BEFORE THE ENVIRONMENT COURT

In the matter of	the Resource Management Act 1991 ("the Act")
And in the matter of	the Proposed One Plan for the Manawatu-Wanganui Region
Between	FEDERATED FARMERS OF NEW ZEALAND ENV-2010-WLG-000148
And	MINISTER OF CONSERVATION ENV-2010-WLG-000150
And	DAY, MR ANDREW ENV-2010-WLG-000158
And	HORTICULTURE NEW ZEALAND ENV 2010-WLG-000155 Appellants
And	MANAWATU-WANGANUI REGIONAL COUNCIL Respondent

STATEMENT OF EVIDENCE OF DR DAN MARSH ON BEHALF OF WELLINGTON FISH & GAME

---

1 INTRODUCTION

My qualifications and experience

1 My full name is Dr Daniel Kenneth Vawdrey Marsh. I am the chairperson of the Department of Economics at the University of Waikato. I hold a Master of Agricultural and Forest Sciences (MA Oxon, 1979) from the University of Oxford, UK and a MSc in Agricultural Economics from the University of Reading (1980), UK. I also hold a PhD in Economics from the University of Waikato (2004).

2 I have more than thirty years' experience as an economist specialising in agricultural and environmental issues, with a particular emphasis on water resources economics. Within New Zealand I have specialised over the last five years, in non-market valuation of water quality changes and in the incorporation of costs and benefits into assessment of alternative environmental policies.

3 I am the immediate past president of the New Zealand Agricultural and Resource Economics Society (NZARES) and a member of the Australian Agricultural and Resource Economics Society (AARES) and the European Association of Environmental and Resource Economists (EAERE). I have been President of NZARES twice (most recently 2010/11) and have served on the Council of AARES. I regularly attend and present papers at NZARES, AARES and EAERE conferences in order to keep up to date with the latest developments.

4 I led the University of Waikato component of a large externally funded Research Programme from 2007-11, (Delivering Tools for Improved Environmental Performance - PROJ-12559-PASTORAL-AGR) funded by the Foundation for Science Research and Technology and Pastoral 21 partners Dairy New Zealand, Meat and Wool New Zealand and Fonterra.

5 I have been Chairperson of the Department of Economics at the University of Waikato since February 2010. I have been employed by the University of Waikato as Lecturer, then Senior Lecturer since 1995.

6 I have read the Environment Court's Code of Conduct for Expert Witnesses contained in the Practice Note on Alternative Dispute Resolution and Expert Witnesses issued by the Environment Court on 31st March 2005, and I agree to comply with it. My qualifications as an expert are set out above. Except where I state that I am relying upon specified evidence of another person, the issues addressed in this brief of evidence are within my area of expertise. I have not omitted to consider material facts known to me that might alter or detract from the opinions expressed.

Scope of Evidence

7 My evidence addresses the following:

a. The importance of an adequate cost: benefit analysis;

b. The cost of abatement by farmers;

c. Economic consideration of environmental benefits (including the effect of property rights); and

d. Assessment of costs and benefits of proposed policy options

2 EXECUTIVE SUMMARY OF EVIDENCE

8 In my evidence I a) summarise recent findings that the costs of reducing N leaching are less than previously reported b) summarise recent findings on the benefits of improved water quality and c) analyse some alternative approaches to achievement of proposed One Plan objectives; and d) outline the costs and benefits of the policies that are currently proposed.

9 I present evidence that Neild and Rhodes overestimated the farm level cost of the proposed One Plan because they analysed change in costs rather than

overall profits, because the case study farms were not representative and because they did not use a farm systems approach that would have taken account of the variety of ways in which different farms can adopt least cost options for reducing N leaching.

10 I also present evidence that Neild and Rhodes overestimated the total cost to the MWRC region and to New Zealand as a whole.

11 I consider that N leaching can be reduced at moderate cost and cite the work of Doole, Marsh and Ramilan and Doole et al., where it is reported that "a 4 per cent reduction in profit was required to achieve a 30 per cent N reduction at catchment level ...".

12 There is a rapidly growing New Zealand literature that allows us to estimate the magnitude of people's willingness to pay (WTP) for better water quality. Taken together these various strands of evidence suggest that MWRC residents and recreational users would be willing to pay well in excess of $6 million per year for better water quality in MWRC.

13 Use of WTP to estimate the benefits of improved water quality will significantly underestimate benefits. The right of New Zealand citizens and Manawatu-Wanganui Region residents to sustainable management of natural and physical resources is enshrined in the Resource Management Act. Given this right, the appropriate measure of the benefits of improved water quality is provided by 'willingness to accept' (WTA) compensation for agreeing to forego those rights.

14 WTA is always substantially larger than WTP. I summarised findings from my recent study of the preferences of Canterbury region residents for future water quality in the Hurunui catchment. I found that households would need to be compensated $282 per household per year to accept deterioration in tributary water quality from 'not satisfactory' to 'poor'.

15 Taking the conservative approach of applying the same figure ($282) to WTA deteriorating water quality across the whole MWRC I find that this amounts to more than $23 million per year.

16 I refer to evidence on the cost of alternative policy instruments for reducing N leaching based on the work of Doole, Panell, Marsh and Ramilan (2012 forthcoming; 2012; 2012). We find that none of the currently recommended mitigation practices (or Best Management Practices') are sufficiently profitable in the absence of policies that require farms to reduce environmental impacts, so broad-scale voluntary adoption is unlikely to occur.

17 I provide an overview of the costs and benefits of the proposed policies now under consideration, namely: the Decisions version, Horizons current approach and the Notified approach (as proposed by Wellington Fish and Game). In addition a 'business as usual scenario' has been included to provide a baseline against which the benefits of the different alternatives can be compared.

18 In the 'Business as Usual' and 'Decisions Version' Scenarios, I expect water quality to continue to decline in all catchments.

19 Under '*Horizons Current Approach*' water quality may improve in most catchments, but various factors may prevent water quality improvements being realised; for example, a higher than expected conversion of land for dairy farming or intensification in other land uses. The expected benefits of this approach will be less than the proposed WFG approach because of this uncertainty.

20 Under the *proposed WFG Approach*. Water quality is expected to slowly improve in all catchments, except Waikawa.

21 Taking the WTA approach across the whole MWRC, I find that the benefits of improving water quality under the proposed WFG approach, amount to more than $26 million per year.

22 Based on the mitigation cost reported by Doole et al., ($25 to $62 per hectare) the total cost to the region of the Notified Version (Wellington Fish and Game proposal) would be in the range $1.8-$4.4 million per year. Note that this cost could be reduced by refining the LUC system to allow trading.

23 When the benefit of better water quality is assessed based on 'willingness to accept' the benefit of improved water quality resulting from implementation of the Notified Version (Wellington Fish and Game proposal) will greatly exceed the cost of this policy.

3 THE IMPORTANCE OF AN ADEQUATE COST: BENEFIT ANALYSIS

24 Section 32 of the Resource Management Act 1991 requires councils to prepare an evaluation which demonstrates they have considered the costs, benefits and alternatives of a proposed policy.. The evaluation must examine the extent to which each objective is the most appropriate way to achieve the purpose of the Act and whether, having regard to efficiency and effectiveness, the policies, rules, and other methods are the most appropriate for achieving the objectives.

25 The Ministry for the Environment (MfE) established the Quality Planning Website (www.qualityplanning.org.nz in 2004) to assist councils in developing the expertise needed to follow RMA requirements. The website provides guidelines for conducting a Section 32 analysis including a definition of the two key terms, efficiency and effectiveness, used in Section 32 to determine whether a proposed plan is the most appropriate.

26 "*Effectiveness* means how successful a particular option is/will be in achieving the stated objective… *efficiency* means where the benefits will outweigh the costs, either immediately or over time. The most efficient policy or method will achieve the stated objective with the greatest benefit and at the least cost (costs and benefits may be quantitative, semi-quantitative and/or qualitative)".

27 *Economic Consideration of Benefits in Policy Analysis.* Economic consideration of [environmental] benefits e.g. water quality is most useful in contexts where decision makers are required to weigh up the costs and benefits of better water quality as part of the policy development process. Cost benefit analysis has long had a central role in policy analysis in many government agencies. The Treasury issued an updated guidance note to assist government departments to make proper use of cost benefit analysis in 2005 (New Zealand Treasury, 2005). Some relevant extracts follow: "*This primer seeks to improve the quality of policy and spending proposals by providing guidance on the issues that should be considered and how proposals will be assessed by the Treasury. It is intended for public sector policy and financial analysts and provides simple, accessible and practical assistance. The Primer presents an overview of Cost Benefit Analysis in a New Zealand public sector context, with particular emphasis on the basic questions that are likely to arise (p. 3)…*

28 *There are often cases where a market does not exist or market prices are not directly observable or easy to estimate. In such cases, it may be difficult to estimate costs and benefits ... Wider social and environmental costs and benefits commonly fall into this category, but should not be ignored simply because they cannot easily be costed. (p. 21)".*

29 In my evidence I will contribute to an improved Section 32 analysis by a) summarising recent findings that suggest that the costs of reducing N leaching are less than previously reported b) summarising recent findings on the benefits of improved water quality and c) by analysing some alternative approaches to achievement of proposed One Plan objectives.

