Factoring community welfare estimates into freshwater allocation decision making in New Zealand: a common good case study.

A thesis submitted in partial fulfilment of the requirements for the degree of

Doctor of Philosophy

in

Natural Resource Management

at

Massey University
New Zealand

November 2020

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Abstract

The study recognises the centrality of the ‘common good’ by working to improve the intergenerational well-being of all people in society. The research adopts the Tukituki River catchment in Hawke’s Bay, New Zealand as a case study to demonstrate how community welfare estimates can be factored into freshwater allocation planning and decision-making. The Tukituki catchment faces water pollution and allocation challenges that are typical of agricultural landscapes with summer water scarcity.

A survey measured both current and future perceptions of the catchment, focussing on comparing perceptions of anglers and gamebird hunters with other recreational users. A second survey estimated the marginal welfare benefits generated by improved water quality and the welfare associated with trust in freshwater advocates and policy-oriented organisations.

Most users felt the catchment was in a poor state and wanted a future with improved water quality. There was little or no difference between the perceptions of anglers and other recreational users. Gamebird hunter’s perceptions were different from other recreational users at the $p<.05$ level. Recreational users were willing to pay a mean $6.67 a month for ten years to improve water quality to a level representative of the successful delivery of current policy goals by 2030. Bayesian trust scores were used to model social capital in the form of a novel social trust economy, which proved to be an effective descriptor of the known political economy.

Keywords: Freshwater, Welfare, Perceptions, Trust, Common good, Latent Class Analysis, Best-worst scaling, Non-market valuation, Contingent valuation.

Dedication

I dedicate this thesis to my wife Justine and my now grown up children Callum and Isobelle. Their love and support mean everything to me.

Acknowledgements

I would like to acknowledge the support of the New Zealand Fish and Game Council and the catchment management team and ecologists at the Hawke's Bay Regional Council. On a personal note I would like to offer special thanks to Professor John Holland for starting my journey with a warm and enthusiastic welcome into the Environmental Management Honours program a long seven years ago. Without his belief and support I simply would not be at this point. I would also like to thank Professor Diane Pearson for her supervision, for the unfailing clarity of her guidance and for her trust in what I was trying to achieve. Also, Dr Thiagarajah Ramilan for agreeing to join as a supervisor and offer his support and expertise in econometric analysis.

Declaration of conflict of interest

This research was undertaken with financial assistance from the New Zealand Fish and Game Council and care has been exercised throughout to avoid any conflict of interest. They have had no part in setting the direction of research and played no part in the design of field studies nor the interpretation of results.

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List of Abbreviations

ACF - Advocacy Coalition Framework
BIC - Bayesian Information Criterion
BOI - Board of Inquiry
BT - Benefit Transfer
BWS - Best-worst Scaling
CHI - Cultural Health Index

CM	- Choice Modelling
CV	- Contingent Valuation
DCE	- Discrete Choice Experiment
DMV	- Deliberative Monetary Valuation
DOC	- Department of Conservation
EDS	- Environmental Defence Society
EM	- Expectation Maximisation
FB	- Forest & Bird
FF	- Federated Farmers
FG	- Fish & Game
GSS	- General Social Survey
HBRC	- Hawke's Bay Regional Council
HNZ	- Horticulture New Zealand
IWI	- Ngati Kahungunu Iwi Inc
LAWA	- Land Air Water Aotearoa
LC	- Latent Class
LCA	- Latent Class Analysis
LCT	- Landcare Trust
LL	- Log Likelihood
MCI	- Macroinvertebrate Community Index
MEA	- Millennium Ecosystem Assessment
ML	- Maximum Likelihood
NIWA	- National Institute of Water and Atmospheric Research
NOAA	- National Oceanic and Atmospheric Administration
NRM	- Natural Resource Management
NZFG	- New Zealand Fish and Game Council
P2T	- Propensity to Trust
PC6	- Plan Change 6
PGF	- Provincial Growth Fund
RiVAS	- Rivers Value Assessment System
RLH	- Root Likelihood
RMA	- Resource Management Act 1991
RP	- Revealed Preference
STE	- Social Trust Economy

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TCM	- Travel Cost Method
TEV	- Total Economic Value
TW	- Trustworthiness
WTP	- Willingness To Pay

1 Introduction

Environmental quality is growing in the global consciousness as one of the major concerns in the new millennium. Driven in no small part by the Millennium Ecosystem Assessment (2003), environmental quality and healthy ecosystems have been established as the cornerstone of human welfare (Alcamo et al., 2003; Tallis et al., 2008). However, natural resources continue to be consumed at unsustainable rates and, high on the list of oversubscribed natural resources is freshwater. The avidity with which it is sought is to the detriment of rivers, streams, and wetlands. Although not directly comparable, the outcome echoes Hardin's (1968) portrayal of common-pool resource collapse through unrestrained consumption. Freshwater provides essential life support for ecosystems, is integral to economic production activities, and is an essential contributor to human welfare. However, the water quality within many rivers, streams, and wetlands continues to decline across the globe. This chapter introduces a body of research conducted to evaluate key social and economic dimensions within the nexus of freshwater management in New Zealand. In this research, the term 'common good' is used in a philosophical context that reflects the basic requirements of social justice, the interests of society as a whole, and the well-being of future generations. This application echoes the 'greatest good for the greatest number of people' approach taken by Paudyal et al. (2016).

1.1 Problem statement

The continued increase in the demand for freshwater exacerbates the tension and conflict among those competing for its benefits. Both good quality and quantity of freshwater are required to support diverse ecosystems and human well-being. It is also a key provision of production, chief among which is agriculture. Agriculture has an already high demand for irrigation, which is forecast to increase further under climate change. While agriculture is a substantial polluter of waterways, the decline in water quality, which in New Zealand is largely attributed to nutrients and bacteria through leaching and runoff, typically carries no cost to the polluter. In such cases, it is said that 'markets have failed.' It then falls upon regulators to design policies to correct that failure and restore the common good to waterways. However, all too often, the attributes surrounding the common good of water are not adequately captured in policies, which leads to decision-making that does not always reflect all stakeholder interests, especially the cultural significance of freshwater. This scenario is repeated in communities and catchments across the globe. With better accounting of welfare benefits, stakeholder needs, advocacy, and freshwater management, the elements that comprise the public good for freshwater can be built into intergenerational decision-making around sustainable freshwater management.

1.2 Project definition

1.2.1 Aim

To factor community welfare estimates into freshwater allocation decision making in New Zealand.

1.2.2 Objectives

To address the aim of the research, three main objectives have been identified:

i. To define the common good of freshwater and determine perception heterogeneity in the study area (a particular focus is placed on comparing fishers and gamebird hunters with the wider public).
ii. To estimate the marginal welfare benefits generated by improved water quality in the study area.
iii. To quantify the willingness to pay for improved water quality as a function of utility based on public trust of freshwater advocates and policy-oriented organisations.

1.2.3 Need for research

In New Zealand, public concern is mounting over the state of waterways and how well they are managed. This is because increasing tension exists between the competing economic demands for water and the need for good water quality to sustain life-supporting ecosystems and human well-being. The Ministerial report *Our Freshwater 2020* details the pressures and ecological costs of degraded waterways in New Zealand and states a "broad and increasing recognition that things need to change, and a growing willingness to act" (Ministry for the Environment & StatsNZ, 2020, p. 2). Degraded freshwater has also had a significant detrimental effect on Māori[1] cultural values. The 2019 *Te Mana o te Wai* (a report to the Ministery for the Environment from a Māori cultural perspective based on an integrated and holistic view of the health and wellbing of a water body and its community) outlines the sentiment and concern for freshwater from a Māori perspective and states that "Our waters are sick. We must heed the cry to make our waters well again" (Smiler et al., 2019, p. 4). *Te Mana o te Wai* was adopted as

[1] Māori are of Polynesian descent and are the indigenous people of New Zealand.

the framework upon which the Ministry for the Environment's National Policy Statment for Freshwater Management (2020b) was formulated. The situation in New Zealand is representative of an emerging global water management crisis. Water is an essential provision of production and is used increasingly in New Zealand to support intensive agriculture. Agriculture represents 78% of all allocated water; industry is the next highest with 11%, followed by human drinking water at 8% and stock water 3% (New Zealand Institute of Economic Research, 2014). The land area in New Zealand under irrigation had increased by 94%, from 384,000 ha in 2002 to 747,000 ha in 2017 (Statistics New Zealand, 2019a). Although surface water abstraction consents presented to local management bodies (Regional Councils) number half that of groundwater consents, surface water abstraction is nearly 50% more by total annual volume (Booker et al., 2017). This pressure is felt most acutely in small to medium rivers and streams (Booker et al., 2017). Subsequent reductions in surface water volume during summer periods and increased nutrient and bacterial loads from agricultural intensification have negatively impacted water quality. This has degraded instream and riparian ecologies, the ecosystem services they provide, and their associated amenity value (Gluckman, 2017).

1.2.4 Research focus

The research outlined in this thesis is focussed on the Tukituki River catchment in Hawke's Bay, on the east coast of the North Island of New Zealand. It is approximately 2,500 km^2 in size and faces water pollution and abstraction challenges typical of agricultural landscapes with summer water scarcity. The catchment has a range of amenity, ecological, and cultural values of national and regional significance. These suffer from pollution from agricultural runoff, nutrient-rich return flows, poor wastewater treatment from rural townships, and low flows (Chisholm et al., 2014). In turn, this fuels ongoing community tension over water quality.

Agriculture makes a significant direct contribution to the local economy and an indirect contribution via its linkages to other sectors in Hawke's Bay (Infometrics, 2020). A 2013 resource consent application to build the nation's largest agricultural water storage facility within the catchment resulted in a national Board of Inquiry (Chisholm et al., 2014). Although the application failed, the Board's review of the catchment's regional plan led to a lowering of allowed pollutant levels and an increase to minimum flows. The first effects of the new plan that resulted came into effect in 2018 (Hawke's Bay Regional Council, 2015).

1.3 Background

Water can have characteristics of both a private and public good (Young & Loomis, 2014). Birol et al. (2006, p. 107) asserts that “both surface water and groundwater have public good characteristics in that people who extract them and use them are not paying their scarcity rents (both in terms of quality and quantity); they only pay the private extraction costs”. In New Zealand consents to abstract water are still allocated on a first come first serve basis. This reflects a race to the bottom that disregards both sustainability and efficiency in a manner that is characteristic of common-pool resources (Gray, 1983). When water is consumed as an off-stream commodity, its abstraction introduces a rivalry across ecosystem services akin to that of a private good. Water taken from the river and applied to the land means less for others to swim in, boat on, or fish in and less for someone else to apply to their land. Instream commodification of water, such as storage for hydroelectric generation, may not result in system losses; however, it has a temporal element to its rivalry in terms of when it is chosen to release volume (Young & Loomis, 2014). Siebert (2008, p. 59) stated that “environmental quality is considered to be a public good”. Applying Sieberts’ perspective to freshwater management, it follows that, although volumetrically rival as a commodity, the quality of the water and the wider ecosystem health this endows can be considered public. This perspective is endorsed by Young (2005, p. 44), who contends that “non-use values (such as biodiversity preservation), water quality improvements, and flood risk reductions are largely public goods.” It may be most appropriate to think of water as a quasi-public good that reflects public, private, and common pool characteristics depending on the ecosystem service under consideration.

Since the signing of the Treaty of Waitangi[2] in 1840 water rights in New Zealand have fallen under British common law, which vested ownership in no one (Nathan, 2007). Ownership of water was then formally vested in the crown in s21(1) of the Water and Soil Conservation Act 1967 (Water and Soil Conservation Act, 1967). The position of the New Zealand government remains that no one person or group owns water. Freshwater

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[2] The Treaty of Waitangi was signed in 1840 between The Crown and many (but not all) Māori chiefs. Copies of the document were made in English and translated to Māori, and most chiefs signed the Māori version. Differences of intent between the two versions continue to fuel controversy, especially with regard to the accession of sovereignty and its effect on rangatiratanga (chiefly authority) Ministry of Culture and Heritage. (2020). *New Zealand history: The treaty in brief*. Ministry of Culture and Heritage. Retrieved 21-06-2020 from https://nzhistory.govt.nz/politics/treaty/the-treaty-in-brief.

management at an operational level is devolved to twelve Regional Councils under the Resource Management Act 1991 (RMA Resource Management Act, 1991). Once a Regional Council grants consent for water abstraction, the market effectively transfers the value of the resource towards an increase in capital land value (Grimes & Aitken, 2008; White et al., 2001). The position that no one owns water finds urban suppliers caught in a paradox. In some areas, water caries a uniform household charge for treatment and supply, and in others it carries a unit price and is charged for volumetrically (Hastings District Council, 2018; Palmerston North City Council, n.d.; Watercare, 2018). Inequity also exists where urban commercial premises are charged a unit price regardless of the nature of business, whereas urban domestic users are charged only the recovery cost of reticulation (Jenkins, 2015).

Many commodity and non-commodity values associated with water are unpriced in the market. Failure to price all values impacts the ability of markets to allocate water resources with economic efficiency and have the costs and benefits fairly distributed (Young & Loomis, 2014). In New Zealand the rising ill-feeling amongst the public about water quality reflects its quasi-public good status (Hughey et al., 2019). Hughey et al. (2019) found a sustained trend that New Zealander's have an unrealistically positive view of our natural environments state. Despite this rosy perception, there is also a sustained public belief that freshwater is the worst managed aspect of our environment. McNeill (2016, p. 314) asserted that "policy effectiveness should be measured in terms of at least halting decline of the country's freshwater quality, reflecting the purpose of the RMA to promote sustainable management". The continued general decline of water quality must therefore cast policy effectiveness in a dim light, but is it policy or implementation? Knight (2018) details the fettered application of the RMA and the repeated political efforts to dilute its promise to "promote sustainable management of natural and physical resources" (RMA, 1991, p. s5(1)). Knight (2018) sites key failings as i) a lack of leadership from central government, in particular, an absence of national environmental standards pertaining to RMA section 6[3] matters, ii) leaving councils to interpret the act unsupported, iii) inadequate monitoring of environmental effects once a consent is

[3] Section 6 of the RMA (1991) pertains to matters of national importance, such as various preservations and protections, as well as matters of public access, relationships with Māori, customary rights, heritage, and natural hazards. Environment Guide. (2018). *Section 6 - matters of national importance*. Retrieved October 31st from http://www.environmentguide.org.nz/rma/principles/section-6-matters-of-national-importance/

granted, and iv) agency capture, where regulatory organisations are dominated by representatives of well organised minority groups which are endowed with power and resources.

In a similar vein, McNeill et al. (2013) also claimed that whilst regional councils face some spatial challenges and often disparate environmental pressures, the most pressing concern should be ensuring the institutions are effective, coordinated, and aligned. McNeill (2016) also posited that regional councils are prone to the concentrated interests and influence of existing power groups and their drive to capture process. The Māori perspective presented in *Te Mana o te Wai* (2019) is that “Aotearoa New Zealand’s current resource management system is broken. It is failing to achieve its purpose and has become complex, dysfunctional and inaccessible” (Smiler et al., 2019, p. 4). When assessing effectiveness, it may, therefore, be necessary to unbundle policy performance from the institutional performance of policy. Nonetheless, when the findings of Hughey et al. (2016) are coupled with a sustained general decline of national water quality since 1991, it is difficult not to take this as an indictment of the institutions charged with delivering environmental quality (Gluckman, 2017). This is a problem for local government as failure to deliver the public good of environmental quality diminishes social well-being and breaches the implicit social contract first defined by Hobbes in 1651 and through which citizens endow the government with power. Jerome Delli Priscoli of the Global Water Partnership identified water decisions as “being at the nexus of ethics, public policies, nature, values, beliefs, and rationality” (Priscoli, 2012, p. 1). Consequently, decision-makers have a duty to consider value broadly, translate widely differing values, and deliver an equitable and socially just distribution of environmental costs and benefits.

Rivers, streams, and wetlands provide significant benefits to people and the environment. Withdrawal of water from rivers and streams enables private use benefits through agricultural irrigation. Irrigation allows pastural, orcharding, viticultural, and horticultural crops to be sustained when rainfall is scarce. Irrigation also supports the enjoyment of private gardens and lawns and public greenspaces such as municipal parks and club spaces. Its withdrawal also provides private use benefits in the form of the municipal water supply to households for drinking and sanitation and industry for food processing and cooling. The return that flows back to waterways from municipal and industrial use have varying levels of contamination that are diluted by waters solvent properties and processed by the ecologies within waterways. Aquaculture may be supported by withdrawal and return flows or by direct instream placement of stock. Benefits derived without withdrawing water are termed ‘instream’ benefits.

A classic example of instream private benefit is hydroelectric generation, where flows are disrupted and controlled but ultimately returned. Although it is a private benefit, hydroelectric generation has a very high entry cost, a long capital life, and a very low marginal cost of each additional user. As a result, hydroelectric generation tends to form natural monopolies attracting the regulatory hand of central government (Young & Loomis, 2014). Larger waterways lend themselves to the transport of goods, and this benefit is often enjoyed as a public good. Private benefits are also realised in the elevated value of property close to rivers and streams. This benefit can be attenuated to some extent by the site-specific risk of flooding.

Instream recreational benefits can be both public and private in nature. Rivers and streams support game fish and wildlife. Recreational game fishing and game bird hunting are typically controlled and excludable activities requiring the user to purchase a licence. In New Zealand, these licence fees are applied directly back to the management and enhancement of the resource. Other water-based recreation is often a public good where public access to waterways is a constitutional right. Recreational activities are often contact pursuits such as swimming, kayaking, and rafting but may be non-contact such as walking along-side the waterway, picnicking, or a combination of all these.

Rivers and streams support non-game fish and wildlife, and riparian vegetation. These provide users with the largely public benefit of wildlife viewing and non-users with gratification derived from knowing wildlife is supported. All types of micro and macroscopic life and vegetation supported by rivers provide a biodiverse reservoir of genetic material. Wetlands confer similar benefits to rivers in the form of, game and non-game fish and wildlife, vegetation, and as genetic reservoirs. In addition, the microbes and vegetation in wetlands provide water filtration and purification benefits as a public good. The ability of wetlands to attenuate peak flows by holding surges in surface runoff and regulating its release provides a flood protection benefit that is also a public good. Table 1.1 summarises the benefits of rivers, streams, and wetlands and the type of good this benefit represents.

Table 1.1 *Benefits of Rivers, Streams, and Wetlands*

Intermediate Benefit	**Final Benefit**	**Type of Good**
River and stream withdrawal and instream benefits		
Municipal water supply	Drinking, sanitary	Private use
Industrial water supply	Food processing, cooling	Private use
Irrigation of crops	Agricultural production	Private use
Irrigation of gardens, lawns and golf courses	Aesthetics, recreation	Private use
Aquaculture	Agricultural production	Private use
Recreation	Water-based recreation	Often public use
Property values	Aesthetics and recreation to owners	Private use
Game, fish and wildlife habitat	Fishing, hunting and genetic diversity	Private use
Non-game, fish and wildlife habitat	Wildlife viewing and genetic diversity	Public use, NUV*
Transportation	Movement of goods	Often public use
Hydroelectricity	Electricity	Private use
Riparian vegetation	Provision of fuel, fibre and genetic diversity	Mixed public, private use and NUV
Pollution dilution	Improved water quality	Mixed public and private use and NUV
Wetland benefits		
Property values	Aesthetics and recreation to owners	Private use
Filtering and water quality	Improved water quality	Public use and NUV
Wetland vegetation	Provision of fuel, fibre and genetic diversity	Mixed public, private use and NUV
Game, fish and wildlife habitat	Fishing, hunting and genetic diversity	Private use
Non-game, fish and wildlife habitat	Wildlife viewing and genetic diversity	Public use, NUV
Surface runoff attenuation	Flood protection	Public use

Note. Sourced and adapted from Young & Loomis, (2014, p. 109). * NUV = Non-Use Value

Ecosystem services are most commonly associated with the works of Costanza et al. (1997), Daily (1997), de Groot et al. (2002), and the Millennium Ecosystem Assessment (MEA) (Millennium Ecosystem Assessment (Program), 2005). The MEA provided a considered distillation of work done by preceding scholars. It continues to offer a useful and enduring taxonomy of natural capital benefits, broadening the historical focus on functional value and embracing aesthetic and moral values associated with nature and landscape (Edwards-Jones et al., 2000). The MEA brought together the concepts of ecosystem services and their aggregated total economic value and, rather than connecting them with wealth generation, grounded them as cornerstones of human well-being requiring equitable distribution. *Figure 1.1* depicts the four ecosystem service classes defined by the MEA; i) provisioning, ii) regulating, iii) cultural and iv) supporting, and their associated benefits.

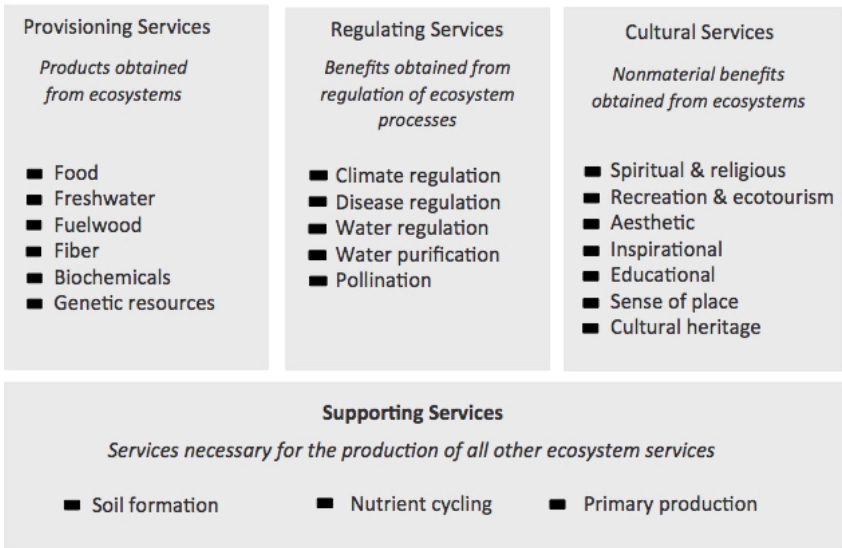

Figure 1.1 Ecosystem Services. Sourced from Alcamo et al. (2003, p. 57)

It is structured to demonstrate the importance of supporting ecosystem services and that they underpin the production of all other ecosystem services. The concept of ecosystem services has been further developed into the Common International Classification of Ecosystem Services by the European Environment Agency (Haines-Young & Potschin, 2018). This system is a more complex nested framework suited to detailed classification and analysis. The original MEA framework was adopted and adapted by The Economics of Ecosystems and Biodiversity when considering the economic value of wetland ecosystems (Russi et al., 2013). Young (2005, p. 6) also reflects it in his grouping of water values into five classes; "(a) commodity benefits, (b) waste assimilation benefits, (c) public and private aesthetic, (d) biodiversity and ecosystem preservation, and (e) social and cultural values." In his second edition, Young and Loomis (2014, p. 109) evolve this to a full ecosystem services framework for identifying freshwater benefits. Ecosystem services of freshwater in New Zealand are covered extensively in Dymond (2013).

Widening the net of value capture has required developing a Total Economic Value (TEV) approach. The TEV framework looks to identify unrecognised scarcity rents by dividing use and non-use values, as demonstrated in *Figure 1.2*. Direct use water values may be off-stream and commercial, such as irrigation, or instream and recreational, such as angling. Indirect use may be nutrient cycling or waste processing. The ability to have the option of using the resource at a later date also carries value. Non-use values are those of a bequest to future generations, such as habitat preservation, or the existence value of knowing a species such as the Longfin eel will continue to exist.

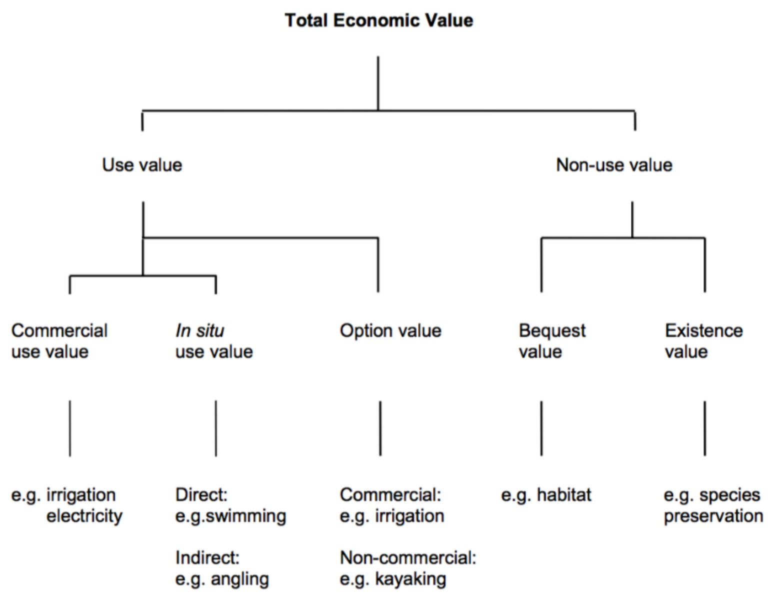

Figure 1.2 Total Economic Value. Sourced from Sharp and Kerr (2005, p. 4)

1.4 Approach

The thesis is broadly interdisciplinary. It blends elements of the natural sciences, sociology, economics, and politics. The overarching approach of the research outlined in this thesis is a case study analysis of the Tukituki River catchment in Hawke's Bay. Quantitative data were collected in two separate studies from two overlapping target populations. The approach to data collection was the use of surveys. The varied nature of the study's objectives necessitated that a mixture of quantitative methods be applied, and these were deployed in two surveys. The first survey targeted those living within the Tukituki River catchment, including the adjacent township of Havelock North. Likert scales were used to measure perceptions of the current state of the catchment and perceptions of an ideal future state of the catchment in the best interest of society as a whole, bearing in mind future generations. The second survey targeted the wider Hawke's Bay population and contained two choice tasks. The first task was a contingent valuation scenario with iterative bidding. The second task was a best-worst choice experiment, where each respondent faced ten randomised choice tasks.

A deductive approach was applied to the data analysis of the first survey. Perception data were analysed initially using a comparison of means applying a combination of *t*-test and Mann-Whitney U, as appropriate. These were used to test two hypotheses regarding environmental perceptions stating i) There is no significant difference between the perceptions of *Fishers* and *Non-fishers*, and ii) There is no significant difference between the perceptions of *Hunters* and *Non-hunters*. A latent class cluster analysis was then conducted across the whole sample. This was undertaken to test two hypotheses stating i) There is a homogenous societal perception of the current catchment state, and ii) There is a homogenous societal vision of the future catchment state. The second survey used an inductive data-driven analysis. A contingent valuation exercise was used to derive individual and mean marginal welfare estimates for improvement in catchment water quality. Bayesian utility scores were used to estimate social trust in organisations active in the freshwater policy space. Correlation analysis of individual Bayesian utility scores was used to model a social trust economy, and a partial least squares analysis was used to explore the relationship between trust utility and willingness to pay for improved water quality.

1.5 Thesis contribution

This research will help define the common good of freshwater and address two gaps in scientific knowledge. The valuation study will contribute to the New Zealand non-market valuation literature for water quality improvement, and the best-worst study will add to a relatively new body of trust literature and a small emerging body of natural resource management themed trust literature. The technique employed is a relatively novel approach within the trust literature, and there is little or no evidence of its use in the examination of freshwater advocates and policy-oriented organisations, either in New Zealand or globally. Correlating respondent trust utility scores with their willingness to pay for improvements in water quality is a novel approach that appears unexplored to date. Its use in this study will give insights into the effects of organisational trust on welfare payments. In this thesis, I advance the idea of a 'social trust economy' in the natural resource context where stocks of trust reflect social capital and flow around organisations. The social trust economy became apparent through the correlation analysis Finally, the adoption of a case study approach means communities facing similar conflict and tension over freshwater will be able to gain insight into the shape of a common good vision, welfare benefits, and organisational trust within their own catchments. With the application of reasoned judgement and adjustment for local variation, the case study has value across New Zealand and the globe.

This project was funded by Fish and Game New Zealand to help contextualise their role in freshwater advocacy against the wider societal well-being. Consequently, particular

attention has been given to understanding angler and hunter perceptions compared to other catchment users. Unsurprisingly literature relating to interest groups usually focusses on preferences associated with specific amenity attributes. For example, angler literature usually treats environmental attributes as subordinate to catch-related and cost-related factors. This makes the comparison of perceptions with the general public problematic. Little or no literature exists comparing the common good vision of interest groups with the general public. Similarly, comparative modelling of perception heterogeneity as it moves from perceptions of the current environmental state towards perceptions of a common good vision also appears unexplored.

This study also adds to the knowledge of the Tukituki River catchment. Every aspect of the study undertaken addresses a gap in the formal understanding of the catchment. There are several other catchments in Hawke's Bay currently under review by the regional council, and so this thesis will make a timely contribution to natural resource management in the area.

1.6 Thesis overview and outline

Chapter 2 reviews the literature relevant to the attainment of the three objectives. Chapter 3 introduces the case study area, provides some background, and describes its various values. Chapter 4 details the methodology used to attain the three objectives. It is sequenced to describe the method applied to the first field study designed to achieve Objective 1, followed by the method applied to the second field study designed to achieve Objectives 2 and 3. Chapter 5 details the results and data-analysis. It is also sequenced to describe the results of the first field study followed by the second. Chapter 6 is set out in a series of sub-sections that discuss the results relative to each objective and compare them with findings from some relevant literature. Chapter 7 draws conclusions, provides recommendations, and describes limitations to the study. It also contains recommendations for further research and some final remarks.

2 Literature review

2.1 Introduction

This chapter discusses relevant literature and key concepts and approaches that provide context to the study and a foundation for the analysis undertaken. Literature is drawn from economics, politics, and sociology, reflecting the interdisciplinary nature of this thesis. This chapter is made up of five further sections. Section 2.2 covers freshwater from the perspective of the common good (it is important to note that in this thesis, the term 'public good' is used in its purely economic sense, and the term 'common good' is used in a philosophical context that reflects the basic requirements of social justice, the interests of society as a whole, and the wellbeing of future generations). This section includes a review of the role of water quality in the interests of the common good, which is then contrasted with the neoliberal commodification of nature. With a view to investigating people's perceptions of water quality, section 2.3 covers perceptions, attitudes, and behavioural intentions. Section 2.4 reviews economic techniques for valuing freshwater benefits and has a particular focus on New Zealand studies. Section 2.5 describes the concept of trust in the natural resource management context and as an essential element of social capital. Chapter conclusions are outlined in section 2.6.

2.2 Freshwater and the common good

To conceptualise freshwater in a philosophical context that reflects the basic requirements of social justice, we must consider to whom water quality belongs. Water can be classified as varying types of economic good depending on its end use (Young & Loomis, 2014). Industrial, municipal, and agricultural offtakes have private good characteristics, whilst instream and environmental use, which are largely non-rival and non-excludable, have public good characteristics (Young & Loomis, 2014, p. 8). The quality of these life-supporting systems and public amenity functions relate directly to environmental quality (Siebert, 2008). The exception being those water bodies that are privately held, in which case the water quality is also private.

Siebert (2008) analysed negative externalities[4] and environmental degradation using the public goods approach, and property-rights. Siebert's (2008) analysis demonstrated that

[4] An externality occurs when the acts of one party has an unintended impact on another party, and where no compensation is paid for a harmful effect (negative externality) and no payment is made for a positive effect (positive externality) Perman, R., Ma, Y., Common, M., Maddison, D., & McGilvary, J. (2011a). *Natural resource and environmental economics* (4th ed.). Edinburgh Gate, Harlow, U.K: Pearson.

both approaches could fall short of supplying environmental quality because environmental quality is consumed by everyone equally and cannot be defined by private property rights. Ultimately, Siebert (2008) concludes that all approaches need to be assessed using morality and sound value judgements. He argues that even where it may be possible to assign property rights to environmental public goods, excluding those unable to pay may be wholly undesirable. This is because freshwater is a basic requirement of human welfare, and the poor are inherently disadvantaged in decision making and water conflicts (Alcamo et al., 2003; Baron et al., 2002; Priscoli, 2012). A moral and ethical dimension is fundamental to the supply of good freshwater quality (Paudyal et al., 2016; Priscoli, 2012). In the New Zealand context, a moral right to the welfare sourced from freshwater is underpinned by the Crown's treaty obligations to Māori (Ministry of Culture and Heritage, 2020). Given this, we must ask why it would be 'wholly undesirable' to assign private property rights, where possible, to all aspects of freshwater? At least some of the answer resides at the very outer edge of neoclassical economics and deeper into the normative realms of humanity's philosophical common good.

2.2.1 Redefining the role of common good in economic theory

Raworth's (2017a) doughnut economic model redefines a functioning economy. Shown in *Figure 2.1*, it combines flavours of Maslow's (1943) 'hierarchy of needs' with a philosophy of social justice within a 'limits-to-growth paradigm' as defined by her 'social foundation' and 'ecological ceiling'. At its core, water is one of the twelve pillars of the social foundation and, at its outer, freshwater withdrawal, one of the nine identified overshoots beyond the safe and just space for humanity. Between the optimal social foundation and the ecological ceiling is the 'safe and just space for humanity' characterized by a 'regenerative and distributive economy.' For water to successfully underpin a safe and just space for humanity, water itself must be stewarded in a regenerative manner, and its benefits must be equitably distributive, not least to the latent majority. To achieve this, water quality must be managed as a public good and for the common good of both current and future generations (Westra et al., 2017).

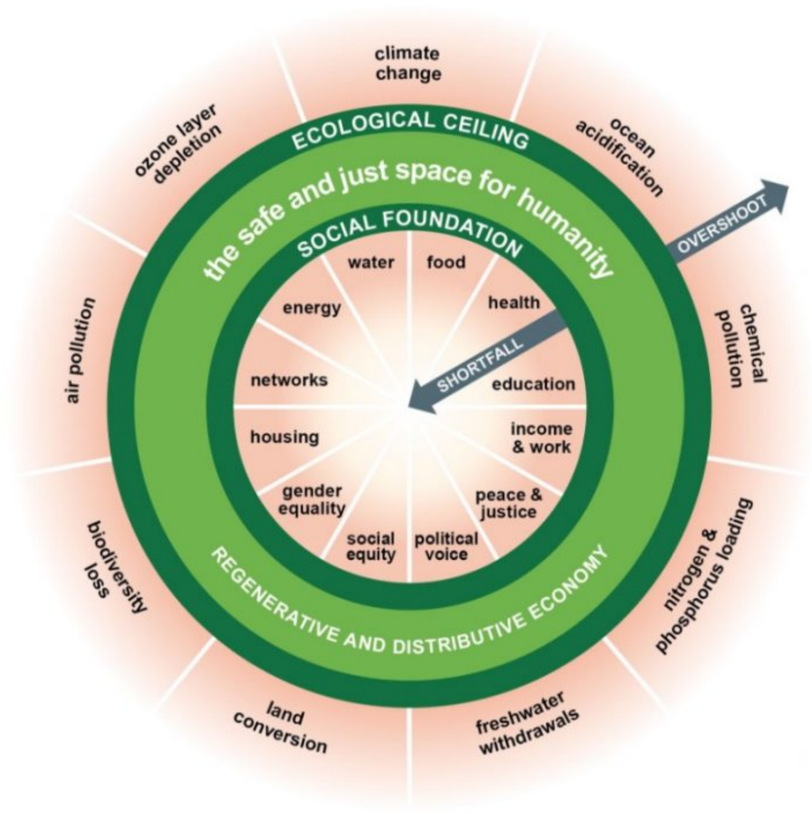

Figure 2.1 The Doughnut of Social and Planetary Boundaries. Sourced from Raworth (2017b)

Smith (1999) examines Aristotle's belief that injustices, fuelled by overconsumption and the desire for power and money, stand in the way of achieving the common good. Applying an Aristotelian lens, Smith (1999) concludes that the lingering questions of the apparent prosperity liberalism delivers are to "Whose community?" and for "Which common good?" given that societies are not homogenous by nature (Smith, 1999, p. 635). Pareto (1927) postulated the common good as optimal social welfare when any increase in one individuals' welfare did not diminish another's. When considering prosperity, it is important to clarify that the 'things' of society and the welfare of society are not the same, even if the first gives rise to the second.

Kaldor (1939) & Hicks (1939) 'improved' on Pareto (1927) with a criterion whereby some could be left worse off as long as those enjoying improvement could theoretically compensate those disadvantaged. Although, perhaps in a reflection of Aristotle's pessimism, no actual compensation need take place. Similarly, Coase (1960) offered a compensation model for environmental damage in which environmental costs could be economically justified through the partial redistribution of the financial gains from its exploitation. The Brundtland Report (1987) spoke of "Our Common Future" regarding global and local sustainability. Among its goals was "to help define shared perceptions of long-term environmental issues and the appropriate efforts needed to deal successfully with the problems of protecting and enhancing the environment" (Brundtland, 1987, p. 5). Given the continued global decline in freshwater quality, the Brundtland Report (1987) does not seem to have achieved its goal of defining a common perception of a sustainable future for freshwater. Felber (2015) advanced a 'Common Good Economy' model and his 'Common Good Balance Sheet Matrix' to assess economic activity in terms of common good outcomes as written into many national constitutions. It extended stakeholder theory to guide management with full human rights at its core, creating a wellbeing-centric framework rather than one weighted towards financial returns and economic stimulus (Felber et al., 2019). Ultimately the mindful pursuit of public value and the creation of common good outcomes requires intergenerational wisdom and ethical judgements (Bryson, 2004, p. 29).

Achieving a common good vision for freshwater will require the bringing together of many conceptual perspectives on water to determine just what makes up the common good of water and its contribution towards the good of humanity. Such consideration would need to entertain an ecosystem services based utility approach with normative notions of deservedness anchored in morality, integrity, and social justice (Sikor et al., 2014). Capturing, rationalising, and grouping the heterogeneity of attitudes and perceptions towards catchment states would provide valuable insights for policymakers and catchment managers. It would enable tailored plans to address resistance points with targeted stakeholder engagement and educational efforts, and perhaps harnessing existing community resources already aligned with a sustainable future.

