs have generally only permitted non-market value changes to take a single sign – because the studies have assumed that development initiatives will diminish aggregate non-market values (the sum of use, existence, option and quasi-option values). This assumption is likely to have resulted in overstated non-market value changes from development. For example, Lynch's Ashburton River study (Lynch & Weber, 1992) produced mean annual willingness to pay of $70 for Canterbury residents and $118 per household for non-fishing Ashburton households. However, median willingness to pay for those two populations were (-$64) and (-$65) respectively. The negative signs could indicate that most households actually preferred the lower flow levels[3]. The skewed nature of responses is also illustrated by Sheppard et al's (1993) study of annual willingness to pay to improve lower Waimakariri River water quality. Mean WTP was $111 per household, but the median was substantially less at $45. Similar results are found for the Waimakariri River and Rakaia River studies reported in Table 1.

[3] This interpretation may be incorrect in the situation where there is a large proportion of the population who simply do not care about Ashburton River flows. In that case the median may actually be zero.

Option and quasi-option values

No New Zealand studies have attempted to isolate and measure option value or quasi-option value. However, as noted above, option value and quasi-option value have been measured indirectly during studies that have estimated total economic value (TEV).

Conclusions

Existing studies indicate that New Zealand residents can place high value on protection of the natural environment. Study design limitations ensure that it is not always possible to separate use and non-use values, but mean total economic value changes estimated for various management interventions for braided Canterbury rivers falls in the order of $60 per household per year. Where separate values have been obtained, non-use values appear to be substantial.

6. Waitaki Catchment non-market values

Evaluation of changes in non-market values associated with alternative management proposals for the Waitaki Catchment requires identification of the ways in which the catchment differs under each scenario. The remainder of the discussion will address only option and existence value changes. We should emphasise again that option value deals with *future use opportunities;* they do not include existing use values. Thus the benefits to those not currently fishing in the Waitaki Catchment would not be counted under the category of “use value”; but these anglers might be willing to pay something to keep a future use opportunity open – this is counted as an “option value”.

Key potential changes in the Waitaki Catchment include reallocations of water between in-stream flows, abstractive irrigation and hydro-electricity generation, which can involve impoundment, abstraction or other impacts on river flows and the surrounding environment. The scale and direction of TEV changes will depend upon the types of changes proposed and the values held by people affected by those changes.

Table 3. Potential causes of value change

Non-market value	Value change caused by changes in:
Use value	Recreational amenity
	Visual amenity
Option value	Supply of recreational resources
Existence value	Natural character
	Water quality
	Soil erosion
	Endangered species populations
	Biodiversity

Recreation use values

Existing recreational use benefits of the lower Waitaki River are in the order of $2 million per annum (Kerr, 2004). The relative magnitude of upper catchment recreational benefits has not been calculated. The complete loss of all recreational opportunities on the lower Waitaki would result in costs of about $2 million per annum from reduced use values. This approach does not provide a measure of ***changes*** in recreational use values contingent upon specific developments or other activities or processes in the catchment. Instead, it provides a measure of recreational values ***potentially at risk***. It provides an estimate of the cost of a total loss of *all* existing recreation activities – commonly termed an "all or nothing scenario". In practice, most catchment changes affect only some recreation activities; they are unlikely to completely eliminate most (if any) activities; they can enhance some recreational activities; and they frequently create new recreation opportunities[4].

Option values

Option values are related to the range of use (eg, recreational and abstractive) opportunities and the uncertainty associated with people's expectations about future use of those facilities. For example, when dealing with recreational values, if people are risk averse and think they may, in the future, take up a recreational pursuit then they may be willing to pay now to ensure that suitable facilities are available in the future – a type of insurance.

To gain an understanding of the potential magnitude of Waitaki Catchment option values, it is necessary to consider the types of activities that are available there now or could be made available in the future under alternative management scenarios.

Table 4. Option value impacts

Recreational activity	Substitute availability	Potential to be affected by catchment management	Likely option value impacts
Kayaking (white water)	Limited locally	High	High (but low use)
River-based power boating	Moderate	High	Moderate (but low use)
River fishing	High	High	Low
Lake fishing	High	High	Low
Picnicking	High	Moderate	Low
Scenic touring	Low	Moderate-Low	Low
Small game hunting	High	Low	Very low
Rowing	Very low	Very low	Very low
Tramping	High	None	None
Large game hunting	High	None	None
Lake-based boating	High	Low	None
Mountaineering	Low	Low	None

[4] The upper Waitaki hydroelectric energy scheme provides an example. Changes to flow regimes in some parts of the catchment (eg, the Pukaki River, which was dewatered) destroyed fishing and white water recreation resources. However, the scheme created new water sport facilities at Lake Ruataniwha, the Tekapo artificial white water course, and a new fishing resource in the hydro canals.