Report by Neild and Rhodes

30 Neild and Rhodes were contracted to prepare a report to estimate the economic impact of implementing the Proposed One Plan (POP). This included defining the changes needed to comply with the POP, estimation of the cost of making these changes and using input-output analysis to estimate regional

impact (Neild & Rhodes, 2009, p. 2). Their analysis aimed to address questions raised in the chairperson's minute #6, namely what are the financial and economic impact of these on-farm changes and do the financial and economic impacts vary if the rate of implementation is varied.

31 *Assessment of Financial and Economic Impact.* The analysis by Neild and Rhodes is based on an assessment of the measures that the authors assess would be required to enable case study farms to comply with Rule 13.1. The approach is very technology focussed – with cost estimates being based on a spreadsheet detailing mitigation strategies, the cost of each mitigation and the number of farms on which each mitigation strategy would be adopted. Results are detailed for the present value of costs for the region or per farm, at a discount rate of 6.5% over 30 years. Annual costs per farm, per hectare and per unit of nitrogen abated could usefully have been presented. This would have facilitated comparison with other sources where costs are generally reported in this way. I believe that their approach overestimated costs for the reasons I will now explain:-

32 Their report focuses on increase in costs (rather than change in farm profit) and does not account for the fact that increases in costs may be offset by increased productivity. For example use of stand-off pads may increase animal welfare and production (see evidence by Alison Dewes).

33 The case study farms were not picked randomly, rather farms were selected "which were considered to be challenging" (Neild & Rhodes 2009, page 30) - because of high production intensity, high rainfall or land class. As a consequence, these results greatly overstate average costs and cannot be extrapolated to the region (see also evidence by Alison Dewes – Section on Profitability).

34 Neild and Rhodes used a static, farm level, technology focussed approach. A more flexible farm systems modelling approach would recognise that different farms would respond to Rule 13.1 in different ways and that many farms are

able to identify lower cost options for reducing nitrogen leaching. My comments in this regard are supported by Matthew Newman (for Fonterra) who contended that Neild and Rhodes "does not appear to have conducted a thorough farm systems analysis…." and Duncan Smeaton who reported that: "I am disappointed that none of the case study results presented by Horizons witnesses appear to have included farm systems modelling work which would have provided a deeper understanding of the impacts of the suggested mitigation options suggested. This particularly applies to the evidence of Mr Jeremy Neild and Mr Anthony Rhodes. Farm systems modelling would have provided a safer result in terms of describing the effects of the N leaching limits on farm profitability and the wider impacts at a community level". (see also evidence by Alison Dewes – Profitability).

35 For the reasons set out in paragraphs 32 to 34 above, I believe that the average level of farm level costs and any reduction in farm profit will be lower than the estimates detailed by Neild and Rhodes.

Assessment of Regional and National Impact

36 Appropriate estimation of farm level costs is a prerequisite for estimation of regional impact. I support the comments made by Matthew Newman – suggesting that care needs to be taken in interpreting estimates of regional impact based on input output coefficients. He is also correct in pointing out that Computable General Equilibrium (CGE) analysis provides a much better method for assessing these impacts. Unfortunately, regional data that would enable regional CGE analysis is generally not available in New Zealand.

37 Assessment of regional and national impact needs to take account of the secondary ('knock on') effects of regulation. For example, if dairy farming is more tightly regulated, this will lead to some displacement into other land uses – for example dairy grazing. Likewise, if intensive farming is regulated more tightly in the Manawatu-Wanganui (M-W) Region compared to other regions then there will be some displacement of intensification to other regions.

38 Any displacement of intensification to other regions will signal that national level impact may be less than the regional level impact. On the other hand, regulations introduced in the M-W Region may pave the way for similar regulations in other regions. In this case, national level impact will be greater – but still less than would be suggested by a farm level approach. This is because some landowners may switch from intensive dairy farming to the next most profitable land use activity.

39 A research project has recently been concluded by the University of Waikato (C10X0603 funded by the Foundation for Research Science and Technology, Dairy New Zealand, Meat and Wool New Zealand and Fonterra) looking at the national impact of regulating the New Zealand dairy industry (Rae & Strutt, 2011). This paper describes the impact of environmental regulation that would reduce N leaching to more sustainable levels on New Zealand's international competitiveness, including changes in total export volumes and returns for dairy products and meats, and changes in New Zealand's share of major foreign markets for these products. This project was based on the GTAP-ENZ model, further refined, to address nitrogen and GHG reduction options for New Zealand pastoral agriculture.

40 The authors estimated that national level dairy regulations to reduce nitrogen leaching by around 30% would have very little effect on national income as measured by GDP. They estimated a reduction of 0.03% - $^{3}/_{100}$ of one per cent; note, these results for GDP are not included in the report but are available from the authors on request.

41 Rae and Strutt did not attempt to model the effect of any change in international consumer demand towards sustainable dairy products. The slightly negative effect noted above could easily be overshadowed by even a slight increase in demand for sustainable dairy products in world markets. Such a change in demand might allow a price premium on sustainable dairy products or might lead to a fall in demand for products associated with adverse environmental effects – such as declining water quality.

42 For the reasons detailed above, I believe that the Neild and Rhodes estimates of the total cost of the Proposed One Plan (and other rules) overestimate the cost to the M-W Region and to New Zealand as a whole.

THE COST OF ABATEMENT BY FARMERS

43 The present value of costs reported by Neild & Rhodes can be annualised in order to allow comparison with estimates of mitigation cost from other sources.

Table 1 Neild &Rhodes Abatement Costs per Hectare

	POP	POP, CSA & CCC	Source
PV per Farm	$170,678	$191, 840	N&R page 7
No. of Farms	428	428	N&R page 7
Land Area (ha)	71,168		N&R page 23
Land Area/farm	167.33 ha		Calculated
Annual Cost per Farm	$13,070	$14,690	Calculated @6.5% over 30 yrs
Annual Cost per hectare	$78	$88	Calculated @ 6.5% over 30 yrs

44 The estimated $78-$88 annual cost per hectare can be compared with estimates from other sources. Some of the most recent work in this area was reviewed at a workshop organised by Motu[1], that I attended in May 2011. Expert opinion on abatements costs can be described as falling broadly under three overlapping perspectives; a) leaching can be reduced while increasing profitability; b) leaching can be reduced at moderate cost; c) reduction in leaching can only be achieved at high cost. In my view leaching can be reduced at moderate cost as detailed below.

45 Some experts suggest that *Nitrogen leaching can be reduced significantly while increasing profitability.* Experts in this group suggest that mitigation options are available which will reduce nitrogen losses and improve profitability. An example is provided by Smeaton who gave evidence that farmers in the catchment of Lake Rotorua could reduce N leaching by 5-25% with a minor negative to slightly beneficial effect on profit. His results for the Waikato

[1] Motu Economic and Public Policy Research, Wellington, NZ.

suggest an increase in profitability, for reductions in N leaching of 7 Kg/ha (12%) and a cost of around $20/ha for mitigation by 27% (from 56kg/ha to 41kg/ha). Alison Dewes provides further evidence on various changes to farm level practice that can enable farms to reduce leaching and improve profitability.

46 I consider that these practices generally require high managerial ability and are most likely to be adopted by leading farmers, especially when supported by suitable technical back up. Such changes will not be voluntarily implemented by the majority of farmers because of various constraints (see below). The majority of farmers will not be able to achieve N reduction without an increase in costs. Overall, at a catchment or regional level, reduction in nitrogen leaching is likely to require a moderate increase in costs and will have a (probably small) negative impact on profits.

47 I, along with most other agricultural economists, take the view that farmers are rational decision makers who respond to incentives. If they are not adopting a mitigation strategy that is claimed to improve profitability, then there must be good reasons. For example adoption may have a cost which has not been included in the analysis or may be restricted by a constraint that has not been taken account of e.g. managerial ability. Doole et al., (2012 forthcoming) modelled the cost of mitigation in the Karapiro catchment and found that none of the commonly listed mitigation strategies would be adopted under current policy settings because they do not increase profitability. Similarly, Motu in a recent summary of research in this area[2] found that "best practice land management will not be sufficient to meet the environmental target set by the Bay of Plenty Regional Council.

48 *I consider that N Leaching can be reduced at moderate cost* – but there are few opportunities for simultaneously reducing N leaching while *increasing* profit, given the managerial and other constraints faced by many farmers. My position is supported by Graeme Doole (2011) who found that "under optimal

[2] Motu (2012) Designing Policy to Protect New Zealand's Water Quality

management, the costs [of mitigation] are generally modest … with differentiated emissions standards". He found that a 4 per cent reduction in profit was required to achieve a 30 per cent N reduction at catchment level, or a 14 per cent reduction in profit to achieve a 50 per cent N reduction.