2.2.2 Neoliberalism, nature, and the rise of advocacy

Since the 1980s, many nations have embraced neoliberalism and its mantra of light-handed government, consumer sovereignty, and market forces (Brenner et al., 2010). Neoliberal ideology has driven a commodification of nature, as demonstrated by the ecosystem services approach and their subsequent monetisation (Castree, 2008; Robertson, 2006). There are two perspectives on the monetisation of public or quasi-public environmental goods. It is either a rational response to represent nature in the ubiquitous cost-benefit analysis or an endeavour to draw the environment completely within the neoliberal paradigm by presenting it as a new type of tradeable commodity (Martin-Ortega et al., 2019; Robertson, 2007, p. 503).

Those competing for freshwater benefits typically do so in adversarial policy arenas with multiple actors reflective of the marketplace ideology. The system relies on the assumption that if something matters enough to people, an advocacy group will form and compete effectively at each level, from stakeholder forums to the law courts. Equally, it assumes "the right result" will subsequently drop out at the end of the process. The supposition that optimality and social justice arise freely from the drive towards collective action leans towards the hollowing out, or absence, of the state as an advocate for the environment.

Reliance on, or perhaps belief in, the purity of collective action is misplaced. Olson's (1971) seminal work, first published in 1965, "The logic of collective action", describes many dimensions of groups, their actions, and public goods. Olson's work has suffered its critics and studies discrediting his assertions (Dougherty, 2003). However, over fifty years later, his overarching concepts still find relevance and continue to be developed in economics and political science (Congleton, 2015; Pecorino, 2015; Sandler, 2015). One of Olson's key assertions is known as the group-size paradox. He posited that small groups have a very high investment per capita in the successful provision of a public good. Also, in smaller groups, choosing not to contribute will have a noticeable effect and will likely attract a negative response from other group members. The larger a group gets, the lower per-capita investment in the public good. Because individuals in large groups feel their contribution represents such a small portion, they choose not to contribute and free-ride.

In the freshwater policy setting, Olson's (1971) paradox translates to a group of highly motivated advocates and a disorganised and disempowered public. Scheffer et al. (2000) conducted an analysis where they combined theories of ecosystem responses with social and economic science. They found that some groups can better overcome problems associated with collective action, which causes a power bias. They also found that the power bias results in an overall social utility that is less than optimal and the degradation of ecosystem services. This means that natural resource deliberations must be able to compensate for a power imbalance between parties in order to ensure just outcomes.

New Zealand's environmental policy process is structured such that air, land, and freshwater are currently managed under the Resource Management Act (1991). It acts as a pivot between environmental protection and development and delivers a framework to manage the effects of development rather than directly regulating development itself.

Central government sets national policy statements, for example, the National Policy Statement for Freshwater Management (2020b), which guides regional policy statements and subsequent regional and district plans. The responsibility for delivering the RMA's intent is devolved from central government to Regional Councils who administer it "on the ground." The Act provides significant latitude for these local decision-makers. The institutional safety valve with which to test regional council decisions is the Environment Court. In the case of proposals of "national significance," the central government may direct a bypass of regional process to either an appointed Board of Inquiry or the Environment Court. Such decisions are made by the Minister for the Environment in consultation with the Environmental Protection Authority. The Environment Court is the first stop for appealing a Regional Council decision under the RMA, with the first step being mediation. Environment Court decisions may then be appealed on a point of law in the High Court. In order to be included in the process, one must be either an applicant, appellant, or respondent. A party may also make application to be included in Environment Court hearings as having interest above that of the general public under section 274 of the RMA, which covers what representation is allowed at natural resource proceedings.

In many ways, the devolution of decision making to Regional Councils embraces the noble elements of Elinor Ostrom's (1990) notion of rejecting leviathan control and embracing local level social-ecological complexity. After all, the provision of latitude to Regional Councils offers an opportunity to avoid prescriptive and ill-fitting solutions. In other ways, however, it falls short of the micro-level community management and the natural equity, reciprocity, and community justice so familiar in Ostrom's work (Bergstrom, 2010). Instead, it places the supply of a public good (environmental quality) into a theatre of advocacy, suasion, and the shifting sands of local power. Interest group motivations vary in orientation between private and public benefit, and regional councils are prone to having their political process captured and controlled by established power structures (McNeill, 2016).

To ensure freshwater ecosystems are maintained regeneratively, and benefits are distributed in a socially just manner, the common good must be advocated for at least as vigorously as private benefits. Section 274 of the RMA would seem then to have pros and cons. The need to constrain the breadth of Environment Court hearings is a financial reality, as is insulating it from vexatious and poorly considered participants. However, excluding the general public from public good management hearings places an additional burden on those advocating for environmental quality. Given that interest groups likely carry a burden of representation that extends beyond their members, capturing public perceptions of environmental issues is an important step in understanding how this representation is weighted in the community.

2.3 Perceptions, attitudes, and behavioural intentions

Explanatory frameworks for human motivations towards behaviours have progressively evolved. Early theories by Maslow (1943) and Vroom (1964) were heavily oriented towards goal attainment and accounted little for inputs from cultural norms and social experiences. Maslow (1943) theorised that an individual worker's behaviour was motivated by a hierarchy of unsatisfied needs. He modelled a five-layer pyramid with basic physiological needs like food, air, shelter, clothing, and water at the base. These are followed by safety needs, love and belonging, esteem, and finally, self-actualisation at the pyramid's peak. Maslow (1943) posited that need satisfaction was strictly sequential and that behavioural motivation was driven solely by the desire to attain unsatisfied needs. The needs satisfaction paradigm was followed by Vroom's (1964) expectancy theory of motivation. It was centred on workers and had, at its core, a more internalised cognitive process behind individual motivation. Expectancy theory's framework revolves around valence (how much you want something) and expectancy (the degree to which you believe performing a certain act will yield a particular outcome). The interplay of valence and expectancy explained worker behaviours as constituents of their motivation.

The theory of reasoned action was expounded by Fishbein (1967). It was founded on the premise that behavioural intentions are based on available information and/or the degree to which an individual believes the behaviour contemplated will elicit a particular outcome. Ajzen and Fishbein (1977) analysed previous attitude and perception studies to determine the conditions under which attitudes are likely to predict overt behaviour. Ajzen and Fishbein (1977) argued that an individual's attitude towards something influences their response to it but need not necessarily be predictive of their actions. By introducing a social component, they also proposed that an individual's intention to perform a behaviour is a function of their attitude towards its performance and their subjective perception of normal behaviour. They found that there must be a high degree of correspondence between the attitudinal and behavioural entities in order for an attitude to be predictive. The level of correspondence translated to the specificity of the question framing where generalised questions such as 'what is your attitude to driving' are likely to have low predictive power whereas ‘what is your attitude to driving in the city during 5 pm peak-hour traffic’ is likely to have higher predictive power.

Salancik and Pfeffer (1978) went further to address the lack of social factors in earlier theories and put forward the social information processing approach to attitudes, which included the role of social influences on a workers job perceptions. This posited that attitudes and needs were the products of a cognitive process accounting for information about the job, past behaviours, and the job’s social context. Applications of Salancik and Pfeffer’s (1978) theory were investigated and critiqued by Zalesny and Ford (1990). They proposed further layers of complexity to capture personal and situational factors regarding the ability to process information, attitude strength, and attitude stability over time.

Ajzen’s (1985) theory of planned behaviour was first published as a book chapter and later as a journal article (Ajzen, 1991). It has become the most widely studied theory of attitude and behaviour (Ajzen, 2011). The theory was predicated on the importance of cognitive self-regulation in determining behaviour, with the principal component being the individual’s intention to perform a specific behaviour. Additionally, the likelihood of a behaviour being performed is also a function of the availability of both the opportunity and resources required to execute it. In short, a behaviour is a function of intentions and perceived behavioural control; however, an accurate prediction of behaviour may require just one of those factors (Ajzen, 1991). Ajzen (1991) demonstrated a strong correlation between his theory’s prediction and an individual’s actual behaviours. He also found that adding in the effects of an individual’s subjective morality further increased the amount of variance explained by the model.

Dietz et al. (1998) used USA General Social Survey data to explain concern for the environment as a function of social structural and social psychological factors and had limited success. They used variables such as age, gender, liberalism, and religious denomination to serve as social structural variables, and economic growth traded off against the environment. They also used beliefs about the fragility of the environment, as social psychological variables. Their social psychological variables explained, on average, only 18% of the variance in respondent’s environmentalism profiles and the social structural variables even less. Dietz et al. (1998) attributed their poor outcomes to a theoretical shortfall where available conceptual models did not accommodate deeper psychological influences on social-environmental attitudes.

Recognising the multiplicity of interrelated influences on behaviour Montaño and Kasprzyk (2008) describe an integrated behavioural model that combines aspects from preceding theories. The model brings together the influences of varying pre-existing beliefs on the components of an individual's attitude and the constraints that influence the likelihood of the attitude, once formed, translating into a demonstrable behaviour.

In summary, the link between attitude and behaviour is complex, which makes predicting behaviours challenging. However, empirical studies have demonstrated that predictions become more reliable if multiple factors are accounted for and/or certain conditions pertaining to the specificity of question framing are applied. The key antecedents to behaviour are likely to be attitudes based on the available information and belief in what is normative. In turn, these notions themselves will have psycho-social contributors to their formation.

2.4 Valuing the benefits of freshwater

This section provides a representative overview of a suite of techniques used to capture the public good benefits of freshwater and their advantages and disadvantages. It covers hedonic pricing, averting expenditure, cost methods, deliberative monetary valuation, benefit transfer, the travel cost method, choice modelling, and contingent valuation. No one technique can capture all forms of value, and different values tend to lend themselves to different methods. This section focuses on techniques designed to capture amenity and non-use values, those being the travel cost method, choice modelling, and contingent valuation. Other techniques are covered briefly, with more detailed information contained in Appendix A.

Although these methods may be applied to many, other ecosystem services, the focus here is on the benefits associated with freshwater. It is important that regulators in New Zealand can quantify the demand for improved water quality and consider the intrinsic ecological and Māori cultural values of freshwater. Due to the likelihood that this research will influence future policy, it was decided that, where available, New Zealand literature would be cited preferentially but not exclusively. Taking this approach will ensure decision-makers can consider the welfare value estimated from this research in the context of a body of work with the most relevance to them. While some international context is provided, an exhaustive representation of international valuation literature is beyond the scope of this review.

2.4.1 Hedonic pricing

Hedonic pricing assumes that a continuous mathematical function relates willingness to pay (WTP) for land or a house to benefits from specific ecosystem services and, by doing so, reveals implicit prices for environmental goods. It has the advantage of revealing preference through real market data and is good for deriving values based on access to the water supply where water markets are unclear or do not exist. It can be applied to both private and public good benefits of water, with the former usually relating to land value with water abstraction rights and the latter to house values associated with an environmental good such as a view over a lake, access to a river, or proximity to a wetland (Young, 2005). Hedonic pricing does have several drawbacks. It requires exhaustive market data and assumes that the market can differentiate clearly between the values associated with the property purchase. It also fails to capture values associated with non-property owners such as renters, hotels, motels, campground users, and day trippers. There must also be frequent ownership changes, and the market must be quick to adjust to changes in the environmental good (Boyer & Polasky, 2004). Hedonic pricing has a limited ability to represent the social welfare associated with improved water quality. A review of New Zealand and international hedonic pricing studies of freshwater can be found in section A.1 of Appendix A.

2.4.2 Averting expenditure

Averting expenditure is based on the cost individuals incur protecting themselves from human health risk. For example, following the Havelock North[5] water contamination incident of 2016, residents purchased large amounts of bottled water, although diminished, this consumption pattern has continued and has a significant increase in the instalment of household water filtration and treatment units. Averting expenditure is a reliable measure because it is usually based on observable real market data. However, it does not capture diverse averting behaviours and associated costs, nor does it capture the broader effect of pollution on utility (Courant & Porter, 1981). As such, estimates based

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[5] The township of Havelock North is a satellite suburb of Hastings, Hawke's Bay, New Zealand. In August 2016 the bore for the town water supply was compromised and contaminated with animal faeces. As a result 5,500 people suffered campylobacteriosis, 45 were hospitalised and it is likely the infections contributed to three deaths. Department of Internal Affairs. (2019). *Government inquiery into Havelock North drinking water: Section one: Introduction and context* [Web page]. Wellington, New Zealand: Department of Internal Affairs. Retrieved October 6th 2020 from https://www.dia.govt.nz/Government-Inquiry-into-Havelock-North-Drinking-Water-Report---Part-1---Overview

on defensive expenditure are likely to be lower bounded, although this may not always be the case (Birol et al., 2006; Courant & Porter, 1981; Orgill-Meyer et al., 2018). Courant and Porter (1981) consider the role of averting expenditure in estimating environmental values using a thought experiment and econometric modelling. They conclude that averting expenditure is a poor measure of WTP and is not always a lower boundary. They assert that even when it is lower bounded, the difference between this and the total effect on utility cannot be attributed to the unavertable consequences of pollution. The narrow focus of averting expenditure makes it a poor choice for valuing amenity and non-use benefits. A review of averting expenditure studies of freshwater can be found in section A.2 of Appendix A.

2.4.3 Cost methods

Cost methods look to match the cost of compensation, replacement, or substitution of ecosystem services (Young & Loomis, 2014). In other words, if the benefits from the ecosystem ceased, what would we have to pay to replace or forego them? Cost methods assume a direct cost and benefit equivalence between environmental service and built capital. This means they can overlook the complex nature of ecologies and require a good understanding of interrelated ecosystem services. Data is the direct cost of providing the environmental services, and the technique is chiefly an accounting exercise that requires fewer resources than surveys. It is most useful to price environmental waste sinks, water purification, and flood protection provided by wetlands. The techniques do not consider community preferences and do not account for non-use values. They do, however, reflect market prices for the averting, abatement, or replacement actions required or for the ecosystem service's contribution to the market value of a commodity. Wide variation in site characteristics, asset values, and the costs of supplying substitute capital make the direct comparison and aggregation of values problematic. A review of New Zealand and international studies applying cost methods to freshwater can be found in section A.3 of Appendix A.

2.4.4 Deliberative monetary valuation

Deliberative monetary valuation (DMV) combines a process of deliberative decision making and conventional monetary valuation, melding welfare economics and deliberative democracy (Bunse et al., 2015). It moves away from individual rationality and towards shared values (Kenter, Bryce, et al., 2016). DMV considers functional, aesthetic, and moral values, then combines with, and potentially improves, stated preference methodologies like choice modelling and contingent valuation. The deliberations are conducted prior to the valuation using focus groups, citizen juries[6] or market-stalls[7], and may continue as a process over several weeks, allowing time for reflection and refinement of stakeholder input. Whilst the method may add weight to other stated preference methods, it still lacks a theoretical base from which to fully explain and contextualise the values produced (Bartkowski & Lienhoop, 2018). Its design is resource intensive and requires a significant time commitment from participants. There are contentions about whether the on-the-ground performance matches up to the theoretical assertions and around the effects of social conformity on agreed prices (Álvarez-Farizo et al., 2007; Kenter, Jobstvogt, et al., 2016; Vargas et al., 2016). The deliberation hopes to derive a figure that communities 'should' pay rather than one each individual is willing to pay. A key problem with the technique is the potential influence of dominant group members over others, and the effects of pressure to conform with the session's emerging social norm (Vargas et al., 2016). There is also added monetary and time cost as well as a need to retain participants for the duration of the deliberation process. DMV must still meet the design requirements of the base valuation construct, and it adds the possibility of suasion and the short-term conformity of individuals to an emerging social norm within the group (Kenter, Jobstvogt, et al., 2016). At the time of writing DMV poses the additional problem of meeting appropriate protocols for managing the global Covid-19 pandemic, be that lockdowns, social distancing, limited group sizes and/or effective sanitation. A brief review of deliberative monetary valuation in the natural resource setting can be found in section A.4 of Appendix A.

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[6]The citizen jury method of non-market valuation takes around a dozen peolpe from a target population and discusses the issues surrounding the relevant problem. In practice willingness to pay estimates are not often targetted as an outcome because their estimates can have a high degree of variability. Instead it is used to guide a particular course of action. MacMillan, D. C., Philip, L., Hanley, N., & Alvarez-Farizo, B. (2002). Valuing the non-market benefits of wild goose conservation: A comparison of interview and group-based approaches. *Ecological Economics, 43*, 49-59. https://doi.org/10.1016/S0921-8009(02)00182-9

[7] The market stall approach takes between five and ten participants from a target population and specifically aims to produce a willingness to pay estimate for a public good. Participants take part in two discussion sessions typically a week apart. Participants are asked to keep a daily diary of thoughts and questions during this week. This is designed to give more time for consideration of the issues at hand and an opportunity to have questions answered by the moderator in the second session. MacMillan, D. C., Philip, L., Hanley, N., & Alvarez-Farizo, B. (2002). Valuing the non-market benefits of wild goose conservation: A comparison of interview and group-based approaches. *Ecological Economics, 43*, 49-59. https://doi.org/10.1016/S0921-8009(02)00182-9

2.4.5 Benefit transfer

Benefit transfer (BT) is an analysis of values estimated in other primary study sites, which are then transferred to the policy site. There are three main mechanisms for transfer, namely; i) fixed value transfer, ii) expert judgement, and iii) value estimator models such as benefit function transfer and meta-analysis (Young, 2005). Values from several primary studies may be used. They usually require movement towards a central tendency and trimming of extreme values or weighting to reflect the quality of the resource (Kerr & Woods, 2010). Benefit transfer is much less time and resource dependant than primary studies, and so is much less expensive, making it the pragmatic choice in many instances (Johnston et al., 2015). However, it requires a high degree of correlation between donor and study site characteristics, scale, ecosystem services valued, and the environmental change. The socioeconomic and preference structure of local communities must also correlate. In particular, any income variations between sites must be corrected for. Even when best efforts prevail, relatively high error terms are still possible (Boutwell & Westra, 2013). Extensive guidance on BT's techniques and application in natural resource and environmental economics is provided in Johnston et al. (2015). A review of New Zealand and international benefit transfer studies of freshwater can be found in section A.5 of Appendix A.

2.4.6 The Travel Cost Method

The Travel Cost Method (TCM) is a recreation and amenity-based revealed preference methodology. It uses a survey and endeavours to capture all the costs in both time and money associated with travel to a particular site and relates these to the site's water quality through a demand function. It has the benefit of using actual market data but again can only derive use-values. The TCM captures the recreational value at a particular site but has the potential risk of not accounting for altered value contingent upon changes in the environment (Sharp & Kerr, 2005). The TCM is vulnerable to the assumptions that must be made on the opportunity cost value of time, perceptions of cost, what costs are unrelated to the travel, length of stay, multi-purpose trips, and substitute or complementary sites and activities (Kerr & Greer, 2004). The traditional application of the TCM is fairly one dimensional and does not capture the effects of changes in site attributes on welfare. When used on its own, it also does not capture non-use values associated with the environment's existence, the option to utilise the amenity at a later date, or indigenous cultural values as shown by Harris (1981) and Cocklin et al. (1994).

Lastly, it is not capable of capturing the desire to bequeath the environment in a healthy condition to future generations (Kerr et al., 2004).

Harris (1981) applied the TCM to value the recreational experience in Lake Tutira, Hawke's Bay, which suffered severe eutrophication. Excluding the casual short stop visitor, the recreational benefit of the lake was valued at approximately $80,000 per year. Harris (1981) made clear that he estimated a partial economic value for the lake and acknowledges the existence of what we would now term option values that were not captured and notes "it is impossible to quantify these extra benefits" (Harris, 1981, p. 164). In addition to the 'extra benefits', the study does not attempt to capture the likely effects on recreation of a positive change in water quality from the baseline described any decline in recreation use associated with the fall in water quality.

Cocklin et al. (1994) applied the TCM to value instream flows of the upper Whanganui and Whakapapa rivers for angling, white water rafting, and kayaking. The catchment has water captured and piped away from its natural watercourse into a hydroelectric generation scheme that drains into a different catchment. Cocklin et al. (1994) extrapolated their demand curve and showed significant increased recreational use value with restored natural flow levels. Cocklin et al. (1994) acknowledged the inability of the method to capture non-use values, especially the significant loss of cultural value the diversion had inflicted upon local Māori. However, they neglect to outline what these Māori values were and failed to mention the significant cultural transgression committed by the hydroelectric scheme by mixing the awa (water) from one river to another.

The inability of the TCM to capture broader values on its own is further illustrated by Kerr et al. (2004). They revisited data gathered in 1983 to study instream water values in the Rakaia and Waimakariri rivers in Canterbury. Both rivers have high amenity values and are productive salmon and trout fisheries. Recognising the narrow focus of the TCM, Kerr et al. (2004) combined the zonal travel cost method with a contingent valuation component in order to capture a broader range of values. Using contingent valuation, they targeted changes in fish stocks in the Rakaia, water quality in the Waimakariri, and preservation (existence and bequest) and option values for both rivers. They calculated a present value (1983 dollars) of angling in the Rakaia of $5 million and that increasing the fish stock fourfold would yield less than $1 million in additional benefit. The present value of preservation values for the Rakaia was $19 million, and the option value $8 million. Values (1983 dollars) for the Waimakariri ranged depending on the data collection method. Its preservation value was $11 million to $30 million, the option price was $4 million to $8 million, and the value of improvement to the water quality was $15 million to $18 million. Although the 7% and 10% discount rates used were relatively high and tended to lower environmental benefits, Kerr et al. (2004) demonstrated the need to select techniques best suited to the values under investigation. In this application, the contingent valuation method proved the most versatile and provided five out of the six welfare estimates.

The TCM does have its merits when applied in the single site format, as Kerr and Greer (2004) show. They applied a single site TCM to value the Rangitata River's recreational trout and salmon fishery benefits. This was used to help inform the decision to place a water conservation order[8] on the river. They compared existing angler TCM data from previous studies on the Rakaia and Caples/Greenstone Rivers, both of which had existing water conservation orders. Kerr and Greer (2004) found that the Rangitata value of $43 (July 2000 dollars) per angling trip was equivalent to that of the Caples/Greenstone and nearly twice that of the Rakaia River. Aggregate values put the angling value of the Rangitata at $3 million (July 2000 dollars and patronage rates). Kerr and Greer (2004) acknowledge that the single site model is simplistic as it does not account for site substitution or complementarity. Its simplicity did mean that the comparison of angler benefits between rivers was easy because there was no site specificity, such as water quality attribute levels, to complicate the comparison.

Modelling site specificity through site attribute levels can be achieved using the more modern random utility TCM as shown by Mkwara and Marsh (2011). They applied random utility TCM to estimate the recreational benefits to anglers in the Rotorua Lakes. The attributes used accounted for lake size, depth, clarity (Can you usually see the bottom?), adjacent urban development, adjacent forestry, facilities like boat ramps, and fish weight. They applied water visibility as a catch-all water quality in a lake district facing moderate to severe eutrophication problems. Mkwara and Marsh (2011) found that consumer surplus increased with improved water clarity, with the greatest aggregate

[8] In New Zealand, a water conservation order gives a river the same status as a national park and recognises its outstanding amenity or intrinsic values. The Rangitata River was placed under a water conservation order in 2006. Ministry for the Environment. (nd). *Purpose of water conservation orders and how to apply* [Web page]. Retrieved October 4th 2020 from https://www.mfe.govt.nz/fresh-water/water-conservation-orders/about-water-conservation-orders.

surplus of approximately $3.7 million (2008 dollars and patronage) for a 3m improvement in water clarity. They also found that variation in welfare gains was site-specific. While this approach improved the TCM by including site attributes and accounting for unobserved site effects, its use of secchi disc visibility measures only captured a singular amenity-centric measure of water quality.

The TCM is also vulnerable to the interpretation of reporting requirements by respondents, as shown by Jiang (2015). He used the TCM to estimate the economic value of angler's access to freshwater in Otago. The Otago Fish & Game region was divided into four areas, with survey respondents providing details of their activity in each area. Problems were encountered with the respondent's understanding of trip definition that may have caused under reporting of travel costs. A low travel cost was often reported by those living a long way from the site. It was surmised that these respondents gave trip cost and frequency from their temporary place of residence while on a multi-day trip instead of their place of permanent residence. This fundamental misinterpretation highlights the heavy reliance on accurate financial reporting when using the TCM. Jiang (2015) found consumer surplus estimates in the range of $88 million to $130 million (2014 dollars and patronage).

In summary, the TCM provides a mostly reliable method for estimating the amenity benefits of freshwater. While modern versions of TCM offer the inclusion of more site-specific attribute levels into welfare estimation the technique is still unsuited to the capture of non-use values. It is also vulnerable to respondents misinterpreting reporting requirements and compromising the data set.

2.4.7 Choice modelling

Choice modelling (CM) or a discrete choice experiment (DCE) is a stated preference methodology grounded in individual rational choice and utility seeking based on McFadden's (1974b) random utility model. Although rational utility maximisation has been a driver behind homo economicus and forms the basis of McFadden's approach, he does recognise that sociality, reciprocity, and reputation all penetrate the outward rigidity of individual rational choice (McFadden, 2010). In an ecosystem services context, it relies on the Lancastrian disaggregation of services into levels or amounts of constituent attributes (Bennett & Blamey, 2001; Lancaster, 1966). For example, the question 'should rivers be safe to swim in without getting sick?' transforms from a binary 'yes/no' response into a swimming attribute with multiple levels describing the potential risk of illness based on a waterborne pathogen load calculation. The swimming attribute itself will be embedded in a choice alternative with several other attributes describing the river's state, including the cost to the individual of achieving that state, which is embedded in a choice set with multiple choice alternatives. The technique is deployed in a survey where respondents are asked to choose between, or rank, alternative policies or states with differing combinations of attribute levels (Christensen et al., 2011; Greiner et al., 2014). Like contingent valuation, it is well suited to site-specific non-use values as well as recreation and amenity (Lee et al., 2013). It has the benefit of providing rich unbundled WTP data on step changes across a range of attributes that is predictive (Hensher et al., 2005).

Although increasingly common in environmental valuation, it is still not as widely tested as contingent valuation. The complexity in experimental design comes with issues around dimensionality[9] and forced-choice versus offering a no-choice option (Brazell et al., 2006; Caussade et al., 2005; DeShazo & Fermo, 2002; Dhar & Simonson, 2003). As the choice tasks require complex trade-offs to be made, the cognitive load is already high. Too large a number of attributes and levels will exceed respondent's cognitive threshold, leading them to employ heuristics that mean choice elements are no longer attended to (Boxall et al., 2009; Hensher, 2006). Caussade et al. (2005) investigated the effects of dimensionality on choice and concluded that the number of attributes and alternatives were the two most critical design dimensions. They found that the higher the number of attributes and alternatives, the greater the variance. Caussade et al (2005) concluded that the likely explanation for this increased variance was an increased use of heuristics by respondents in order to reduce their cognitive load by skipping attributes to simplify the choice making process.

DCEs have been popular with researchers as they identify the water quality attributes that matter most to the community and provide price points for step-changes towards meeting the demand for improved water quality. This ability appeals to decision-makers looking to find the cheapest option for meeting public expectations of improved water quality.

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[9] Dimensionality refers to the number of choice sets faced by respondents along with the number of alternatives within the choice set and the number of levels of each alternative. As dimensionality expands, cognitive load increases, however some complexity is required to adequately portray the environmental good being valued. Hensher, D. A. (2004). Identifying the influence of stated choice design dimensionality on willingness to pay for travel time savings. *Journal of Transport Economics and Policy*, 425-446. http://www.jstor.org/stable/20173065

While popular, DCE are associated with an array of difficulties. Rakotonarivo et al. (2016) conducted a review of 107 DCE articles. They found "a considerable proportion of respondents' choices were inconsistent with the utility axioms assumed by DCEs[10] and evidence on the content validity was sparse" (Rakotonarivo et al., 2016, p. 107). Given the lack of evidence that responses conformed with the axioms of utility maximisation it is perhaps not surprising that Rakotonarivo et al. (2016) found that across the 107 studies, 17-40% of respondents found the tasks to be 'incomprehensible' and 10-62% found them to be 'inconsequential.' These sentiments likely stem from cognitive overload and the brutally reductionist approach to attribute selection required to try and mitigate this. Rakotonarivo et al. (2016) concluded that, given the sparse and subjective evidence on the validity of DCEs, great caution should be taken when basing decisions on their results.

Despite their shortfalls, DCE has been a very popular technique for estimating the non-market benefits of freshwater in both urban and agricultural catchments. Kerr and Sharp (2003a) applied CM to assess the community value of offsetting urban riparian and instream degradation. In the choice experiment, improvement in a degraded stream was traded off against decline in a natural stream. Attributes included water clarity, native fish species, fish habitat, vegetation, and channel contour. Two areas were covered, one in the North Shore and one in South Auckland, and each had both postal and interview surveys conducted. Water clarity in both stream types was significant and positive, as was naturalising channels in the degraded stream and increased native fish in the natural stream. The cost coefficient was negative and significant, as expected. Kerr and Sharp (2003a) noted concerns that the dimensions of their CM had led to very complex choice sets with nine attributes, whereas it is more common to have between four and eight. While evaluations of task difficulty and understanding were good for those interviewed,

[10] DCE are predicated on four axioms of utility maximisation; i) continuity - all attribute levels are attended to and a compensatory decision making process occurs in which the most preferred choice is made rather than using heuristics to reduce cognitive load, ii) monotonic preferences - all things being equal a worse level of an attribute should never be preferable to a better level, iii) transivity - that if option A is preferred over option B and B over option C then option A must be preferred over option C, iv) stability - that a respondent's preference order for options is not reversed later on if re-presented to them. Rakotonarivo, O. S., Schaafsma, M., & Hockley, N. (2016). A systematic review of the reliability and validity of discrete choice experiments in valuing non-market environmental goods. *Journal of Environmental Management, 183*(Part 1), 98-109. https://doi.org/10.1016/j.jenvman.2016.08.032

and no evaluation was done of postal surveys. A very low postal response rate from South Auckland raised concerns that the high task complexity was not suited to this community.

Kerr and Swaffield (2007) also delivered a complex CM with a large number of attributes to assess the values associated with the lower Selwyn River in Canterbury. This section of the river is contributed to by a number of spring-fed streams. They used key informants and a Q sort technique to determine attributes of flow, quality, clarity, streamside vegetation, local jobs, and cost. Flow and clarity, however, would today likely be seen as constituents of quality. This study was in the early days of choice modelling and was intended to help form a methodological foundation in New Zealand. It contrasted farmer's values with those of anglers and had a very small sample of just 32 farmers and 17 anglers. The sample was not intended to represent the wider community, and as such, the results were not scalable. Farmers placed more value on gorse control than clarity and low winter flows, whereas anglers did not place significant value on local jobs. Once again, the CM in this study contained nine attributes, each with between two and four levels. Although four flow attributes were included, 'low flows' were left out, meaning state descriptions only contained a choice between the number of 'moderate flow days' or 'no flow days'. Given that the study was largely about the impact of water volume changes on angler's amenity, this seems an unusual decision.

Beville and Kerr (2008) and Beville and Kerr (2009) used nine attributes, each with between one and three levels, to investigate how fishery environmental quality influences angler choice of fishing site. Higher costs and travel times were both significant and negative. *Didymosphenia gemintata* colonisation and damaged riparian margins were also significant and negative. Clarity, fish size, and bag limit were all significant and positive. Backcountry rivers were constantly the preferred river type across statistical models, and angler preference heterogeneity was evident. Although water quality attributes were represented by clarity, condition of riparian margins, and the presence of *Didymosphenia gemintata* (which is limited to the South Island of New Zealand), the volume of flow was not represented. The targeting of this CM to a narrow amenity group did mean researchers could use attributes specific to a fishing experience with greater assurance they would be well understood. It is also possible that a much better trained/educated audience made task complexity less problematic than for studies delivered to the wider public (Hensher, 2006).

Marsh and Mkwara (2010) used CM to estimate welfare associated with water quality changes in the Karapiro catchment using a more conventional number of attributes. They were, percentage of sites swimmable, the richness of ecology, trout present, clarity, and household cost. In an added dimension, their survey also asked respondents about their perceptions of the attributes at the *status quo* and found perceptions were unrealistically positive. All attributes were significant in the multinomial and random parameter logit models generated. Median WTP to; i) improve clarity was $44 pa to see the bottom, ii) $60 pa for increasing quality so trout are usually seen (this relates to the quantity of trout and not clarity), iii) $70 pa to increase ecological health to excellent for 90% of sites, and iv) $96 pa for 90% of sites to be swimmable. No attempt was made in this study to account for wider cultural values nor those particular to Māori. Between the base levels and the values for these top-level state changes are WTP estimates for the various states described by the intermediate attribute levels. Together they form an anthropocentric 'recipe book' based on a detailed commodification of nature. From this decision-makers look to make the most economically efficient welfare gains in a process, which in its purest application, ignores intrinsic ecological value and the relatedness of attributes. For example, it is unlikely that trout would be absent when ecological health was excellent. It is equally unlikely 90% of sites would be swimmable if the bottom was not visible. Taking a piecemeal approach does not present a holistic depiction of water quality state movement.

Tait et al. (2011) used CM to value the impact of dairying effect mitigation programmes, such as the Dairy and Clean Streams Accord on rivers and streams in Canterbury with a five-year horizon. Attributes were health risk, ecology, flow, and cost. Once again, Māori cultural values were ignored in this study. Households were found to have an informed awareness of the issues involved and were WTP $154 pa for the middle outcomes and $213 pa for the highest outcomes. This aggregated to $134 million and $186 million, respectively. The authors enriched the data by adding a GIS component to test the effects of local water quality on WTP (Tait et al., 2012). Whilst this research stated it was valuing outcomes from agri-environmental policy, the examples stated were all non-regulatory responses, and at least one was an entirely voluntary industry initiative with aspirational goals. Although the selection of attributes as described in Tait's (2010) thesis was well grounded, there is no direct link between attributes and their levels and any specific legislative policy or regional plan. The five-year time frame for household WTP also has no grounding in a policy target deadline. This means that although household WTP was estimated for improvement to a selection of water quality attributes, taking that as the value of benefits from any or all of the programmes described by Tait et al. (2012) is tenuous at best.

In an effort to ground a CM design in real-world consequences, Marsh (2012) assessed the effect of potential job losses on WTP for improvements to water quality. The study site was in an area renowned for its intensive dairy farming, and the scenario was predicated on the assumption that improvements to water quality could not be made without less intensive dairy production. He found that job losses were significant and negative, and as such, respondent WTP dropped when potential job losses increased. He found that for example, a $26 pa household welfare gain from improved water quality dropped to a $4 pa welfare loss when associated with jobs in dairying falling by 5%. This demonstrates the importance of job losses to a rural service community and suggests that the somewhat low initial WTP estimate may have reflected an inherent resistance to the survey's subject matter. The most contentious element in this study is the presumption that clean water must come at the expense of local jobs. It may have been more appropriate to have presented potential job losses as either a whole number rather than a percentage or even in conjunction with a probability of occurrence.

Job losses were also an attribute for Marsh and Phillips (2012), and they also had taken an absolute approach to both gain or loss of jobs. They looked at the effect on household welfare for water and land use scenarios in the Hurunui River catchment in Canterbury. Attributes were: swimmability, ecological health, ability to support salmon and trout, tributary water quality, jobs, and household cost. Attribute levels were connected to policy by using the minimum standards set by the Canterbury Regional Council to define 'satisfactory' levels and anything above that as being 'good.' Households required a mean $315 pa to accept a drop in water quality from 'satisfactory for recreation' to 'unsatisfactory' in the main river and $244 pa for a drop in ecological health from 'satisfactory' to 'unsatisfactory'. Willingness to pay for improvement in water quality from satisfactory to good in the main river was much lower at $33 pa and $44 pa to improve ecological health from satisfactory to good. A mean $205 pa was required to compensate for the loss of 250 jobs, but WTP for 250 more jobs was only $23 pa which increased to $29 for 500 additional jobs. The difference between willingness to accept compensation for a loss and WTP for a gain is an accepted characteristic of stated preference studies, and contemporary guidance tends to promote the use of WTP measures (Johnston et al., 2017).

Widening the sphere of CM design to include both Māori cultural values and the potential for job losses, Miller (2014) applied CM in her thesis to examine the conflicting uses of freshwater in the Selwyn/Waikirikiri River in Canterbury. She found that households were willing to pay $182 pa for improvement in environmental quality from poor to excellent, $59 pa for improvement in swimming water quality from good to very good, and $57 pa to move from poor to above average food gathering opportunities. Job losses would require $45 pa household compensation and $19 compensation for a fair quality of habitat. This was the first stated preference study to make a conscious effort to include Māori cultural values in the CM design. She grounded her selection of a Māori cultural attribute on the Cultural Health Index developed by Tipa and Teirney (2006) and settled on mahinga kai, which was applied as customary Māori food gathering. While there are significant limitations in the ability and desirability to capture Māori cultural values (see section 6.6 for a full discussion), the fact that mahinga kai was the singular attribute and that it was then reduced in meaning from 'food, tools and other resources' to just 'food' is indicative of the reductionist drive of CM. If Miller (2014) had tried more fully to capture and describe the cultural values at stake the overall design dimensions would have rapidly increased, causing cognitive load and respondent fatigue issues.

In summary, DCE, otherwise known as CM, has the ability to capture detailed welfare estimates for step changes in attributes associated with water quality and has grown in popularity over the past decade. The information it provides offers decision-makers an opportunity to make changes to freshwater management that achieve the most financially efficient gains in social welfare. This 'recipe book' approach to welfare gain accentuates the anthropocentric nature of non-market valuation and detracts from a more holistic consideration of intrinsic values. Its chief drawback is the relatively high cognitive burden it places on respondents. The need to contain cognitive load necessitates a deeply reductionist approach to defining attributes and their levels. This can deprive respondents of useful contextual information and makes the description of Māori cultural values more difficult.