Provision of kayaking facilities has the highest potential to impact on option values for individual recreators. There are few white water kayak opportunities in the Waitaki Catchment, although the neighbouring Clutha and Rangitata catchments provide quality opportunities for highly-skilled paddlers. Catchment management has the potential to influence availability of white water facilities, principally through artificial course development and recreational flow releases. Consequently, changes in catchment management could have significant effects on current and potential kayakers' option values. However, only a very small proportion of the population is involved in, or potentially involved in, white water kayaking, so while individual effects might be large, the aggregate impact is likely to be small.

Lake-based boating is common in the Waitaki Catchment. However, the close proximity of lakes in the Clutha Catchment, the large number of lakes in the Waitaki Catchment, and the limited impacts of catchment management on lake boating opportunities indicate that potential option value impacts of a change in any one lake are insignificant.

Existence values

Changes in existence values typically arise because of impacts on the structure and functioning of the natural environment. In general, people place higher value on natural environments (eg, braided river systems) that are functioning well, are not polluted, and/or support rare or endangered species.

Reductions in water quality in the Waitaki Catchment, for example from agricultural runoff or community sewage discharges, would be likely to reduce existence values (and may also affect recreational use values).

Changes in biodiversity can have significant existence value impacts. Potential causes in the Waitaki Catchment include conversion of native grasslands to pasture or introduced forest, introduction of pest species such as wilding pines, mustelids and lagorasyphon, or changes in wild species habitats caused by different drainage patterns, vegetation changes and provision of artificial food, shelter and nesting sources.

Impacts on endangered species, such as the black stilt or the wry-billed plover, have the potential to produce significant impacts on existence values. Such impacts may arise from direct management interventions (such as Project River Recovery) or from indirect impacts such as loss of habitat or increased predation.

7. Discussion and conclusions

Existing information on the likely environmental impacts of water resource development points to quite variable impacts in the Waitaki Catchment. Beyond this observation, it is difficult to draw any firm conclusions other than: (a) environmental impacts differ across irrigation and hydro-electricity development; (b) little is known about the qualitative impact of water resource development on changes in the environment that could possibly impact non-use/existence values; and (c) even in a qualitative sense, it is not possible to summarise the net impact of each alternative on the flow of environmental services. In the absence of this information the prospect of misallocating a scarce water resource remains a distinct possibility.

Even allowing for possible inaccuracy, change in TEV estimates derived for the Kawarau River indicate that people from all over New Zealand placed significant values on protection of the natural environment. For the Kawarau case, non-market values amounting to hundreds of millions of dollars per year send a clear signal that non-market impacts can be of sufficient magnitude to cause otherwise financially viable developments to fail a cost benefit test. Very few of the respondents to the Kawarau study would have engaged in active recreation on the river (fishing, white water rafting, goldmining, etc), although many would have travelled along the highway traversing the section of the river that would have been affected by the proposed hydro-electricity development. Such travellers would have considered the aesthetic effects of the development – a type of use value. Even so, magnitudes of use value estimates from other New Zealand non-market valuation studies indicate that non-use impacts are likely to have been the source of a very large proportion of estimated change in TEV for the Kawarau case.

Could the Waitaki catchment have TEV of similar magnitude to the Kawarau? That depends on the nature of any proposed changes in the Waitaki Catchment, people's awareness of the Waitaki Catchment's attributes, and their attachment to them. The Kawarau River hydro-electricity development proposals concentrated development within a rugged, narrow river corridor containing obvious historic artefacts beside a state highway in an area receiving high visitor usage from across the country. Some potential developments in the Waitaki Catchment might be less obvious and less important.

Existing studies indicate that New Zealand residents can place high value on protection of the natural environment. Study design limitations ensure that it is not always possible to separate use and non-use values, but mean total economic value changes estimated for various management interventions for braided Canterbury rivers falls in the order of $60 per household per year. Where separate values have been obtained, non-use values appear to be substantial.

If recreational use values are in the order of $2 million per annum, this capitalises into $20 million (at a 10% discount rate) or $40 million (at a 5% discount rate) (Kerr, 2004). The relative magnitude of upper catchment recreational benefits is not known, principally because of the absence of information on recreational activity levels. The complete loss of all recreational opportunities on the lower Waitaki would result in costs of about $2 million per annum from reduced use values.

In general, people place higher value on natural environments that are functioning well, are not polluted, and/or support rare or endangered species. Reductions in water quality in the Waitaki Catchment, for example from agricultural runoff or community sewage discharges, would be likely to reduce existence values (and may also affect recreational use values). Changes in biodiversity can have significant existence value impacts. Impacts on endangered species, such as the black stilt or the wry-billed plover, have the potential to produce significant impacts on existence values.

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