49 Work by Graeme Doole (2011) on the Karapiro catchment in the Waikato suggests that abatement costs vary depending on the policy instrument used (Table 2). His modelling suggests that costs are higher when all farms face a uniform cap – with no trading allowed. For example, reducing average leaching across the catchment from 31 to 30 kg/ha would cost around $23/ha under a uniform cap but less than $1 with trading. Under the uniform cap all farms have to meet the cap irrespective of the cost, whereas with trading abatement is carried out by those farms who can do so at lowest cost.

Table 2: Abatement quantity and cost for simulated policies

Leaching target (kg/ha)	*30*	*26*	*22*
Abatement quantity (kg/ha)	*1*	*5*	*9*
Cap emissions - no trade (cost $/ha)	22.9	49.47	96.6
Cap emissions – trade (cost $/ha)	0.69	14.79	54.39

Source: Doole, Marsh, Panell & Ramilan (2012 forthcoming). Note: Farmers are assumed to make use of Currently Recommended Mitigation Practices (CRMPs)

50 The third group – put forward the view that *reduction in N leaching can only be achieved at high cost.* I do not agree with this view. Analysis supporting this perspective tends to be based on individual farm case studies and a prescriptive approach whereby it is assumed that farmers must adopt various capital items in order to achieve the required level of mitigation. Cost levels reported under this approach may be biased upwards because they do not take account of farmers ability to find lower cost ways of achieving any given mitigation target and also because they may not take account of variation in the cost of mitigation for different farms across a catchment or region.

4 ECONOMIC CONSIDERATION OF ENVIRONMENTAL BENEFITS OF WATER QUALITY

An Introduction to the economic approach to assessing the value of water quality based on excerpts from Sharp and Kerr (2005)

51 Basil Sharp and Geoff Kerr were commissioned by the Ministry for the Environment to report on the option and existence value of the Waitaki Catchment (Sharp & Kerr, 2005). Their report thoroughly documents economic approaches to valuation so I will introduce the economic approach to assessing the value of improved water quality by quoting from this report. Paras 52 to 60 (below) are extracted from this report, with minor modification indicated in [square brackets] where words have been added to clarify the relevance to water quality in the MWRC.

52 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."

53 [Rivers and other water bodies provide] "… 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 .. to produce electricity [by diverting the headwaters of the Whanganui and Rangitikei]. 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 … [rivers] 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*'.

54 However, some people may place a value on … [rivers] 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… 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… If non-use values are large then ignoring them could result in a misallocation of resources".

55 Total economic value, as illustrated in Figure 1, provides a convenient framework for organising the different classes of value that might be associated with … [changes in water quality in the MWRC].

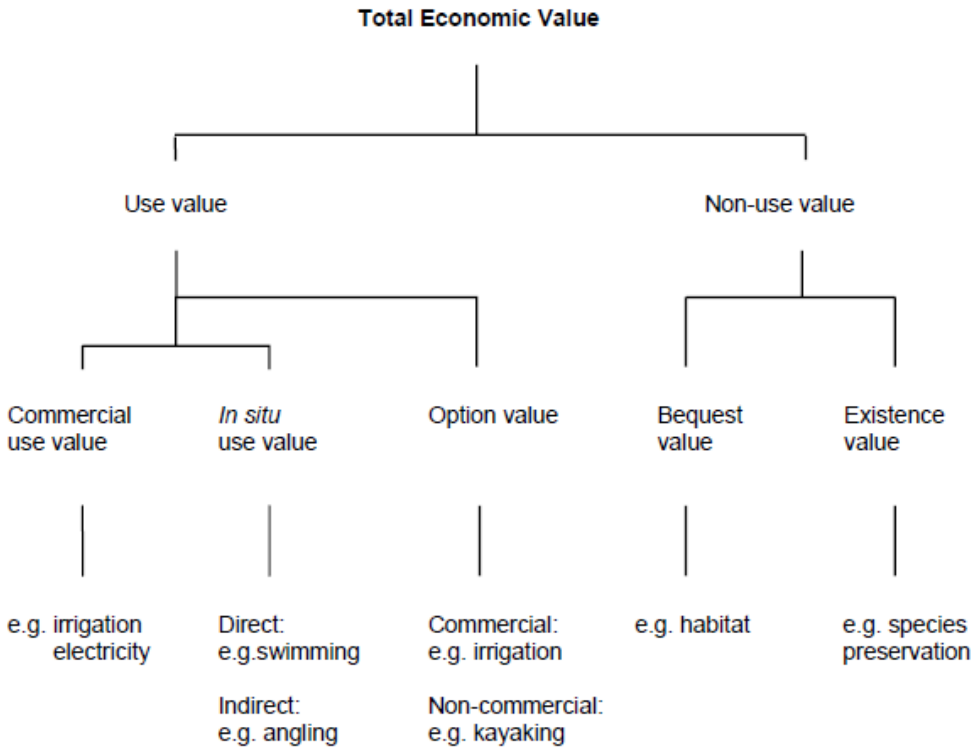
56 *Use values*: Use value derives from actual use of the water resource. For example, water as an input into dairy production; the energy potential in water to generate electricity; angling and hunting; and so on. As noted earlier, use value necessarily involves the combination of other factors of production with the resource. Use values can be further broken down into:

a. *Commercial value*, where water is combined with other factors of production and the output sold (eg, milk and electricity).

b. *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.

c. *Option value*, where, although individuals/firms 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. For example … anglers not currently fishing the [Manawatu] River might be willing to pay for a future opportunity to fish in [that] … River…

Figure 1: Total Economic Value



Reproduced from Sharp and Kerr (2005)

57 *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).

The New Zealand and International Literature on the Value of Better Water Quality

58 There is a large international literature that reports on the benefits of improving water by reducing agricultural pollution. For example, Pretty et al. (2003) estimate the damage cost of freshwater eutrophication in England and Wales to be $105-$160 million per year, while Viscusi et al. (2008) provide estimates for increasing the percentage of lakes and rivers in US regions with water quality rated as "good". New Zealand research in this field is more limited but may be dated back to work by Harris and Meister (1981) on the

benefits of reducing eutrophication in Lake Tutira and analysis of water pollution control in the Waikato Basin (B. Harris, 1983) and the Lake Taupo Catchment Control Scheme.

59 The ecological economics literature overlaps with environmental economics with many areas of agreement and some areas where the two fields are more distinct. The famous Costanza et al., "Value of Global Ecosystem Services" paper attempted to estimate the total value of services supplied by ecosystems on the basis of marginal values (e.g. small changes in the level of services). I consider that the environmental economics approach of focussing on the cost or benefit of a change in water quality is most useful in assessing the benefits of alternative policies that may be implemented by MWRC.

60 This is also the approach generally taken internationally in countries where use of non-market valuation methods to assess environmental benefits and costs has been widely incorporated into the policy making process e.g. USA and Europe (see below). In my view, it is not appropriate to estimate total values based on marginal values (the Costanza approach) and in any case it is unclear how a 'total value' should be used since policy makers are not usually considering the total removal of an ecosystem.

61 Valuation of market and non-market environmental costs and benefits is a well-established part of the public policy making process in many countries. In the United States the Environmental Protection Agency's Guidelines for Preparing Economic Analyses (United States Environmental Protection Agency, 2000)… "establish a sound scientific framework for performing economic analyses of environmental regulations and policies. They incorporate recent advances in theoretical and applied work in the field of environmental economics. The Guidelines provide guidance on analyzing the economic impacts of regulations and policies, and assessing the distribution of costs and benefits among various segments of the population, with a particular focus on disadvantaged and vulnerable groups…"

62 Environmental valuation is also well developed and accepted in Europe and many other OECD countries. The Water Framework Directive has provided a major impetus for non-market valuation of the benefits of better water quality in Europe:

"The Water Framework Directive (WFD) (European Parliament, 2000) represents a fundamental change in the management of water quality in Europe. The Directive imposes outcome-based targets, requiring a shift away from standards framed in terms of the chemical composition of water in favour of an approach which assesses the ecological quality of water bodies…" (Bateman, et al., 2006).

63 The situation in Europe has some parallels with New Zealand in that there is a requirement for policy makers to take account of the costs and benefits of policy measures. This has led to a rapid growth in non-market valuation and use of choice analysis to allow the assessment of costs and benefits. Roy Brouwer (2008) provides a useful introduction to "the potential role of stated preference methods in the Water Framework Directive to assess disproportionate costs".

64 In New Zealand, choice analysis has been used to estimate the value that residents attached to the condition of streams in the Auckland region (Kerr & Sharp, 2003) and the amenity value of spring fed streams and rivers in the Canterbury region (Kerr & Swaffield, 2007). Sharp and Kerr (2005) discuss non market values for the Waitaki catchment as part of a national cost benefit analysis of proposals to take water from that river. They also provide a comprehensive review of all New Zealand studies in this area, including several unpublished papers that address the existence values associated with proposed changes directly affecting rivers.