2.4.8 Contingent Valuation

Contingent Valuation (CV) is a survey technique where respondents are asked to state their WTP, or accept compensation, for a change in a site's state. It is suited to capturing use, existence, and option values, and due to the hypothetical nature of the proposition, it can be used when there are no precedents to the situation (Perman et al., 2011b). Unlike revealed preference methods, for example, the TCM, the CV surveys are also able to give a WTP across the full breadth of society, and like DCE, they are based on utility theory.

The academic fraternity appears split deeply into factions with regard to the efficacy of contingent valuation versus discrete choice modelling. This relationship, at times, leads to critiques that are somewhat frank and at times plainly feudal (Diamond & Hausman, 1994; Hausman, 2012; McFadden & Train, 2017). The split's genesis followed Carson et al's (1992) contingent valuation assessment of the lost passive use values following the Exxon Valdez oil spill in Prince William Sound, Alaska in 1989. It was quickly followed by an Exxon Mobil funded publication, titled 'Contingent valuation: A critical assessment', edited by Hausman (1993) and aimed singularly at discrediting the contingent valuation methodology. Hausman, McFadden and Leonard (1995) offered an alternative, and dramatically reduced, assessment of damages from the Exxon Valdez event. The main contentions between Hausman et al. (1995) and Carson et al. (1992) were the demonstrated biases, as stated in the review of CV, all of which stem essentially from the frailty and vagaries in the minds of respondents that are inherent to the human condition. As shown in the DCE review, the same human limitations pollute results, and respondents behaviour challenges the axioms of utility[10] (Rakotonarivo et al., 2016).

Contingent valuation is prone to influence from the type of payment vehicle selected and a number of biases related to the scenario, question framing, and respondent behaviour. It also ignores trade-offs between multiple attributes of the environmental good or ecosystem service (Birol et al., 2006). These potential failings have fuelled criticism of the method's integrity and value (Hausman, 2012). The 2012 Fall issue of *The Journal of Economic Perspectives* has critique and response articles by Hausman (2012) and Carson (2012) in which Carson rebuts criticisms clearly and rationally.

When investigating CV validity, Carson et al. (1996) made 616 comparisons across 83 studies between CV and revealed preference (RP) welfare estimates. The mean CV/RP ratio was 0.89, and correlation coefficients ranged from 0.78 to 0.92. This demonstrated a moderate to high degree of convergent validity even though, on average, CV estimates were lower than revealed preference (Perman et al., 2011b). Mekonnen et al. (2020) used both CV and DCE to estimate the per-hectare WTP for the operation and maintenance of irrigation schemes in Ethiopia. They found the DCE yielded $41.00 USD and the CV $43.56 USD, a CV/DCE ratio of 1.06. It is worth holding this in the context of the Exxon Valdez oil spill valuation, where the inference from critics was that CV is prone to overstate the value of amenities or externalities. Hynes et al. (2011) tested a holistic CV versus an attribute-based DCE approach to agri-environmental policy valuation in Ireland. They applied an attribute-based CV and a DCE. Their results also showed that the CV method produced more conservative estimates of WTP than DCE, although they were not significantly different at the ninety-five percent level. They also found that the variance was very much less for the CV than the DCE, which endorses the accuracy of the CV in this instance. When faced with choosing a methodology, Hynes et al. (2011, p. 326) conclude that "the selection of the method to be used by the researcher/policy-maker should be based on whether or not the overall objective is the valuation of the agri-environmental policy package in its entirety or the valuation of separate environmental outputs of the policy."

Following the Exxon Valdez oil spill, the Unites States organisation the National Oceanic and Atmospheric Administration (NOAA), assembled a panel of economic experts to assess CV and published a list of survey design and control recommendations in 1993 (Arrow et al., 1993). Guidance has since been updated by Johnston et al. (2017) to reflect advancements and a more contemporary operating environment. The recommendations are intended to minimise the biases that influence respondent perceptions, beliefs, attitudes, and motivations, all of which lie at the heart of McFadden's model of the choice process (McFadden, 2001). This influence leads respondents to be open to suggestions through text, sub-text, and interviewer body language, influenced by the order of questions, prone to cost prompts from the pricing scale, demand more compensation to give something up than they will pay to gain it, strategizing answers toward a particular outcome, and keen to be seen to 'do the right thing' and equally keen to feel good about themselves for doing so (Arrow et al., 1993; Diamond & Hausman, 1994; McFadden & Train, 2017).

It should be recognized that much of the quality debate of the CV stems from its use in environmental litigation, where the dollar value of an adverse environmental impact is translated into the amount paid in damages by the offending party. In cases like the Exxon Valdez oil spill, the number may be hundreds of millions of dollars, which means even small differences in welfare estimation translate into large sums of money. Such an application is more likely in North America, but the vast majority of the thousands of CV studies are used as part of the many economic submissions to inform policy decisions. Advocated by NOAA and supported by Carson (2012) is that the highest quality CV survey is delivered in person by trained interviewers. However, Lindhjem and Navrud

(2011) conducted a payment card CV study and compared mean WTP and the proportionality of response types between face-to-face and internet delivery. They found no difference between the two and no evidence of a social bias towards personal contact.

The dichotomous choice, also known as a referendum format, is favoured by NOAA for its approximation to real-life take-it-or-leave-it consumer decisions reflecting neoclassical economic theory and for reducing hypothetical bias by generating a sense of policy consequentiality (Arrow et al., 1993; Herriges et al., 2009). Also, by not creating an incentive to under or overstate payment, the format is incentive compatible (Arrow et al., 1993; Carson & Groves, 2007). Single bounded dichotomous choice does, however, require a large number of respondents in order to build a reliable distribution of responses and estimate WTP (Hanemann et al., 1991). This is problematic due to the cost of implementation and the risk a low response rate has to the survey outcome. Statistical efficiency can be improved with follow up questions to create a double bounded model where a higher bid is presented if the first offer is accepted and a lower bid if the first offer is declined (Hanemann et al., 1991). Cameron and Quiggin (1994) caution the guarded correlation between first and second responses citing first response effects. Herriges and Shogren (1996) also caution the anchoring effects of the first bid offered and the starting point bias this may create.

A payment card approach, first developed by Mitchell and Carson (1981), is statistically rich enough to allow WTP estimation with lower respondent numbers. It is, however, more open to anchoring effects and central tendency. A variation on the payment card is iterative bidding in which respondents face repeated price offers in the direction of their choice of the first price offered. For example, if the first price was accepted, a series of higher prices are offered until one is declined, or if the first price is declined, a series of lower prices are offered until one is accepted or zero is reached. An open ended payment question is respondent specific but is prone to overstatement, strategic bias, and free-riding effects (Bateman et al., 1995).

The type of payment vehicle used in stated preference valuation has an effect on the magnitude of WTP via its ability to generate a sense of payment consequentiality. A compulsory vehicle such as increased taxation or compulsory levy gives a greater sense of consequentiality than voluntary vehicles such as donations to a trust or charitable fund (Carson & Groves, 2007; Herriges et al., 2009). Studies can suffer from what is termed part-whole bias, where two components valued separately do not sum to match (often they exceed) the value when the entity is valued in its entirety. Respondents are said to overstate or answer in a way that gives them a good feeling about what they have done which is said to be a warm-glow effect and they may answer in a strategic manner with the hope of influencing the final outcome in a specific direction that reflects their motivations (Johnston et al., 2017; Mitchell & Carson, 1989).

CV is widely used for estimating welfare gains from changes in river water quality. Bergstrom and Loomis (2017) analysed 38 valuation studies of river restoration. They found that 71% of the studies were stated preference based and that the proportion was relatively evenly split between CV with 34% and choice experiments with 37%. The remaining 29% was fairly evenly split across the hedonic price method, travel cost method, and benefit transfer. CV was used regularly for estimating the benefits of freshwater in New Zealand from the late 1980's to 2009. Over the past decade, CV has fallen out of favour as interest in DCE has grown. However, when CV has been used, it has proven itself a flexible technique with a holistic approach to freshwater attributes that provides welfare estimations with a relatively low cognitive load.

In an early application, Kirkland (1988) applied CV to estimate the non-market value of preserving and improving the Whangamarino wetland. He used a national postal survey, an annual open-ended payment to a special trust as the payment vehicle, and an open-ended payment elicitation question. Kirkland found mean household WTP for the preservation of the wetland was $12.68 per year while a further $6.31 per year was the mean bid for improving the wetland by reducing the farmed area and providing improved amenity facilities. Kirkland also asked respondents to portion out their WTP by purpose and found that, on average, 53.2% was apportioned for preservation for future generations, 25% to know it exists, 16.3% for the option of future use, and 5.5% for use within the next 12 months. Some of the main components of this early CV design go against both the contemporary guidance offered by Johnston et al. (2017) and the earlier guidance of Mitchell and Carson (1989). Clearly, however, this application predates that guidance. The annual payment should have had a time constraint, and preferably one with relevance to a policy, the payment vehicle should have been in the form of compulsory taxation in order to be incentive compatible, and an open-ended payment elicitation is prone to the non-attendance to cost. Using the Reserve Bank of New Zealand (2021) inflation calculator, the inflation adjusted household WTP are $26.41 and $12.96 respectively, in 2020 dollars. This is a relatively high payment given it is for a single area and this must be placed in context with the households WTP for a multitude of other degraded habitats. The singular holistic WTP figure also allowed for the apportionment approach taken to give a sense of the type of non-use value attached to the wetland by the New Zealand public.

As previously stated, the dichotomous choice format requires a large sample (the NOAA report by Arrow et al. (1993) recommends a sample >1000) and other formats that give an exact bid value, such as iterative bidding and the payment card approach, suffer more from introduced bias (Hanemann et al., 1991). There seems to be little or no guidance on sample sizes for dichotomous choice format outside of the NOAA guidelines. When smaller samples are anticipated, or if an exact bid amount is required for each respondent, using alternative payment elicitation formats, and accepting and reporting potential bias may be the preferred option. Kerr (1996) used data from an unpublished Master's Thesis by Cessford (1987) in which a CV was applied to high-country recreational users on-site in Department of Conservation huts. The aim was to value the recreation values in the Greenstone and Caples Valleys as part of the argument around competing rights for crown pastoral lease land and the potential to exclude recreational use. Cessford (1987) used the payment card approach for a sample of trampers (n=350), anglers (n=117), hunters (n=181) and trekkers (n=91). With a focus on order of magnitude estimates, Kerr (1996) then used Department of Conservation records to estimate annual visitor numbers to derive aggregate welfare estimates for each visitor type and a total visitor welfare estimate of $240,000 per year.

Weber et al. (1991) conducted a comparison of dichotomous choice and iterative bidding to estimate the value of welfare associated with a 50% increase to minimum flows in the Ashburton/Hakatere River. For the iterative bidding and dichotomous choice methods, estimates ranged from $84 - $118 per year for Ashburton households to $57 - $63 per year for Canterbury households outside of Ashburton. Weber et al. (1991) found aggregated WTP was $9.6 million per year for iterative bidding and $9 million per year for dichotomous choice. They applied a 10% trimmed mean to the iterative bidding calculation to test for the effects of outliers. This dropped its aggregate to $7.2 million per year, which suggests that, although the overall welfare estimated by the two techniques was very similar, the iterative bid distribution was in fact positively skewed.

Positive skewness of welfare bids is often attributed to a non-response bias in which only those with a special interest in the subject matter return a survey response. Sheppard et al. (1993) investigated the effects of non-response bias by comparing the factors influencing behaviour centred on the river between a non-response population and the sample population. The sample population valued improved water quality in the lower Waimakariri River using the dichotomous choice elicitation format and an increase in rates as the payment vehicle over an open ended time period. Of the 1161 survey respondents, 47.5% were considered users whilst 30.3% of non-respondents were river users. Using a follow-up survey of non-respondents, which had only demographic and behavioural questions, Sheppard et al. (1993) corrected for the over representation of river users in the sample and concluded that there was no significant difference in characteristics between the respondent and non-respondent populations. Testing of non-respondent populations is expensive and time consuming and requires the researcher to know who the non-respondents are. The increasing use of electronic delivery and social media recruitment means researchers have no means of following up non-responders. Sheppard et al. (1993) estimated a WTP of $102 per household pa for the improved water quality scenario representing an aggregate of $96.4 million. This compares with an upper end estimated cost of upgrading discharges into the river of $17.2 million. As a side note, Sheppard et al's. (1993) focus on point source effluent discharge as the chief source of pollution in 1992 contrasts with the focus on non-point source agricultural pollution in the region by Tait (2010) and Miller (2014). The change reflects the environmental effects of land-use change to more intensive agriculture over the same time period.

Positive skewness may also occur when the payment range offered does not adequately reflect the real-life distribution of WTP. When paired with an inappropriate elicitation format, this can lead to doubtful results. White et al. (2001) valued changes in the Waimea Plains, Nelson *in-situ* groundwater resource, and the springs and ecosystems it supports. An increase in annual rates was the payment vehicle and the time frame was open ended. White et al. (2001) found a mean household WTP of $183 per year for a 20% reduction in groundwater extraction and the benefits this would bring to ecosystems and the reduced likelihood of saltwater incursion into the aquifer. The study was fat tailed with too many respondents choosing the highest payment option of $250, meaning that the *a priori* estimates of WTP were too low and the true upper bound could not be determined. This meant that the mean calculation was also erroneous. Aggregating their lower bounded estimate gave a WTP of $1.2 million pa. Using dichotomous choice payment elicitation, and although NOAA recommends a sample size of 1,000, White et al. (2001) targeted 398 households with completed responses returning just 180 point estimates of WTP (Arrow et al., 1993). Low sample sizes have been a feature for several applications of dichotomous choice in New Zealand (Bell & Yap, 2004; Kerr et al., 2003; Ndebele, 2009; White et al., 2001).

Kerr et al. (2003) valued Christchurch household WTP for management of groundwater extraction to preserve flows into affected springs, rivers and wetlands and the avoidance of watering restrictions. They targeted 471 households using the dichotomous choice format, with the payment vehicle being an increase in rates, which appeared to be open ended. With responses returning only 169 point estimates a mean WTP of $416 per household per year to augment water supply but maintain river flows was estimated. This aggregates to $46.4 million per year across Christchurch city (1999 dollars and population). Flow preservation in local rivers and streams was to be achieved through surface water abstraction from either a larger mountain fed river or groundwater from further afield.

Bell and Yap (2004) assessed the impact of reduced water quality and algal blooms on intangible values of the Rotorua lakes. With 348 responses and the dichotomous choice format, they found Rotorua households were WTP $91.24 in a non-fixed term rates increase to improve water quality and reduce algal blooms. This was significantly higher than the $11.85 by households in the rest of the Bay of Plenty, leading Bell and Yap (2004) to conclude an underlying distance decay in WTP. However, a select group representing Auckland-based anglers had a WTP of nearly three times that of Rotorua residents. This was an already select group demonstrably willing to pay the cost of travel from Auckland to Rotorua and therefore valued the resource more highly at the outset. Finally, Ndebele (2009) identified CV as the most appropriate method to estimate the total economic value of restoring and preserving the Pekapeka Swamp in Hawke's Bay. Using a mail survey and a special levy collected on power bills as the payment vehicle, Ndebele (2009) used dichotomous choice combined with the open ended elicitation method. Despite acknowledging the NOAA recommendation as guidance for the sample size, 958 surveys were sent out and 405 useable responses were received. Ndebele found households were willing to pay between $30.00 and $76.89 dollars a year for five years. Despite the apparent mismatch between sampling and elicitation format in some studies, they are foundational for the application of CV in the New Zealand context. They serve as a useful reference point for both the order of magnitude of WTP estimates, elicitation formats, payment vehicles, and expected sample sizes.

The inherent flexibility of CV, has made it an attractive technique for modification. Reynaud et al. (2017) conducted an *ex post* valuation of green infrastructure at the Gorla Maggiore water park in the Lombardy region of Northern Italy. They went so far as to state that a discrete choice experiment (DCE) would have been their preference but the *ex post* nature of their survey and the publics familiarity with the facility led them to use an attribute based CV method instead. Attribute based CV methods have also been used by Moore et al. (2011) in valuing hemlock forest protection in the eastern United States and by Jobstvogt et al. (2014) when valuing cultural ecosystem services from hypothetical marine protected areas in the United Kingdom. Most recently, Bennett et al. (2018) applied an attribute based CV methodology to assess investments in improving waterway health in Blacktown, New South Wales.

Bennett, an accomplished proponent of discrete choice modelling, with Cheeseman and Milenkovic embraced the flexibility of CV and the convenience of internet panels in a novel application designed to provide richer than usual CV data. They conclude that their modified method provides "good 'value for money' in the decision-making process" (p. 254). In this application, respondents were asked to prioritize and allocate an annual fund for improving waterway health and were then asked what they would pay to have more waterway improvements achieved. A key aspect of the study is that the respondents are given the opportunity to review their answers and check they are still happy with the allocation decisions they have made. Bennett et al. (2018) were good enough to supply the survey instrument for their study. It was dense with scenario information and contained several very long passages of written descriptions and explanations, which placed a considerable time burden and cognitive load on respondents.

In summary, matching the TEV components of water and their appropriate technique for valuation is shown in Table 2.1 (taken from Birol et al. 2006, p. 107). Birol et al. (2006) argue that the most appropriate methods for non-use and option values are the contingent valuation and choice experiment (choice modelling) methods. These methods are also able to capture recreational use values. A revision of the table today would presumably also include deliberative monetary valuation and benefit transfer in these categories. In particular the CV method is a flexible technique that provides a holistic valuation suitable for valuing welfare changes associated with improved freshwater quality.

Table 2.1 *Total Economic Value Components of Water Resources and Appropriate Economic Valuation Methods*

Components of TEV of water resources and appropriate economic valuation methods	
TEV component	**Economic valuation methods**
Direct use values	
Irrigation for agriculture	PF, NFI, RC, MP
Domestic and industrial water supply	PF, NFI, RC, MP
Energy resources (hydro-electric, fuelwood, peat)	MP
Transport and navigation	MP
Recreation/amenity	HP, TC, CVM, CEM
Wildlife harvesting	MP
Indirect use values	
Nutrient retention	RC, COI
Pollution abatement	RC, COI
Flood control and protection	RC, MP
Storm protection	RC, PF
External ecosystem support	RC, PF
Micro-climatic stabilisation	PF
Reduced global warming	RC
Shoreline stabilisation	RC
Soil erosion control	PF, RC
Option values	
Potential future uses of direct and indirect uses	CVM, CEM
Future value of information of biodiversity	CVM, CEM
Non-use values	
Biodiversity	CVM, CEM
Cultural heritage	CVM, CEM
Bequest, existence and altruistic values	CVM, CEM

Note. PF - production function, NFI - net factor income, RC - replacement cost, COI - cost of illness, MP - market price, HP - hedonic price, TCM - travel cost method, CVM - contingent valuation method, CEM - choice experiment method. Source Birol et al. (2006, p. 107).

It can be formatted to present respondents with attribute-based descriptions in a similar way to the discrete choice method, but with a much lower cognitive load. The most favoured payment elicitation format for CV is dichotomous choice in which individuals face a single tendered price which they can accept or decline. Whilst this method avoids many of the biases found in other elicitation formats, it provides very little information about an individual's actual WTP. This means it requires a large sample size to estimate an accurate demand curve. Iterative bidding and the payment card approach have the advantage of providing a WTP price for every individual. Iterative bidding is recognised for introducing starting point bias, but unlike the payment card approach, it does not reveal the full range of prices at the outset. Both formats introduce a range bias.

2.5 Trust

Although the New Zealand natural resource policy process provides for public submissions, the complex and litigious policy space is inevitably dominated by well organised and well-resourced interest groups. Consequently, the public must trust interest groups and regional councils for both information and outcomes. Trust is a key component of social capital, and trust in public institutions is a core component of law-abiding behaviour and the perceived legitimacy of process outcomes (Glaeser et al., 2000; Marozzi, 2015). In Fairbrother's (2017) review, he concludes that distrust of environmental scientists, communicators, and policy makers has serious ramifications for the demand for better public policy with regard to the environment. He states, "trust, or its absence, shapes public support for environmental protection and policy in a number of ways, reflecting that the findings and understandings of scientists and other researchers feed through to the attitude, preferences, and behaviours of the public" (Fairbrother, 2017, p. 2).

As pressure mounts on natural resource management institutions to tackle complex problems with inherent uncertainties and the potential to attenuate property rights, public trust becomes essential (Hamm, 2017). By extension trust judgments must overflow into the policy process. Purdue (2001) shows that trust has a role in forming and maintaining social capital and impacts leadership pathways. He finds low trust means forming social capital becomes difficult. As such, the level of public trust held by organisations should reflect the public's perception of their performance in their role of regulator, industry advocate, or environmental watchdog. For example, low public trust may translate to a perception of predominantly private good motivations and high public trust may translate to a perception of predominantly public good motivations.

2.5.1 Describing trust

The literature on trust is still young and there is as yet no single accepted theory describing trust (Erdem, 2018). The most widely accepted definition of trust is the trustor's willingness to accept vulnerability to the target or trustee. Trust is multidimensional and in the natural resource setting has been described by Stern and Coleman (2014) as being an amalgam of dispositional, rational, affinitive, and procedural trust. Stern and Coleman (2014, p. 122) define each component of trust as being; i) dispositional - predisposition of someone to trust or distrust an entity in a particular context, ii) rational - based mainly on a calculated expectation of increased utility as an outcome, iii) affinitive - based mainly on emotions and cognitive or subconscious judgments of trustees qualities, or iv) procedural - based on trust in robust systems that reduce vulnerability and enable action when trust is missing.

The concept of trust as choice has its roots in Williamson's (1993) notion of 'calculativeness', where the judgement to trust is based on the likelihood of receiving a benefit. Williamson (1993) conducted a lengthy contemplation of calculativeness using a series of thought experiments that framed 'trust as risk' from an economic perspective. Williamson (1993) argued that calculativeness is embedded in the opportunism and bounded rationality of transaction economics. He postulated that three types of trust existed: calculative trust, personal trust, and institutional trust.

While Williamson (1993) only theorised, Berg et al. (1995) used laboratory experiments to clarify the strategic nature of rational trust. Their subjects were assigned to two separate rooms. Those in the first room were given a sum of money and then asked to decide how much of that they would then give to an individual in the second room. Once in the second room, the sum transferred was tripled and the recipient then decided how much of the proceeds to return back to the individual in the first room. Berg et al's. (1995) results proved individuals make choices based on a calculative trust in reciprocity, thus demonstrating that trust is an economic primitive. The main concern with their results was that they defied the fundamental economic assumption of rational self-interest. Ortmann et al. (2000) repeated Ber et al's. (1995) experiment and introduced additional scenario challenges to further test their respondent's behaviour. Ortmann et al's. (2000) results confirmed the findings of Berg et al. (1995).

Li (2015) argued for a trust-as-choice model. He framed trust-as-attitude as based on a backward-looking assessment of the trustee driven by a desire to minimise the transaction cost. In contrast he framed, trust-as-choice as forward looking and seeking to maximise transaction benefit. Li (2015) echoed the transactional calculativeness theorised by Williamson (1993) and established by Berg et al. (1995). Building on Li (2015), Stern and Coleman (2015) constructed a framework for trust in the natural resource setting, which included four dimensions of trust: dispositional, rational, affinitive, and procedural. They define rational trust as "based primarily upon expectations of reciprocity or perceived utility in strategic interaction" (Stern & Coleman, 2015, p. 123). Also, because this is based on a calculative expectation of personal benefit, "rational distrust may develop if expectations are not met or if the trustor acquires knowledge that shows the trustee to be incompetent, unpredictable, inconsistent, or reckless" (Stern & Coleman, 2015, p. 124). Stern and Coleman's (2014) rational trust, is consistent with the premise of utility theory as described by McFadden (1974b).

Hamm (2017) takes from Stern and Coleman (2015) and Li (2015), and conceptualises both trust-as-attitude and trust-as-choice in the natural resource setting. He bases trust-as-choice on the expectation of benefits from the trusted institution and that these benefits need not be material. Hamm (2017) surveyed Michigan hunters and measured propensity to trust, motivation, and cooperation. His results showed strong support for trust-as-choice and the role of motivation with the expectation of benefit. In *Figure 2.2*, Hamm (2017) models the roles of each in contributing to cooperation (Coop) in the natural resource context. He describes cooperation as a function of trustworthiness (TW), willingness to accept vulnerability (W2AV), and of motivation (Motiv). The propensity to trust (P2T) is included but is not significantly linked to predict trust as an outcome based on previous research (Hamm et al., 2016).

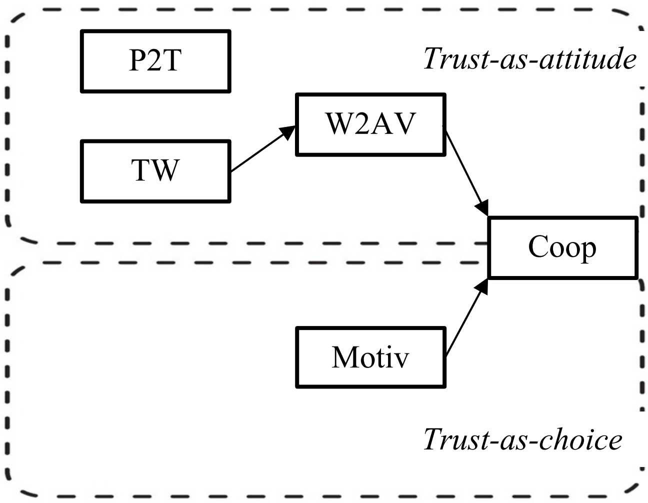


Figure 2.2 Trust Model. Sourced from Hamm (2017, p. 923)

The results of Hamm's (2017) work demonstrated support for his model and as such means that it could be adopted as a guide to the research of relationships between trust elements or for researchers to focus on one particular element with confidence that it has a significant effect on the rest of the model. From this, we can make the assumption that measuring the perceived trustworthiness of an actor in a policy space using a utility model with trust as choice will relate significantly to an individual's willingness to accept the actor's agenda and to cooperate with its outcomes.

2.5.2 Trust as social capital

Trust is widely regarded as one of the key factors of the social capital required for the effective governance of natural resources and successful collective action (Pretty & Ward, 2001; Purdue, 2001; Sampson et al., 2011; Stern & Coleman, 2014). Whilst the position of trust in social capital is not disputed, the necessity of social capital to achieve environmental change has been challenged (Raymond, 2006). Cook et al. (2005) use an encapsulated interest model of trust, where the incentive to trust and maintain the relationship is based on self-interest, to argue that strong and transparent institutions are far more effective forms of social capital than interpersonal trust.

Considering the role of trust, rules, and institutions, Ostrom (1998, p. 16) states “we can expect many groups to fail to achieve mutually productive benefits due to their lack of trust in one another or to the lack of arenas for low-cost communication, institutional innovation, and the creation of monitoring and sanctioning rules” and that without trust “no police force and court system on earth can monitor and enforce all the needed rules on its own.” This sentiment is echoed by Stern and Baird’s (2015) assertion that although strong and transparent institutions can create their own systems-based trust and serve to buffer the risk of vulnerability and that collective action will likely fail without strong community leadership, trust and reciprocity. In their ‘trust ecology’, Stern and Baird (2015) describe how an institution’s resilience to breaches in trust will depend on how well developed trust in them is across each of Stern and Coleman’s (2014) four trust dimensions.

In the New Zealand context, Norton et al. (2020, p. 8) concluded that in order to affect landscape-level change in agricultural systems, building trust is essential and that “we need to avoid letting our policy systems (national, regional and district) fall back on a strict rules-based approach”. Edwards et al. (2019, p. 8) surveyed 128 members of the public and found that in order to maintain a social licence to operate, resource management organisations require “a local, face to face component that engenders trust” and that a perception of honesty was key to generating trust. Tyson et al. (2017) sought to identify key predictors of successful catchment management through analysis of the New Zealand Landcare Trust’s success in three community-driven South Island catchment projects. Their survey of 89 farmers showed that farmer trust in the public was very low, despite this having been identified as one of six key components of success. Tyson et al. (2017) attributed low farmer trust to a long running negative narrative of agriculture and water pollution having overshadowed farmer’s efforts to improve environmental performance. Swaffield (2013) surveyed key expert informants about current best practice in integrated management of agricultural landscapes in New Zealand. He found that best practice was characterised by the social capital oriented "keys to success" of partnerships based on trust, local leadership, and enlightened self-interest (Swaffield, 2013, p. 199). Sampson et al. (2011) found trust to be a significant factor in rural New Zealand families with strong social capital, which helped them cope with industry change.

2.5.3 Trust measurement

Measuring trust historically has been based on asking respondents a series of attitudinal questions about their trust and trustworthiness of others. The long running North American General Social Survey (GSS) uses a ten-point Likert scale, which has also been adopted into New Zealand's GSS and wellbeing reporting. Such questions are open to varied interpretations and difficult to analyse (Glaeser et al., 2000). Likert scales are also used to determine attitudes towards trust with their analysis producing descriptive statistics and/or linear mixed effects models as applied in the MacKeracher et al. (2018) exploration of trust and communication in the management of the Great Barrier Reef. Sharp and Curtis (2014) used a 5-point Likert scale across a series of questions to measure the ability of staff to build trust with farmers on behalf of the New South Wales Office of Water.

Maeda and Miyahara (2003) investigated the determinants of trust in industry, government, and citizen groups for communication of environmental risk in Nagoya City, Japan, where residents suffered contaminated groundwater and flooding. They used a questionnaire with a four-point scale from low to high trust. Brewer and Ley (2012) examined trust in sources of scientific information about the environment in metropolitan Milwaukee. Employing a telephone survey, respondents were asked to rate their trust from a choice of four descriptors which were then coded into a four-point scale. Jones et al. (2012) use a GSS style ten-point Likert scale in face-to-face interviews to measure social trust and trust in institutions involved in the management of Ramsar River delta systems in Greece. However, there is another option for use in ranking tasks. Best-worst scaling is a recent choice modelling technique and "many applications of rating scales are amenable to replacement by best-worst questions" (Flynn & Marley, 2014, p. 204). Erdem (2018) applied best-worst scaling as a novel approach to measure the trust United Kingdom consumers had in information about nanotechnology.

2.6 Chapter conclusions

Other than in privately held water bodies, the quality of freshwater has public good characteristics (Siebert, 2008). It is also a cornerstone of the common good (Alcamo et al., 2003). In order to realise the vision for freshwater and a sustainable future for humanity, a reimagining of the neoclassical economic model is required. Currently the natural resource management paradigm has focussed on a cost-benefit analysis approach which has fuelled neoliberalism and the commodification of nature (Robertson, 2007). The devolution of freshwater management responsibility to regional councils under New Zealand's Resource Management Act 1991 has proven prone to political swings and has underdelivered on its promise (McNeill, 2016). The policy space is complicated and is dominated by well-resourced organisations advocating for those competing over the benefits of freshwater.

Olson's (1971) group-size paradox is predicated on small groups having a high per-capita investment and will be well organised and highly motivated to achieve their goal. Olson (1971) posits that the larger groups get the lower the per-capita investment and the less organised they become. This makes larger groups more likely to fail to provide a public good. In the freshwater policy space this describes a group of highly motivated advocates and a disorganised and disempowered wider public.

Eliciting public perceptions of a desirable freshwater future is a key component to discovering which benefits of freshwater need strong representation in the policy process. Perceptions and attitudes are complex constructs based on an individual's social norms and experiences. Nonetheless, given the right question framing, they are established predictors of behaviours (Ajzen, 1991, 2011).

Although monetisation of nature is contentious, a range of valuation techniques are available to quantify freshwater benefits. Discrete choice experiments (DCE) and the contingent valuation method (CV) are able to capture the widest range of recreational, amenity, and non-use values, such as bequest, option and existence values (Birol et al., 2006). DCE has risen in popularity due to its ability to provide prices for step-changes in the attributes of a non-market good (Bennett & Blamey, 2001). DCE suffer from high cognitive load problems with task difficulty leading respondents to employ heuristic coping strategies in which tasks are simplified by not attending to some attributes (Boxall et al., 2009; Hensher, 2006). A substantial portion of respondents also find DCE as a whole to be conceptually beyond their cognitive grasp (Rakotonarivo et al., 2016).

CV asks respondents to choose between a baseline description and a future case scenario (Perman et al., 2011b). This gives flexibility in the approach taken to conveying the baseline and future scenarios and allows respondents to take a holistic approach to considering value. CV has a lower cognitive load than DCE. A counterpoint to this is that it ignores trade-offs between the attributes of the environmental good (Birol et al., 2006). CV is considered prone to influence from the starting point bid, bid range, payment elicitation format, type of payment vehicle, and warm glow bidding (Hausman, 2012; Mitchell & Carson, 1989). Despite the need to manage specific aspects of delivering CV, it has been proven to give welfare estimates with a high correlation to those of revealed preference studies and continues to be widely used in freshwater non-market valuation (Bergstrom & Loomis, 2017; Carson et al., 1996).

Trust is a key component of social capital and trust in public institutions is a core component of law-abiding behaviour and perceived legitimacy of process outcomes (Glaeser et al., 2000; Marozzi, 2015). As pressure mounts on institutions to manage towards improving water quality, attenuate property rights, public trust becomes essential (Hamm, 2017). Trust is multidimensional, and in the natural resource setting has been described by Stern and Coleman (2014) as being an amalgam of dispositional, rational, affinitive, and procedural trust. Hamm (2017) uses the definition of trust, as the trustors willingness to accept vulnerability to the target or trustee, to model trust-as-attitude or trust-as-choice in the natural resource setting. Trust-as-choice is based on an individual choosing to trust with the expectation of receiving increased utility and conforms with Stern and Coleman's (2014) 'rational trust' dimension. Therefore, utility measures are appropriate to quantify trust. Best-worst scaling is a ranking technique founded on utility theory (Finn & Louviere, 1992; Louviere & Woodworth, 1990). It is a relatively novel approach to trust measurement first applied by Erdem (2018). Best-worst scaling provides richer information than traditional ranking and has a low cognitive load (Chrzan & Orme, 2019). It enables Bayesian estimation of individual utility that accounts for respondent heterogeneity, and the scores can be rescaled in such a way as to make them easily interpreted by a range of audiences (Chrzan & Orme, 2019). The next chapter introduces the case study area and describes its associated values.

3 Case study area

3.1 Introduction

New Zealand has a substantial area of its landmass in agricultural production, and the proportion of this intensively farmed under irrigation continues to grow. The productive demand for freshwater finds some catchments oversubscribed and suffering very low summer flows. Many of these catchments also suffer nutrient and bacterial pollution from the agricultural activity they support. In addition, the pollution can be exacerbated by inadequate wastewater treatment from small rural townships within the catchment. In determining a case study area, it was important that it have attributes broadly representative of catchments facing similar water allocation pressures across New Zealand. These are: i) seasonal water scarcity, ii) increasing sectoral competition for freshwater, iii) pressure from interest groups to intensify land use, and iv) pressure from interest groups to maintain or improve water quality.

The Tukituki River catchment in Hawke's Bay, as shown in *Figure 3.1*, was selected as the case study area. It meets the selection criteria as follows:

i. A substantial portion of the catchment area receives less than 1,000 mm of rainfall annually, within which a large area has less than 900 mm annually, and some lowland areas less than 800 mm. In Hawke's Bay, dry spell periods with less than 1 mm of rainfall are common in late spring, summer, and early autumn. In an average year, they occur two to three times and last 19 days (Chappell, 2013).
ii. As of 2015, there was 98 surface water takes consented to the catchment. In general, they had no annual volume specified, although they were regulated by minimum flow conditions. Surface water takes have been considered overallocated since 2006 (Chisholm et al., 2014). Groundwater from the Ruataniwha Basin drains into the rivers and streams of the catchment. As of 2015, there was 174 groundwater takes in the catchment. Groundwater extracted from the Ruataniwha aquifer has increased from 3 million m^3 in 1990 to approximately 25 million m^3 in 2015 (Chisholm et al., 2014).
iii. Landholders seek to maintain current irrigation levels to support existing capital investment and to increase financial returns by increasing the area under irrigation. Increasing farm production through irrigation is also forecast to increase regional economic activity, including job creation (AgriBusiness Group, 2013; Butcher Partners Ltd, 2016; Irrigation New Zealand, 2014).