65 Discrete choice experiments (*choice analysis*) have gained widespread recognition since their early application by Louviere & Hensher (1982) and Louviere & Woodworth (1983) and their earliest application to environmental valuation by Boxall et al (1996). Choice analysis is an attribute-based technique in which respondents are presented with different alternatives defined in terms of

environmental attributes and cost. They are then asked to select their preferred one. The tradeoffs that they reveal during this exercise between the cost of the proposed options and their environmental attributes are used to derive implicit estimates of monetary value under a set of well qualified assumptions.

Examples of non-market valuation of water quality: – The Waitaki Report.

66 Basil Sharp and Geoff Kerr's report on the *option* and *existence* value of the Waitaki Catchment (Sharp & Kerr, 2005) includes a compilation of New Zealand Studies that indicate "potential value magnitudes". The regional studies are probably most relevant to the current investigation and are reproduced below (Table 3):

Table 3 Regional Estimates of the Value of Better Water Quality

Author(s)	Study population	Item valued	$ per h' hold per year	NPV S millions
Harris	Households in 4 main Waikato urban centres	Prevent **Waikato River** pollution returning to 1960s quality	$93	$928 m
Kerr, Sharp & Leathers	Canterbury households*	Prevent **Waimakariri River** irrigation development for 5 yrs	$37	$155 m
		Preserve the **Waimakariri River** in its existing state	$42	$421 m
		Improve **Waimakariri River** water quality standard	$34	$346 m
	Canterbury households* that use the Waimakariri	Prevent **Waimakariri River** irrigation development for 5 yrs	$45	$187 m
		Preserve the **Waimakariri River** in its existing state	$51	$512 m
		Improve **Waimakariri River** water quality from D to C standard	$40	$401 m
	Canterbury households* that do not use the Waimakariri	Prevent **Waimakariri River** irrigation development for 5 yrs	$15	$63 m
		Preserve the **Waimakariri River** in its existing state	$12	$117 m
		Improve **Waimakariri River** water quality standard	$14	$135 m
Kerr, Sharp & Leathers	Canterbury households*	Prevent **Rakaia River** irrigation development for 5 years	$44	$182 m
		Preserve the **Rakaia River** in its existing state	$43	$430 m
	Canterbury households* that use the Rakaia	Prevent **Rakaia River** irrigation development for 5 years	$77	$321 m
		Preserve the **Rakaia River** in its existing state	$77	$766 m
	Canterbury households* that do not use the Rakaia	Prevent **Rakaia River** irrigation development for 5 years	$25	$104 m

		Preserve the **Rakaia River** in its existing state	$25	$249 m
Beanland	Manawatu-Wanganui Region households	Payment of a special rate to lease and preserve Aorangi-Awarua forest (on private land)	$11	$113 m
Lynch	Canterbury households (excludes Ashburton)	Preserve **Ashburton River** flows	$70	$703 m
Lock	Manawatu-Wanganui Region households	Payment into a Manawatu-Wanganui possum control fund	$88	$879 m
Mortimer, Sharp & Craig	Auckland households	Maintain current conservation activities on Little Barrier Island	$45	$454 m

Notes: All money values were adjusted to December 2003 values using the consumers' price index. [Multiply by 1.16 to adjust to Dec 2011 values].
Reproduced from Sharp & Kerr (2005)

67 Sharp and Kerr concluded their review of the New Zealand literature on water quality valuation with the statement that: "*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*."

Examples of non-market valuation of water quality since 2005.

Results from stated preference studies - Waikato Region

68 *Stated preference studies* can be used to assess the total economic value of a resource – including use and non-use values. The studies outlined below were conducted on particular populations and so provide an estimate of the total economic value for that population, but not for the resource as a whole. For example – the first study provides estimates for use and non-use value of water quality improvements in the Karapiro Catchment, based on a survey of catchment residents. In determining the total economic value of water quality improvements in that catchment, we would need to *add* the benefits attributable to those who use the catchment but are not resident (e.g. recreational and commercial users) and also *add* the non-use values of non-residents.

69 I led a research project from 2007-2011, funded by FRST and industry stakeholders[3] that aimed to assist farmers and policy makers to identify the most cost effective options for achieving any given improvement in water quality by developing appropriate methodology for valuation of water quality improvements in New Zealand.

70 Relevant outputs from this project include:- estimates of the value of water quality improvements in Lakes Karapiro and Arapuni for residents of the Karapiro catchment (Marsh, 2010, 2012 Forthcoming); estimates of the value of water quality improvements in Lakes Karapiro and Arapuni for recreational users[4] (Marsh & Mkwara, 2010b); estimates of the value of cleaner streams in the Karapiro catchment for catchment residents (Marsh & Mkwara, 2010a).

71 Results are reported in an international peer reviewed journal article (Marsh, Mkwara, & Scarpa, 2011), a report for the Environment Waikato Technical Committee (Marsh, Davies, & Petch, 2009), two papers in the Department of Economics working paper series[5] and in other work under revision or preparation.

72 Some of the key results from these studies are summarised in Tables 4 and 5 below. Clean water and ecological health were the attributes valued most highly by catchment residents, with median annual willingness to pay of $102 per household per year to reduce the risk of algal blooms to 2% per year and $103 to increase the proportion of excellent ecological health readings to above 80%. Data for the 1st and 3rd quartiles indicate that 25% of people would be willing to pay more than $191 and 75% of people would be willing to pay at least $32 for the same reduction in algal blooms.

---

3 FRST Programme C10X0603: Delivering tools for improved environmental performance funded by The Foundation for Research Science and Technology (FRST) and the Pastoral 21 partners Dairy New Zealand, Meat and Wool New Zealand and Fonterra.

4 The sample of recreational users was drawn from a total population of 3940 participants in Rowing NZ Karapiro events. Of these only 2640 had email addresses. A total of 939 emails were sent out with one reminder 7-10 days later from which 115 completed surveys were collected representing a response rate of 14%. Due to this high non-response rate, the results presented in this paper may not be a true representation of the total population of recreational users.

5 http://econpapers.repec.org/paper/waieconwp/

73 The overall consumer surplus (or 'benefit') associated with a change from the status quo ('business as usual') to an improved outcome was estimated based on different combinations of attributes (Table 5). Such estimates provide one of the most useful cost-benefit analysis tools for policy makers drawing-up management plans. It should be noted however that procedures for correctly estimating these benefits are not well established. There has for example been a tendency to focus on part worth estimates for individual attributes (e.g. Table 4) while ignoring the fact that these estimates are valid only for marginal changes and are based on a ceteris paribus assumption. There has also been a tendency to estimate WTP using random parameter logit models[6] but to ignore this assumption of randomness when estimating the benefits of multi attribute policy improvements. It should further be noted that procedures that take account of randomness tend to produce lower benefit estimates – since for example individuals who highly value clean water may care less about water clarity. When these factors are considered together these two effects may to some extent cancel each other out (Table 5).

Table 4: Median Willingness to Pay for Better Water Quality in the Karapiro Catchment ($ per household per year)

Attribute		Catch-ment Residents	Rec-reational Users	Cleaner Streams		
Suitability for swimming (*Probability of algal bloom*)	20%	28	78	**Suitability for swimming** *(% of readings satisfactory for swimming)*	50%	33
	10%	141	129		70%	66
	2%	102	192		90%	96
Water clarity *You can usually see for ..m underwater*	1.5 m			**Clarity** *Ability to see bottom*		44
	2 m		83			
	4 m	58	140			
Ecological health *Percentage of excellent readings*	50%	37	108	**Presence of Trout**		60
	60%		128	**Ecological**	Med	34

6 These models allow different individuals to have different patterns of preferences.

	80%	103	222	**Health**	High	70
Job losses in dairying	5%	-90				
% reduction	10%	-51				
	20%	-177	-83			

Note: Missing cells indicate that the result was not statistically significant

74 Respondents said that they would be willing to pay for water that was safer for swimming and improvements in clarity and ecological health. Median willingness to pay for Policy 1 – a slight improvement over the status quo was low ($26 per household per year). Households had a higher willingness to pay for larger improvements (Policy 3) with a median value of $86 per year to reduce the chance of algal blooms to 2% while improving clarity and ecological health.

75 We also found that households had strong preferences to avoid job losses in dairying; for example, median willingness to pay for Policy 1 would be reduced to zero if accompanied by 5% job losses.

76 There are two reasons why this finding does not provide an argument against regulation of leaching: a) in a cost benefit analysis –costs should be assessed based on the effect of reduced leaching on farm profit. The preferences of households to avoid job losses would not be included in the analysis in order to avoid double counting b) we expect that the effect of reduced leaching requirements on farm profitability will be small and will not lead to significant net job losses. Indeed, any small loss in dairy sector jobs may well be offset by an increase in jobs associated with angling and kayaking, for example.