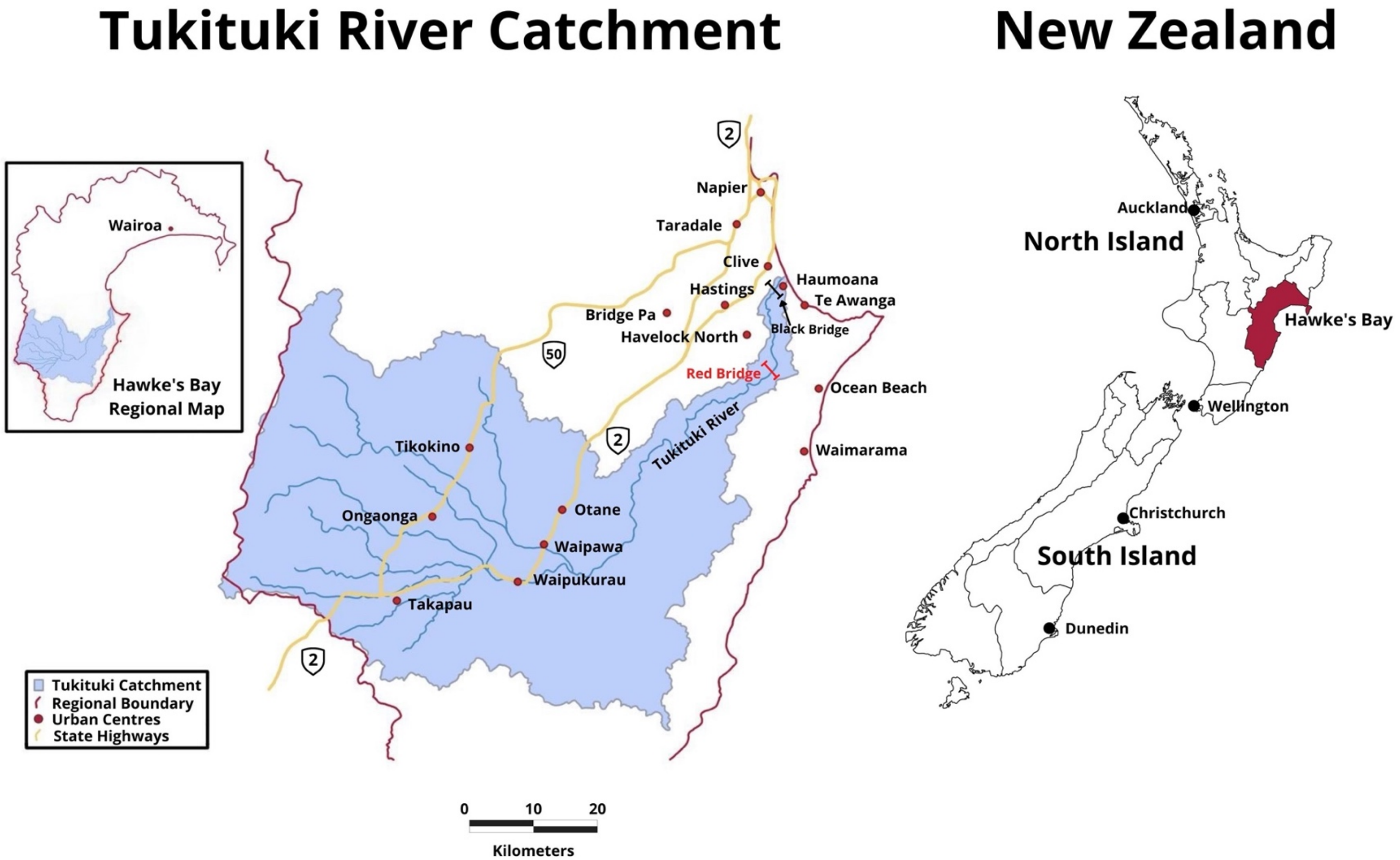


Figure 3.1 Map Showing the Location of the Tukituki River Catchment in Hawke's Bay, New Zealand. Adapted with Permission from the Hawke's Bay Regional Council

iv. The Tukituki River and its tributaries are well-used recreational amenities with a highly regarded ecological value. Various interest groups such as Fish and Game, Forest and Bird, and the Environmental Defence Society have advocated for improved water quality (Environmental Defence Society, 2014; Fish & Game New Zealand, 2015; Forest & Bird, 2017).

This chapter has three more sections. Section 3.2 describes the case study area, identifies key stakeholders, and provides background on its current freshwater policy. Section 3.3 describes the study area's values, and Section 3.4 is the chapter summary.

3.2 Case study area description and background

Hawke's Bay is a province of New Zealand located mid-way up the east coast of the North Island. It is roughly crescent-shaped surrounding Hawke Bay and is bordered inland by mountain ranges that transition to rolling hill country. The first Māori settled the region between 1250-1300 AD, and those that became known as the iwi (tribe) Ngati Kahungunu settled in the 16th century (Pollock, 2009, p. 4). They are the current tangata whenua (local people born of the land). English explorer Captain James Cook arrived by ship in 1769 and returned in 1773 (Pollock, 2009, p. 5). Pastoral agriculture began in earnest from 1850 to the 1870s, when land purchased from Māori by the Crown and private settlers was cleared of native forest and converted to pasture (Pollock, 2009, p. 6). Land purchases by the Crown sometimes involved misrepresentation and/or deceit and have been subject to settlement claims. The impact of historic bad-faith dealings on local Māori is described in the Heretaunga Tamatea Claims Settlement Act (2018).

Progressive land clearing has meant that pastoral agriculture is now the dominant land use of Hawke's Bay's rolling and steep hill-country. The hill-country gives way to the fertile Wairoa flood plains in the north and the Heretaunga plains in the middle of the region, which support intensive orcharding, horticulture, and viticulture. The Ruataniwha Basin in southern central Hawke's Bay is the third substantial flat land area that supports a range of agricultural activity, including increasing numbers of intensive dairy production units. The hydrology of the Ruataniwha Basin drains into the Tukituki River catchment.

Hawke's Bay has two main urban centres, namely the cities of Napier and Hastings. Napier has a deep-water port through which the region exports a high volume of produce from pastoral agriculture, orcharding, and vineyards, and until Covid-19 was hosting a steady flow of tourist cruise ships. The region has a number of small rural townships that historically serviced farming communities in the days before modern transportation. The two largest rural townships are Waipukurau and Waipawa in central Hawke's Bay. The region has 166,368 people, of which 27% are Māori (Statistics New Zealand, 2020). The median income is $28,000 per year, with 12.5% of the population earning more than $70,000 per year (Statistics New Zealand, 2020).

Seasonal water scarcity is well documented on the east coast of New Zealand. The provinces of Canterbury in the South Island and Hawke's Bay are particularly well known for this characteristic. Both regions are forecast to suffer more frequent severe drought conditions in the future due to the effects of climate change (Clark et al., 2011). Hughey et al. (2019) is the most recent publication of research tracking the New Zealand public's perceptions of the environment, including freshwater. Whilst Hughey et al. (2019) provides an extensive analysis at a national level, little previous research has investigated community perceptions of freshwater at a catchment level. There is no apparent work investigating trust in organisations involved in the freshwater policy space.

Two recent studies by Tait (2010) and Miller (2014) (see section 2.4.7) focussed on the marginal value of improved water quality using discrete choice experiments. They were both completed using Canterbury as a case study area. Tait (2010) valued the impact of dairying effect mitigation programmes such as the Dairy and Clean Streams Accord on rivers and streams in Canterbury with a five-year horizon. Miller (2014) estimated the marginal value of improved water quality in the Selwyn/Waikirikiri River in Canterbury. There has been no apparent research investigating community perceptions or estimating welfare associated with improved water quality in Hawke's Bay. The closest is a study by Ndebele (2009) valuing welfare associated with the restoration and preservation of the Pekapeka swamp.

Hawke's Bay has six main rivers, namely (from north to south) the Wairoa, Mohaka, Esk, Tutaekuri, Ngaruroro, and Tukituki rivers. The Mohaka is one of fifteen rivers in New Zealand that are subject to a water conservation order. The Ngaruroro is currently under application for a water conservation order. The Tukituki River catchment has been heavily modified to predominantly pastoral agriculture and covers approximately 2,500km^2 extending east from its headwaters in the Ruahine Ranges across much of central Hawke's Bay (Hawke's Bay Regional Council, 2016b). Many small tributaries converge across the Ruataniwha Basin into the Tukituki and Waipawa rivers, which themselves converge south-east of Waipawa township to form the Tukituki River. From there, it is joined by many more small tributaries as it flows north-east to Hawke Bay at the township of Haumoana. Notable population centres within the catchment are the towns of Waipukurau, Waipawa, and Haumoana. The township of Havelock North is directly adjacent to the catchment, and the Tukituki may be considered its 'natural' or 'local' river. The City of Hastings may be considered equidistant from the Tukituki and Ngaruroro rivers.

The Tukituki River was the subject of a 2013 resource consent application by the Hawke's Bay Regional Investment Company Ltd[11] in conjunction with a proposal to construct a water storage facility. The facility would have been the largest irrigation dam in the country and was intended to supply water to allow intensification of land within the Ruataniwha Basin in the upper Tukituki catchment (Chisholm et al., 2014). The consent application created conflict between those stakeholders wishing to use the river for recreation or wishing to preserve and restore its already declining ecological health and those wanting to generate economic activity through intensive agriculture. Considered by the central government as a project of national significance, the consent process was referred by the Minister for the Environment to a government appointed board of inquiry. In 2015 the inquiry's deliberations delivered outcomes that altered the proposed Regional Plan Change 6 (2015) (PC6). The status of the project, viewed by many as a national test case, and its associated technical and political complexities make this catchment topical, nationally significant, and a potentially rich research resource.

Plan Change 6 (2015) lowered maximum nutrient levels, increased minimum ecological flows, and introduced subsequent limits for both ground and surface water allocation. The plan was operational from 1st October 2015. Farm Environmental Management Plans had to be submitted to the Hawke's Bay Regional Council (HBRC) by 1st June 2018 and nitrogen leaching targets were to be met by 31st May 2020. A dissolved inorganic nitrogen target of 0.8mg/L and a dissolved reactive phosphorus target of 0.01-0.015mg/L were set for the River and must be met by 2030 (Hawke's Bay Regional Council, 2015). The first

[11] The Hawke's Bay Regional Investment Company Ltd is a development entity owned by the Hawke's Bay Regional Council (the regional natural resource regulator). In the instance of the consent application for the Ruataniwha water storage scheme, the regional council was essentially seeking consent from itself.

increase in minimum flows occurred in July 2018, and the second is due in 2023 (Hawke's Bay Regional Council, 2016a). This means there was less water available for the irrigation of crops in the catchment from the summer of 2018/19 onward, and this will drop further in 2023.

Following the summer of 2018/19 there was a failed bid by the Tukituki Water Taskforce[12] to have the Regional Plan changed to rescind the 2018 flow rate increase and delay its implementation to 2021 (Sharpe, 2019). Nutrient targets and limits must be met and complied with by 2030 (Hawke's Bay Regional Council, 2015).

There are salient points surrounding PC6 (2015) that are particular to the background of this case study. They are:

i. The BOI was established to rule on a proposal for significant increases in allowable non-point source pollutant levels in the Tukituki River and its tributaries.
ii. The applicant for these increases was the HBRC.
iii. The driver for this application was to facilitate land-use intensification under irrigation after a proposal for a large-scale water storage dam.
iv. The principal proponent of the water storage scheme was the HBRC under an investment company it had set up.
v. In the October 2016 local body elections, there was a change in the elected members of HBRC. The result delivered a power shift towards a more sceptical view of the scheme. In March 2017, the HBRC chief executive, who was also the chief executive of the HBRC Investment Company, resigned and the scheme was ultimately shelved after a Supreme Court ruling in July 2017.

The BOI found that the existing water quality management regime was detrimental to the ecosystem services of the Tukituki River and imposed the changes in PC6 (2015) as outlined. At the time of this decision, the agricultural community expected the water storage scheme to proceed and were more or less content that access to its water would more than offset the new minimum flows. Indeed, central to the storage scheme's consent was the provision of four Mm^3 pa to increase flows and an obligation to provide additional

[12] The Tukituki Water Taskforce consisted of members of the Central Hawke's Bay District Council, Hawke's Bay Regional Council, irrigators, local residents, environmental groups, and local taiwhenua (Māori of the land or district).

flushing flows (Butcher Partners Ltd, 2016). The scheme was shelved in 2017 after a legal battle over the proposed flooding of 22ha of native forest protected under the Conservation Act (1987). In 2015, the Minister for the Environment directed the Department of Conservation's Director-General to endorse the swap of the 22ha of old-growth forest with 147ha of farmland, some of which was replanted in juvenile native regrowth. The Supreme Court endorsed the ruling by the Court of Appeal and ruled this plan illegal (The Supreme Court of New Zealand, 2017). Ill feeling in the agricultural community has generated talk of needing to revisit the limits imposed in PC6 (2015) given alternative water has not materialised.

In this unusual case, those advocating for a common good vision of the Tukituki River catchment found themselves lobbying the HBRC, knowing that they were also the developer. The situation meant that until the BOI was instigated by the Minister for the Environment, the HBRC was making an application to itself to substantially increase nitrogen pollution in the catchment. In the minds of many, the HBRC appeared to be ethically compromised in its role as a freshwater regulator on behalf of the public. During the PC6 (2015) and water storage consent process, there was much work done on quantifying the potential economic value of the consumptive use of water in the catchment; however, assessment of "environmental values" was only qualitative (Butcher Partners Ltd, 2016, p. 6). As a consequence, a significant gap in knowledge about the catchment existed. No quantitative information of public perceptions of the catchment's current state or vision for its future state existed. There was also no valuation study undertaken to estimate the impact of low flows and pollution in the Tukituki River catchment on public welfare.

3.3 Values of the case study area

The values in the Tukituki catchment are diverse. The HBRC conducted an assessment of values across the region's catchments during the PC6 (2015) process by utilising internal personnel and commissioning external reports. These were conducted for salmonid angling, swimming, native birdlife, native fish, natural character, whitewater kayaking, and irrigation. The assessments were conducted using existing information both internal and external to the HBRC, and expert panels in conjunction with the River Values Assessment System (RiVAS and RiVAS+) (Booth, 2012; Booth, Bellamy, et al., 2012; Booth, Cameron, et al., 2012; Booth, Coubrough, et al., 2012; Booth, Madaraz-Smith, et al., 2012; Harris, 2012; Hughey et al., 2013).

The RiVAS system uses expert panels to identify attributes and their indicators and thresholds. It then used weightings to identify and rank river significance at a local, regional, and national levels. Most of the RiVAS studies undertaken in Hawke's Bay acknowledge some level of debate, data deficiencies or estimation associated with the assessment process. Ultimately the results are a comparative scale that rates river sections as being of national, regional or local significance with regard to the attribute under assessment. Despite shortcomings, the distillation of significant expertise provides essential insight into the catchments differing values. The significance scale for these values in the Tukituki catchment is summarised in Table 3.1.

Table 3.1 *Tukituki Catchment Values Assessed Using the RiVAS System*

Value Assessed by RiVAS	Level of significance within the Tukituki Catchment
Salmonid Angling	**National** significance Tukituki River from Red Bridge to sea, Tukituki River from Waipawa confluence to Patangata Bridge, Waipawa River to Makaroro confluence. **Regional** significance Tukituki River from Red Bridge to Patangata Bridge, Makaroro River, Tukipo River, Mangaonuku Stream. **Local** significance Maharakeke Stream, Makaretu Stream.
Swimming	**Regional** significance Tukituki River at Shag Rock off River Road and Patangata Bridge. **Local** significance for the remainder of catchment†.
Native birdlife	**National** significance Tukituki River from Waipawa confluence to sea and Tukituki River upstream of Waipawa confluence including Maharkeke and Porangahau Streams. **Regional** significance Waipawa River to headwaters, Tukipo River, Makaretu Stream and upper reaches of the Tukituki River to SH50. **Local** significance upper reaches of Tukituki River from SH50 to headwaters, Makaroro River and Mangaonuku Stream.
Native fish	**National** significance for the entire Tukituki catchment. Especially for the Upland and Crans bully and Dwarf galaxiid, which are the last three non-migratory species surviving in Hawkes Bay.
Natural character	**National** significance Tukituki River from Waipukurau to headwaters, Maharakeke Stream, Makaretu Stream, Waipawa River from Waipawa to headwaters, Makaroro River. **Regional** significance Tukituki River from Waipukurau to Moore Road including tributaries, Waipawa River from Waipawa to confluence, Tukipo River, Mangaonuku Stream. **Local** significance lower Tukituki River from approximately Moore Road to sea.
Whitewater kayaking	**Local** significance at Makaroro River and otherwise the catchment was insignificant.
Irrigation	**Regional** significance upper and lower Tukituki River.

This table aggregates the values and level of significance in the Tukituki River catchment as they were assessed in seven separate RiVAS (River Values Assessment System) reports.

†Sites on the Tukituki River at Black Bridge and Rochford Road were identified as able to move to regional significance with the addition of public toilets.

The HBRC aggregated and distilled commissioned reports and, in conjunction with internal expertise, arrived at a values assessment presented to the Board of Inquiry (Sharp, 2013). They identified that some values applied to the entire catchment and that others varied between sub-catchments. Those values applying to the entire catchment were; i) life supporting capacity, ii) mauri (life force), iii) contact recreation in relative safety from health consequences, iv) water use, and v) fish passage. Those varying by sub-catchment were; i) recreation, ii) natural state, iii) native fish habitat, iv) trout spawning habitat, v) trout habitat, vi) wetlands, vii) riverine bird habitat, viii) inanga spawning habitat, and ix) inanga habitat. Table 3.2 lists these values and correlates them with their corresponding Total Economic Value (TEV) and Ecosystem Service classes using the freshwater based TEV taxonomy from Sharp and Kerr (2005, p. 4) as well as that from the Millennium Ecosystem Assessment (Alcamo et al., 2003).

Table 3.2 *Hawke's Bay Regional Council's Tukituki Catchment River Values Typology*

Value		Total Economic Value class	Ecosystem Service class
Life supporting capacity	Value applies to all sub-catchments	Non-use: Existence & bequest	Supporting
Mauri		Non-use: Existence & bequest	Cultural
Contact recreation (health)*		Use: *In situ*	Cultural
Water use		Use: Commercial & option	Provisioning
Fish passage		Non-use: Existence & bequest	Supporting
Recreation (amenity)	Value varies across sub-catchments	Use: *In Situ* direct and indirect Option	Cultural & Provisioning
Natural state		Non-use: Existence & bequest	Cultural
Native fish habitat		Non-use: Existence & bequest	Supporting
Trout spawning habitat		Non-use: Existence & bequest	Supporting
Trout habitat		Non-use: Existence & bequest	Supporting
Wetlands		Non-use: Existence & bequest Use: *In situ* direct & indirect Option	Cultural, Supporting, Provisioning & Regulating
Riverine bird habitat		Non-use: Existence & bequest	Supporting
Inanga spawning habitat		Non-use: Existence & bequest	Supporting
Inanga habitat		Non-use: Existence & bequest	Supporting

Source: Sharp (2013)
* Wading and swimming in relative safety from health consequences

The catchment also has a waste assimilation value to many discharge consent holders. The towns of Waipawa, Waipukurau, and Otane all discharge treated municipal waste from oxidation ponds into the waterway. Additionally, consents are held by private dwellings for septic tank wastewater discharge to land with likely seepage to groundwater and waterways. At the time of writing, work has begun for the Central Hawke's Bay townships to improve their wastewater treatment. Currently, work is underway to pipe raw waste from Otane to Waipawa for treatment in a combined facility. Long-term solutions include either separate upgraded facilities for Waipawa and Waipukurau or a single larger treatment plant at Waipawa to service all three townships (Sharpe & Anselm, 2020). A feasibility study is underway to discharge the treated wastewater to land near Waipawa, and the proposed site is alongside the river (CHB Mail, 2020).

3.3.1 Value to Māori

Māori values within the catchment were assessed by Te Taiwhenua O Tamatea in partnership with Te Taiwhenua O Heretaunga in a report commissioned by HBRC. The hapu (primary political unit in traditional Māori society comprised of related families) of Heretaunga Tamatea have a deep cultural connection with the catchment as it falls within their rohe (territory). This mana whenua (relationship to the land) is founded on the role of the catchment's whenua (land) and awa (water) in tribal life. The key values identified in the report have been listed, described, and correlated with their corresponding cultural ecosystem sub-class as per the Millennium Ecosystem Assessment taxonomy in Table 3.3.

Table 3.3 *Maori Cultural Values within the Tukituki Catchment*

Maori Cultural Value	**Description**	**Cultural Ecosystem Service Sub-Class**
Awa	Landing place on the banks of a waterway for canoes	Sense of place
Mahinga kai	Places where food is gathered or grown	Cultural heritage (also a provisioning service)
Mana	Authority, prestige, influence, and power	Sense of place
Mauri	Life principle or source of emotion	Spiritual & religious
Rongoa	Healing remedies and medicines taken from nature	Cultural heritage
Tikanga	Customary right, rule, plan or method	Cultural heritage
Wāhi taonga including Wāhi tapu	Special places (Wāhi tapu) and objects that are considered sacred or spiritually significant. Including but not limited to waterways, landforms, and vegetation	Spiritual & religious

Source: Wakefield et al. (2012)

The catchment's role in Māori life is multifaceted as it is: i) imbedded in a spiritual connection to mythology and familial ancestry, ii) a provider of traditional mahinga kai (food) and the customs surrounding its collection and preparation, iii) a source of traditional medicines and remedies, iv) a vessel for the mauri (life force) of the river and from this a sense of kaitiakitanga (guardianship), and iv) a source of mana (prestige and power) and prosperity (Te Manaaki Taiao Te Taiwhenua o Heretaunga, 2012; Wakefield et al., 2012).

3.3.2 Value to horticulture and farming

The Tukituki catchment has varied arable farming and horticultural land uses. In the main these include arable cropping, pipfruit, process crops, stone fruit, and vineyards (AgriBusiness Group, 2013). It is estimated that of the catchment area used for forestry and farming, 5% is in arable farming, and less than 1% is in orcharding and viticulture (Chisholm et al., 2014). Of all permits to take water in the catchment (both groundwater and surface water), 39% of the volume is for irrigating crops, 12% for orchards, and 2% for vineyards (Hawke's Bay Regional Council, 2017). In 2020, horticulture and fruit growing made a direct contribution of 3% ($255m) to Hawke's Bay's GDP (Infometrics, 2020).

The most immediate impact of PC6 (2015) on this land use is the new minimum flow requirements. HBRC has divided the catchment into three management zones, each with a minimum flow measurement point. These are the Red Bridge, Waipawa Bridge, and upper Tukituki River at Tapairu Road, as shown in *Figure 3.2*. Direct surface water consents and consents deemed hydrologically connected upstream of these points will be affected by the new flow requirements. The horticultural land use type under irrigation for each section of the catchment is shown in Table 3.4.

Table 3.4 *Horticultural and Arable Land Use in Hectares Across the Tukituki Catchment by Flow Regime Area*

	Arable cropping	Pipfruit	Process Cropping	Stone fruit	Vineyard	Total
Red Bridge	6	76	341	45	105	573
Waipawa	57	33	69	0	13	172
Tapairu	1,490	43	245	1	20	1799
Total						2544ha

Sourced from AgriBusiness Group (2013, p. 10)

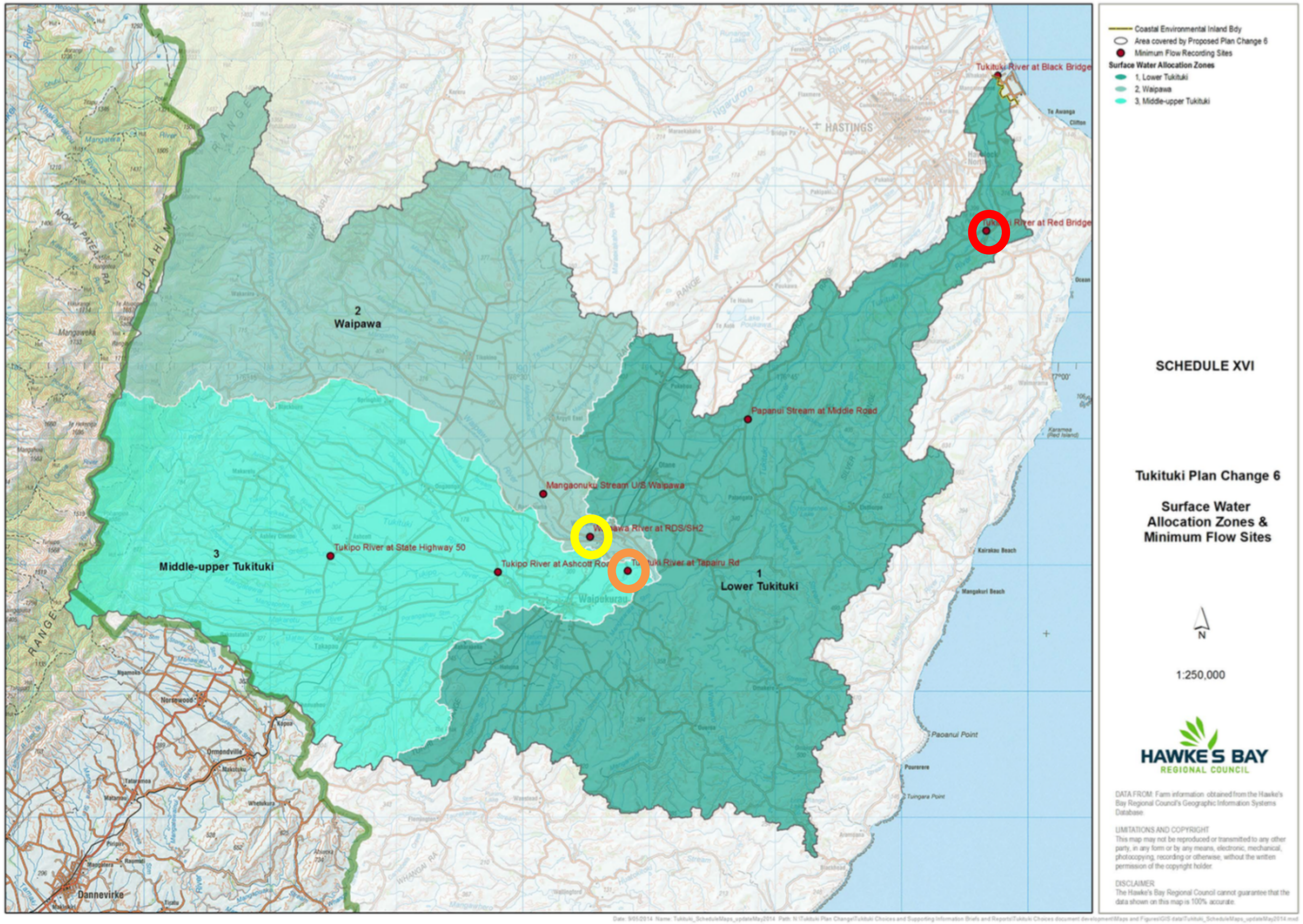


Figure 3.2 Flow Recording Sites and Surface Water Allocation Zones of the Tukituki River Catchment

Source: Hawke's Bay Regional Council (2014, p. 4).

Red Bridge recording site, Waipawa Bridge recording site, Tukituki recording site at Tapairu Road

A report for Horticulture NZ by the AgriBusiness Group (2013) concluded that only the Red Bridge and Tapairu zones would be adversely affected by the new minimum flows as the water supply in the Waipawa area was already too unreliable to support significant horticulture. Process cropping (341 ha), vineyards (105 ha), and orcharding (pipfruit 76 ha and stone fruit 45 ha) dominate the Red Bridge area. Process crops are significant (245 ha) in the Tapairu area; however, the area is predominantly arable cropping (1,490 ha). Total estimated revenues (2012 dollars) from the Red Bridge area were \$10,596,703 and Tapairu \$13,179,104 with gross margins of \$3,504,143 and \$4,746,922 respectively. The Red Bridge area faces two step-changes in minimum flows, the first in 2018, which was estimated to reduce annual operating revenue by 10% and gross margin by 20%. The second, in 2023, would reduce revenue and gross margins by 38% and 66%, respectively. The Tapairu area would only have one step-change, and this would impose reductions in revenue of 14% and gross margin of 25%. The total aggregate reductions for the full implementation of minimum flows in PC6 (2015) would, therefore, be \$5,897,265 in revenue and \$3,505,766 in gross margin annually (AgriBusiness Group, 2013).

Of the catchment area used for farming and forestry, it is estimated that 70% is in sheep and beef production, 18% forestry, and 4% dairying (Chisholm et al., 2014). Dairy production represents a total area of 10,500 ha compared to 164,000 ha for sheep and beef (Hawke's Bay Regional Council, 2017). Of all permits to take water in the catchment (both groundwater and surface water), 47% of the volume is for pastoral irrigation (Hawke's Bay Regional Council, 2017). Very little catchment-level data on the value of pastoral agriculture appears to be in the public realm. On a regional basis, however, agriculture accounts for approximately 8.9% of Hawke's Bay's GDP, and the processing of dairy, meat, and horticultural output sustains 22% of the region's manufacturing employment (Chisholm et al., 2014). In 2020, Sheep, beef, and grain farming's combined direct contribution to the region's GDP was 2.6% (\$221m), whilst dairy farming was 0.5% (\$41.1m) (Infometrics, 2020).

3.3.3 Values by surface water management zones

The HBRC has divided the Tukituki River catchment into three surface water management zones. Each zone makes further distinctions between the river's main stem, its tributaries, and some riverine areas with special character such as significant ground water upwelling contributing to flows. Details of the parameters for targets and limits and their indicators can be found in PC6 (2015, pp. 8-12). A copy of these pages is reproduced in Appendix B - Surface water quality limits, targets, and indicators for the Tukituki River catchment.

In PC6, limits and targets are zone specific for nitrate-nitrogen (NO_3-N), dissolved reactive phosphorus (DRP), and instream periphyton biomass and cover. Due to a quirk of the BOI's delivery of the document, the zone-specific nitrate-nitrogen targets (as high as 5.6 mgL^{-1}) are defunct. The absolute target measure for nitrate-nitrogen is governed by the total dissolved inorganic nitrogen target of 0.8mgL^{-1}(a product of nitrate + nitrite + ammoniacal nitrogen). Water quality limits are also placed on temperature, dissolved oxygen, *Escherichia coli* (*E. coli*), and other toxins. The environmental state indicators used to monitor outcomes are the Macroinvertebrate Community Index (MCI), visual water quality and deposited sediment (Hawke's Bay Regional Council, 2015). Groundwater will be managed to limits for "aesthetic, organic and inorganic determinants; *Escherichia coli*, and nitrate-nitrogen" (Hawke's Bay Regional Council, 2015, p. 3). Drinking water supply take sites will comply with the relevant regulations and standards (Hawke's Bay Regional Council, 2015).

As described in section 3.3.2, the HBRC has divided the catchment into three surface water allocation zones following the tributaries of the Waipawa, upper-middle Tukituki and the lower Tukituki. *Figure 3.2* depicts the allocation zones and the flow recording sites at Red Bridge, Waipawa Bridge, and on the Tukituki at Tapairu Road that are critical to the step changes in PC6 (2015). Table 3.5 displays the pre-2018 minimum flows, 2018 minimum and the 2023 minimums at the three critical catchment nodes at the base of each surface water allocation zone. Flows between the lower Black Bridge, located on Mill Road approximately 1,800 m from the river mouth, and the sea are exempt from change. The increased flows are expected to deliver significant increases in protection for fish species offering up to 90% protection for trout in the lower Tukituki and 90% protection for longfin eel and other high flow demanding fish species in both the Waipawa and Upper-middle Tukituki zones (Hawke's Bay Regional Council, 2015). The anticipated positive effect of these flows on non-market values and the negative impact on agricultural use values in two zones makes the surface water allocation zones significant geographical divisions in the value assessment process.

Table 3.5 *Required Changes to Catchment Minimum Flows at Main Flow Recording Sites*

	Minimum flow regime (L/sec)		
Flow recording sites at critical catchment nodes†	**Pre-2018**	**2018**	**2023**
Red Bridge	3,500	4,300	5,200
Waipawa Bridge	2,300	2,500	2,500
Tukituki at Tapairu Road	1,900	2,300	2,500

Source: Hawke's Bay Regional Council (2015, p. 15).

† Additional recording sites and minimum flows exist at; i) Papanui Stream on Middle road, ii) Mangaonuku Stream upstream of Waipawa, iii) Tukipo River at Tapairu Road, and iv) Tukipo River at Ashcroft Road.

As demonstrated in the seven RiVAS reports summarised in Table 3.1, there is wide variation in the type and significance of values in waterways across the catchment. The surface water allocation zones are important geographic boundaries within the catchment because they delineate policy impact boundaries and follow the natural hydrology of the two main tributary systems. In order to explore the possibility of utilising the surface water allocation zones more fully as analytical boundaries, a series of seven overlayed maps were constructed and are contained in Appendix C - Values overlay maps. Each map uses the surface water allocation zones as a base layer and overlays one of the RiVAS value maps.

The results of the overlay analysis are summarised in Table 3.6. An attribute may not have the same level of significance over all sections of the waterways within a single zone. Therefore, a zone may have more than one value level as discrete sections of the main river stem, or its tributaries may have attributes valued at different levels. The table ranks each value attribute based on its aggregate value point score and provides a total score for each zone. Nationally significant is scored as three points, regionally as two points, and locally as one point. This approach is limited in that it does not account for the depth of significance at each level nor does it account for the total length of river or stream valued. It does, however, offer some basis for comparison. Angling, native birds, and natural character are the three top ranked values across the catchment by this method. It also shows the Waipawa zone has a lower total significance than the Tukituki zones.

All zones have three nationally significant values: only native fish is common across all zones. Zones two and three have nationally significant areas of natural character within them, zones one and three have nationally significant areas for native birds, and zones one and two have nationally significant areas for angling.

Table 3.6 *Significance of RiVAS Values by Surface Water Allocation Zone*

	Surface Water Allocation Zones			
Value Attributes	Lower Tukituki Zone 1	Waipawa Zone 2	Middle-Upper Tukituki Zone 3	Total Attribute Score†
Angling	***, **	***, **	**, *	13
Native Birds	***	**, *	***, **, *	12
Natural Character	**, *	***	***, **	11
Native Fish	***	***	***	9
Swimming	**, *	*	*	5
Irrigation	**	Not significant	**	4
Whitewater Kayaking	Not significant	*	Not significant	1
Zone total†	19	16	20	

*** Nationally Significant, ** Regionally Significant, *Locally Significant
Surface water allocation zones 1,2 & 3 are depicted in *Figure 3.2*.
†Totals are the sum of values scored as: National = 3, Regional = 2, and Local = 1. A single zone may have discrete sections of waterway valued at different levels. This means a zone may have more than one value score.

All three zones are regionally significant for angling. Zones two and three are regionally significant for native birds, zones one and three for natural character, zone one for swimming, and zones one and three for irrigation. Other values are either locally significant or insignificant.

Earlier tables have shown values are wide ranging at a coarse catchment level, and shows they are still widely varied at the allocation zone level. An economic assessment of these values should recognise and accommodate both the value heterogeneity and policy impacts of the allocation zones.

3.3.4 Value to Fish and Game

As shown in Table 3.6, the Tukituki River catchment is nationally and regionally significant to anglers. The catchment holds both rainbow and brown trout and is an important sport fishery. It is one of four main trout fishing river catchments in Hawke's Bay and has the highest fishing effort of all catchments with over 12,550 ± 1,190 angler days per year. This accounts for 34% of the total angler effort in Hawke's Bay (Unwin, 2016). Hawke's Bay is also a destination for anglers from other regions (16% of the regional total effort) and international fishers (4.6% of the total regional effort). There is an indication that fishing effort has declined in the mid and lower reaches since the 2000/2001 season (Unwin, 2016). The catchment also offers gamebird hunting opportunities with the possibility to shoot both waterfowl and pheasants (Fish & Game Hawke's Bay, 2020).

3.4 Chapter summary

The Tukituki River catchment was selected as the case study area. It is found in Hawke's Bay, a province of New Zealand located on the east coast of the North Island. The river forms part of the traditional whenua (land) of the Māori iwi (tribe) Ngati Kahungunu. In particular, it is part of the rohe (territory) of the hapu (sub-tribes) Heretaunga and Tamatea. Like much of New Zealand, the catchment has undergone a dramatic and rapid landscape change from native forest to pastoral agriculture following European settlement in the mid-19th century. The more fertile flat land is under intensive horticulture, orcharding, and viticulture, as well as increasing amounts of dairy production, all of which rely on irrigation to maintain current production practices. Irrigation water is sourced from groundwater and from surface water abstracted from the river system. Typical of New Zealand's east coast, the region suffers summer water scarcity and dry spell periods, which at times become a drought. The effects of climate change mean that more frequent drought events are forecast over the coming decades.

The Tukituki River catchment has significant cultural value to local Māori. It holds spiritual significance and is a traditional source of transportation, food, medicines, and tribal prestige. One of their guiding principles is that the water has a mauri (life force) in its own right and that this must be protected. The catchment's recreational values include being a trout fishery of national significance. It has the highest angler effort (measured in days fishing) of all the rivers in Hawke's Bay. The catchment also has high ecological value as it harbours nationally significant populations of native birds and native fish.

The catchment has a rich and contentious recent history, having been subject to a national Board of Inquiry in 2013 over a proposal by the development arm of the regional council to substantially increase the allowance for nitrogen pollution. Principally this was designed to allow further intensive dairying using water from a proposed water storage scheme that was also undergoing consideration from the same inquiry. The bid to build the water storage failed and the Board delivered a sweeping set of changes in 2015 to restore health to the catchment. The changes included stepped increases to the minimum flows in 2018 and 2023, and substantial reductions in the limits for nutrient pollution, including nitrogen. All pollution targets are to be met by 2030.

The next chapter describes the methodology and methods used to gather data. Two survey instruments were used for gathering data. The first was focussed on measuring perceptions of the catchment and was undertaken in mid-2019 to achieve Objective 1. The second contained a contingent valuation exercise to value an improvement in water quality and a best-worst choice experiment to quantify trust. It was delivered in early 2020 to achieve Objectives 2 and 3.

4 Methodology and methods

4.1 Introduction

This chapter describes the methodology and methods used to deliver two field studies designed to address the objectives defined in section 1.2.2. Section 4.2 describes the method and methodology used to design the first field study deployed in mid-2019 to address Objective 1: ‘To define the common good of freshwater and determine perception heterogeneity in the study area (a particular focus is placed on comparing fishers and gamebird hunters with the wider public)’. Section 4.3 describes the method and methodology used to design the second field study deployed in early 2020 to address both Objective 2: ‘To estimate the marginal welfare benefits generated by improved water quality in the study area’ and Objective 3: ‘To quantify the willingness to pay for improved water quality as a function of welfare based on public trust of freshwater advocates and policy-oriented organisations’.

4.2 Study Objective 1

Objective 1: To define the common good of freshwater and determine perception heterogeneity in the study area (a particular focus is placed on comparing fishers and gamebird hunters with the wider public).