Table 5: Median annual CS estimates per household associated with different policy options

Attribute	***Status Quo***	**Policy 1**	**Policy 2**	**Policy 3**
SWIM (Chance of Algal Bloom)	50%	20%	10%	2%
CLARITY (metres)	1 m	1.5 m	2 m	4 m

ECOLOGY (% excellent)	40	50	60	80
Median welfare gain ($ per year)		$26	$51	$86
Mean welfare gain		$37	$77	$126

77 *Results for Recreational Users.* Findings from this study provide information on *use values*. We found that recreational users are more willing to pay for cleaner water that is satisfactory for swimming, better clarity with better ecological health than catchment residents. Recreational users and Auckland residents were less concerned about job losses in dairying than catchment residents in the household survey. The study further revealed that in general Auckland residents were more willing to pay for less algal blooms, better clarity and good ecological health than the catchment residents. Furthermore, while rowers were more concerned about better clarity, non-rowers were more willing to pay for fewer algal blooms.

78 *Benefits of Cleaner Streams.* The results from this study indicate that respondents would be willing to pay for cleaner water for swimming, for better ecological health (with eels, bullies and smelt present), for the presence of trout and for better clarity such that 'you can usually see the bottom'. Respondent preferences were strongest for water suitable for swimming, followed by ecological health, presence of trout and clarity.

79 *Stated Preference Studies in Other Regions.* In addition to the studies of the Karapiro Catchment detailed above, a further five studies relating to water quality are listed in the NZ Non-Market Valuation Database (http://www2.lincoln.ac.nz/nonmarketvaluation) for the period 2006-2011 (see Table 6). Results from the Canterbury studies are broadly supportive of earlier work and increase our confidence in some of the specific estimates and results for particular groups of stakeholders. The study of Hamilton streams used choice analysis to demonstrate WTP for improved stream quality in an urban environment.

Table 6 New Zealand Water Quality Related Studies since 2005

Topic	Year	Authors	Method	Results
Riparian attributes, lower Selwyn River	2007	Geoff Kerr & Simon Swaffield	Choice Based Method	Mean Value: Farmers (type 1)(per annum): summer no flow day -$2.49, winter no flow day -$0.91, summer low flow day -$1.48, clear water $45, safe to swim $122, grassy banks $38 gorse on banks -$39, local job $23
North Canterbury Freshwater fishing experiences	2008	Stephen Beville & Geoff Kerr	Choice Based Method	Marginal values (per angler visit): 1 trout = $16, Increased fish size = $24 per pound, Bag limit = $27 per trout, Eroded riverbanks = -$60, Didymo = -$41, Encounters = -$5
Hamilton Streams	2008	Yvonne Matthews	Choice Based Method	Mean Value: good water clarity, $56/household/year: Mown grass, $11/household/year: Native vegetation, $52/household/year: Natural channel, $51/household/year: Plentiful native fish, $39/household/year: Walkway access, $24/household/year
Pekapeka swamp	2008	Tom Ndebele	Contingent Valuation Method	Mean WTP to preserve swamp from agricultural development = $30.52/household/year
Karapiro Catchment Waikato Region	2009 -	Dan Marsh Ric Scarpa Lena Mkwara	Choice Based Method	See above

Source: New Zealand Non-Market Valuation Database
http://www2.lincoln.ac.nz/nonmarketvaluation/

80 I am not aware of any non-market valuation research into the benefits of water quality improvements that relate specifically to the area covered by the MWRC. However, the fact that significant benefits have been identified and quantified for a variety of water bodies, covering several regions – allows me to state with some confidence that willingness to pay for water quality improvement in the MRC region is likely to be significant and of a similar order of magnitude to the studies referred to above.

Results from revealed preference studies.

81 Revealed preference methods of valuing environmental benefits often involve "a kind of detective work for piecing together clues about the values individuals place on environmental services as they respond to other economic signals" (Freeman, 1978). They provide an important supplement to stated preference studies and counteract the claim that some people would not actually pay the dollar amounts they report in contingent valuation and choice analysis surveys. It should be noted that revealed preference methods provide information on *use values* – they cannot (by definition) provide information on non-use (including existence) values.

82 Researchers in the Department of Economics at the University of Waikato have estimated the some of the benefits of cleaner water in the Rotorua Lakes by analysing property prices and the behaviour of anglers. These results provide a broad indication of possible effects on property values and benefits to anglers in the Horizons region.

83 Data from housing markets has been widely used, internationally, to put a value on environmental services since the price of houses depends on a range of attributes relating to the house, the neighbourhood and other factors, including environmental quality. This study was based on the idea that property prices around the Rotorua Lakes depend on various attributes including water quality, so (holding other factors constant) property is likely to sell at a higher price if the water quality in the nearby lake is higher.

84 Analysis was carried out using data for 1179 property sales from 2005 to 2010. The data set was limited to arm's length sales of single unit homes located within one kilometre of Lakes Rotorua, Rotoiti, Tarawera or Okareka. The data set included variables capturing property characteristics, property sales data, water quality data and distance to lake. We were able to estimate a model that accounted for around 65% of the variation in house sale price

and found a statistically significant positive relationship between secchi disk depth (the water quality/clarity indicator) and house sale price.

85 We found that that a one metre improvement in water clarity resulted in an average increase in house sale price of around 7 per cent. So for example a typical house on Lake Rotoiti, worth $300,000 – where water clarity has typically been 4 to 6 metres would increase in value by around $70,000 if water clarity improved by 3 metres – achieving water quality levels similar to those currently found in Lake Okareka. We plan to carry out further analysis using this data base to refine the model and to help us to assess the overall impact on the value of housing stock in the district (Marsh & Woodham, 2011 forthcoming). This study demonstrates that the value of properties close to water bodies can be strongly influenced by water quality. Better water quality in the MWRC will increase the value of such properties as property buyers are willing to pay more for better environmental quality.

86 Another researcher that I supervise is using data from the National Angling Survey to look at how water quality affects anglers' choice of fishing destination. Travelling to a more distant lake increases travel cost, so this data can be used to put a lower limit on the amount that anglers are willing to pay to achieve better water quality. Preliminary results indicate that a modest (one metre) improvement in water quality[7] could produce direct benefits for anglers in excess of $1 million per year (Marsh & Mkwara, 2011 forthcoming).

87 Further information on the benefits of angling to the New Zealand economy can be extracted from the National Angling Surveys conducted by NIWA (2009) on behalf of Fish and Game.

88 The report of the 2001/02 National Angling survey (2003) – notes that "angling is primarily a local activity, often undertaken within 50km of where anglers live… Much of this angling takes place on waters which may be

[7] In seven lakes that currently have lower water quality (Rotorua, Rotoiti, Okaro, Rotoehu, Rotomahana, Okaraka & Rerewhakaaitu).

categorised as lowland rivers, and which several recent studies have shown are becoming increasingly degraded (Parkyn et al, 2002, Jellyman et al 2003). This resource is of fundamental importance to many New Zealanders" (p. 23).

89 New Zealand's trout fisheries are recognized both internationally and domestically, attracting both local and foreign tourism. Tourism generated a direct contribution to GDP of $6.9 billion in 2010/2011, with total tourist expenditure totalling $23 billion (Statistics New Zealand, 2011).

90 Trout fishing based tourism contributes a significant component of these figures, with recreational tourist anglers reported to spend more on their fishing holiday than most other tourist activities (Tourism New Zealand pers comm., 2009). In acknowledging the importance of New Zealand's rivers and their recreational value, the Associate Minister for Tourism stated that " New Zealand's rivers are assets that support tourism and recreational opportunities", and that "promoting and protecting our natural environment makes dollars and sense" (Dr Colman, 2009).

5 THE EFFECT OF PROPERTY RIGHTS ON ECONOMIC CONSIDERATION OF BENEFITS

91 There are in the economics discipline, two measures of the economic benefit (or cost) of environmental improvement (or deterioration). Such benefits or costs can be assessed using the measure of willingness to pay (WTP) for an improvement in provision of the good or willingness to accept compensation (WTA) to forgo such improvements (or to accept deterioration).

92 While early economic theorists predicted that WTP for a unit gain and WTA for a unit loss are approximately equal (Hicks, 1939; Randall & Stoll, 1980), empirical evidence reveals that WTA is almost always significantly higher. This can be explained with a simple example as follows: households might be asked how much they would be willing to pay to increase the length of river in a region that is safe for swimming by 20%. Asuming median WTP is $100 per year, standard theory suggests that the same households would be willing to accept a reduction in swimmable rivers by 20% if they were offered

compensation of around $100. In practice however, we would find that the median value for WTA would be much higher.

93 Most studies conducted in experimental or survey settings for both marketed and non-marketed environmental goods have reported higher WTA than WTP values (Anderson, Vadnjal, & Uhlin, 2000; Hanemann, 1991; Rowe, D'arge, & Brookshire, 1980; Willig, 1976). Furthermore, disparities between WTP and WTA tend to be higher for public goods than private goods (Horowitz & McConnell, 2002).

94 The difference between WTA and WTP is mainly attributed to income and substitution effects. The amount of disposable income available to an individual constrains how much of a good can be demanded in terms of WTP, while the demand for compensation is not limited by income. Some authors contend that if WTA is used as a measure of value, individuals may demand higher compensation than the actual value of the resource and as a result the benefits of a proposed policy may be overvalued.

95 On the other hand, higher WTA values are justified on the following grounds. Close substitutes may not be available for most public goods. Consequently, once the quality of such goods deteriorates, it is not possible to compensate individuals for the losses and hence individuals may reject being bought off to allow pollution by demanding high WTA values (Rowe, et al., 1980).

96 Property rights for environmental goods although crucial for economic valuation, are often not clearly defined (Brown & Gregory, 1999; Lienhoop & MacMillan, 2007). This lack of clearly defined property rights has also partly contributed to the continued reliance on the use of WTP even in cases of environmental damage where WTA should be more appropriate. However, as noted by Brown & Gregory (1999) use of WTP leads to the undervaluation of benefits and so may result in sub-optimal policy outcomes.

97 *Where property rights are clearly defined, WTA provides the correct measure of compensation for a loss in environmental quality* since WTA, by definition,

leaves an individual indifferent between the status quo and a loss in environmental quality plus compensation. Such individuals will feel that they have not been fully compensated if compensation is based on WTP.

98 I am advised that the policy proposed by Fish and Game will prevent future deterioration of water quality, whereas if no action is taken, water quality will deteriorate. In this case the size of the benefit depends on the assumption made regarding property rights. Assuming that the citizens of the region have the right to clean water, the correct measure of benefit is willingness to accept (WTA).

99 In simple terms, WTA should be estimated by reminding the citizens of the region that they have the right to sustainable management of natural resources including water that is not deteriorating in quality. They would then be asked what amount of compensation would induce them to accept a reduction in water quality. An estimate of benefit based on this measure of compensation would have a much higher value than the WTP estimates referred to above.

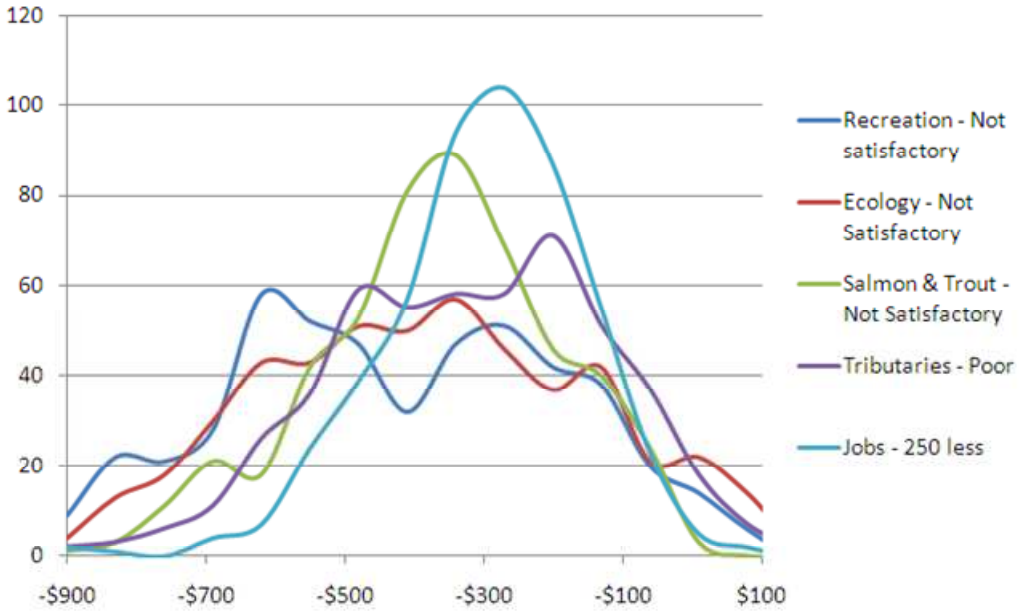
100 In 2011, I conducted a survey in the Hurunui to understand the preferences of Canterbury Region residents with respect to existing conditions (the status quo) and potential future land use and water quality scenarios for the Hurunui catchment. Our survey provides new information (for New Zealand) in that we estimated values for WTA e.g. how much compensation would residents require to accept policies that would lead to deteriorating water quality. Preliminary results, based on analysis with my co-author, Yvonne Phillips are provided below and were presented to Environment Canterbury and Lincoln University in September 2011. The full results of this study are currently being written up for publication and presentation at the 2012 conference of the New Zealand Association of Economists.

101 We found that Canterbury households would need to be compensated for loss in quality of:

Suitability for recreation (good to not satisfactory)	$410 per h'hold per year
Ecological health (good to not satisfactory)	$351
Salmon and trout (good to not satisfactory)	$327
Tributary water quality (not satisfactory to poor)	$282

102 It should be noted that the values reported above are median values e.g. 50% of the households would need to be compensated by $410 per year to accept deterioriation in suitability for recreation of the Hurunui river. The distribution of WTA values across the population is shown in Figure 2 below.

Figure 2: Willingness to accept compensation for decline in water quality



103 A particular objective of the study was to find out whether residents were equally concerned about the quality of the main river and the tributaries. One of the key findings was that preferences for water quality improvement were strongest for improvement of tributaries where water quality is currently not satisfactory.

Conclusions on the Benefits of Better Water Quality

104 The use of methods from environmental economics, including non-market valuation, to assess the benefits of improved water quality is well established internationally, especially in the United States and Europe.

105 In New Zealand we have access to a rapidly growing database of information on this topic. Stated preference studies have been used to assess willingness to pay for improved water quality and can take account of both use and non-use values.

106 Sharp and Kerr (2005) concluded their review of the New Zealand literature with the statement that: "… *New Zealand residents can place high value on protection of the natural environment… mean total economic value changes estimated for various management interventions for braided Canterbury rivers falls in the order of $60 per household per year...*" [in 2003 dollars].

107 More recently, I investigated the preferences of residents of the Karapiro catchment for water quality improvements. I found median willingness to pay was $51 per household per year to reduce the chance of algal blooms to 10% while improving clarity and ecological health.

108 In related research, I and my co-authors found that recreational users had a higher willingness to pay (compared to residents), while residents also expressed strong preferences (and willingness to pay) for improved water quality and ecological health in catchment streams and creeks.

109 I have also presented evidence from revealed preference studies. These studies provide estimates of the amount that consumers would be willing to pay for improved environmental quality based on their actual behaviour in purchasing houses and in selecting angling destinations.

110 We found that that a one metre improvement in lake water clarity resulted in an average increase in house sale price of around 7 per cent. So for example a

typical house on Lake Rotoiti, worth $300,000, would increase in value by around $70,000 if water clarity improved by 3 metres.

111 Similar work on the behaviour of anglers using the Rotorua Lakes indicates that a modest (one metre) improvement in water quality[8] could produce direct benefits for anglers in excess of $1 million per year.

112 Taken together these various strands of evidence suggest that MWRC residents and recreational users would be willing to pay well in excess of $6[9] million per year for better water quality in the M-W Region.

113 Use of WTP to estimate the benefits of improved water quality will significantly underestimate benefits. The purpose of the Resource Management Act is to promote the sustainable management of natural and physical resources while (a) sustaining the potential of natural and physical resources … to meet the reasonably foreseeable needs of future generations; and (b) safeguarding the life-supporting capacity of air, water, soil, and ecosystems; and (c) avoiding, remedying, or mitigating any adverse effects of activities on the environment. Given this purpose, the appropriate measure of the benefits of improved water quality is provided by 'willingness to accept' compensation for agreeing to forego the right to sustainable management.

114 WTA is always substantially larger than WTP. I summarised findings from my recent study of the preferences of Canterbury region residents for future water quality in the Hurunui catchment. I found that households would need to be compensated for loss in quality of 'suitability for recreation' from good to not satisfactory, by a median amount of $410 per household per year. Alternatively residents would need to be compensated $282 per household per year to accept deterioration in tributary water quality from 'not satisfactory' to 'poor'.

---

8 In seven lakes that currently have lower water quality (Rotorua, Rotoiti, Okaro, Rotoehu, Rotomahana, Okaraka & Rerewhakaaitu).

9 This estimate – intended to indicate an appropriate order of magnitude is based on the Kerr and Sharp (2005) estimate of $60 per household updated to 2012 values = $70 per household X 93,200 households in MWRC (Statistics New Zealand Medium projection for 2011) = $6.5 million. WTP of anglers and other recreational users from outside the region (likely to be well in excess of $1 million per year, should then be added to this figure.

115 Taking the very conservative approach of applying the same figure ($282) to WTA deteriorating water quality across the whole MWRC I find that this amounts to more than $26 million per year.

116 Given that residents of MRC have the right to sustainable management of natural and physical resources **the benefit of improved water quality (or avoided deterioration) will have a value in excess of $26 million per year and may greatly exceed the cost of a set of appropriately designed policies that will deliver improved water quality.** (The costs and benefits of the specific policies under consideration are assessed in Section 6 below).