4.2.1 Measuring perceptions

In 1927 the measurement model called the ‘law of comparative judgement’ was published by Thurstone (1927a) along with his second paper (1927b) in which he applied a method of paired comparisons to derive social values. Thurstone (1927b) can be viewed as the first modern-day attempt at attitudinal measurement. Thurstone (1928) then contemplated a continuum to represent the distribution of attitudes to a given subject in the way that a frequency may be distributed. His continuum had those strongly in favour at one end and those strongly against at the other with a neutral zone in the middle. Likert (1932) expressed a preference for the conceptualisation of attitudes as a disposition toward an overt action and put forward his technique to measure social attitudes. He asked North American college students questions about aspects of internationalism using four question formats, one of which was a 5-point scale ranging from 1=Strongly approve, 2=Approve, 3=Undecided, 4=Disapprove, to 5=Strongly disapprove.

Likert (1932) found this simple format yielded strong correlations with Thurstone’s (1927b) earlier and more complicated methods but was much simpler and used only half the number of items. Likert (1932) then applied the same technique to the Thurstone-Droba war scale, first used by Droba (1930), in which the choices featured 'agreement' rather than 'approval', with comparable results. Psychometric scales in the Likert rating format are employed in either 5-point or 7-point format as measures for applying both the theory of reasoned action and the theory of planned behaviour (Montaño & Kasprzyk, 2008). Likert scales have been widely applied in contemporary natural resource management literature to quantify attitudes and perceptions towards the environment (Aldrich et al., 2007; Fish et al., 2016; Hughey et al., 2019; Kantenbacher et al., 2018; Miller et al., 2018; Parkins et al., 2018; Poppenborg & Koellner, 2013; Schulz et al., 2013; Talukdar & Gupta, 2018).

4.2.2 Likert-type data and its treatment

Historically the analysis of categorical and ordinal Likert data has had some controversy over the appropriate statistical methodology used to report central tendency, data variability, data associations, and group comparisons (Jamieson, 2004). Controversy has centred around whether parametric or non-parametric analysis is appropriate for the ordinal data gathered using Likert-type questions (see section 4.2.1). It is now agreed that when Likert-type questions are grouped and closely related in topic and framing, a 'scale' can be said to have been formed (Harpe, 2015; Norman, 2010). As such, the use of parametric reporting using means for central tendency and standard deviations for data variability is appropriate. It is also appropriate to use parametric tests for data associations, such as Pearson's *r*, and a *t*-test, analysis of variance or regression for inferential statistics (Carifio & Perla, 2008; Harpe, 2015; Norman, 2010). Where Likert-type questions do not meet the described requirements for a 'scale', they should be treated as non-parametric data. In the case of non-parametric analysis, median or mode should be used for central tendency, frequencies for data variability and Kendall's τ B or C for data associations. Non-parametric tests should be applied for inferential statistics such as χ^2, Spearman's ρ or the Mann-Whitney U-test (Jamieson, 2004).

4.2.3 Questionnaire development

A survey was designed to capture and quantify individual perceptions of the Tukituki River catchment's current state and perceptions of a vision for the future state that most represents the common good. It consisted of eight modules. The first four modules were; i) Introduction and demographics, ii) Catchment engagement including frequency and reason for visiting the catchment, iii) Environmental activity, and iv) Income dependency on water abstraction. Modules v) - vii) applied psychometric rating to measure attitudes and perceptions. Modules v) & vi) required the selection of catchment state variables. These were derived from three sources; i) the catchment values as summarised in the preceding section, ii) analysis of Hawke's Bay Regional PC6 pertaining to the Tukituki River catchment, and iii) from an extensive review of New Zealand non-market valuation literature.

Module v) asked respondents to rate agreement with positively framed statements regarding the catchment's current state. For example, "In the past 5 years, water levels in the Tukituki River catchment posed no problem". A 5-point Likert scale was used with 1= strongly agree, 2= somewhat agree, 3= neither agree nor disagree, 4= somewhat disagree, and 5=strongly disagree. A 5-point scale was selected in line with the recommendation of Revilla et al. (2014) that five points is best for agree-disagree scales. Both independent Likert questions and groups of related questions forming Likert scales were used. The five-year time frame reflects the regional plan's water quality compliance monitoring in the catchment, where target values are treated as five-year averages.

Module vi) asked respondents to rate agreement with statements regarding their vision of a hypothetical future state. They were asked to approach the statement using an established 'citizen framing' adopted as a proxy for 'the common good' of society as a whole. The wording for this framing was "Thinking about society as a whole and keeping in mind future generations, to what extent do you agree with the following statements?" The wording was taken mainly from Miller's (2014) work choice modelling improvements in water quality in the Selwyn River, Canterbury. Miller tested for the possibility of positive bias in willingness to pay resulting from citizen framing. She found no support for a hypothesis of bias, and as such, we introduced citizen framing as a means of focusing respondents without expectations of bias. The framing also serves to represent the purpose of the RMA (1991), as described in s5(2 a) of the Act; "sustaining the potential of natural and physical resources (excluding minerals) to meet the reasonably foreseeable needs of future generations". Module vii) asked respondents to rate agreement with statements regarding catchment health and management. Module viii) was a categorical question to clarify the reason most responsible for any neutral responses. A copy of the survey instrument can be found in Appendix D - Survey instrument for Objective 1.

4.2.4 Ethics and pre-testing

The survey content was peer-reviewed in an iterative process with two environmental management university professors, an academic expert in Māori culture, and a Regional Council catchment manager with expert knowledge of the study area. Reviewer feedback was incorporated prior to piloting the survey. A pilot was run via electronic web-link delivered to a convenience sample of Fish & Game licence holders. With a purported special interest in river attributes supporting the benefits of trout fishing, responses from this sample expressing a bias were expected. In Total 60 emails were sent out with 26 opened, 14 surveys were started, and 11 completed, including two non-anglers, yielding a response rate of 18%. The sample was exclusively male with a median age of 59 and an educational achievement ranging from high school to post-graduate tertiary education. The 11 complete responses were tested for comprehension and usability. No evidence of poor comprehension, answer-sets, or protest was found, and responses appeared to represent the expected skewness. At this point, a structural failure was missed. One respondent did not visit the catchment in the past 24 months, and they were subsequently not presented with an opportunity to identify themselves as a gamebird hunter or not. This proved to be a minor failing in the full survey, and the data discrepancy is identified in the results.

4.2.5 Survey delivery and sampling

The target population was those residents within the Tukituki River catchment and the adjacent town of Havelock North. The survey was distributed by a New Zealand Research Association registered company owing to the fact that its members abide by a code of practice and adhere to both data security and privacy standards that meet the requirements of the Privacy Act 2020. The survey was delivered using; i) direct email to a database of fishing licence holders supplied by the New Zealand Fish and Game Council, ii) mail-drop leaflets, and iii) social media using a catchment-oriented Facebook page. The distribution of the database across postcode districts is shown in Table 4.1.

Advertisements of the survey link from the Facebook page were constrained using the radius-of-delivery function within Facebook's advertisement settings to specify territorial units within the catchment boundary. Respondents 18 years and above who lived within the catchment were selected from the data before delivery.

Table 4.1 *Breakdown by Post Code Area of the Fish & Game Tukituki Catchment Database*

Post Code district	Number in F&G database	Frequency distribution %
Haumoana	28	4.5
Havelock North	301	48.8
Hastings†	19	3.1
Otane	45	7.3
Waipawa	57	9.2
Waipukurau	129	20.9
Takapau	21	3.4
OngaOnga	17	2.8
Total	617	100
Number with Rural Delivery post codes	158	25.6

† Only a very small rural area of the Hastings postcode falls within the catchment.

Each mode had a web-link, and there were separate landing pages for Fish and Game licence holders and the general population. The mail-drop was carried out in Havelock North n=3750, and Haumoana n=250. Funding did not allow the extension of mail drops to Waipawa and Waipukurau. As social media proved a cost-effective alternative, an additional Facebook page targeting this area was implemented. Data collection spanned 6 weeks from the 12th August to the 16th September 2019, with follow-up reminders to the email database weekly. Those who replied from the database were excluded from any further follow-up emails.

4.2.6 Testing for difference between samples

The data were analysed using IBM SPSS V26. The analysis was undertaken in two parts. Firstly, a descriptive analysis of the sample as a whole. Secondly, perceptions of the catchment *Current-state* and of a *Future-state* in the common good. The sample was split based on respondents either being a *Fisher* or a *Non-fisher* and tested for differences. The null and alternate hypotheses were:

H_0 There is no significant difference between the perceptions of *Fishers* and *Non-fishers*.

H_1 There is a significant difference between the perceptions of *Fishers* and *Non-fishers*.

This was repeated for game bird *Hunters*.

H_0 There is no significant difference between the perceptions of *Hunters* and *Non-hunters*.

H_1 There is a significant difference between the perceptions of *Hunters* and *Non-hunters.*

The comparative analysis of samples was undertaken using a *t*-test of independence for the Likert-scales regarding perceptions of *Current* and *Futu*re catchment states. In line with the rationale for parametric analysis in section 4.2.2, the *t*-test provides a statistical comparison of the differences between the mean scores between two populations (Fowler et al., 1998). The Mann-Whitney U test of mean ranks was used for single Likert items (Fowler et al., 1998). In recognition of the additional value in reporting frequency distributions these have also been reported for the Likert scales (Sullivan & Artino Jr, 2013).

4.2.7 Testing for differences within the sample

It is postulated that the future common good of freshwater is best served by equitably distributing social costs and benefits over time. This study classifies respondents based on their perceptions of the current and possible future state of water quality using latent class cluster analysis and Latent Gold 5.1. It applies the following hypotheses.

H_0 There is a homogenous societal vision of the current catchment state.

H_1 There is a heterogenous societal vision of the current catchment state.

And for the possible future state:

H_0 There is a homogenous societal vision of the future catchment state.

H_1 There is a heterogenous societal vision of the future catchment state.

4.2.8 Latent Class analysis and categorical data

Latent class analysis (LCA) is also known as finite mixture modelling. It is based on the premise that within any given data set, unobserved subgroups can be identified and clustered based on a set of modelled parameters (Vermunt & Magidson, 2003). Each cluster contains homogenous cases based on their parametrized responses (Vermunt & Magidson, 2005).

Latent class analysis was initiated by Lazarsfeld and Henry (1968) to derive latent attitudinal variables not otherwise apparent from the response patterns to dichotomous (yes or no) survey items. It is similar to factor analysis and K-means in that it is used to impose order on a number of observed variables by deducing groups, clusters, or classes of individual cases (Hagenaars & McCutcheon, 2002). Latent class models, however, assume latent variables to be categorical, whereas factor analysis assumes continuous latent variables. Goodman (1974a) & (1974b) extended the previous work to include nominal variables and developed the maximum likelihood (ML) algorithm behind many modern day LCA computer applications.

The probability-based ML algorithm uses an individual's response pattern to estimate and model the probability of belonging to a particular group using the maximum log-likelihood function. It has been demonstrated to be a model-based alternative that is far more stable, versatile, and rigorous than K-means with grouping performance directly comparable to discriminant analysis (Magidson & Vermunt, 2002; Vermunt & Magidson, 2016a). Following Goodman (1974a), work was done by Clogg (1979), evolving the model to handle multiple variables of varying types. Cloggs' particular interest was the psychometric data of ordinal Likert scales. Hagenaars (1990) constructed the first generalised latent variable model for categorical data, which was progressed by Vermunt (1997).

Eventually, models were also developed to handle a range of variable types, multiple latent variables, covariates, local dependencies, and ordinal variables (Vermunt & Magidson, 2003). Latent class analysis is, therefore, ideally suited to classifying responses to perception and attitudinal surveys using Likert-type scales in association with nominal and interval covariates. Analysis of categorical data from sociological surveys is, in fact, the primary use of LCA in the social sciences (Vermunt & Magidson, 2003).

Applying the maximum likelihood statistical model means formal criteria such as the Log Likelihood, p-value, Bayes Information Criterion (BIC), and Akaike Information Criterion (AIC), can be used to assess the goodness of model fit and select the most parsimonious model requiring the least number of parameters (Magidson & Vermunt, 2002; Vermunt & Magidson, 2005). Additionally, paring down the observed variables to only those that contribute significantly to model estimation means future surveys can be shortened by discarding poorly performing variables (Vermunt & Magidson, 2005). This would save resources and respondent fatigue in future scaled-up surveys. The following studies are included to demonstrate the diverse application of latent class analysis in the natural resource management setting and show how each made a unique contribution to informing managers and policy.

Barnes et al. (2013) used LCA to group dairy farmers in Scotland based on their perceptions of climate change risk. Using eight themed and related questions in a 5-point Likert scale, they found dairy farmers fell into three classes. The majority of farmers (62%) were 'confused moderates' with no strong opinions regarding climate impact. The remainder were either 'deniers' (18%) or 'risk perceivers' (20%). Barnes et al. (2013) found that identifying farmer clusters helped link attitude towards climate change with the channels through which farmers received climate change information. This informed recommendations for improving the perception of climate change risk by increasing social capital using farmer and family off-farm networks.

Ehrlich et al. (2017) modelled attitudes towards water resource, and their implications for recreational demand in the St Johns River Water Management Area, Florida, USA. Forcing respondent's into making a choice, they combined predominantly 4-point Likert scales, non-market valuation using the travel-cost method and LCA. Analysis resulted in two classes of respondents split 52% and 48%. They found that clustering resulted in a more efficient demand model and more accurate value estimates. LCA enabled them to demonstrate that those who did not use the river for recreation would otherwise have had their demand function overestimated by the combined model.

Kerr (2019) used LCA in conjunction with a discrete choice experiment to group New Zealand deer hunters based on their utility associated with the attributes of varying hunt scenarios. He used hunter satisfaction as a proxy for utility and identified four groups; i) harvesters, ii) experience seekers, iii) aesthetes, and iv) nascents. Groups ii)-iv) experienced diminishing utility from increased kills and group i) did not. In this application, LCA provided an insight into hunter heterogeneity which was directly applicable to the assessment of a one deer per hunt bag limit as an efficient game management strategy.

Sevenant and Antrop (2010) grouped perceptions of landscape aesthetics using 6-point scales for 'environmental attitude' and 'behaviour in the landscape,' and a 10-point scale for 'landscape beauty.' They found that clustering respondents based on maximum likelihood offered insight into the primary determinants of five classes of respondents with differencing preferences dimensions for landscape importance. The inclusion of a covariate analysis provided a deeper understanding of what characteristics influence respondent’s perceptions of an aesthetic landscape. They found that individual attitudes towards environment and behaviour in the landscape were more important determinants of class membership than demographics. Sevenant and Antrop’s (2010) application of LCA directed managers to focus on public behaviours and attitudes, rather than traditional demographic factors, when crafting landscape policy.

Tomaselli et al. (2019) used 5-point Likert scales to analyse Canadians’ perceptions about growth, prosperity, and the environment. Through clustering, they found that 41% of Canadians felt technology would provide answers that allowed endless growth, 36% were ambivalent, and 23% were concerned about sustainability and aware of the limits to growth. They found that gender and political orientation correlated significantly with class membership. This application of LCA focuses political parties on public attitudes and opinions towards a growth oriented economic model, which has direct implications for setting policy platforms.

Walelign and Jiao (2017) used latent class cluster analysis to group households in Nepal based on their asset investments in different livelihood strategies. They found that, although all were reliant on environmental services, households with upwardly mobile income and assets were less reliant on provisional ecosystem services than those on low incomes. This application of LCA showed decision-makers that careful environmental management was essential to sustain poor populations and that implementing poverty alleviation strategies would also lift pressure on the environment.

In summary, LCA is a flexible technique that is well suited to the analysis of categorical data. It brings out the underlying structure of data that is not otherwise apparent in descriptive statistics. LCA assigns class membership based on probability, making it superior to distance measures, like K-means, because there is a range of goodness of fit measures with which to justify the model choice. In general, the most parsimonious model with the least number of parameters is desirable. Application of the technique invariably provides useful insight into the underlying structure of the data that informs future engagement with target populations and resource management decisions. There are no apparent studies that contrast latent class characteristics between a community's perceptions of a base-line environmental state and their vision of an aspirational future state.

4.2.9 Latent Class model

The purpose of LCA in this research is i) to model heterogeneity in respondent's perceptions of the current and future water quality in the Tukituki River catchment, and ii) to conduct an exploratory analysis of the influence of covariates on class membership. The bias-adjusted 3 step approach estimates a standard latent class model, the effects of covariates on class membership, and it is applied in the analysis of this research (Bakk et al., 2014, 2016; Bakk et al., 2013; Bolck et al., 2017; Vermunt, 2010). The three-step approach models one or more covariates (*Z*) affecting the latent variable *X* and with the predicted class membership *W* as the single indicator of the underlying latent variable *X* (Bakk et al., 2013, p. 285).

Step 1: is the estimation of the standard latent class model for a set of *K* categorical response (indicator) items. Following Bakk et al (2014), the standard latent class model is defined in Equation 1.

$$P(\boldsymbol{Y_i}) = \sum_{t=1}^{T} P(X_i = t) P(\boldsymbol{Y}_i | X_i = t) \tag{1}$$

Where

$\boldsymbol{Y}_i$ is the observed response vector (indicator variable) for subject *i*.

T is the total number of unobserved (latent) classes.

t is a particular latent class.

X is the discrete latent class variable.

The $T - 1$ unique latent class sizes (mixture proportion) are the first parameters estimated by this first stage of the first-step model and are denoted as $\rho_t = P(X = t)$.

As a general rule, the indicator responses (*K*) are assumed to be mutually independent within each latent class *t*. The conditional probability of the i^{th} response given the latent class can then be written as a product of conditional item responses, as defined in Equation 2.

$$P(\boldsymbol{Y}_i | X_i = t) = \prod_{k=1}^{K} P(\boldsymbol{Y}_{ik} | X_i = t) = \prod_{k=1}^{K} \prod_{r=1}^{R_k} \pi_{ktr}^{I(Y_{ik} = r)} \tag{2}$$

Where

Y_{ik} is the response of subject *i* on item *k*.

R_k is the set of categorical responses for item *k*.

r is the categorical response of subject *i*.

$I(Y_{ik} = r) = 1$ if subject *i* has response *r* on item *k* and 0 otherwise.

π_{ktr} defines the $(K - 1)KT$ unique probabilities and is based on the assumption that conditional item responses are equal for all units. These multinomial parameters are the second set estimated by the first-step model.

Maximum likelihood estimation of parameters ρ_t and π_{ktr} requires maximising a log-likelihood function for the sample data L_{STEP1} by combining equations 1 and 2 and assuming independence of observations.

(3)

$$L_{STEP1}(\theta_1) = \sum_{i=1}^{N} \log P(\boldsymbol{Y}_i) = \sum_{i=1}^{N} \log \left[\sum_{t=1}^{T} \rho_t \prod_{k=1}^{K} \prod_{r=1}^{R_k} \pi_{ktr}^{I(Y_{ik}=r)} \right]$$

Where

$\theta_1 = [\rho, \pi]$ is the first parameter estimated and collects the latent class sizes ρ and conditional item response probabilities π.

(Bakk et al., 2014, p. 253)

The optimal number of class profiles is chosen using principally BIC and AIC, with the lowest BIC and AIC being preferred.

Step 2: is the assignment of units into classes creating a new variable *W* (Vermunt, 2010). Following Bakk et al. (2014), assignment is based on each respondent's probability of belonging to class *t* given observed responses $\boldsymbol{Y}_i$. This is called the posterior probability $P(X = t|\boldsymbol{Y}_i)$ obtained by the Bayes's rule and applied in Equation 4.

(4)

$$P(X_i = t|\boldsymbol{Y}_i) = \frac{P(X_i = t)P(\boldsymbol{Y}_i|X = t)}{P(\boldsymbol{Y}_i)}$$

Where

$\boldsymbol{Y}_i$ is the observed response vector for subject i.

t is a particular latent class.

X is the discrete latent class variable and X_i for subject i.

This thesis applies the most widely used modal classification rule for W. Modal classification assigns each unit with the largest (modal) estimated posterior probability from Equation 4. Applying modal assignment, the value of $P(W_i = t|\boldsymbol{Y}_i) = 1$ is assigned for $P(X_i = t|\boldsymbol{Y}_i) > P(X_i = \acute{t}|\boldsymbol{Y}_i)$ for all $t \neq \acute{t}$. For all other classes, this value is set to 0, giving what is termed a hard partitioning.

Regardless of the classification rule applied, the true (X) and assigned (W) class membership scores will differ, and the classification error must be calculated. After assignment, the assignment variable W will require a correction for these errors in Step 3.

Summing over all observed data patterns, the amount of classification error can be quantified by means of the conditional probability $P(W = s|X = t)$ expressing the probability of the estimated posterior profile value conditional on the true value, as shown in Equation 5 (Bakk et al., 2014; Vermunt, 2010).

(5)

$$P(W = s|X = t) = \frac{\frac{1}{N}\sum_{i=1}^{N} P(X_i = t|\boldsymbol{Y}_i)P(W_i = s|\boldsymbol{Y}_i)}{P(X = t)}$$

(Bakk et al., 2014, p. 254)

Step-3: is the estimation of a vector of covariates (***Z***) as they relate to their assigned class (W), while correcting for the classification error in W (Vermunt, 2010). Following Bakk et al. (2014), $P(X = t|\boldsymbol{Z}_i)$ and $P(W = s|\boldsymbol{Z}_i)$ are related such that $P(W = s|\boldsymbol{Z}_i)$ can be written as a weighted sum of the latent classes given the covariates, with classification error probabilities as weights, as shown in Equation 6.

(6)

$$P(W = s|\boldsymbol{Z}_i) = \sum_{t=1}^{T} P(X = t|\boldsymbol{Z}_i)P(W = s|X = t)$$

While the classification error $P(W = s|X = t)$ is fixed, the structural part of the equation $P(X = t|\boldsymbol{Z}_i)$ is free. By denoting Z_{iq} the value of subject *i* on one of the *Q* covariates*,* the structural component can be parametrised via a logistic regression model, shown in Equation 7.

$$P(X = t|\boldsymbol{Z}_i) = \frac{\exp\left(\beta_{0t} + \sum_{q=1}^{Q} \beta_{qt} Z_{iq}\right)}{\sum_{s=1}^{T} \exp\left(\beta_{0t} + \sum_{q=1}^{Q} \beta_{qs} Z_{iq}\right)} \tag{7}$$

Where

Z_{iq} is one the value of subject i on one of Q covariates.

β_{qt} is a parameter effect on a particular covariate q in latent class *t*.

β_{qs} is a parameter effect on a particular covariate q in latent class *s*.

Maximum likelihood estimation for the third-step can give variables that predict latent class membership, and are obtained using a log-likelihood equation as shown in Equation 8. The parameters of interest are the logistic regression coefficients β_{qt}, gathered in vector θ_3. Consistent estimates $\hat{\theta}_3$ can be obtained by maximising the third step log-likelihood (Vermunt, 2010).

$$L_{STEP3}\left(\theta_3|\theta_2 = \hat{\theta}_2\right) = \sum_{n=1}^{N} \sum_{s=1}^{T} P(W = s|\boldsymbol{Y}_i) \log \sum_{t=1}^{T} P(X = t|\boldsymbol{Z}_i) P(W = s|X = t) \tag{8}$$

In Equation 8, the third-step logistic regression coefficients contained in vector θ_3, are freely estimated. The classification errors of W as a proportion of *X*, and contained in vector θ_2, are held fixed at their sample maximum likelihood estimates, $\theta_2 = \hat{\theta}_2$.

(Bakk et al., 2014, pp. 525-526)

The 3-step application following these equations is available in Latent GOLD 5.1 (Vermunt & Magidson, 2016b). It uses a combination of the Expectation Maximisation (EM) and Newton-Raphson (also called Newton's method) algorithms (Dempster et al., 1977; Polyak, 2007; Vermunt & Magidson, 2016a). The EM is used initially until either the maximum number of EM iterations or the EM convergence criterion are met. It then switches to the Newton-Raphson until either its maximum iterations or convergence criterion are met (Vermunt & Magidson, 2016a, p. 101). This makes the most of the EM's stability even when it is far away from the optimum and Newton-Raphson's speed when close to the optimum (Vermunt & Magidson, 2016a, p. 98)

As outlined earlier, one of the main benefits of a maximum likelihood algorithm is the ability to apply statistical model fit criteria to model selection. The benefit of being able to apply model fit criteria is the ability to defend the choice of latent class model against comparable metrics. The main selection criteria are p-value, BIC, and log-likelihood ratio χ^2 test (χ^2). It is important to note that latent class model selection differs from the native statistical desire to denote a significant association by a p-value below 0.05. Because the desire is to have a number of modelled classes that fit within the shape of the existing data, a p-value greater than 0.05 is required as the first indication of a good model fit. A p-value below 0.05 means the model is significantly different from the data and, therefore, is not a good fit. Once the first criterion is met, subsequent comparisons of BIC and χ^2 can be undertaken where a lower number is desired. Ultimately the desire is to have the most parsimonious model with the lowest number of parameters that meets the model fit criterion.

In summary, latent class cluster analysis uses probability-based algorithms that can be applied to model the effects of covariates on class membership using a 1-step or 3-step approach. The 3-step approach offers some advantages in its flexibility and more closely follows the logical progression of research. The software package Latent GOLD 5.1 by Vermunt and Magidson (2016b) relies on the Expectation Maximisation and Newton Raphson algorithms and can model the effects of covariates using a 3-step approach (Dempster et al., 1977; Polyak, 2007; Vermunt & Magidson, 2016a).

4.3 Study Objectives 2 & 3

Objective 2: To estimate the marginal welfare benefits generated by improved water quality in the study area.

Objective 3: Quantify the willingness to pay for improved water quality as a function of welfare based on public trust of freshwater advocates and policy-oriented organisations.

4.3.1 Questionnaire development

The questionnaire was designed to deliver a contingent valuation exercise and a choice experiment using Sawtooth Software Lighthouse Studio 9.8.0 (Sawtooth Software, 2020).

It consisted of five blocks; i) a Suitability filter to ensure respondents were over 18 years old and responsible for paying some of the household bills, ii) Demographics and catchment engagement, iii) a Contingent valuation experiment, iv) a best-worst scaling experiment, and v) Follow up questions. All questions were compulsory other than the final question, where respondents were given the opportunity to enter a draw for the survey incentive, one of ten fifty-dollar supermarket vouchers. Respondents were informed that 'providing this information implies your consent and that you understand your response will no longer be anonymous'. A copy of the survey instrument can be found in Appendix E - Survey instrument for Objectives 2 and 3.

4.3.2 Valuation method

In the contingent valuation task, respondents were faced with two descriptions. The first was representative of the current state and the second representative of a possible (hypothetical) future state designed to reflect the completely successful implementation of Regional Plan Change 6 by 2030. Firstly, respondents were shown a map and a bullet point description of the catchment. Secondly, current and possible future state descriptions were presented side by side in an infographic. Thirdly an iterative bidding system solicited respondent's willingness to pay for the improvement to variables embodied within the possible future state.

4.3.2.1 Selection of key variables

Key variables from the deliberative process followed in Objective 1 were revisited. To avoid a bias created through misspecification, the variables and their descriptions were peer reviewed and refined through an iterative process of development in conjunction with two catchment managers, an ecologist, and a hydrologist from the Hawke's Bay Regional Council (HBRC). Feedback was also given from a wetland consultant with many years of experience in conservation management. The framing was designed to reflect the elevated pressures and states reflective of summer water scarcity. Key variables were; i) Summer flows, ii) Summer weed (algae), iii) Swimming health risk, iv) Agricultural production, v) Ecosystem health, and vi) Mauri (the Māori cultural perspective of the rivers' life force). Mahinga kai was used specifically as a tangible representation of mauri as described in the Cultural Health Index developed by Tipa and Teirney (2006).

4.3.2.2 Choice-card

A significant challenge was to contain the survey's overall cognitive load. To overcome this, rather than use dense written descriptions, an infographic was built by the researcher using commercial design software. Each of the six variables were represented in a pair of contrasting panels. Each panel had a variable heading, bullet-pointed description, and a photographic image. Additionally, a colour coded outer ring was placed on each image using the universal traffic light colours of red, yellow, and green to further illustrate improvement or decline in the variable under each contrasting scenario. This follows Brouwer et al., (2016), Reynaud et al., (2017), and Skeie et al., (2019). A copy of the final infographic is shown in *Figure 4.1*.

4.3.2.3 Elicitation of payment and consequentiality

Following the viewing of the infographic, respondents faced a cheap-talk script in which they were reminded to "Please bear in mind your total household income and all the other bills you have to pay." The payment vehicle selected was a compulsory monthly household tax payment to local authorities for ten years. This follows best practice and imposes the motivation associated with compulsory payments (Johnston et al., 2017). In order to test the relationship between willingness to pay and trust in organisations involved in the freshwater policy space, an exact bid amount was required for each respondent. A process of iterative bidding was used starting at $4 per month moving incrementally towards an upper bound of $12.50 per month and a lower bound of zero. In practice, if a respondent were positive about paying the starting bid, they would then be asked to pay the next upward increment, and if they were negative, they were asked to pay the next downward increment and so forth until payment was agreed, or the bounds reached. Zero bids were followed up with a question soliciting a reason in order to help identify protest responses. Iterative bidding creates its demand curve within the bounds of the upper limit, meaning estimation of welfare is a simple calculation of median and mean willingness to pay. It also delivers an exact payment bid for each individual instead of the very low level of information regarding individual willingness to pay offered by the dichotomous choice format.

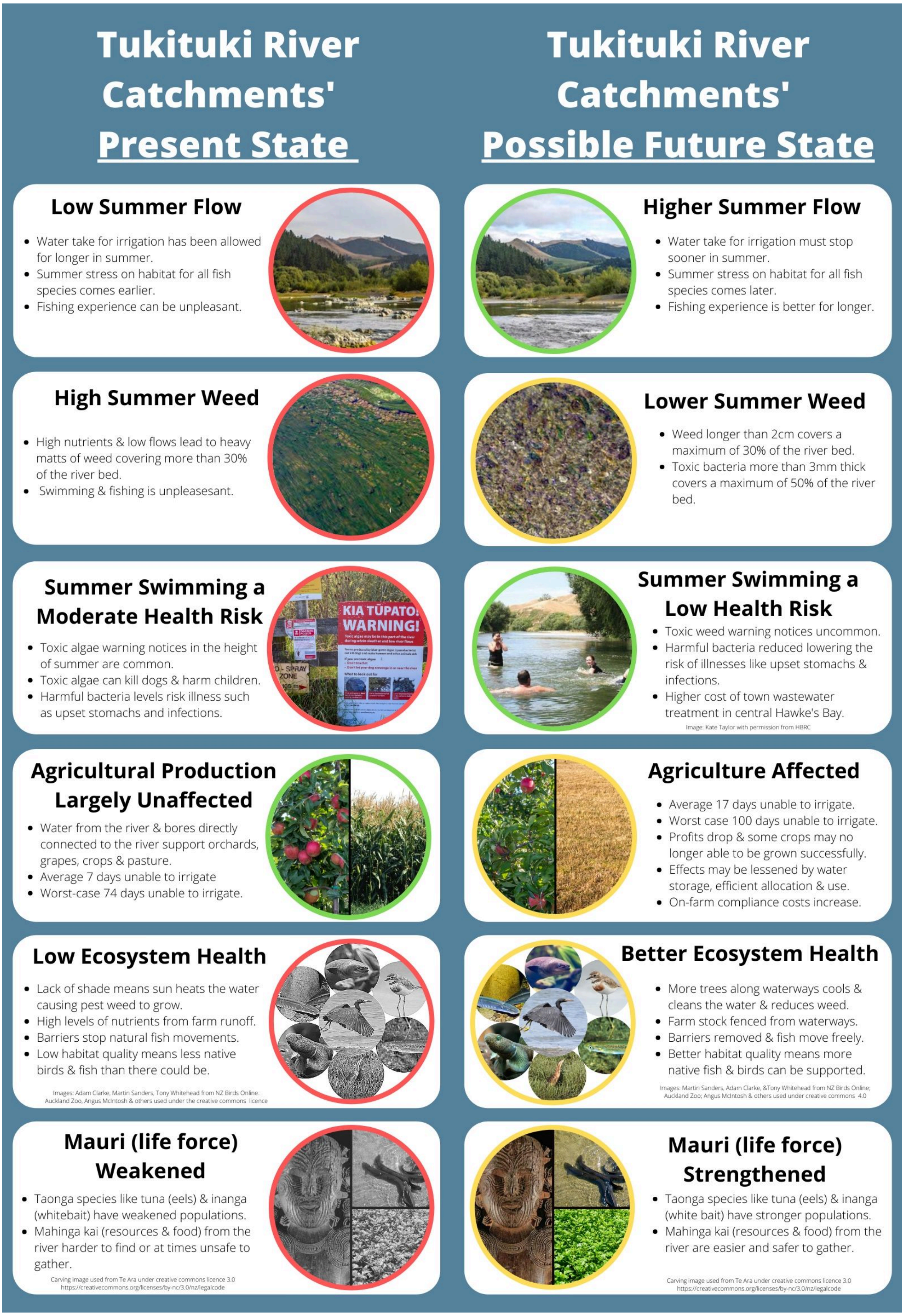


Figure 4.1 Choice-card Infographic for the Contingent Valuation task within Study Objective 2

A second mean and median payment based on the halfway point between the respondent's highest accepted bid and the bid rejected was also calculated. The start point bid was decided through reasoned judgment. It was based on a weighted share of the proportion of the mean regional household tax (rate) in Hawke's Bay currently spent on integrated catchment management ($160pa), and what represented a common and accessible good a householder could equate with the start bid as either an opportunity cost or additional expense. A weighted proportion of $48 a year or $4 a month per household appeared reasonable, given the significance of the catchment. This also equated with the approximate cost of a cup of coffee per month, which could help respondents place the start bid in context with household expenses. All bidders faced an additional question to identify any negative impact on bids due to economic effects from the Covid-19 Level-4 lockdown. Being mindful of the order effects of questions on bids, this was placed after the elicitation question. Consequentiality was assessed with a question asking respondents if they felt authorities should be made aware of the results of the study. Once again, being mindful of order effects, this was placed as the last survey question.

4.3.3 Ranking trust

4.3.3.1 Best-worst scaling

Best-worst scaling (BWS), as proposed by Louviere and Woodworth (1990) advanced by Finn and Louviere (1992), and is grounded in the Random Utility Theory of decision-making proposed by Thurstone (1927a) and advanced by McFadden (McFadden, 1974b). It is a paired comparison choice task that identifies both the utility maximising and utility minimising choice in each set of alternatives and provides much richer data than rating tasks such as Likert scales or ranking exercises (Flynn & Marley, 2014; Louviere et al., 2015). Although based on utility, the underlying principles of BWS are applicable to choice motivations such as level of concern or level of trust (Erdem, 2018; Finn & Louviere, 1992).

It can be applied to what Flynn and Marley (2014) refer to as 'Case 1' or an 'object case,' and it is the least complex application of BWS. In doing so, the weighting given to an attribute's importance is separated from scale effects associated with any fraction of its supply (Flynn et al., 2007). It is a suitable option when researchers are interested in choices based on absolute attributes and not on ascribed attribute levels, such as in aspects of service provision or trust (Erdem, 2018; Flynn et al., 2007). Louviere et al. (2015, p. 14) assert Case 1 designs apply to i) batteries of "agree/disagree" statements, ii) traits or characteristics, iii) pictures or graphical images, iv) politically relevant issues, v) electoral candidates, vi) food and drink products, vi) potential job candidates, vii) academic journals, viii) product features, and more.

The model underpinning BWS "assumes that the relative choice probability of a given pair is proportional to the distance between the two attribute levels on the latent utility scale" (Flynn et al., 2007, p. 176). Respondents are presented with choice sets of three or more options in a balanced incomplete block design to ensure that all choice sets have the same number of options. This avoids any possibility of respondents attaching significance to options in choice sets of different size (Flynn & Marley, 2014). From each choice set, they select the most desirable (highest utility) and least desirable option (lowest utility). An example of such a choice scenario is shown in *Figure 4.2*.

Figure 4.2. It has a relatively low cognitive load and so is 'easy,' and respondents respond more consistently to extreme options (Marley & Louviere, 2005).

Figure 4.2 Demonstration Best-worst Choice Set. Sourced from Daly (2018)

In making the choice, a respondent may employ different strategies in their cognitive process, each one with its own statistical model. According to Louviere et al. (2015) they may:

> i) evaluate the options in a set and simultaneously decide what option is best and what option is worst; ii) choose best first and worst second; iii) choose worst first and best second; iv) mentally rank all options to determine which is best and which is worst; v) eliminate all options that are not best one at a time, and then select the best from the non-eliminated, returning to the eliminated options to select the worst; or vi) evaluate all possible pairs of different options, and choose the (one) pair that exhibits the largest positive difference on the underlying scale. (p. 50)

Best-worst scaling is defined specifically by the cognitive order in which the choices are made. It is characterised by the individual's choice of their best option followed independently by the choice of their worst option. Best-worst scaling can provide individual level trust utility scores, using Bayesian estimation, that accounts for respondent heterogeneity. It also allows rescaling to simplify results for ease of interpretation by a wide range of audiences.

4.3.3.2 Estimating utility from best-worst scaling

Best worst scaling assumes an individual's choice will be firstly utility maximising (best) followed by a choice that is utility minimising (worst). Applying the multinomial logit equation (McFadden, 1974a), the weighted utility of the item is derived from a maximum likelihood fit to each individual's choice set responses. The equation for the best item (utility maximising) where the probability of choosing the i^{th} item as best (utility maximising) from a choice set of $i=1...,k$ items is shown in Equation 9.

$$P_i = \frac{e^{U_i}}{\sum_1^k (e^{U_i})} \tag{9}$$

Where

P_i is the probability that item i is chosen from the set of k items

e is the exponential function

U_i is the utility of the i^{th} item in a set of $i=1...,k$ items

Utility estimation for the worst item (utility minimisation) is shown in Equation 10.

$$P_i = \frac{e^{-U_i}}{\sum_1^k (e^{-U_i})} \tag{10}$$

(Chrzan & Orme, 2019, p. 41)

Where

e^{-U_i} is equivalent to taking the negative antilog of the utility for item i.