6 ASSESSMENT OF COSTS AND BENEFITS OF PROPOSED POLICY OPTIONS

117 The purpose of this section is to provide an overview of the costs and benefits of the proposed policies now under consideration, namely: the Decisions version, Horizons current approach and the Notified approach (as proposed by Wellington Fish and Game). In addition a 'business as usual scenario' has been included to provide a baseline against which the benefits of the different alternatives can be compared.

Table 7: Summary of Specific Policies Assessed

	Policy	**Description**
1.	'Business as Usual' Voluntary approaches	Various measures to encourage voluntary uptake of BMPs. No regulatory requirement
2.	Decisions Version of Horizons One Plan	New farms capped. Clean stream accord requirements must be met. Reasonably practicable farm management practices must be implemented for existing farms.
3.	Horizons Current Approach	Cap on nitrogen emissions varying by soil type
4.	Notified Approach Wellington Fish and Game proposal	Cap on nitrogen emissions varying by soil type, reducing over time

118 Current and expected water quality outcomes are summarised in Table 8, drawing on evidence from Jon Roygard & Maree Clark and Olivier Ausseil.

119 *Current Situation.* Water Quality targets are not met (except to some extent in Coastal Rangitikei).

120 *Business as Usual*. Intensification is likely to continue and there will not be any widespread uptake of currently recommended mitigation practices because these tend to increase costs and reduce profit. I assume that water quality will continue to deteriorate in all catchments. In 'Year 20' – water quality targets will not be met in any catchment.

Table 8: Summary of Estimated Water Quality Outcomes

Policy/Scenario Catchment	Water Quality Targets Met? Current Situation	Expected Water Quality Trend			
		'Business as Usual'	Decisions Version	Horizons Proposal	WFG Proposal
Upper Manawatu (Weber Rd)	No	--ve	-ve	+ve ?	+ve
Middle Manawatu (Hopelands)	No	--ve	-ve	+ve ?	+ve
Mangatainoka (SH2)	No	--ve	-ve	+ve ?	+ve
Makakahi	No	--ve	-ve	+ve ?	+ve
Manawatu (Upper Gorge)	No	--ve	-ve	+ve ?	+ve
Waikawa (at Huritini)	No	--ve	-ve	-ve	-ve?
Coastal Rangitikei	No/ Yes	--ve	-ve	-ve	+ve
Mangapapa	No	--ve	-ve	+ve ?	+ve

Cost of Proposed Policies

121 Analysis of the report by Neild & Rhodes suggests that 428 dairy farms covering 71,168 hectares will be affected by the Proposed One Plan. I have annualised their cost estimates to allow comparison with estimates of mitigation cost from other sources; see Table 9 below.

122 Neild and Rhodes estimated that implementation of the Proposed One Plan would have a present value of future costs of $73.1 million, equivalent to an annual cost of $5.9 million (at 6.5% over 30 years).

Table 9 N&R Abatement Costs per Hectare

	POP	POP, CSA & CCC	Source
PV 428 Farms	$73.1 m	$82.1 m	N&R page 7
PV per Farm	$170,678	$191, 840	N&R page 7
No. of Farms	428	428	N&R page 7
Land Area (ha)	71,168		N&R page 23
Land Area/farm	167.33 ha		Calculated
Annual Cost 428 Farms	$5.9 m	$6.3 m	Calculated @6.5% over 30 years
Annual Cost per Farm	$13,070	$14,690	Calculated @6.5% over 30 years
Annual Cost per hectare	$78	$88	Calculated @ 6.5% over 30 years

123 I contend that Neild and Rhodes substantially overestimated costs and consider that Doole and Panell (2011) provide a more realistic estimate of actual costs. They report an abatement cost of $25 per hectare for a 20% reduction in N leaching and $62 per hectare for a 30% reduction, using a uniform policy instrument (such as the Proposed One Plan).

124 Based on the cost range detailed above ($25 to $62 per hectare) total cost to the region of the Notified Version (Wellington Fish and Game proposal) would be in the range $1.8-$4.4 million per year. Note that this cost could be reduced by use of a policy instrument which incorporates trading.

Benefits of Alternative Policies (compared to Business as Usual)

125 *Decisions Version*. I believe that the outcome will be similar to the 'Business as Usual' scenario. Intensification is likely to continue and there will not be any widespread uptake of currently recommended mitigation practices because these tend to increase costs and reduce profit (see below). I assume that water quality will continue to deteriorate in all catchments. In 'Year 20' – water quality targets will not be met in any catchment.

126 One of the main problems with the Decisions Version requiring implementation of 'reasonably practicable farm management practices' is

that it is not *incentive compatible* – a term first coined by the Nobel prize winning economist Leo Hurcwicz (1972)[10]; in particular the incentives faced by farmers are not correctly aligned to persuade them to act in a manner which will enable water quality to be improved efficiently and effectively.

127 Most farmers would probably consider they are practicing 'practicable and affordable best management practices' and will not wish to change their practices unless input or output prices or technology changes. If the regulator identifies BMPs that would reduce N leaching (but reduce profit) then the farmer will seek to demonstrate that these BMPs are not practicable or affordable (see footnote "if the agents realize how the information they reveal is to be used, they will have an incentive to misrepresent"). Even if they are forced to implement some of these BMPs they may only 'go through the motions' – they will seek to demonstrate that they are carrying out the practice 'to get the regulator off their back' but will not be interested in whether the practice actually reduces N leaching.

128 I am supported in this contention by Doole, Marsh and Ramilan (2012 forthcoming) who found that "None of the Currently Recommended Mitigation Practices are sufficiently profitable in the absence of policies that require farms to reduce environmental impacts, so broad-scale voluntary adoption is unlikely to occur, at least with the current set of CRMPs available to producers". Similarly Motu in a recent summary of research in this area[11] found that "best practice land management will not be sufficient to meet the environmental target set by the Bay of Plenty Regional Council.

129 Assuming that the 'Decisions Version' has any effect at all, the 'benefit' of this approach is that water quality does not deteriorate quite so fast as under the 'Business as Usual' scenario.

---

10 "If the relevant characteristics of individual agents, such as preferences, happen to be publicly known, then the social choice rule can be implemented trivially because the choice set itself is known. The problem of incentive compatibility arises precisely because these characteristics are not known by the planner *a priori.* The planner may attempt to learn characteristics directly by asking agents to reveal them. In general, however, if the agents realize how the information they reveal is to be used, they will have an incentive to misrepresent. Then the task of the planner in implementing the social choice rule is more difficult…." (Dasgupta, et al., 1979).

11 Motu (2012) Designing Policy to Protect New Zealand's Water Quality

130 This 'benefit' is hard to quantify and likely to be small. This 'benefit' could be assessed using choice analysis by telling the residents of MWRC "water quality is not acceptable in any of the MWRC catchments and is getting worse – we have a policy that will stop it deteriorating quite so fast. Water quality will go on getting worse – just not so fast as it otherwise would have done. Are you willing to accept this policy?

131 *Horizons Current Approach.* Horizons suggest that this approach will lead to water quality improving in most catchments. Various factors may prevent water quality improvements being realised; for example a higher than expected conversion of land for dairy farming or intensification in other land uses.

132 The expected benefits of this approach will be less than the proposed WFG approach. They can be estimated by assessing the benefits as detailed for the WFG approach below, then accounting for uncertainty.

133 The expected benefits of an uncertain outcome are always less than the benefits of a more certain outcome. For example if a policy has a 50% chance of producing benefits of $20 million per year and a 50% chance of producing no benefits, the expected rate of benefit is calculated by adjusting for the probability. In this case the expected benefit would be $10 million [(0.5*20)+(0.5*0)=10].

134 *WFG Approach*. Water quality is expected to slowly improve in all catchments, with the possible exception of Waikawa.

135 The 'benefit' of this approach is that water quality slowly improves whereas it deteriorates under the 'Business as Usual' scenario. The benefit should be estimated as follows:-

a. Explain to (or remind) residents that they have the right to sustainable management of resources including water[12].

[12] Refer to Horizons One Plan objective to "safe guard life supporting capacity and advance the achievements of the values".

b. Explain that there are two possible approaches to management of water quality in MWRC.

    i. Approach A – water quality will get worse in all catchments,

    ii. Approach B – water quality will gradually improve in all catchments (with the possible exception of Waikawa)

c. Use choice analysis to estimate how much compensation they will require before they are willing to allow approach A to proceed? This provides a measure of the benefit of approach B compared to approach A.

d. In Para 101 above, I refer to my finding that Canterbury Region residents would need to be compensated $282 per household per year to accept deterioration in tributary water quality from 'not satisfactory' to 'poor'.

e. This estimate ($282) refers to the tributaries of a particular river system (the Hurunui) – rather than water quality in the region as a whole. It provides a conservative minimum value for the benefits of improving water quality per household per year.

136 Taking the approach of applying the same figure ($282) across the whole MWRC I find that the benefits of improving water quality amount to more than $26 million per year (see Para 113 above).

137 These benefits substantially exceed the cost of the proposed measures (Notified Version) – which I estimated above, to be in the range of $1.8 to $4.4 million per year.

138 I believe that the LUC approach recommended by WFG should be further refined in order to reduce costs for farmers and improve environmental outcomes. This would involve a) ensuring that the catchment level cap implied by the LUC approach is appropriate b) a mechanism to ensure that LUC allocations if fully taken up (through trading or land use change) do not allow leaching to increase in catchments where water quality standards are not met;

and c) a low cost and transparent mechanism to encourage trading of N allocations within catchments – in order to allow flexibility for individual landowners while reducing the overall cost of reducing N leaching.

139 Advantages of this approach include:

a. Cost of reducing N leaching is reduced[13].

b. Automatically takes account of all leaching across the catchment.

c. Flexibility in rate of reduction of N cap towards sustainable level.

d. Enables cost sharing – for example government or MWRC can buy nitrogen leaching allowances in the market – thus compensating landowners for selling discharge 'rights'.

[13] Doole, Marsh and Ramilan (2012 forthcoming) found that the most cost-effective policy instrument across all nutrient targets was a tradable permit system targeted at nitrate emissions. The tradable permit instrument achieved the 26 kg N ha^{-1} goal for the Karapiro catchment at a cost of \$3 kg N^{-1}, which was 62 per cent less than the \$7.89 kg N^{-1} abatement cost with a uniform policy that requires every farm to restrict average emissions to 26 kg N ha^{-1}.

REFERENCES

Anderson, J., Vadnjal, D., & Uhlin, H. (2000). Moral dimensions of the WTA–WTP disparity: an experimental examination. *Ecological Economics, 32*, 53–162

Bateman, I. J., Brouwer, R., Davies, H., Day, B. H., Deflandre, A., Falco, S. D., et al. (2006). Analysing the Agricultural Costs and Non-Market Benefits of Implementing the Water Framework Directive. *Journal of Agricultural Economics, 57(2)*, 221-237. doi: doi:10.1111/j.1477-9552.2006.00049.x

Boxall, P., Adamowicz, W., Swait, J., Williams, M., & Louviere, J. (1996). A comparison of stated preference methods for environmental valuation. *Ecological Economics, 18*, 243-253.

Brouwer, R. (2008). The potential role of stated preference methods in the Water Framework Directive to assess disproportionate costs. *Journal of Environmental Planning and Management, 51*(5), 597 - 614.

Brown, T. C., & Gregory, R. (1999). Survey :Why the WTA–WTP disparity matters. *Ecological Economics 28*, 323–335

Dasgupta, P., Hammond, P., & Maskin, E. (1979). The Implementation of Social Choice Rules: Some General Results on Incentive Compatibility. *The Review of Economic Studies, 46*(2), 185-216.

Doole, G., Marsh, D., & Ramilan, T. (2012 forthcoming). Evaluation of alternative policy instruments for the regulation of nitrate leaching in the catchments of Lake Arapuni and Lake Karapiro. *Land Use Policy*.

Doole, G. J. (2012). Cost-effective policies for improving water quality by reducing nitrate emissions from diverse dairy farms: An abatement–cost perspective. *Agricultural Water Management, 104*(0), 10-20.

Doole, G. J., & Pannell, D. J. (2012). Empirical evaluation of nonpoint pollution policies under agent heterogeneity: regulating intensive dairy production in the Waikato region of New Zealand*. *Australian Journal of Agricultural and Resource Economics, 56*(1), 82-101. doi: 10.1111/j.1467-8489.2011.00565.x

Hanemann, W. M. (1991). Willingness to Pay and Willingness to Accept: How Much Can They Differ? *The American Economic Review, 81*(3), 635-647.

Harris, B. (1983). Valuation of Non Market Goods : An Application of Contingent Valuation to Water Pollution control in the Waikato Basin: Waikato Valley Authority

Harris, B. S., & Meister, A. D. (1981). A Report on the Use of a Travel Cost Demand Model for Recreation Analysis in New Zealand: an Evaluation of LakeTutira: Massey University.

Hicks, J. (1939). *Value and Capital*. Oxford, UK: Clarendon Press.

Horowitz, J. K., & McConnell, K. E. (2002). A Review of WTA / WTP Studies. *Journal of Environmental Economics and Management, 44*, 426-447.

Hurcwicz, L. (1972). On Informationally Decentralized Systems In C. B. McGuire & R. Radner (Eds.), *Decision and Organization* North Holland.

Kerr, G., & Sharp, B. (2003). Transfer of Choice Model Benefits: A Case Study of Stream Mitigation *Occasional Paper No. 4*.

Kerr, G., & Swaffield, S. R. (2007). Amenity Values of Spring Fed Streams and Rivers in Canterbury, New Zealand: A Methodological Exploration: Agribusiness and Economics Research Unit.

Lienhoop, N., & MacMillan, D. (2007). Valuing wilderness in Iceland: Estimation of WTA and WTP using the market stall approach to contingent valuation. *Land Use Policy 24*, 289–295.

Louviere, J., & Hensher, D. A. (1982). Design and analysis of simulated choice or allocation experiments in travel choice modeling. *Transportation Research Record, 890*, 11-17.

Louviere, J., & Woodworth, G. (1983). Design and analysis of simulated consumer choice or allocation experiments: An approach based on aggregate data. *Journal of Marketing Research, 20*, 350-367.

Marsh, D. (2010). *Water Resources Management in New Zealand:Jobs or Algal Blooms?* Paper presented at the Joint Annual Conference of the New Zealand Association of Economists and the Law and Economics Association of New Zealand, University of Auckland Business School.

Marsh, D. (2012 Forthcoming). Water Resources Management in New Zealand:Jobs or Algal Blooms? *Journal of Environmental Management.*

Marsh, D., Davies, A., & Petch, T. (2009). Willingness to Pay for Water Quality in the Karapiro Catchment. A Case Study of Residents: Environment Waikato. Report to Environment Committee 31 July

Marsh, D., & Mkwara, L. (2010a). An Assessment of the Benefits of Cleaner Streams: A New Zealand Case Study: Department of Economics, University of Waikato.

Marsh, D., & Mkwara, L. (2010b). *Rowing through the Bloom; A Survey of the Water quality Preferences of Rowers in the Run up to the World Champs*. Paper presented at the New Zealand Agricultural and Resource Economics Society Conference, Nelson.

Marsh, D., & Mkwara, L. (2011 forthcoming). Trout angling benefits of Rotorua Lakes water quality improvements: University of Waikato, Department of Economics.

Marsh, D., Mkwara, L., & Scarpa, R. (2011). Do Respondents' Perceptions of the Status Quo Matter in Non-Market Valuation with Choice Experiments? An Application to New Zealand Freshwater Streams. *Sustainability, 3*(9), 1593-1615.

Marsh, D., & Woodham, M. (2011 forthcoming). The Effect of Water Quality on House Prices around the Rotorua Lakes. A Preliminary Analysis: University of Waikato, Department of Economics.

Neild, J. D., & Rhodes, A. P. (2009). Economic Impacts of Proposed One Plan LUC Nitrogen Leaching/Run-Off Values on Behalf of Horizons Regional Council.

NIWA. (2009). Angler usage of lake and river fisheries managed by Fish & Game New Zealand: results from the 2007/08 national angling survey: Fish & Game New Zealand.

Pretty, J. N., Mason, C. F., Nedwell, D. B., Hine, R. E., Leaf, S., & Dils, R. (2003). Environmental Costs of Freshwater Eutrophication in England and Wales. *Environ. Sci. Technol., 37*(2), 201-208.

Rae, A., & Strutt, A. (2011). Modelling the Impact of Policies to Reduce Environmental Impacts in the New Zealand Dairy Sector: University of Waikato, Department of Economics. Retrieved from http://econpapers.repec.org/paper/waieconwp/

http://ideas.repec.org/s/wai/econwp.html.

Randall, A., & Stoll, J. (1980). Consumer surplus in commodity space. *American Economic Review, 70*, 449-455.

Rowe, R. D., D'arge, R. C., & Brookshire, D. S. (1980). An experiment on the economic value of visibility. *Journal of Environmental Economics and Management, 7*, 1-19.
Sharp, B., & Kerr, G. (2005). Option and Existence Values for the Waitaki Catchment: Report prepared for Ministry for the Environment.
Statistics New Zealand. (2011). Tourism Satellite Accounts: 2011.
United States Environmental Protection Agency. (2000). Guidelines for Preparing Economic Analyses: Environmental Protection Agency,.
Viscusi, W. K., Huber, J., & Bell, J. (2008). The Economic Value of Water Quality *Journal Environmental and Resource Economics 41(2)*(October), 169-187 doi: DOI 10.1007/s10640-007-9186-4
Willig, R. (1976). Consumer's surplus without apology. *American Economic Review, 66*, 589-597.