4.3.3.3 Rescaling best-worst utilities

Zero-centred raw utility scores have both positive and negative values and can be rescaled on a 0-100 ratio scale to make for easier interpretation where a score of 9 is three times as preferred as a score of 3. The transformation is shown in Equation 11.

$$P_i = \frac{e^{U_i}}{(e^{U_i} + a - 1)} \tag{11}$$

Where

e is the exponential function

U_i is the zero centred raw logit weight for item *i*

a is the number of items shown per set

(Chrzan & Orme, 2019, p. 56)

In summary, trust is one of the building blocks of social capital and an essential component of cooperation. It is defined most frequently as the willingness to accept vulnerability to the trustee. In the natural resource setting, trust has been modelled as either 'attitude' or 'choice'. Trust modelled as a choice with the expectation of a beneficial outcome reflects the premise of utility maximisation underpinning utility theory. Historically Likert-type scales have been the first choice for measuring trust. Best-worst scaling is a relatively novel approach to trust measurement that has proven promising. Best-worst scaling allows the estimation of utility scores associated with trust in a set of potential trustees at both an individual and population level. Individual level trust utility scores are generated using Bayesian estimation that accounts for respondent heterogeneity. The utility scores can be rescaled to simplify results into percentages for ease of interpretation by a wide range of audiences.

4.3.3.4 Selection of key variables and choice-set design

Trust ranking was undertaken using best-worst scaling (BWS) in the style of Erdem (2018). The selection of organisations to be ranked was based on a review of the 2013 Board of Inquiry process, scanning of media, consultation with local and central government agencies, and personal networks. In total, ten organisations were identified as being actively involved with freshwater issues in Hawke's Bay. They are shown in Table 4.2. Choice sets were generated in a balanced incomplete block design. Three hundred versions of the BWS experiment were generated and assigned randomly to respondents. No prohibitions were required. Respondents faced ten choice-sets; each set contained four organisations from which to choose the one they trusted the most and the least. Choice set format is shown in *Figure 4.3*.

The combination of ten organisations (v), four choices (k) in each set and ten sets (b) gave a partially balanced incomplete block design. One-way frequency assessment showed each item appeared in the design 1200 (r) times. Two-way level frequency assessment showed items appeared with each other a mean 400 (λ) times with a standard deviation of 0.3. Positional frequency assessment showed each item appeared in each choice position a mean of 300 times with a standard deviation of 0.5. This design ensured every respondent would see each organisation between three and five times before completion. The choice task was followed by a direct anchoring question where respondents were asked to select only those organisations trusted from a complete list. The experimental design is shown in Appendix F - Best-worst choice experiment design.

Table 4.2 *Freshwater Advocates and Policy-oriented Organisations Adopted as Study Variables*

Organisations used in best-worst scale study
Crown entities
1. Department of Conservation
2. New Zealand Fish & Game Council
3. NIWA (National Institute for Water and Atmospheric research)
Local government
4. Hawke's Bay Regional Council
Treaty of Waitangi partners
5. Ngati Kahungunu Iwi Inc
Non-governmental organisations
6. Federated Farmers
7. Landcare Trust
8. The New Zealand Royal Forest & Bird Protection Society
9. Horticulture New Zealand
10. Environmental Defence Society

Figure 4.3 Example of the Best-worst Choice Sets Presented to Respondents

4.3.3.5 Coding and welfare estimation

The best-worst scenario of decision making was adopted for coding. Best-worst assumes the choice for best is independent of the choice for worst and is the most prevalent coding in academic literature (Chrzan & Orme, 2019). Coding is summarised in Table 4.3.

Table 4.3 *Dummy Codes Used in Best-worst Choice Scenarios*

Choice	Code
Most-trusted	1
No choice	0
Least-trusted	-1

To avoid linear dependency, item number 4 (Hawke's Bay Regional Council) was set as the reference level. This meant the utility of item 4 was set to zero and the utility of the other nine items were estimated relative to this. To account for respondent preference heterogeneity a hierarchical Bayes multinomial logit model was used to derive both mean and individual level utility scores for each of the ten organisations.

4.3.3.6 Testing for random responses

Testing for random or 'bad' responses followed the method outlined by Orme (2019). Four hundred random survey responses were computer generated for the survey. Respondent level utilities were then generated for the best-worst choice task using Hierarchical Bayes estimation. There were 20,000 preliminary iterations followed by 10,000 draws for each respondent with five prior degrees of freedom. Thirty thousand iterations were computed in total. Graphical Bayes output for the random data is shown in Appendix K - Hierarchical Bayes graphical outputs, *Figure K.1*. The root likelihood fit statistic (RLH) scores were exported to SPSS v26, where the median RLH of 0.280

and 95% percentile of 0.331 were calculated. A minimum RLH fit statistic of 0.331 was adopted above which a response can be said to be not random with 95% confidence. The threshold fit statistic, very short response times and 'straight-line' answer patterns were all considered when removing respondents from the data set.

4.3.4 Testing for relationships between variables

The sample was tested for relationships between variables using bivariate correlation analysis, regression equation estimation, and partial least squares regression. There were two special focuses of the correlation analysis; i) the relationship between willingness to pay (WTP) for improvements in freshwater and trust in organisations involved in the management of freshwater, and ii) the inter-organisational public trust relationships. The regression equation estimation was applied to test for any significant relationship and to subsequently inform which trust variables to take forward into a partial least squares regression exploratory analysis of public trust's potential to be an accurate predictor of WTP.

4.3.5 Ethics and pre-testing

The survey content was reviewed by both internal and external reviewers drawn from the Massey University Manawatu campus and the Hawke's Bay Regional Council. Their feedback was incorporated prior to piloting the survey. The survey was covered under the existing ethics approval as a low-level notification, and all responses were anonymous. A pilot was run during the Covid-19 level 4 lockdown, which came into effect on March 25th and ended April 27th 2019. This was delivered using email snowballing seeded from a convenience sample of eight individuals from Havelock North, Hastings, and Napier. Emails contained an electronic web-link directly to the pilot survey. From this 25 responses were gathered over a 48-hour period. There were 4 incomplete and 2 not meeting the selection criteria as a 'bill payer' leaving 19 completed responses. Completed responses were 53% female and 47% male with an average age of 54. The sample had an urban character and was spread across the region from the towns of Havelock North (26%) and Taradale (32%) and from the cities of Hastings (16%) and Napier (26%). No evidence of poor comprehension, answer-sets, or protests was found.

Respondent's utilities were calculated using the binary anchoring question and hierarchical Bayes estimation. As utility is calculated relative to a baseline item, structural changes were made to the BWS back end design to ensure the Hawke's Bay Regional Council, as the statutory regulator, was used as the base line item. A test of 400 random dummy responses was generated and analysed using both logit and hierarchical Bayes estimation; however, it cast some concern over possible bias from unbalanced positional frequency of the items. Further investigation made it clear that accurate estimation of respondent level utility required each respondent to face at least the same number of choice tasks as there were items (Sawtooth Software, 2013). Multiple combinations of total items/items per set/total questions faced were design tested. The best design at 2677 iterations was the 10/4/10 combination. Across 300 versions, it gave a 1-way frequency of (r)1200, perfect positional frequency of 300, and 2-way frequency of (λ) 400 with a standard deviation of 0.298. No improvement was found up to 100,000 iterations. Two organisations, *Irrigation NZ* and *Dairy NZ* were subsequently removed from the design. These organisations were not trusted by any of the pilot respondents in the anchor question and were selected as least trusted in multiple choice sets. Given the very urban nature of the pilot respondents and the very low public profile of these organisations it was surmised that the negativity was likely associated with the words 'irrigation' and 'dairy' and their negative association with water quality within the current national freshwater narrative. Notwithstanding that a completely rural sample may have given a different result, the final sample was likely weighted towards urban respondents. Additionally, with a view to context-misspecification bias and question-order bias, the question relating to consequentiality was moved towards the end of the survey and revised.

4.3.6 Survey delivery and sampling

The survey ran for 25 days from May 6th, 2020, until the month end. The target population was Hawke's Bay residents over the age of 18 years that were responsible for paying some of the household bills. The survey was delivered using a 'Tukituki River Research' branded website with traffic driven using a Facebook page of the same name and direct email snowballing. Snowballing was seeded from a base of social and work-place contacts and contacts within the Hawke's Bay Regional Council. Social media was promoted using paid Facebook advertisements targeting individuals aged 18-80+ years of age living in Hawke's Bay and social media snowballing in a strategy similar to the emails. The website landing page, Facebook post/add, and the survey landing page are shown in Appendix L *Figure L.1*, *Figure L.2*, and *Figure L.3*. From the website respondents could select a web-linked 'button' to the survey platform hosted servers contracted to Sawtooth Software Inc. The button was labelled 'Take the survey', providing an additional layer of implied consent before viewing the survey landing page.

Respondents were incentivised with the possibility of receiving one of ten fifty-dollar supermarket vouchers. Participation in the draw was on an ‘opt-in’ basis in which respondents were fully informed that they would need to surrender their anonymity by providing a contact name and email address. This non-contact mode of delivery was deemed as not only cost-effective but also the most appropriate in a Covid-19 environment. In Hawke’s Bay, 82.2% of residents have access to the internet and 90.2% to a mobile phone (Statistics New Zealand, 2020). The experience of Hughey et al., (2019) suggests that electronic delivery gives a ‘greener’ and more pessimistic response that postal delivery, however they find the difference in Likert scores between the two methods are non-significant. The next chapter details the results of the two field studies described in chapter four.

5 Results and data-analysis

5.1 Introduction

This chapter details the results of the two surveys and their analysis. It is divided into two main sections. Firstly, section 5.2 details the results and analysis of the first survey designed to satisfy Objective 1: 'To define the common good of freshwater and compare the perceptions of anglers with those of the wider public'. It begins with descriptive reporting of the survey results and is followed by a comparison of mean perceptions of *Fishers* with *Non-fishers* and *Hunters* with *Non-hunters*. This is followed by a latent class cluster analysis of catchment current state perceptions, and future state perceptions. Section 5.3 details the results and analysis of the second survey designed to satisfy Objective 2: 'To estimate the marginal welfare benefits generated by improved water quality in the study area' and Objective 3: To quantify the willingness to pay for improved water quality as a function of welfare based on public trust of freshwater advocates and policy-oriented organisations'. Section 5.3 also begins with a descriptive report of the second survey's results and is followed by the welfare analysis of willingness to pay for improved water quality in section 5.3.2. This is followed by the analysis of trust in organisations in section 5.3.3 and an exploration of variable relationships, including between willingness to pay for improved water quality and trust, in section 5.3.4.

5.2 Study Objective 1

Objective 1: To define the common good of freshwater and determine perception heterogeneity in the study area (a particular focus is placed on comparing fishers and gamebird hunters with the wider public due to the funding support for this research).

5.2.1 Descriptive analysis

In total 321 surveys were started. There were 28 incomplete responses, leaving a sample of 293 completed surveys representing a completion rate of 91%. Of these 156 (53%) came from the Fish & Game database, 64 (22%) from Facebook, and 73 (25%) from other non-verifiable sources including the mail drop. The data were checked, coded, and cleaned, and no patterned or protest responses were noted. The data were then categorised into a *Fisher/Non-fisher* and a *Hunter/Non-hunter* split. The subgroup sizes were *Fishers* = 169, *Non-fishers* = 124, *Game bird hunters* = 51, and *Non-hunters* = 234. The *Fisher* group included = 157 trout fishers, = 7 whitebait only fishers, = 4 eel only fishers, and = 1 flounder only fisher. The *Non-hunter* group excluded eight respondents that had not visited a waterway in the catchment in the past 24 months. This was because the survey logic did not give these eight respondents the opportunity to identify themselves as active gamebird hunters or otherwise. The overall *Hunter/Non-hunter* sample was, therefore, 285. Data were stored and analysed on password and virus-protected computers, and the survey delivery company confirmed destruction of all databases and response data from their servers.

The demographic profile of the samples is summarised and compared to that of the Hawke's Bay population in Table 5.1.

Table 5.1 *Demographic Profile of Sample Groups Compared to the Hawke's Bay Population*

	Fishers		**Non-fishers**		**Hunters**		**Non-hunters**		**Mean**	**Hawke's Bay**
	n	%	n	%	n	%	n	%	%	%
Gender										
Female	19	11.2	89	71.8	-	-	105	44.9	32	51.3
Male	148	87.6	35	28.2	49	96.1	129	55.1	66.8	48.7
Transgender female	1	0.6	-	-	1	2	-	-	0.65	-[a]
Self-described	1	0.6	-	-	1	2	-	-	0.65	-[a]
Age										
18-49[b]	43	25.4	46	37.1	21	41.2	65	27.8	32.9	47.5
50-64	67	39.6	46	37.1	25	49	87	37.2	40.7	27.1
65+	59	34.9	32	25.8	5	9.8	82	35	26.4	25.3
Ethnicity[c]										
European	50	29.6	37	29.8	11	21.6	73	31.2	28	75
New Zealander	116	68.6	84	67.7	36	70.6	158	67.5	68.6	NA
Maori	9	5.3	10	8.1	4	7.8	14	6	6.8	27
Pasifika	-	-	1	0.8	-	-	1	0.4	0.3	6.7
Other	7	4.1	8	6.5	4	7.8	11	4.7	5.8	9.4
Education										
Secondary school	42	24.9	18	14.5	17	33.3	41	17.5	22.5	26.1
Post-secondary school certificate or diploma	56	33.1	35	28.2	15	29.4	75	32.1	30.7	56.4
University Bachelor's degree	39	23.1	41	33.1	12	23.5	66	28.2	27	11.3
Post-graduate degree	32	18.9	30	24.2	7	13.7	52	22.2	19.8	6.2
Where do you live?										
Farm	11	6.5	10	8.1	8	15.7	12	5.1	35.4	-[d]
Lifestyle block	38	22.5	43	34.7	16	31.4	64	27.4	29	-[d]
Town	115	68	68	54.8	24	47.1	153	65.4	58.8	-[d]
Town and own a farm	5	3.0	3	2.4	3	5.9	5	2.1	13.4	-[d]
Household income										$
$0-$50,000	34	20.1	24	19.4	4	7.8	53	22.6	17.5	
$50,001-$100,000	56	33.1	42	33.9	11	21.6	84	35.9	31.1	$99,719[e]
$100,001-$150,000	33	19.5	41	33.1	20	39.2	50	21.4	28.3	
$151,001-$200,000	25	14.8	9	7.3	11	21.6	23	9.8	13.4	
$200,001 or more	21	12.4	8	6.5	5	9.8	24	10.3	9.7	

[a] Available National Census data does not support categories for gender fluidity.
[b] The 2018 National Census data for this bracket differs in that it starts from age 20 not 18.
[c] The 2018 National Census and this survey allow for respondents to select more than one ethnicity, consequently percentages sum >100.
[d] No data is available for comparison.
[e] Mean household income for 2020 taken from Infometrics (2020).

In general, the *Fisher* sample is older and a little more affluent than the general population. It is also more educated, with a combined 42% of the sample having a bachelor's degree or higher. The gender split is 87.6% male and this reflects the gender profile from the National Angler Survey (Unwin, 2016). The sample included one respondent as transgender female and one gender as self-described. The reported ethnicity identifies 29.6% as European, 68.6% as a New Zealander, 5.3% Māori, no Pasifika, and 7% as Other. A cross-section of dwelling type was represented with 68% residing in town, 22.5% on a lifestyle block, 6.5% on a farm and 3% living in town and owning a farm. The *Non-fisher* sample was also a little older than the Hawke's Bay population but have an income profile closer to that expected of the wider population. They are also more educated, with a combined 57.3% having a university bachelor's degree or higher. The gender split was 71.8% female and 28.2% male.

Ethnicity was similar to the *Fishers* with 29.8% European, 67.7% New Zealanders, 8.1% Māori, 0.8% Pasifika, and 6.5% Other. *Non-fisher* respondents were slightly more rural than *Fishers*, with 8.1% living on a farm and 34.7% on a lifestyle block, 54.8% in town and 2.5% living in town and owning a farm. *Hunters* were 96.1% male, with the remainder being the transgender female and the gender self-described individual. Reported ethnicity was 21.6% European, 70.6% New Zealander's, 7.8% Maori, no Pasifika, and 7.8% Other. They were younger with 90.2% being within 18-64 years of age, less educated with 13.8% having a university Bachelor's degree or higher, and wealthier with at least 70.6% having an income above the regional median. *Hunters* were also the most rural with 15.7% living on a farm, 31.4% on a lifestyle block, 47.1% in town and 5.9% living in town and owning a farm. A comparison of the total sample's demographic profile with the Hawke's Bay population is summarised in Appendix H - Additional tables for the analysis of perceptions of the Tukituki River catchment's current and future states, Table H.1. Of the total sample, of 293, 97.4% had visited a waterway in the catchment over the past 24 months. All *Fishers* and *Hunters* had visited the catchment, and 93.5% of *Non-fishers* had visited the catchment.

The main reasons for respondents visiting the catchment are summarised in Table 5.2. Of the 285 respondents that visited the catchment, the five most cited reasons were walking (65.3%), trout fishing (50.5%), swimming (25.6%), wildlife watching (17.2%), and picnicking (15.8%) or similar. The five least activities engaged in were spiritual or cultural observance (8.8%), camping (7.4%), whitebaiting (7%), rafting or kayaking (6.7%), and gathering food other than by trout fishing, whitebaiting, or game bird hunting

(2.8%). Gamebird hunting was engaged in by 27 (9.5%) of respondents. 'Other' was cited by 19.3% of engagement activities, and this was predominantly cycling/mountain-bike riding and horse riding. It also accounts for some respondents not connecting directly with a category, for example, those that distinguished 'dog walking' as being different from 'walking'.

Table 5.2 *Main Activities Respondents Engaged in While Visiting the Tukituki River Catchment*

Main reasons for visiting the catchment (Respondents able to choose multiple activities)	n	% of sample n=285 that visited in the past 24 months and engaged in activity
Walking	186	65.3
Trout fishing	144	50.5
Swimming	73	25.6
Wildlife watching	49	17.2
Picnic or similar	45	15.8
Game bird hunting	27	9.5
Spiritual or cultural observance	25	8.8
Camping	21	7.4
Whitebaiting	20	7.0
Rafting or kayaking	19	6.7
Gathering food other than trout fishing, gamebird hunting or whitebaiting	8	2.8
Other	55	19.3

Note. Respondents were able to identify more than one activity.

As summarised in Table 5.3, the environmental orientation, as defined by the donation of money or volunteering for an environmental organisation, differed across the groups. For the total sample, 33.4% had donated or volunteered in the past 24 months. Across subgroups, 44% of *Fishers*, 43.5% of *Non-fishers*, and 19.6% of *Hunters* had donated or volunteered. Of the *Fishers*, 39 (23.1%) were also *Hunters* and, conversely, a substantial 76.5% of *Hunters* were also *Fishers*. Of the *Non-hunters*, 130 (55.6%) were *Fishers*. Of the *Non-fishers*, 12 (10.3%) were *Hunters*. Direct income reliance on taking water from waterways also varied across the subgroups, corresponding to 9.5% *Fishers*, 6.5% of *Non-fishers*, and 17.6% of *Hunters*. Of the total sample, 8.2% had a water offtake, and this was mainly for stock-water.

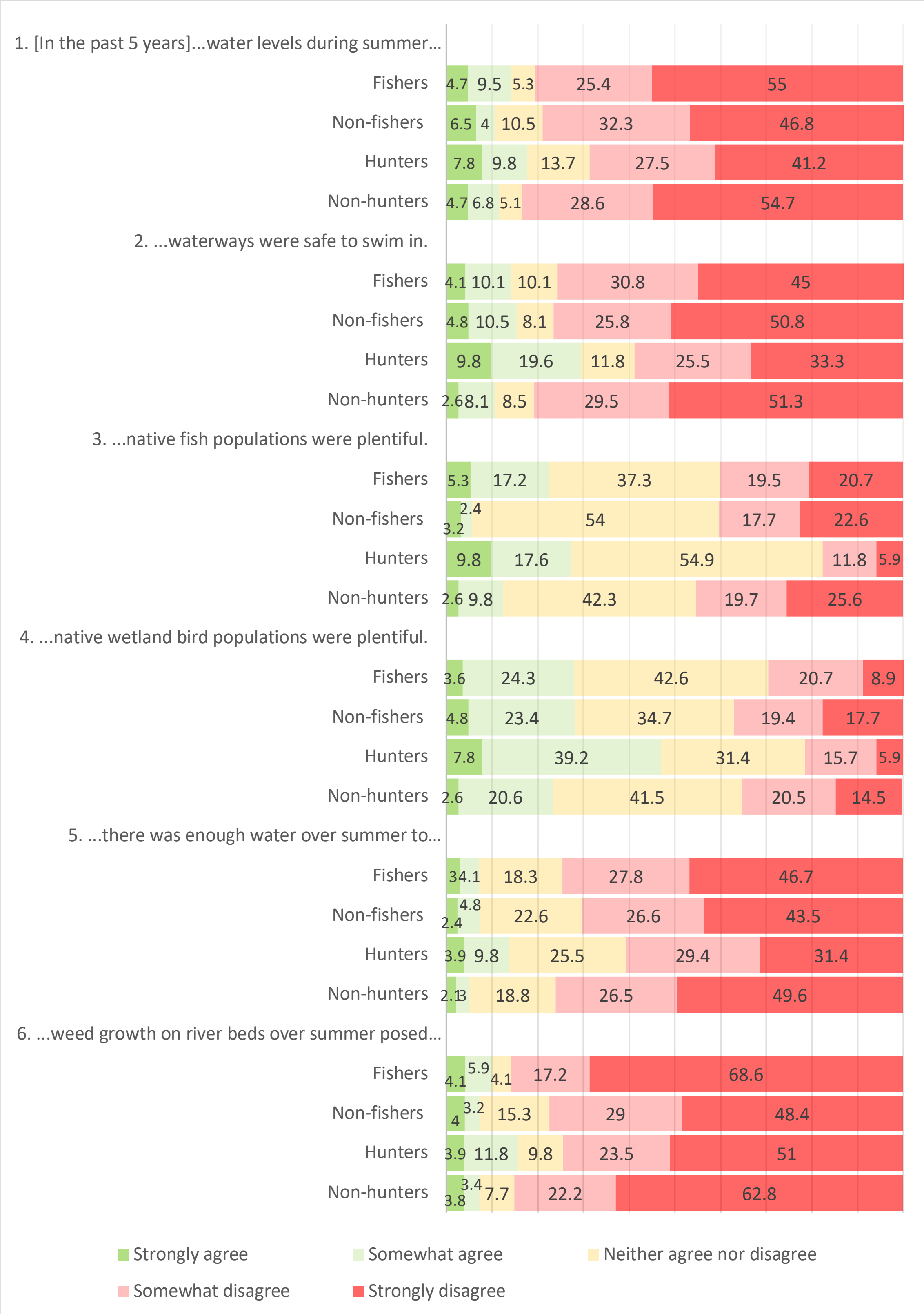
Table 5.3 *Active Visitation, Donations to Environmental Organisations, and Business Water Use.*

	Fishers				**Non-fishers**				**Hunters**				**Non-hunters**			
	Yes		No		Yes		No		Yes		No		Yes		No	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%
Have you visited a waterway in the catchment in the past 24 months?	169	100	-	-	116	93.5	8	6.5	51	100	-	-	234	100	-	-
Are you an active gamebird hunter?	39	23.1	130	76.9	12	10.3	104	89.7	51	100	-	-	-	-	234	100
Have you donated money or volunteered for an environmental organisation?	44	26	125	74	54	43.5	70	56.5	10	19.6	41	80.4	86	36.8	148	63.2
Does your business take water from the catchment?	16	9.5	153	90.5	8	6.5	116	93.5	9	17.6	42	82.4	15	6.4	219	93.6

5.2.2 Perceptions of the catchment's current state

It is important to recognise that the substantial cross-over population of 39 *Fisher/Hunters* may influence the mean perceptions of *Fishers*. It is worth noting that although there are 39 *Fisher/Hunters*, only 27 of the 51 gamebird hunters selected hunting as a main reason for visiting the catchment. This means that between 12 and 24 of the 39 *Fisher/Hunters* are likely to be mainly *Fishers* in their recreational use of the catchment. The effect of these *Fisher/Hunters* on mean perception scores is investigated later in this section. A demographic comparison of the 39 *Fisher/Hunters* and 12 *Hunters_Only* is summarised in Appendix H - Additional tables for the analysis of perceptions of the Tukituki River catchment's current and future states, Table H.2. Notably, 75% of *Hunter_Only* have a rural connection compared to 46% of the *Hunter/Fishers*.

Likert scale questions were used to measure perceptions of the current catchment state. The scores relate to a scale of agreement with 1 = strongly agree, 2 = somewhat agree, 3 = neither agree nor disagree, 4 = somewhat disagree and 5 = strongly disagree. The frequency distribution of results for *Fishers*, *Non-fishers*, *Hunter*s, and *Non-hunters* are summarised in *Figure 5.1*. The mean scores are summarised in Table 5.4 and Table 5.5.



Note. Any Fisher or *Non-fisher* may also be a Hunter or *Non-hunter*, and vice versa.
1. In the past 5 years water levels during the summer posed no problem.
2. In the past 5 years waterways were safe to swim in.
3. In the past 5 years native fish populations were plentiful.
4. In the past 5 years native wetland bird populations were plentiful.
5. There was enough water over summer to continue irrigating agricultural crops at current rates without causing any problems.
6. Weed growth on riverbeds over summer posed no problem.

Figure 5.1 Distribution (%) of Perceptions of the Tukituki River Catchment's Current State

Table 5.4 *Fisher and Non-fisher Perceptions of the Tukituki River Catchment's Current State: t-test for Independence*

		$\bar{x}$	SD	*t*	df	p-value	Cohen's *d*
In the past 5 years water levels in the Tukituki River catchment during summer posed no problem.	Fisher	4.17	1.18	0.558	291	.577	0.066
	Non-fisher	4.09	1.15				
In the past 5 years waterways in the Tukituki River catchment were safe to swim in.	Fisher	4.02	1.15	-0.352	291	.725	-0.041
	Non-fisher	4.07	1.20				
In the past 5 years native fish populations in the Tukituki River catchment were plentiful.	Fisher	3.33	1.14	-1.644	291	.101	-0.197
	Non-fisher	3.54	0.98				
In the past 5 years native wetland bird populations in the Tukituki River catchment were plentiful.	Fisher	3.07	0.97	-1.159†	240	.248	-0.139
	Non-fisher	3.22	1.14				
In the past 5 years there was enough water over summer in the Tukituki River catchment to continue irrigating agricultural crops at current rates without causing any problems.	Fisher	4.11	1.04	0.587	291	.557	0.069
	Non-fisher	4.04	1.04				
In the past 5 years weed growth on the beds of the Tukituki River catchment over summer posed no problem.	Fisher	4.40	1.09	2.024	291	.044*	0.240
	Non-fisher	4.14	1.06				

Note. This table shows the results of a t-test for independence of the means for respondents split into *Fisher* and *Non-fisher* groups.
* Significant at $p < .05$
† Levene's Test for equality of variances between populations was significant at $p < .05$. This means equal variances between populations for that variable could not be assumed and the alternative *t*-test p-value provided in SPSS was used.
Any *Fisher* or *Non-fisher* may also be a *Hunter* or *Non-hunter*, and vice versa.

The results show that most respondents disagreed with the positively framed statements and felt that summer water levels, safe swimming, and summer weed growth were all a problem, and that there was not enough water to continue irrigating at current levels. *Hunters* differentiated themselves by consistently having the lowest mean scores and by being the only group to agree that, over the past 5 years, populations of native fish and wetland birds were plentiful (fish $\bar{x}$ = 2.86, birds $\bar{x}$ = 2.73). *Fishers* ($\bar{x}$ = 4.40) stood out for their perception that summer weed growth was more of a problem than any other group, and *Non-hunters*, the largest group, had the highest mean scores for the remaining variables.

Table 5.5 *Game Bird Hunter and Non-hunter Perceptions of the Tukituki River Catchment's Current State: t-test for Independence*

		$\bar{x}$	SD	*t*	df	p-value	Cohen's *d*
In the past 5 years water levels in the Tukituki River catchment during summer posed no problem.	Hunter	3.84	1.29	-2.108	283	.036*	-0.311
	Non-hunter	4.22	1.12				
In the past 5 years waterways in the Tukituki River catchment were safe to swim in.	Hunter	3.53	1.39	-3.186†	63	.002**	-0.538
	Non-hunter	4.19	1.06				
In the past 5 years native fish populations in the Tukituki River catchment were plentiful.	Hunter	2.86	0.96	-4.615†	79	p<.001***	-0.703
	Non-hunter	3.56	1.06				
In the past 5 years native wetland bird populations in the Tukituki River catchment were plentiful.	Hunter	2.73	1.02	-3.223	283	.001**	-0.499
	Non-hunter	3.23	1.02				
In the past 5 years there was enough water over summer in the Tukituki River catchment to continue irrigating agricultural crops at current rates without causing any problems.	Hunter	3.74	1.13	-2.810	283	.012*	-0.415
	Non-hunter	4.18	0.98				
In the past 5 years weed growth on the beds of the Tukituki River catchment over summer posed no problem.	Hunter	4.06	1.21	-1.881	283	.061	-0.276
	Non-hunter	4.37	1.03				

Note. This table shows the results of a t-test for independence of the means for respondents split into *Hunter* and *Non-hunter* groups.
*Significant at p < .05, ** p < .01, ***p<.001
† Levene's Test for equality of variances between populations was significant at p < .05. This means equal variances between populations for that variable could not be assumed and the alternative *t*-test *p*-value provided in SPSS was used.
Any *Fisher* or *Non-fisher* may also be a *Hunter* or *Non-hunter*, and vice versa.

Compared to the other variables, there were high levels of uncertainty about the status of native fish and native wetland bird populations. The highest level of uncertainty regarding the status of native fish populations was held by *Non-fishers* (54%) and *Hunters* (54.9%). *Fishers* (42.6%) and *Non-hunters* (41.5%) were most uncertain about the state of native wetland bird populations.

The two sample sets (*Fisher/Non-fisher & Hunter/Non-hunter*) were tested to see if mean perceptions of the catchment's current state were statistically different between special interest and general interest respondents. An independent samples t-test was used in line with the rationale for analysis and Cohen's *d*[13] as a measure of effects size. The results are summarised in Table 5.4 and Table 5.5.

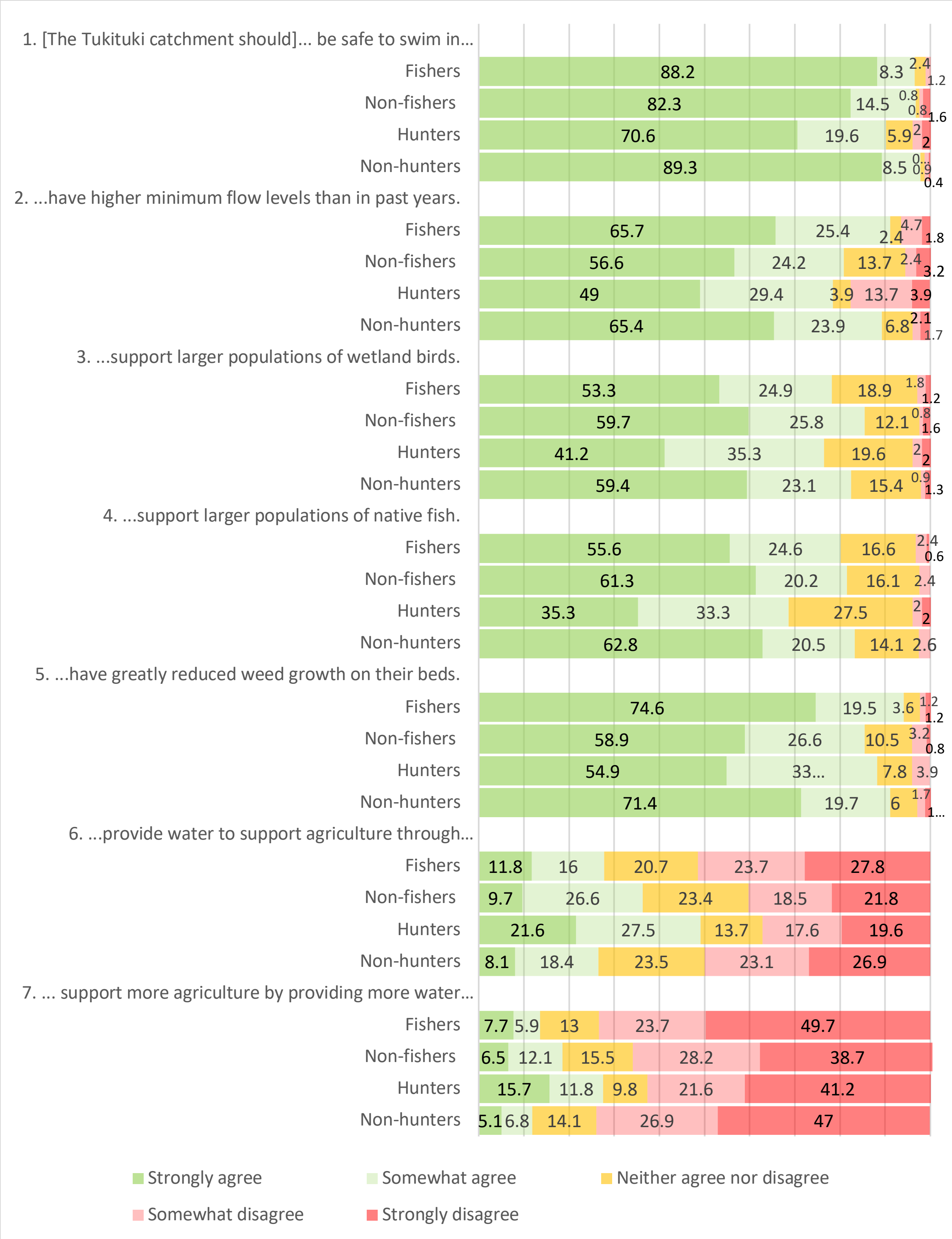
Given that *Hunters* distinguished themselves with low mean disagreement scores and that 39 *Fishers* are also *Hunters*, these *Fisher/Hunters* may have exerted a moderating effect on the *Fisher* mean scores. Similarly, the remaining 12 *Hunters* may have moderated the *Non-fisher* mean scores. In order to test for the effect of *Hunters*, a second *t*-test was conducted with *Hunters* removed from the sample. In order to be sure of respondent's hunting status, the sample was restricted to the 285 individuals given the opportunity to identify as a *Hunter*. The results are summarised in Appendix H - Additional tables for the analysis of perceptions of the Tukituki River catchment's current and future states, Table H.2.

For the full (includes all *Hunter/Fishers* and *Hunter*/*Non-fishers*) *Fisher* and *Non-fisher* sample, the only perception that was statistically different between groups was for weed growth over summer ($p = .044$, $d = 0.24$), where *Fishers* felt that weed growth was slightly more of a problem than *Non-fishers*. The repeated *t*-test, with *Hunters* removed, found no significant difference in sample means across any variable at the $p<.05$ level. This means that the current state perceptions of *Fishers* and general interest catchment users are essentially the same. In contrast, *Hunter's* perceptions of all attributes, other than weed on the riverbeds in summer, were statistically different from *Non-hunters* at the $p<.05$ level, with *Hunters* having a more positive perception of the catchment across all variables.

5.2.3 Perceptions of a future catchment state representing the best interests of society as a whole

Respondent's perceptions of their desired future catchment state were guided by the request to think about society as a whole and bear in mind future generations. The frequency distribution of results for *Fishers* vs *Non-fishers* and *Hunters* vs *Non-hunters* are summarised in *Figure 5.2* and the mean scores in Tables 5.6 and 5.7.

[13] Cohen's *d* is based on the difference between two means and indicates the number of standard deviation units by which the means of two data sets differ. American Psychology Association. (2020). *APA Dictionary of psychology: Cohen's d*. Retrieved 3rd July 2021 from https://dictionary.apa.org/cohens-d



Note. Any *Fisher* or *Non-fisher* may also be a *Hunter* or *Non-hunter*, and vice versa.
1. The Tukituki catchment should be safe to swim in summer.
2. The Tukituki catchment should have higher minimum flow levels than in past years.
3. The Tukituki catchment should support larger populations of wetland birds.
4. The Tukituki catchment should support larger populations of native fish.
5. The Tukituki catchment should have greatly reduced weed growth on their beds.
6. The Tukituki catchment should provide water to support agriculture through irrigation at current levels.
7. The Tukituki catchment should support more agriculture by providing more water for increased irrigation.

Figure 5.2 Distribution (%) of Perceptions of a Future State of the Tukituki River Catchment in the Common Good

Table 5.6 *Fisher and Non-fisher Perceptions of a Future State in the Common Good: t-test of independence*

		$\bar{x}$	**SD**	***t***	**df**	**p-value**	**Cohen's *d***
The Tukituki River catchment should be safe to swim in summer.	Fisher	1.17	0.51	-1.175	220	.241	-0.143
	Non-fisher	1.25	0.671				
The Tukituki River catchment should have higher minimum flow levels than in past years.	Fisher	1.51	0.89	-1.818	291	.070	-0.213
	Non-fisher	1.72	1.01				
The Tukituki River catchment should support larger populations of native wetland birds.	Fisher	1.73	0.91	1.325	291	.186	0.157
	Non-fisher	1.59	0.86				
The Tukituki River catchment should support larger populations of native fish.	Fisher	1.67	0.88	0.762	291	.447	0.090
	Non-fisher	1.60	0.84				
The Tukituki River catchment should have greatly reduced weed growth on their beds.	Fisher	1.35	0.72	-2.688†	271	.008**	-0.324
	Non-fisher	1.60	0.86				
The Tukituki River catchment should provide water to support agriculture through irrigation at current levels.	Fisher	3.40	1.35	1.492	291	.137	0.044
	Non-fisher	3.16	1.30				
The Tukituki River catchment should support more agriculture by providing more water for increased irrigation.	Fisher	4.02	1.25	1.427	291	.155	0.169
	Non-fisher	3.80	1.25				

Note. This table shows the results of a t-test for independence of the means for respondents split into *Fisher* and *Non-fisher* groups. **Significant at p < .01. Any *Fisher* or *Non-fisher* may also be a *Hunter* or *Non-hunter*, and vice versa.

† Levene's Test for equality of variances between populations was significant at p < .05. This means equal variances between populations for that variable could not be assumed and the alternative *t*-test p-value provided in SPSS was used.

Results showed that the vast majority of respondents wanted a future for the catchment that included safe summer swimming, increased minimum flows, larger populations of native fish and native wetland birds, and greatly reduced river weed. *Hunters* had the highest mean scores across all these variables, meaning they were less supportive of the future vision than the other three groups. There were elevated levels of uncertainty regarding having a future with increased native wetland bird and native fish populations. The most uncertain about these were the *Hunters* (*birds* 19.6%, *fish* 27.5%), and the least uncertain were *Non-fishers* (*birds* 12.1%) and *Non-hunters* (*fish* 14.1%).

There was also increased uncertainty surrounding the proposition to provide water to support agriculture through irrigation at current levels. *Non-hunters* (23.5%) were the most uncertain about continuing to provide water to support agriculture, and *Hunters* (13.7%), the least.

Table 5.7 *Hunter and Non-hunter Perceptions of a Future State in the Common Good: t-test of Independence*

		$\bar{x}$	SD	*t*	df	p-value	Cohen's *d*
The Tukituki River catchment should be safe to swim in summer.	Hunter	1.45	0.86	2.462†	57	.017*	0.453
	Non-hunter	1.14	0.50				
The Tukituki River catchment should have higher minimum flow levels than in past years.	Hunter	1.94	1.21	2.404†	62	.019*	0.413
	Non-hunter	1.51	0.86				
The Tukituki River catchment should support larger populations of native wetland birds.	Hunter	1.88	0.93	1.965	283	.050*	0.297
	Non-hunter	1.61	0.87				
The Tukituki River catchment should support larger populations of native fish.	Hunter	2.02	0.95	3.467	283	.001**	0.513
	Non-hunter	1.56	0.83				
The Tukituki River catchment should have greatly reduced weed growth on their beds.	Hunter	1.61	0.80	1.546	283	.123	0.237
	Non-hunter	1.41	0.79				
The Tukituki River catchment should provide water to support agriculture through irrigation at current levels.	Hunter	2.86	1.46	-2.758	283	.006**	-0.409
	Non-hunter	3.42	1.28				
The Tukituki River catchment should support more agriculture by providing more water for increased irrigation.	Hunter	3.61	1.51	-1.915†	63	.060	-0.322
	Non-hunter	4.04	1.162				

Note. This table shows the results of a t-test for independence of the means for respondents split into *Hunter* and *Non-hunter* groups.
*Significant at p < .05, **Significant at p < .01
† Levene's Test for equality of variances between populations was significant at p < .05. This means equal variances between populations for that variable could not be assumed and the alternative *t*-test p-value provided in SPSS was used.
Any *Fisher* or *Non-fisher* may also be a *Hunter* or *Non-hunter, and vice versa.*

Hunters ($\bar{x}$ = 2.86) were also the only group to have a mean score in agreement with providing water to support current levels of irrigation. Uncertainty diminished across all groups regarding any increased offtake to support more agricultural irrigation, and no group had a mean score that agreed with the proposition. *Hunters* had the highest level of agreement by percentage (27.5%) and *Non-hunters* the lowest (11.9%).

Once again, the sample sets were tested to see if perceptions of the catchment's future state in the public good were statistically different between special interest and general interest respondents. The results are summarised in Table 5.6, Table 5.7, and in Appendix H - Additional tables for the analysis of perceptions of the Tukituki river catchment's current and future states, Table H.3.

For the full *Fisher* and *Non-fisher* sample, the only variable that was significantly different at the $p<.05$ level was weed growth (p = .008, *d* = -0.324), where *Fishers* felt slightly less weed was in the public good than *Non-fishers*. For the second *t*-test with all *Hunters* removed, this remained unchanged (p = .018, *d* = -0.320).

Mean scores for safe summer swimming (p = .017, *d* = 0.453), higher minimum flows (p = .019, *d* = 0.413), larger populations of native wetland birds (p = .050, *d* = 0.297) and native fish (p = .001, *d* = 0.513), and providing water for agricultural irrigation at current levels (p = .006, *d* = -0.409), were all significantly different between *Hunters* and *Non-hunters* at the $p<.05$ level. The effects signs (*d*) mean that *Hunters* felt improvements in the first four variables were less in the public good than *Non-hunters*, and current levels of offtake for irrigation were more in the public good than *Non-hunters*.

5.2.4 Perceptions of overall catchment health and management

Perceptions of overall catchment health and management are summarised in Table 5.8 and Table 5.9. Perceptions of catchment health were poor across all groups. For 'All things considered, the Tukituki River catchment is in good health', 80.5% of *Fishers*, 74.5% *Non-fishers*, 62.7% *Hunters*, and 81.6% of *Non-hunters* gave a negative rating. For 'All things considered, the Tukituki River catchment is well managed', 79% of *Fishers*, 66.9% of *Non-fishers*, 66.7% of *Hunters*, and 76.5% of *Non-hunters* gave a negative rating. Rates of neutrality were low and ranged from 5% to 17.2%. The highest positive rating was 31.4% by *Hunters* for 'All things considered; the Tukituki river catchment is in good health.' All other positive ratings were 16% or less. A non-parametric comparison between *Fisher/Non-fisher* and *Hunter/Non-hunter* groups was undertaken for perceptions of catchment health and management using a

Mann-Whitney U test. This test is designed to compare mean rank values of non-normally distributed ordinal data. The hypotheses are:

H_0: The distribution of scores of the two groups is equal.

H_A: The distribution of scores of the two groups is not equal.

The results show we accept H_0 that there was no significant difference between *Fisher* and *Non-fisher* perceptions of overall catchment health ($z = -0.983$; $p = .326$) and no significant difference between in perceptions of catchment management ($z = -1.308$; $p = .191$) at the $p<.05$ level. There was a significant difference between *Hunter/Non-hunter* perceptions of catchment health ($z = -3.653$; $p = .000$) at the $p<.01$ level and a significant difference in perceptions of catchment management ($z = -2.415$; $p = .016$) at the $p<.05$ level. We reject H_0 and accept H_A in both instances. *Hunters* felt overall catchment health was better than *Non-hunters*.

Table 5.8 *Fisher and Non-fisher Perceptions of the Tukituki River Catchment's Health and Management*

	Fisher			**Non-fisher**		
	% Distribution					
	Positive ratings	Neutral	Negative ratings	Positive ratings	Neutral	Negative ratings
All things considered; the Tukituki river catchment is in good health.	14.8	4.7	80.5	15.3	10.5	74.2
All things considered the Tukituki River catchment is well managed.	9.5	10.7	79.9	15.3	17.7	66.9

Table 5.9 *Hunter and Non-hunter Perceptions of the Tukituki River Catchment's Health and Management*

	Hunter			**Non-hunter**		
	% Distribution					
	Positive ratings	Neutral	Negative ratings	Positive ratings	Neutral	Negative ratings
All things considered; the Tukituki river catchment is in good health.	31.4	5.9	62.7	11.1	7.3	81.6
All things considered the Tukituki River catchment is well managed.	15.7	17.6	66.7	10.7	12.8	76.5

5.2.5 Perceptions of organisations involved in managing the catchment

The distribution of responses to the questions, i) 'Thinking about how you want the Tukituki River catchment to be managed, which one of the following organisations do you think represents your vision the most?', and ii) 'Thinking about how you want the Tukituki River catchment to be managed, bearing in mind the wider community and future generations, which one of the following organisations do you think represents your vision the most?', are summarised in Table 5.10 and Table 5.11.

Table 5.10 *Respondent's Perception of which Organisation Most Represents their Personal Vision for Managing the Tukituki River Catchment*

	Fishers	**Non-fishers**	**Hunter**	**Non-hunter**	$\bar{x}$
			% Distribution		
HB Regional Council	19.5	24.2	25.5	20.5	22.4
Fish & Game	59.8	17.7	51	41.5	42.5
Ngāti Kahungunu Iwi Incorporated	3.0	9.7	-	6.4	4.8
Federated Farmers	4.1	4.0	13.7	1.7	7.9
Royal Forest and Bird Protection Society	5.9	23.4	2	15.8	11.8
Horticulture NZ	1.8	0.8	-	1.7	1.1
The Environmental Defence Society	0.6	6.5	-	3.8	2.7
Other	5.3	13.7	7.8	8.5	8.8

The two organisations most representing respondent's personal management vision are Fish & Game ($\bar{x}$ = 42.5%) and the Hawke's Bay Regional Council ($\bar{x}$ = 22.4%), and the lowest were Horticulture NZ ($\bar{x}$ = 1.1%) and the Environmental Defence Society ($\bar{x}$ = 2.7%). The strong showing for Fish & Game is unsurprising given that over half the sample were *Fishers*. When reconsidering their answers with a common good framing, there was a change in mean support for all categories except 'Other'. The relative ranking of organisations remained largely unchanged, with the Hawke's Bay Regional Council having the largest gain in support (+7.2%) and Fish & Game the largest loss (-8%). The redistribution of support suggests that respondents seriously considered the common good framing and reconsidered their answers.

Across the total sample, 26 individuals supplied answers under the 'Other' category for both management vision questions. For, 'Thinking about how you want the Tukituki River catchment to be managed, which one of the following organisations do you think represents your vision the most?', 6 responses could be classed as 'don't know' and one did not fit any category.

Table 5.11 *Respondent's Perception of which Organisation Most Represents a Management Vision for the Tukituki River Catchment that is in the Common Good*

	Fishers	**Non-fishers**	**Hunter**	**Non-hunter**	$\bar{x}$
	% Distribution				
The Regional Council	29.6	30.6	27.5	30.8	29.6
Fish & Game	43.8	16.9	47.1	30.3	34.5
Ngāti Kahungunu Iwi Incorporated	5.3	8.1	2	6.8	5.5
Federated Farmers	4.1	3.2	11.8	1.7	5.2
Royal Forest and Bird Society of New Zealand	7.7	19.4	3.9	14.5	11.4
Horticulture NZ	0.6	-	-	0.4	0.25
The Environmental Defence Society	3.6	8.1	-	6.8	4.6
Other	5.3	13.7	7.8	8.5	8.8

A thematic analysis of the remaining 19 individuals revealed 5 main themes. They were i) None of them - 7, ii) An organisation not listed - 3, iii) A combination of two or more listed organisations - 6, and iv) Central Hawkes Bay community or council - 3.

Respondents not happy with any of them made comments such as:

"None. They all have their own conflicted agenda"

"Bring in something new, the rest all failed to keep promises"

Respondents citing a combination of two or more made comments such as:

"Needs to be a wide range of groups to represent a range of viewpoints and hopefully get consensus"

"All of the above + the wider public"

With one respondent commenting:

"The Tukituki River needs to be cared for by people who have the whole district at heart and not a group who have their own agenda, or supporting those who support them into council"

For, ‘Think about the management of the Tukituki River catchment again, this time thinking about society as a whole and bearing in mind future generations. Which one of the following organisations do you think represents this vision the most?’, 5 responses could be classed as ‘don’t know’ and 2 did not fit any category. The remaining fell into the same thematic categories as above with very slight changes in distribution. They were i) None of them - 9 responses, ii) An organisation not listed - 2 responses, iii) A combination of two or more listed organisations - 5 responses, and iv) Central Hawkes Bay community or council - 3 responses. Two responses were not otherwise codable.

5.2.6 Latent Class Cluster Analysis

Firstly, cluster model estimation was conducted using the six *Current-state* variables (Table 5.4), followed by the same procedure for the *Future-state* variables (Table 5.6) using Latent GOLD 5.1. The *Current-state* variables are important because they describe key attributes of recreational amenity, ecological health, and productive agricultural use, and the *Future-state* variables test respondent’s perceptions of change the reflect the common good. Using Latent GOLD 5.1, a strict ordering condition was imposed by coding the variables as ordinal and fixed, which applies a restricted multinomial probability density function to each variable. This enables a more parsimonious model.

5.2.6.1 Model fit

The primary determinant of model fit is based on the p-value for the L^2 (model fit statistic) under an assumed χ^2 distribution. The L^2 signals the degree of association between variables that remains unexplained by the model. A lower L^2 is, therefore, desirable. The p-value is assessed with the following hypotheses.

H_0: There is no significant difference between the model and the data.

H_1: There is a significant difference between the model and the data.

To be clear, in the initial assessment of model fit, a p-value that is not significant at the $p<.05$ level is desirable. All other elements of the model are assessed for their significance in the conventional manner.

Current-state model estimation was conducted using the six *Current-state* variables as shown in Table 5.4. Using aggregated responses coded as Agree=1, Neither agree nor disagree=2, and Disagree=3, 1-6 cluster models were estimated and are summarised in Table 5.12. Initial assessment revealed the p-value of the 4, 5, and 6 cluster models to be > .05. Model 4 had the lowest Bayes Information Criterion (BIC(LL)) and was the most parsimonious with the lowest number of parameters (Npar =33). A bootstrap χ^2 comparison of the 4, 5, and 6 cluster models was undertaken using random seeds and 500 replications. This yielded boot-strap p-values of .08, .15 and .21 respectively. Initially, Model 4 (4-class) was selected based on a lower BIC(LL), indicating it was the most parsimonious model.

Table 5.12 *Current-state Model Fit Statistics*

	LL	BIC(LL)	Npar	L^2	df	p-value	Bootstrap p-value	Class error
1-Cluster	-1401.13	2870.43	12	703.05	281	$p<.001^{***}$		0
2-Cluster	-1258.69	2625.30	19	418.16	274	$p<.001^{***}$		0.04
3-Cluster	-1214.09	2575.87	26	328.96	267	$.006^{**}$		0.08
4-Cluster	-1197.40	2582.25	33	295.58	260	.06	.08	0.12
5-Cluster	-1185.58	2598.36	40	271.94	253	.20	.15	0.13
6-Cluster	-1182.27	2631.50	47	265.32	246	.29	.21	0.13

Note. Latent Class Cluster model fit statistics for models containing between 1 and 6 estimated latent classes for perceptions of the Tukituki River catchment's current state.
Npar = The number of parameters in the model.
** Significant at the p<.01 level, ***p<.001

Examination of the 4-class bivariate residuals, however, gave reason for reconsideration of the model. The two-way table χ^2 value with 1df determines that bivariate residual values over 3.84 are significant at the p<.05 level and are not explaining the relationship between the two variables effectively. A value above 2.0 is considered a concern for Latent Class analysis, and the 4-class bivariate residual for *Bird Population/Fish Population* was 3.17. Examination of the 5-class bivariate residuals yielded no values of concern and is summarised in Table 5.13. A comparison of model fit between the 4-class and 5-class models was undertaken using the log-likelihood-based conditional bootstrap method. This yielded a p-value of .008 demonstrating the 5-class model was a significant improvement over the 4-class. Therefore, the 5-class model with 40 parameters was adopted, and we reject H_0 and accept H_1: there is a heterogeneous societal vision of the current catchment state.

Future-state cluster model estimation of 1-6 models was conducted using the six-variable set to ensure it was directly relatable to the Current-state analysis. Estimation of models for 1-6 classes yielded p-values>.05 for models of 2-6 classes, and all these values were 1.00. A bootstrap $\chi 2$ comparison of these models was undertaken using random seeds and 500 replications. Models for 4, 5, and 6 classes yielded L2 p-values>.05. The highest p-values yielded by the 4-class model (.15) and 5-class model (.11) were very close, with the 5-class model having a lower LL.

Table 5.13 *Current-state 5-class Bivariate Residuals*

Indicators	1	2	3	4	5
1. Water Levels	.				
2. Swimming	0.65	.			
3. Fish Population	0.13	0.24	.		
4. Bird Population	0.40	0.87	0.02	.	
5. Current Irrigation	0.00	0.28	0.24	0.02	.
6. Weed Growth	0.02	0.04	0.00	0.02	0.08

Note. Bivariate residuals for the 5-class model demonstrating that all variables have a satisfactory bivariate explanatory relationship.

The 4-class model, however, had the lowest Bayes Information Criterion (BIC(LL)) and was the most parsimonious with the lowest number of parameters (33). Increasing Bootstrap replications to 1000 revealed a strengthening of the 4-class model p-value to .158 and the 5-class model to .128. Additionally, a comparison of model fit between the 4-class and 5-class models was undertaken using the log-likelihood-based conditional bootstrap method. This yielded a p-value of .47 demonstrating the 5-class model was not a significant improvement over the 4-class. Based on this comparison, it was decided to progress with the 4-class model.

An examination of the 4-class model's bivariate residuals revealed that no interactions were significant. However, examination of the 4-class model parameters revealed *Safe Swimming* ($p = .67$) and *More Native Fish* ($p = .17$) were not significant contributors to class selection at the $p<.05$ level. These two redundant variables were removed from the base model, and models with 1-6 classes were estimated in a further iteration as summarised in Table 5.14.

Table 5.14 *Future-state Model Fit Statistics*

		LL	BIC(LL)	Npar	L^2	df	p-value	Bootstrap p-value	Class. Err.
Model1	1-Class	-724.17	1493.77	8	133.87	72	$p<.001^{***}$		0.00
Model2	2-Class	-681.52	1436.87	13	48.57	67	.96	.62	0.05
Model3	3-Class	-679.97	1462.18	18	45.48	62	.94		0.16
Model4	4-Class	-678.53	1487.70	23	42.59	57	.92		0.20
Model5	5-Class	-673.44	1505.92	28	32.42	52	.99		0.11
Model6	6-Class	-672.27	1531.98	33	30.08	47	.97		0.19

Note. Latent Class Cluster model fit statistics for models containing between 1 and 6 estimated latent classes for perceptions of the Tukituki River catchments future-state in the common good.

*** Significant at the p<.001 level

This yielded a 2-class model as the best fit with 13 parameters, a p-value of .96, and a BIC of 1436.87. The 2-class model fit was further tested using a bootstrap χ^2 test with a random starting seed. This yielded a p-value of .62, which was still non-significant (see section 5.2.6.1) and reinforced that the 2-class model was a good fit. Log-likelihood conditional bootstrap comparison with the 3-class model yielded a p-value of .74, thus demonstrating the 3-class model was not a significant improvement on the 2-class model. Bivariate residuals are summarised in Table 5.15, and there were no residuals >1. Therefore, the 2-class model was selected as the best fit for this analysis, and we reject H_1 and accept H_0: there is a heterogeneous societal view of the future catchment state.

Table 5.15 *Future-state* 2-*class Bivariate Residuals*

Indicators	1	2	3	4
1. Higher Flows	.			
2. More Birds	0.7875	.		
3. Reduced Weed	0.0009	0.2251	.	
4. Continued Irrigation	0.0171	0.1055	0.0207	.

Note. Bivariate residuals for the 2-class model demonstrating that all retained variables have a satisfactory bivariate explanatory relationship.

5.2.6.2 Model parameters

An evaluation of *Current-state* parameters is summarised in Table 5.16. All parameters yielded a p-value < .05, and as such, all make a significant contribution towards discriminating between classes. The R^2 values show *Weed Growth, Bird Population*, *Water Levels*, and *Fish Population* all explained over half of the variance. Paired comparison models for the indicator variables show significant contributions to class discrimination in just over half of possible pairs and are summarised in Appendix I - Additional tables for latent class analysis, Table I.4 .

Table 5.16 *Current-state 5-class Model Parameters*

Indicators	Class-1	Class-2	Class-3	Class-4	Class-5	Wald	p-value	R^2
Water Levels	2.46	0.33	-1.23	-2.52	0.97	33.31	$p<.001^{***}$	0.54
Swimming	0.15	2.84	-0.11	-2.30	-0.59	34.82	$p<.001^{***}$	0.47
Fish Population	0.00	5.40	0.07	-2.44	-3.02	31.59	$p<.001^{***}$	0.52
Bird Population	0.51	5.69	-0.19	-1.87	-4.13	27.42	$p<.001^{***}$	0.59
Current Irrigation	0.40	1.18	-1.32	-2.25	1.99	40.62	$p<.001^{***}$	0.38
Weed Growth	3.50	0.85	-2.65	-4.26	2.56	27.59	$p<.001^{***}$	0.61

Note. Table shows model parameters for the accepted 5-class model demonstrating that all variables have significant contributions to the model.
***Significant at the p<.001 level.

All *Future-state* model parameters have a significant contribution towards discriminating between classes, and R^2 values range from 0.39 for *Higher flows* to 0.18 for *Continued Irrigation*. These are summarised in Table 5.17. As there are only two classes, tabling paired comparisons serves no purpose.

Table 5.17 *Future-state 2-class Model Parameters*

Indicators	Class-1	Class-2	Wald	p-value	R^2
Higher Flows	-1.2456	1.2456	20.46	p<.001***	0.39
More Native Birds	-1.0247	1.0247	24.80	p<.001***	0.21
Reduced Weed	-1.3799	1.3799	21.30	p<.001***	0.29
Continued Irrigation	0.8605	-0.8605	12.37	p<.001***	0.18

Note. Table shows model parameters for the accepted 2-class model demonstrating that all variables have significant contributions to the model. *** Significant at the p<.001 level.

5.2.6.3 Class profiles

Current-state class profiles are summarised in Table 5.18.

Table 5.18 *Current-state Class Profiles by Proportional Distribution of Responses Across Indicator Variables*

	Recreationists	Pessimists	Non-committers	Pro-irrigators	Biodiversity Positive
Class membership distribution (%)	40.2	22.7	18.0	11.6	7.5
Indicators					
Water Levels					
Pose no problem	0.000	0.016	0.228	0.700	0.005
Neutral	0.008	0.065	0.195	0.165	0.036
Are a problem	0.991	0.919	0.577	0.135	0.960
Swimming					
No risk to health	0.058	0.000	0.092	0.794	0.197
Neutral	0.103	0.008	0.125	0.121	0.165
Risk to health	0.839	0.991	0.783	0.085	0.638
Fish Population					
Populations plentiful	0.069	0.000	0.063	0.546	0.684
Neutral	0.635	0.010	0.625	0.437	0.309
Populations not plentiful	0.296	0.990	0.312	0.018	0.007
Bird Population					
Populations plentiful	0.165	0.000	0.312	0.735	0.965
Neutral	0.623	0.016	0.588	0.257	0.035
Populations not plentiful	0.212	0.984	0.100	0.008	0.000
Current Irrigation					
Poses no problem	0.009	0.002	0.137	0.372	0.000
Neutral	0.142	0.071	0.415	0.441	0.033
Poses a problem	0.850	0.927	0.448	0.187	0.967
Weed Growth					
Poses no problem	0.000	0.000	0.114	0.587	0.000
Neutral	0.001	0.014	0.285	0.291	0.003
Poses a problem	0.999	0.986	0.601	0.122	0.997

Note. Table shows the distribution of class members with responses at each variable level across the five latent classes. With allowance for rounding error values for each individual variable sum vertically to 1 under each class.

With allowances for rounding error, Class-1 has the largest proportion of respondents with 40%, Class-2 23%, Class-3 18%, Class-4 12% and Class-5 8%. Class-1 concerns are concentrated on indicators associated with contact recreation; while they had high levels of neutrality regarding native wetland birds and fish, this class is labelled the *'Recreationists.'* Class-2 was almost entirely negative about the current state of all variables and this class is labelled the *'Pessimists.'* Class-3 had the second-highest positive perceptions of *Water Levels* (23%) and the highest neutral (20%). It also had the second-highest neutral perceptions of *Bird Population* (59%), *Fish Population* (63%), *Swimming* (13%), *Current Irrigation* (42%), and *Weed Growth* (29%), and this class is labelled the *'Non-committers'*.

In contrast, 70% of respondents in Class-4 felt *Water Levels* in the summer posed no problem, and 80% felt the catchment was safe to swim in. They felt both *Native Fish* and *Native Bird* populations were plentiful (55% & 74%) and were three times more likely to feel positive about *Current Irrigation* than any other class. They were also five times more likely (55%) to feel *Weed Growth* in the summer was not a problem so this class is labelled the *'Pro-irrigators.'* Class-5 has a very similar negative profile to Classes 1 and 2 for *Water Levels* (96%), *Current Irrigation* (97%) and *Weed growth* (100%). It was slightly more negative about *Swimming* than classes 1,2, and 3 and differed from all classes by having the highest positive ratings for *Fish Population* (68%) and *Bird Population* (97%). Class-5 is labelled the '*Biodiversity Positive* group. Across-class mean probability for each variable is summarised in Appendix I - Additional tables for latent class analysis, Table I.5 . *Future-state* class profiles are summarised in Table 5.19.

With allowances for rounding error, Class-1 represents 85% of respondents and Class-2 15%. Class-1 was overwhelmingly positive for improvements in *Higher Flows* (95%), *More Birds* (88%), and *Reduced Weed* (97%), and 54% negative for *Continued Irrigation*. Class-1 is labelled the *'Pro-quality'* group. Class-2 was split fairly evenly between support (40%) for and opposition (38%) to *Higher Flows*. They were predominantly positive (42%) or neutral (43%) regarding *More Native Birds*, and the majority (54%) were positive about *Reduced Weed*. The most striking feature was the 80% support for *Continued Irrigation* at current levels, and so this class is labelled the *'Pro-irrigators.'* Appendix I - Additional tables for latent class analysis, Table I.8 summarises the across-class mean probability for each *Future-state* variable level.

Table 5.19 *Future-state 2-class Class Profiles by Proportional Distribution of Responses Across Indicator Variables*

	Pro-quality	Pro-irrigators
Class membership distribution (%)	85.1	14.9
Indicators		
Higher Flows		
Should have higher minimum flows	0.949	0.396
Neutral	0.045	0.226
Should not have higher minimum flows	0.006	0.378
More Native Birds		
Should have more native wetland birds	0.880	0.422
Neutral	0.114	0.425
Should not have more native wetland birds	0.005	0.153
Reduced Weed		
Should have reduced riverbed weed	0.969	0.537
Neutral	0.030	0.264
Should not have reduced riverbed weed	0.001	0.199
Continued Irrigation		
Should continue to support irrigation at current levels	0.230	0.797
Neutral	0.232	0.144
Should not continue to support irrigation at current levels	0.539	0.060

Note. Table shows the proportion of class members with responses at each variable level across the two latent classes. With allowance for rounding error values for each individual variable sum vertically to 1 under each class.

5.2.6.4 Model covariates

An analysis of covariates was done in order to determine the significance, if any, of the effects of demographic variables on class membership. It was also conducted to assess the influence of being a *Fisher* or *Hunter* on class membership in order to reflect the study's special focus on those groups. Covariate definitions and levels are shown in Table 5.20. For the *Current-state* analysis, the 5-class model was coded with the covariates; *Age_agg*, *Income*, *Dwelling*, *Education*, *Hunter*, and *Fisher*. All variables were scaled as Numerical-fixed. The model was classified proportional, and the maximum likelihood method of bias-adjustment applied. Variables were effects coded and a main effects only model estimated. The initial model was rejected as being significantly different from the data.

Table 5.20 *Covariate Variable Descriptions and Levels*

Variable	Description	Levels
Age_agg	Respondent's aggregated into age ranges	1. 18-49
		2. 50-64
		3. 64+
Income	Total household income before tax	1. $0-$50,000
		2. $50,001-$100,000
		3. $100,001-$150,000
		4. $150,001-$200,000
		5. $200,000 or more
Dwelling	Rural/urban orientation of respondents dwelling type	1. On a farm
		2. On a lifestyle block
		3. In town
		4. In town & own a farm
Education	Highest academic achievement	1. Secondary school
		2. Post-secondary school certificate of diploma
		3. University Bachelor's degree
		4. Post-graduate degree
Hunter	Game bird hunter	1. Hunter
		2. Non-hunter
Fisher	Fisher for trout or other species	1. Fisher
		2. Non-fisher

Following several iterations, it was decided to model *Age-agg*, *Income*, *Dwelling*, and *Education* together (Model-1) and to separately model *Fisher* and *Hunter* (Model-2). These models returned non-significant p-values of .13 and .52 respectively, and so were accepted as being a good fit (see section 5.2.6.1). Covariate parameters are summarised in Table 5.21. All the individual covariate parameters had no significant relationship with class membership at the $p<.05$ level. Fit statistics for all three models are summarised in Appendix I - Additional tables for latent class analysis, Table I.10.

Fisher ($p = .51$) had no significant relationship with class membership at the $p<.50$ level, however, *Hunter* ($p = .002$) did have a significant relationship with class membership. Table 5.22 summarises the class profiles by covariate levels across the two models. This is consistent with the results of section 5.2.2, where *Fisher's* perceptions are no different to the wider user group, and *Hunters* distinguished themselves from other catchment users.

Table 5.22 summarises the class profiles by covariate levels across the two models. *Recreationists* had the highest proportion of Post-graduate educated respondents (25%) and the second-highest proportion in the top three income brackets. They also had the second highest proportion of town dwellers (64%), the second highest in the 50-64 age group (38%), and the highest proportion of *Fishers* (61%). As the largest class (40.4%), they can be characterised as largely older, wealthier, and more educated town dwellers with an elevated probability of being a *Fisher*.

Table 5.21 *Current-state Covariate Effects Parameters*

	Recreationists		Pessimists		Non-committers		Pro-irrigators		Biodiversity Positive			
Model-1		s.e.		s.e.		s.e.		s.e.		s.e.	Wald	p-value
Covariate												
Age_agg	0.125	0.173	0.074	0.168	-0.084	0.238	-0.163	0.249	0.048	0.293	1.193	.880
Income	0.028	0.146	-0.113	0.117	-0.238	0.232	0.273	0.143	0.051	0.242	4.600	.330
Education	0.320	0.158	0.272	0.138	0.251	0.226	-0.087	0.169	-0.755	0.317	9.267	.055
Dwell	0.190	0.226	0.111	0.181	0.319	0.403	-0.509	0.293	-0.111	0.435	4.384	.360
Model-2												
Covaritae												
Hunter	0.114	0.344	1.223	0.505	0.622	0.549	-1.193	0.378	-0.765	0.469	16.996	.002**
Fisher	-0.092	0.272	0.214	0.269	0.396	0.353	0.234	0.364	-0.752	0.533	3.311	.510

Note. Table shows the effect of covariates on class membership and their parameters based on perceptions of the Tukituki River catchments' current state. Two separate covariate models were conducted, the first for demographic variables and the second for being either a *Fisher* or *Hunter*.**Significant at the **p<.01 level.

Table 5.22 *Current-state Class Membership Profile Distribution by Covariate Category*

	Latent Class				
	Recreationists	Pessimists	Non-committers	Pro-irrigators	Biodiversity Positive
Class membership distribution (%)	40.2	22.7	18.0	11.6	7.5
Covariates					
Age_agg*					
18-49	0.294	0.292	0.331	0.348	0.259
50-64	0.384	0.376	0.360	0.444	0.396
65+	0.323	0.332	0.309	0.208	0.345
Income					
$0-$50,000	0.181	0.224	0.255	0.114	0.209
$50,001-$100,000	0.326	0.350	0.365	0.269	0.365
$100,001-$150,000	0.252	0.241	0.236	0.291	0.271
$150,001-$200,000	0.129	0.104	0.089	0.149	0.094
$200,001 or more	0.113	0.080	0.056	0.178	0.061
Education					
Secondary school	0.156	0.176	0.184	0.263	0.520
Post-secondary school certificate or diploma	0.299	0.320	0.336	0.286	0.326
University Bachelor's degree	0.295	0.281	0.272	0.280	0.120
Post-graduate degree	0.250	0.224	0.208	0.172	0.035
Dwell					
On a farm	0.055	0.066	0.049	0.153	0.110
On a lifestyle block	0.273	0.269	0.224	0.390	0.266
In town	0.641	0.638	0.693	0.448	0.608
In town and own a farm	0.031	0.027	0.035	0.010	0.017
	Class-1	Class-2	Class-3	Class-4	Class-5
Class Size	0.402	0.227	0.181	0.116	0.074
Covariates					
Fisher					
Fisher	0.613	0.519	0.481	0.586	0.777
Non-fisher	0.387	0.481	0.519	0.414	0.223
Hunter†					
Yes	0.170	0.060	0.100	0.411	0.356
No	0.804	0.911	0.867	0.561	0.629

Note. Table shows the proportional distribution of class members across the covariate levels. With allowance for rounding error values for each individual variable sum vertically to 1 under each class. Sum horizontally for total cluster size proportions in row one.
* Age_agg is the reported ages of respondents aggregated into age brackets.
† Note that the profile proportions for *Hunter* sum to 97%. This is due to 3% of respondents having not visited the catchment in the past 24 months and a consequence of the survey logic meant they were not given the opportunity to distinguish themselves as a hunter or not.

Pessimists had the second-highest proportion of aged 65+ (33%), are most likely to live in town (64%). They have the second-highest proportion in both the \$0-\$50,000 (22%) and \$50,001-\$100,000 (35%) bracket, and the second-highest proportion with post-graduate education (22%). They also have the second-highest proportion of *Non-fishers* (48%). Representing 22.7% of respondents, *Pessimists* can be characterised as most likely to be older, well-educated middle income earners with near even chances of being a *Fisher* of *Non-fisher*.

The *Non-committers* had the highest proportion of those in the \$50,001-\$100,000 income bracket (35%), and the \$0-\$50,000 bracket (25%), the highest proportion to dwell in a town (69%), and highest proportion with post-secondary school certificates or diplomas (34%). They also had the highest proportion of *Non-fishers* (52%). *Non-committers* were 17.8% of respondents and can be characterised as most likely to be moderately educated lower to middle income earners that live in town and are most likely a *Non-fisher*.

The *Pro-irrigators* had the highest proportion of 50-64 year old's (44%), and the highest proportion with incomes over \$200,000 per year (18%) and in the preceding two income brackets (15%, 29%). They also had the highest proportion of those that either lived on a farm (15%) or lifestyle block (39%), and the highest proportion of *Hunters* (41%). Remembering they are the second smallest class (11.7%), this characterises them as most likely to be older, wealthier individuals with a connection to agricultural land and an elevated probability of hunting gamebirds.

The *Biodiversity Positive* had the highest proportion of 65+ (36%), highest proportion of those holding only secondary school education (52%), the highest equal in the \$50,001-\$100,000 (36%) income bracket and the second highest in the \$100,001-\$150,000 bracket (27%). It also had the highest proportion of members as *Fishers* (78%). Remembering they are the smallest class with 7.5% of respondents, this characterises them as older less educated *Fishers* in the middle-income bracket. Appendix I - Additional tables for latent class analysis, Table I.6 summarise covariates by class probability means.

Future-state model covariate parameters are summarised in Table 5.23. *Age_agg, Income,* and *Education* had no significant relationship with class membership at the $p<.05$ level, however, *Dwell* ($p = .019$) was significant. *Fisher* had no significant relationship, however, *Hunter* ($p = .011$) was significant at the $p<.05$ level.

Table 5.23 *Future-state 2-class Covariate Effects Parameters*

Model-1	Pro-quality	s.e.	Pro-irrigators	s.e.	Wald	p-value
Covariates						
Age_agg	0.070	0.151	-0.070	0.151	0.214	.640
Income	-0.064	0.080	0.064	0.080	0.643	.420
Education	-0.014	0.098	0.014	0.098	0.021	.890
Dwell	0.373	0.159	-0.373	0.159	5.496	.019*
Model-2						
Covariates						
Hunter	0.606	0.238	-0.606	0.238	6.459	.011*
Fisher	-0.401	0.220	0.401	0.220	3.312	.069

Note. Table shows the effect of covariates on class membership and their parameters based on perceptions of the Tukituki River catchment's future state for the common good. Two separate covariate models were conducted, the first for demographic variables and the second for being either a *Fisher* or *Hunter*. *Significant at the p<.05 level.

Table 5.24 summarises the class profiles by covariate levels across the two models. Within-variable values sum vertically to 1 or 100%. Several notable differences distinguish the *Pro-irrigators* from the *Pro-quality*. With allowance for rounding error, *Pro-irrigators* had the highest proportion of 50–64-year-old's (43%), the highest proportion in all income brackets over $100,000, the highest proportion of both Bachelor's (30%) and Post-graduate degrees (24%), and the most likely to live on a farm (16%) or a lifestyle block (39%). *Pro-irrigators* were also least likely to be a *Fisher* (45%) and most likely to be a *Hunter* (32%). In short, a *Pro-irrigator* is more likely to be a post-middle-aged, well educated, high income earner with a rural connection and a propensity to hunt gamebirds, than a *Pro-quality.* Appendix I - Additional tables for latent class analysis, Table I.9 summarises class membership by covariate probability means.

Table 5.24 *Future-state Class Profile Distribution by Covariate Category*

Model-1	Pro-quality	Pro-irrigators
Class membership distribution (%)	85.4	14.6
Covariates		
Age_agg*		
18-49	0.299	0.334
50-64	0.378	0.431
65+	0.323	0.236
Income		
$0-$50,000	0.206	0.152
$50,001-$100,000	0.341	0.297
$100,001-$150,000	0.249	0.273
$150,001-$200,000	0.114	0.128
$200,001 or more	0.090	0.150
Education		
Secondary school	0.206	0.200
Post-secondary school certificate or diploma	0.319	0.262
University Bachelor's degree	0.269	0.298
Post-graduate degree	0.207	0.240
Dwell		
On a farm	0.056	0.163
On a lifestyle block	0.257	0.392
In town	0.657	0.436
In town and own a farm	0.030	0.010
Model-2		
Class Size	0.854	0.146
Covariates		
Hunter†		
Yes	0.149	0.319
No	0.825	0.644
Fisher		
Fisher	0.598	0.454
Non-fisher	0.402	0.546

Note. Table shows the proportional distribution of class members across the covariate levels. With allowance for rounding error, values for each individual variable sum vertically to 1 under each class.
* Age_agg is the reported ages of respondents aggregated into age brackets.
† Note that the profile proportions for *Hunter* sum to 96%. This is due to 4% of respondents having not visited the catchment in the past 24 months and a consequence of the survey logic meant they were not given the opportunity to distinguish themselves as a hunter or not.

5.3 Study Objectives 2 & 3

Objective 2: To estimate the marginal welfare benefits generated by improved water quality in the study area.

Objective 3: To quantify the willingness to pay for improved water quality as a function of welfare based on public trust of freshwater advocates and policy-oriented organisations.

5.3.1 Descriptive analysis

The Facebook post used to attract respondents reached a total of 14,706 users, of which 13,556 were from paid 'Boosting'. There were 1,753 post engagements (1,080 from 'Boosting' at the cost of $0.14 per engagement), 99 'likes' 45 'comments', and 25 'shares.' Only 43 comments remained visible, and almost all without reply from other Facebook users other than one thread which generated a discussion of 18 replies. This thread was entirely devoted to discussing the role of agriculture with regard to water quality in the catchment and perceptions of risk associated with any further intensification of land use. The only other themes noted were those making comments that were substantially unrelated to the catchment (8), those putting forward a Māori perspective (2), and those confused or criticizing the survey (7). Facebook responses and snowballed email responses were not distinguished from each other in the analysis. Data was stored and analysed on password and virus-protected computers and all response data was removed from host servers. Following contact with the incentive winners, the name and address variables were deleted from the data set.

The total number of respondents was 687, with 448 completed responses representing a 65.2% completion rate. Of those that did not complete the survey, 2.3% stopped at the start information page, 11.6% during the demographic section, 9.3% during the valuation section, 10.5% during the best-worst section, and 1% during the final attitudinal and follow up questions. Of the complete responses, 39 were early completion due either to being under 18 years old or not being a household bill payer. This left a total useable sample of 409. Further reductions for responses with protest bids in the valuation section of 34 and 4 for best-worst responses with a log likelihood fit statistic (RLH) below the critical value of 0.331 as calculated in section 4.3.3.6. The median response time was 11m 22s, and the lower fifth percentile 6m 38s. Thirteen response times were below the lower threshold, and four of those also registered the maximum willingness to pay amount. Two of the four had contact names attached and were individuals recognisable to the researcher as being well educated and informed. It was decided that no evidence of 'straight-lining' for the incentive was apparent among low response times. One gender outlier was removed and one respondent with an inconsistent response set, leaving a total useable sample of 369 and of those 194 (52.6%) entered details for the incentive draw. The demographic comparison between the sample and the Hawke's Bay population is summarised in Table 5.25. There was a much higher proportion of respondents in the 50–64-year-old category (41.2%) than the regional statistics (19.6) and a slightly higher proportion of 65+years old (21.1% vs 18.3%). The sample gender split was 52.6% female and 47.4% male, which closely reflected the Hawke's Bay population.

Table 5.25 *Comparison of Survey Sample (n=369) and the Wider Hawke's Bay Population*

	n	%	Hawke's Bay Population %
Age			
18-49	139	37.7	47.5[a]
50-64	152	41.2	27.1
65+	78	21.1	25.3
Gender			
Female	194	52.6	51.3
Male	176	47.4	48.7
Household Income			
0-$50,000	86	23.3	
$50,001-$100,000	139	37.7	$99,719[b]
$100,001-$150,000	84	22.8	
$150,001-$200,000	36	9.8	
more than $200,000	24	6.5	
Education			
High School	68	18.4	26.1
Certificate or Diploma	143	38.8	56.4
Bachelor's Degree	115	31.2	11.3
Post-Graduate Degree	43	11.7	6.2
Respondent's closest town			
Within catchment boundaries	94	25.5	-
Havelock North[c]	76	20.6	-
Outside catchment boundaries	200	53.9	-

[a] 2018 NZ Census data age grouping starts from age 20 years.
[b] Mean household income for 2020 taken from Infometrics (2020).
[c] Havelock North is directly adjacent to the catchment and the Tukituki can be considered its local river.

The largest proportion (37.7%) of respondents came from a household with an income of between \$50,000-\$100,000 which reflects the 2018 regional median household income of \$77,700 as reported by the Ministry of Business Innovation and Employment (2020).

The sample was more educated than the regional population with the proportion of bachelor's degree holders nearly three times that of the regional population and nearly double for post-graduate degrees. The towns selected by respondents as being closest to them were categorised as either being inside or outside the Tukituki River catchment boundary. The township of Havelock North was given its own category in order to reflect both its close proximity and strong use relationship with the Tukituki River as well as its elevated socio-economic profile.

Respondent's perceptions of their prior knowledge of catchment management, general catchment management, and the provision of catchment information are summarised in Table 5.26. Overall, more respondents felt positive about their knowledge of catchment management (34%) than negative (29%), while only 11% agreed that the voices of the people were being heard by those managing the catchment. The majority of respondents felt that information on water quality was not well communicated to the public (55%), and this sentiment strengthened with regard to reporting on wildlife populations (70%). Notably, 73% of respondents would be more trusting of the taxes authorities charged if they were more informed about the catchment's state. Overall the majority (52%) felt the catchment was not being well managed, with only 9% in agreement.

The most preferred channel for receiving catchment information was *Social media* 37.4%, which is expected given the survey was delivered largely by social media advertising, and the least preferred options were *Mobile App* 3.3% and *Radio* 3%. Only 10 respondents (2.7%) were not interested in receiving more catchment information. The sample was heavily engaged with the catchment. Ninety percent (n= 332) of respondents had visited a waterway in the Tukituki River catchment in the past 24 months. Respondents were geographically dispersed across Hawke's Bay from the southern rural township of Takapau to Wairoa in the north.

Table 5.26 *Perceptions of Prior Knowledge, Catchment Management, and Catchment Information.*

	Frequency of responses %									
	Very good		Good		Neither good nor poor		Poor		Very poor	
	n	%	n	%	n	%	n	%	n	%
How would you rate your understanding and knowledge of how the authorities manage catchments and waterways?	39	10.6	88	23.8	135	36.6	79	21.4	28	7.6
	Strongly agree		Agree		Neither agree nor disagree		Disagree		Strongly disagree	
The voices of the people are being heard by the managers of the Tukituki catchment.	6	1.6	35	9.5	130	35.2	131	35.5	67	18.2
Information about water quality in rivers, streams and wetlands is well communicated to the public.	2	0.5	79	21.4	86	23.3	145	39.3	57	15.4
Information about the populations of native wildlife in Hawke's Bay catchments is well communicated to the public.	-	-	28	7.6	83	22.5	191	51.8	67	18.2
If I was more informed about the state of catchments, I would be more trusting of the taxes charged by the authorities managing them.	77	20.9	191	51.8	59	16.0	30	8.1	12	3.3
All things considered; the Tukituki River catchment is being well managed.	2	0.5	30	8.1	119	32.2	134	36.3	84	22.8

5.3.2 Objective 2

Objective 2: To estimate the marginal welfare benefits generated by improved water quality in the study area.

Response frequencies for the iterative bidding exercise are summarised in Appendix J - Additional tables for WTP for improved water quality, Table J.1. Of the 369 respondents, 15 (4.1%) would pay nothing more towards the described possible future state. Of those, 5 sighted they could not afford to pay more and 10 felt there was nothing wrong with the catchment. In total, 88 (23.8%) said the Covid19 Level-4 lockdown period had reduced the amount they chose to pay. The bids were not normally distributed and appeared to cluster around the four price points: $4.00, $5.00, $9.50, and $12.50. The mean WTP for the described possible future catchment state was $6.67 per month for the next ten years, with a standard deviation of $3.68. The median value was $5. An upper bound was calculated using the midpoint values between the accepted bid and the declined bid, and this gave a figure of $7.22 with a standard deviation of $3.60, and a median value of $5.75.

There was no survey variable to test respondent non-attendance to cost, and so there is a need to account for possible strategic overbidding. To test the effects of outlier bids on mean WTP ($6.67), a series of truncated mean calculations, using an Excel spreadsheet, were conducted on the respondent bid dataset as recommended by Bateman et al. (1995). A truncated mean removes a percentage of data from each end of the distribution before the mean is calculated, thus removing potential outliers. The 5% truncated mean was $6.69, the 10% truncated mean was $6.70, and the 20% truncated mean was $6.68. This shows that the mean WTP is very robust to truncation and likely not affected by non-attendance to cost. It also shows that outliers do not explain the substantial difference between the median and mean and that the difference likely reflects the more general positive skewness in bids.

Respondent's engagement with the consequentiality of their bids was tested in a final survey question where they were asked, 'Do you think the results of this survey should be passed on to the authorities?', to which 93.8% responded 'Yes'. This is taken as an affirmation that their willingness to pay for improved water quality should be used to inform the authority with the power to enforce increased regional taxation.

5.3.2.1 Welfare estimation by geographic distribution

WTP was analysed by two geographic criteria utilising the town's respondents identified as being closest to them. The distribution of responses by closest township is summarised in Appendix J - Additional tables for WTP for improved water quality, Table J.2. The first criteria aggregated those towns that were located within the Tukituki River catchment boundaries and those outside of the boundary. Given its position on the boundary of the catchment and its special relationship with the river, *Havelock North* was given its own category, and results are summarised in Table 5.27.

Table 5.27 *Comparison of Sample Profiles and WTP, Defined by Respondents Closest Town, Aggregated to those Within and Outside the Tukituki River Catchment, and the Township of Havelock North.*

	Total Sample n=369		In_catchment n=94		Havelock North n=76		Out _catchment n=199	
	n	%	n	%	n	%	n	%
Age								
18-49	139	37.7	28	29.8	31	40.8	80	40.2
50-64	152	41.2	44	46.8	24	31.6	84	42.2
65+	78	21.1	22	23.4	21	27.6	35	17.6
Gender								
Female	194	52.6	50	53.2	36	47.4	108	54.3
Male	176	47.4	44	46.8	40	52.6	91	45.7
Income								
0-$50,000	86	23.3	18	19.1	13	17.1	55	27.6
$50,001-$100,000	139	37.7	43	45.7	26	34.2	70	35.2
$100,001-$150,000	84	22.8	23	24.5	17	22.4	44	22.1
$150,001-$200,000	36	9.8	6	6.4	13	17.1	17	8.5
more than $200,000	24	6.5	4	4.3	7	9.2	13	6.5
Education								
High School	68	18.4	23	24.5	12	15.8	33	16.6
Certificate or Diploma	143	38.8	34	36.2	21	27.6	88	44.2
Bachelor's Degree	115	31.2	33	35.1	28	36.8	54	27.1
Post-Graduate Degree	43	11.7	4	4.3	15	19.7	24	12.1
Mean WTP[a]	$	SD	$	SD	$	SD	$	SD
Lower bound	6.67	3.68	6.31	3.89	7.49	3.83	6.53	3.49
Upper bound	7.22	3.60	6.86	3.81	7.98	3.67	7.09	3.43
Median WTP[a]								
Lower bound	5.00	-	5.00	-	6.50	-	5.00	
Upper bound	5.75	-	5.75	-	7.25	-	5.75	

[a] WTP = Willingness to pay amount each month for the next ten years to achieve the proposed change in catchment state.

Mean WTP for those *In_catchmen*t (lower bound) was $6.31 and the upper bound was $6.86, and the medians were $5 and $5.75 respectively. Their median age (56) was older than the wider sample population. They had fewer people in the two highest income brackets (10.7%) but also fewer in the lowest bracket (19.1%). They had a greater proportion (24.5%) with high school education only and a lower rate of post-graduate education (4.3%). The mean WTP amongst sampled residents of *Havelock North* had a lower bound of $7.49, and an upper of $7.98, and the median was $6.50 and $7.25. On average, the *Havelock North* group was younger with a median age of 52 years and more male 52.6%. It was wealthier with 23.6% in the top two income brackets and more educated with 19.7% having a post-graduate degree.

The mean WTP for *Out_catchment* (lower bound) was $6.53, the upper bound was $7.09, and medians were $5.00 and $5.75 respectively. *Out_catchment* respondents also had a median age of 52 years and the lowest proportion of those 65+ years old (17.6%) and had a greater proportion of females (54.3%). Their income closely matched the wider sample and they had slightly more respondents with certificates of diplomas (44.2%) and slightly lower levels of bachelor's degrees (27.1%). The chart in *Figure 5.3* summarises the frequency of WTP bids by catchment/non-catchment towns, and Havelock North.

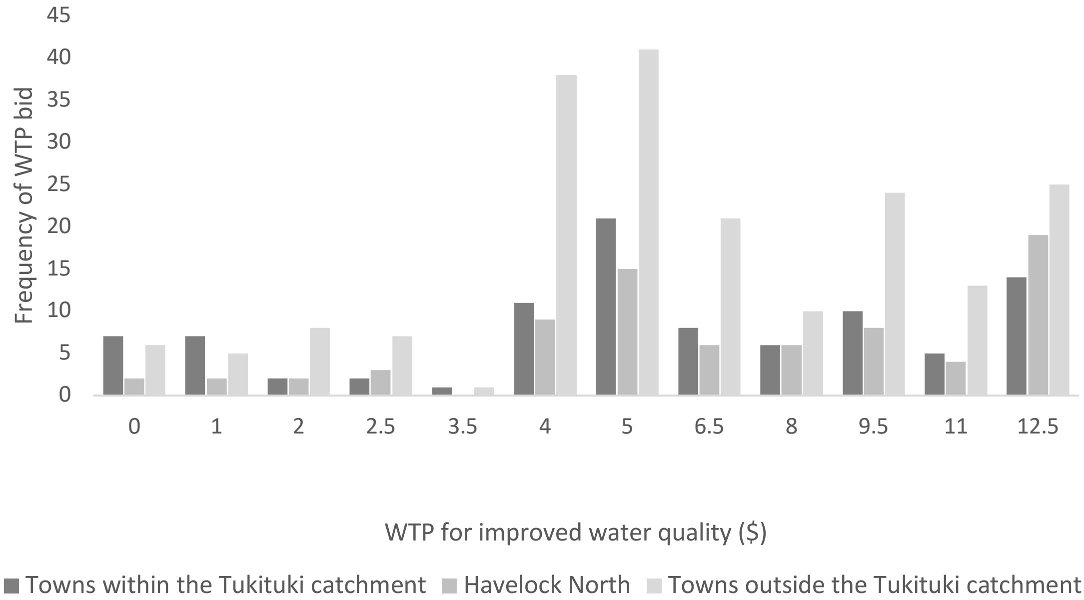


Figure 5.3 Frequency of *Willingness to Pay Bids by Respondent's Closest Town Aggregated to those Within or Outside the Tukituki River Catchment, and Including the Township of Havelock North.*

The second criteria aggregated those towns that were considered *Rural* centres and those that were considered *Urban*. The results are summarised in Table 5.28. The mean WTP for *Rural* had a lower bound of $6.09 and an upper of $6.64. The mean WTP for *Urban* residents was a lower bound of $6.94 and an upper of $7.48. *Urban* residents were slightly younger with a median age of 53 years versus *Rural* at 55 years.

Urban also had a greater proportion in the 18-49 age group (40.6%) than *Rural* (31.4%). *Rural* had more females than *Urban* (55.9% vs 51%). *Urban* had more respondents in the lowest income bracket than *Rural* (24.3% vs 21.2%). *Urban* also had more in the second highest bracket (10.8% vs 7.6%).

Table 5.28 *Comparison of Sample Profiles and WTP, Defined by Respondents Closest Town, Aggregated into Those Considered Either Rural or Urban Townships*

	Total sample n=369		Rural townships n=118		Urban townships n=251	
	n	%	n	%	n	%
Age						
18-49	139	37.7	37	31.4	102	40.6
50-64	152	41.2	55	46.6	97	38.6
65+	78	21.1	26	22	52	20.7
Gender						
Female	194	52.6	66	55.9	128	51
Male	176	47.4	52	44.1	123	49
Income						
0-$50,000	86	23.3	25	21.2	61	24.3
$50,001-$100,000	139	37.7	51	43.2	88	35.1
$100,001-$150,000	84	22.8	26	22	58	23.1
$150,001-$200,000	36	9.8	9	7.6	27	10.8
more than $200,000	24	6.5	7	5.9	17	6.8
Education						
High School	68	18.4	27	22.9	41	16.3
Certificate or Diploma	143	38.8	43	36.4	100	39.8
Bachelor's Degree	115	31.2	41	34.7	74	29.5
Post-Graduate Degree	43	11.7	7	5.9	36	14.3
Mean WTP[a]	$	SD	$	SD	$	SD
Lower bound	6.67	3.68	6.09	3.84	6.94	3.59
Upper bound	7.22	3.60	6.64	3.78	7.48	3.49
Median WTP[a]						
Lower bound	5.00	-	5.00	-	6.50	-
Upper bound	5.75	-	5.75	-	7.25	-

[a] WTP = Willingness to pay amount each month for the next ten years to achieve the proposed change in catchment state.

In contrast, *Rural* had greater numbers of respondents in the second income bracket than *Urban* (43.2% vs 35.1%). Median WTP for both was a lower bound of $5 and an upper bound of $5.57. The chart in *Figure 5.4* summarises the frequencies of WTP bids across *Rural* and *Urban* townships.

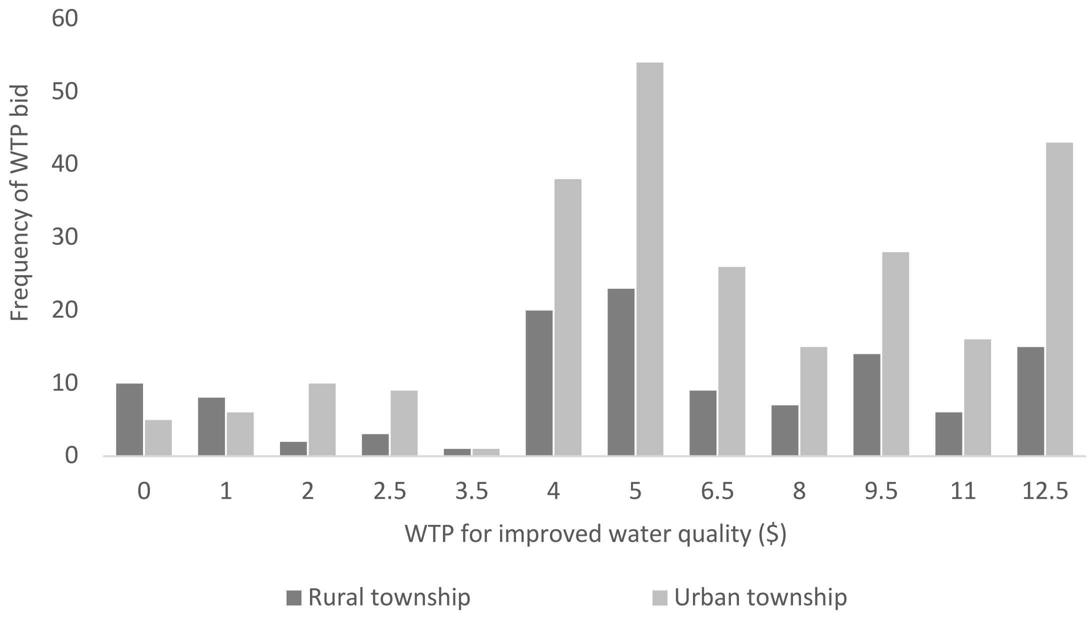


Figure 5.4 *Frequency of Willingness to Pay Bids by Respondent's Closest Town Aggregated into those Considered Either Rural or Urban Townships.*

5.3.3 Objective 3

Objective 3: To quantify the willingness to pay for improved water quality as a function of welfare based on public trust of freshwater advocates and policy-oriented organisations.

In order to account for heterogeneity in respondent preferences, trust scores were estimated for each individual using the hierarchical Bayes multinomial logit (HB-MNL) model. There were 20,000 preliminary iterations followed by 10,000 draws for each respondent with five prior degrees of freedom for the 369 respondents. Thirty thousand iterations were computed in total, and a root-likelihood fit statistic of 0.661 was achieved. The root-likelihood is the geometric mean of the probabilities of choosing the alternatives and is directly linked to the number of alternatives in each choice task. In a four-item choice set, the probabilities of utilities being equal (the null likelihood) is 0.25. The fit statistic of 0.661 is more than double the null likelihood and so represents a good model fit to the data at the individual level. Response rates by choice set position were evenly distributed, demonstrating no positional bias, and are summarised in Table 5.29.

Graphical Bayes output for the survey response data is shown in Appendix K - Hierarchical Bayes graphical outputs, *Figure K.2*.

Table 5.29 *Best-Worst Experiment Response Rates by Choice Set Position*

	Responses by Position Frequency %	
Position	'Best'	'Worst'
1	24.97	25.88
2	23.77	23.66
3	24.97	26.18
4	26.28	24.28
Total	100.00	100.00

Mean trust scores re-scaled into probability scores from zero to one hundred are shown in Table 5.30, along with their lower and upper ninety-fifth percentiles.

Table 5.30 *Mean Utility Scores for Respondent Trust in Organisations Involved in Catchment Management Estimated Using Hierarchical Bayes Multinomial Logit.*

	Rescaled Utility scores† (0-100)		
Organisation	Mean	95% Lower	95% Upper
NIWA	19.4	18.6	20.1
Department of Conservation	12.6	11.7	13.6
The Royal Forest & Bird Protection Society of New Zealand	11.2	10.3	12.2
Environmental Defence Society	10.8	9.9	11.7
New Zealand Fish & Game Council	9.6	8.7	10.4
Landcare Trust	9.1	8.4	9.8
Hawke's Bay Regional Council	7.9	6.9	8.8
Federated Farmers	7.1	6.1	8.1
Ngati Kahungunu Iwi Inc	6.4	5.6	7.2
Horticulture New Zealand	6.0	5.2	6.8
Total (with allowance for rounding error)	100		

† The rescaled utility scores are ratio scaled and can be read as percentages.

These scores are ratio scaled and can be interpreted as percentages where 10% is twice as 'trusted' as 5%. The most trusted organisation was the crown research institute *NIWA* (19.4%), with a large drop in utility to the next most trusted *Department of Conservation* (12.6%). This was followed by two non-government environmental organisations the *Royal Forest & Bird Protection Society of New Zealand* (11.2%) and the *Environmental*

Defence Society (10.8%). The *New Zealand Fish & Game Council* (9.6%) and *Landcare Trust* (9.1%) were next most trusted followed by the *Hawke's Bay Regional Council* (7.9%). The lowest three were *Federated Farmers* (7.1%), *Ngati Kahungunu Iwi Inc* (6.4%), and *Horticulture New Zealand* (6%). Respondent's raw utility and re-scaled probability scores were transferred from the hierarchical Bayes multinomial logit output into the greater SPSS data file as variables to allow exploratory analysis of variable relationships.

5.3.4 Exploratory analysis of variable relationships

Due to the novelty of relating trust utility scores to willingness to pay for improved water quality, an exploratory analysis of variable relationships was undertaken. This was conducted in three stages using SPSS v26. First, an analysis of bivariate correlations was performed to identify broad relationships between variables and assess the degree of collinearity. Second, regression estimation was conducted to identify the shape of regression equations for significant relationships. Thirdly, a singular partial least squares analysis was used to model the relationship between WTP and multivariate trust scores. The partial least squares analysis was repeated for WTP and the categorical variables. Bivariate correlation analysis was split into two variable subsets. The first was the relationship between WTP and Raw individual trust scores as summarised in Table 5.31, and the second between WTP and categorical variables as summarised in Table 5.32.

Table 5.31 *Bivariate Correlation Coefficients (Spearman's ρ) for Willingness to Pay for Improved Water Quality with Respondents Organisational Trust Scores.*

Variable	1	2	3	4	5	6	7	8	9	10
1. WTP										
2. FB	.209**									
3. FG	.079	.581**								
4. FF	-.375**	-.803**	-.472*							
5. HNZ	-.364**	-.727**	-.431**	.906**						
6. IWI	.180**	.164**	-.016	-.332**	-.340**					
7. EDS	.208**	.661**	.513**	-.627**	-.541**	.092				
8. DOC	.140**	.049	-.141**	-.306**	-.322**	-.162**	-.149**			
9. NIWA	.097	-.206**	-.332**	-.012	-.034	-.083	-.265**	.177**		
10. LCT	-.023	-.041	-.131*	.139**	.117*	.064	.282**	-.467**	-.163**	
11. HBRC	.036	-.366**	-.412**	.124*	.031	-.184**	-.507**	.284**	.103*	-.393**

Note. The numbers along the top row of the table represent the variable of the same number in the first column of the table.
The trust scores used for correlation were the Bayesian estimated individual zero-centred raw scores.
* The correlation was significant at the p<.05 level, ** p<.01
WTP = Willingness to pay amount each month for the next ten years to achieve the proposed change in catchment state, FB= Royal Forest & Bird, FG= Fish & Game, FF= Federated Farmers, HNZ= Horticulture NZ, IWI= Ngati Kahungunu Iwi Inc, EDS= Environmental Defence Society, DOC= Department of Conservation, NIWA= National Institute for Water and Atmospheric Research, LCT= Landcare Trust, HBRC= Hawke's Bay Regional Council.

Spearman's rank correlation coefficient and Spearman's ρ were used for both correlations. Non-parametric analysis was most appropriate for the categorical variables. The distribution of WTP was considered non-normal and the distribution of trust scores in *NIWA* was positively skewed. In order to translate the Likert variables into more intuitive correlation signs, they were all recoded to reverse the number ordering with, for example, 'Strongly agree = 1' changing to 'Strongly agree = 5'. This means a positive correlation sign relates increasing WTP to improving sentiment towards the Likert-type variables.

5.3.4.1 Bivariate correlations of WTP and trust variables

As shown in Table 5.31, several variables had a significant correlation with WTP at the $p<.05$ level. The results imply that the more you trust in the environmental oriented organisations; the Royal Forest & Bird Protection Society of New Zealand (*FB*, .209), the Environmental Defence Society (*EDS*, .208), Ngati Kahungunu Inc (*IWI*, .180), and the Department of Conservation (*DOC*, .140), the more likely it is that you are willing to pay more for improved water quality. In contrast, the more you trust the agricultural organisations; Federated Farmers (*FF*, -.375) and Horticulture NZ (*HNZ*, -.364), the less likely you are willing to pay more for improved water quality. Notably, there was widespread multicollinearity between the trust variables and this is explored further in section 5.3.4.3.

5.3.4.2 Bivariate correlations of WTP and categorical variables

Bivariate correlations of WTP and categorical variables are summarised in Table 5.32. Several variables had a significant correlation with WTP at a $p<.05$ level, although they were weak. Those with higher *Education* (.191) and *Income* (.202) were likely to pay more for improved water quality, as were those less affected by the Covid-19 Level-4 lockdown (*Covid-19*, .280). Those individuals that felt that being better informed about the state of the catchment would make them more trusting of the taxes charged by the authorities managing them (*Info_tax*, .266) were also likely to pay more.

Table 5.32 *Bivariate Correlation Coefficients (Spearman's ρ) for Willingness to Pay for Improved Water Quality with Demographic and Descriptive Variables.*

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13
1. WTP													
2. Age	-.043												
3. Gender	.051	.070											
4. Education	.191**	-.121*	-.068										
5. Income	.202**	-.290*	.077	.292**									
6. Covid19	.280**	.039	.099	.005	.107*								
7. Knowledge	-.009	-.005	.174**	.013	.104*	.085							
8. Info_quality	-.099	.037	-.030	.004	.100	.064	-.198**						
9. Info_wild	-.179**	.136**	-.012	-.020	.063	-.013	-.271**	-.567**					
10. Info_tax	.266**	.042	.007	-.015	-.088	-.026	.235**	.143**	.240**				
11. Management	-.224**	-.024	-.076	-.019	.025	-.061	-.083	-.439**	-.438**	.118*			
12. Voices	-.017	-.105*	.012	.009	.108*	-.050	-.095	-.376**	-.325**	-.030	-.567**		
13. Town_Catchment	.017	.098	.023	-.019	.049	.141**	-.224**	-.061	-.076	.176**	.085	.130*	
14. Town_RuralUrban	-.106*	.070	-.046	-.081	-.022	.056	-.254**	-.079	-.107*	.172**	.106*	.183**	-.657**

*The correlation was significant at the p<.05 level, ** p<.01

Note. The numbers along the top row of the table represent the variable of the same number in the first column of the table.

WTP = Willingness to pay amount each month for the next ten years to achieve the proposed change in catchment state, Covid19= Did the Level-4 lockdown period reduced the amount you chose to pay?, Knowledge= How would you rate your understanding and knowledge of how the authorities manage catchment and waterways?, Info_quality= Information about water quality in rivers, streams and wetlands is well communicated to the public, Info_wild= Information about the populations of native wildlife in Hawke's Bay catchments is well communicated to the public, Info_tax= If I was more informed about the state of catchments, I would be more trusting of the taxes charged by the authorities managing them, Management= All things considered, the Tukituki River catchment is being well managed, Voices= The voices of the people are being heard by the managers of the Tukituki catchment, Town_Catchment= Respondents closest town (1= Within the catchment, 2= Havelock North, 3= Outside the catchment), Town_RuralUrban= respondents closest town (1= Rural centre, 2= Urban centre).

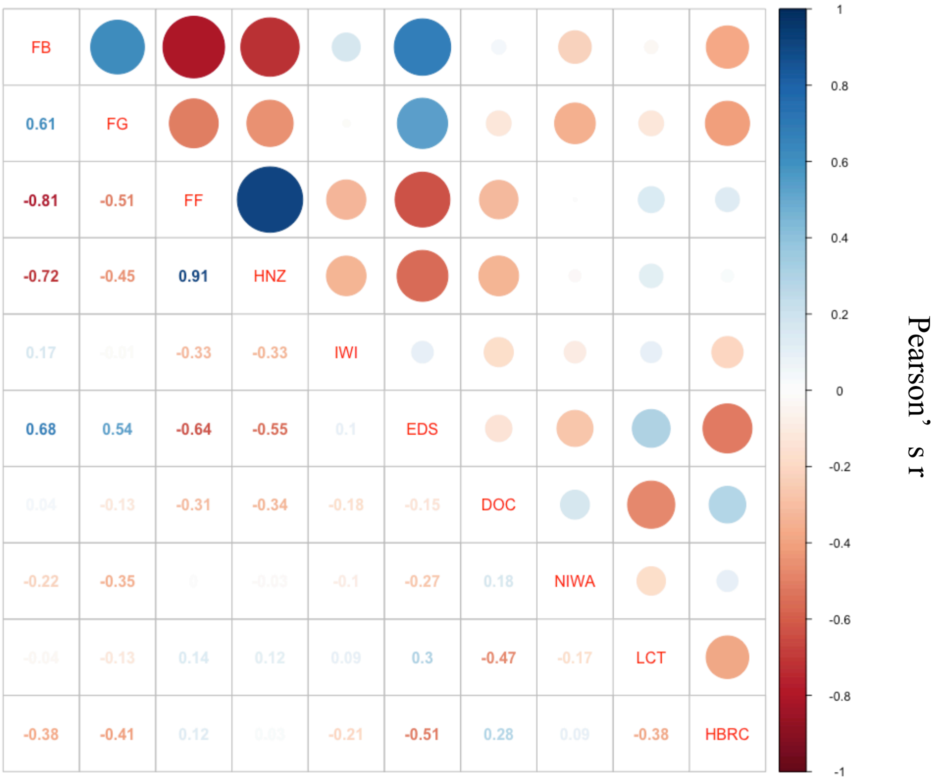
The negative correlations that were significant at the $p<.05$ level were weak or very weak. The most notable was that those agreeing the catchment is well managed (*Management, -.224*) were likely to pay less towards improved water quality.

As shown in Table 5.32, there was significant collinearity at the $p<.05$ level across a number of categorical variables, although they were mainly weak. *Knowledge* had the largest number of interactions. Self-belief in a good prior knowledge of catchment management practices was associated with being rural (*Town_*RuralUrban, -.254), living within the catchment (*Town_Catchment*, -.224), being male (*Gender*, .174), and having a higher income (*Income*, .104). If an individual believed they had a good prior *Knowledge* of catchment management practices, this was associated with less agreement that information about the state of the catchment (*Info_catch*, -.198), and wildlife (*Inf-wild*, -.271), was well communicated. Self-belief in good prior knowledge was also positively associated with agreement that more information would make them more trusting of the taxes authorities charged.

5.3.4.3 Correlation analysis of public trust as a lens to political economy

As shown in Table 5.31, there was a great number of correlations between the trust utility variables. Interpretation of the table suggested that at least some correlations reflected *a priori* expectations based on the freshwater political economy at a regional, if not national, level. In order to crystallise this nexus, a plot of significant correlations was rendered using the ‘corplot’ package in R, as shown in *Figure 5.5*. Apart from a small positive skew in NIWA, all trust variables appeared normally distributed; as such the Pearson coefficient was applied to this analysis. The direction of correlation is colour coded (blue = positive and red/ochre = negative), and the degree of opacity and colour saturation denotes the strength of correlation. The diagram depicts a factional ‘trust economy’. This trust economy is characterised in the first instance by a widespread predominating distrust of differing intensities.

The strongest negative relationship being that trust in *FF* relates strongly to distrust in *FB*. Within this there are two strongly positive trust-groups. The first is a binary group where respondents with trust in Federated Farmers (*FF*) are almost certain to share this with trust of Horticulture NZ (*HNZ*). This can be labelled the ‘Pro-agriculture’ group. The second is a triangular grouping where respondents with trust in Forest & Bird (*FB*) are likely to share this with trust of both Fish & Game (*FG*) and the Environmental Defence Society (*EDS*) and vice versa. This centre can be labelled the ‘Pro-environment’ group. Trust in any one of, the territorial authority (*HBRC*), crown research institute *NIWA,* and state service Department of Conservation (*DOC*) is correlated with trust in the other two. This can be labelled the 'Statutory-power'[14] group.



Note. The shade and size of the circle reflects the strength of correlation. The colour reflects the sign of the correlation, blue = positive and red/ochre = negative. FB = Forest & Bird, FG = Fish & Game, FF = Federated farmers, HNZ = Horticulture NZ, IWI = Ngati Kahungunu Iwi Inc, EDS = Environmental Defence Society, DOC = Department of Conservation, NIWA = National Institute for Water and Atmospheric Research, LCT = Landcare Trust, HBRC = Hawke's Bay Regional Council.

Figure 5.5 Correlation Plot Depicting Relationships Between Public Trust in Freshwater Advocates and Policy-oriented Organisations in Hawke's Bay.

Both the Pro-agriculture and the Statutory-power groups have negative trust relationships with the Pro-environment group. Trust in *IWI* appears somewhat isolated from any strong trust relationship with another organisation, as does *LCT*. Trust in *IWI* has a negative relationship with trust in the Statutory-power group and the Pro-agriculture group. In contrast, trust in *IWI* has a weak positive relationship with trust in *EDS*, *FB* and *LCT*. Trust in *LCT* has a weak negative relationship with trust in the Statutory-power group and

[14] *NIWA* is a Crown Research Institute without statutory power. However, it is a Crown entity backed by the government, bestowing credibility and scale, which empowers *NIWA* relative to other organisations.

a weak negative relationship with trust in two out of three Pro-environment organisations. *LCT* has a weak positive relationship with *EDS* and *IWI*, and also with *FF* and *HNZ*. From these associations a weak fourth triangular trust-group can be postulated involving *EDS*, *IWI* and *LCT*. This trust-group would be unique because it is the only group with a member with public trust from both Pro-agriculture (*FF, HNZ*), a Pro-environment group (*EDS*), and *IWI*.

5.3.4.4 Correlation analysis of public trust with demographics and categorical variables

In order to gain insight into the demographic profile, perceptions, and motivations underlying trust in organisations, a bivariate correlation analysis was undertaken. Using Spearman's ρ , a number of weak correlations were significant at the $p<.05$ level, and the results are summarised in Table 5.33.

The results showed that trust in *FG* and *FB* had a very close match in the variables, signs and strengths of their correlations. The similarity reflects the positive trust correlation between the two organisations. Fish & Game and *FB* both held negative correlations with *Knowledge*, *Voices*, *Info_wild*, *Info_quality*, and *Management*. Forest & Bird had an additional negative correlation with *Income*, and a positive correlation with *Town_RuralUrban*, implying that lower income respondents were more trusting of *FB,* as were those living in a town. The *EDS* shared a similar profile to *FG* and *FB*, but with a reduced number of variables.

Also reflecting their organisational trust correlation, FF and HNZ had almost identical correlation profiles. Both organisations had positive correlations with *Knowledge*, *Management*, *Info_quality*, and *Info_wild*. These imply that individuals with higher trust in *FF* and *HNZ* felt more knowledgeable about how the catchment was managed, felt that it was managed well, and that information about the catchment's state and wildlife was well communicated. Both *FF* and *HNZ* had negative correlations with *Education*, *Town_RuralUrban*, and *Info_tax*. This implies that individuals with higher trust in *FF* and *HNZ* had a lower level of education, were rural, and would not be more trusting of the taxes paid to authorities if they had more information about the catchment's state.

Table 5.33 *Bivariate Correlations (Spearman's ρ) of Organisational Trust Scores with Categorical Variables*

Variable	FB	FG	FF	HNZ	IWI	EDS	DOC	NIWA	LCT	HBRC
Income	-.107*	-.067	.066	.064	-.029	-.122*	-.012	.152**	-.028	.063
Age	-.005	-.023	.038	-.025	-.016	-.018	.043	-.001	.032	-.018
Education	.099	-.020	-.161**	-.189**	.050	.069	.077	.174**	-.053	.016
Gender	-.011	.037	-.001	-.020	-.003	-.050	-.020	.107*	-.020	.001
Town_Rural Urban	.143**	.072	-.162**	-.137**	-.015	.102*	.078	.022	-.103*	.010
Knowledge	-.228**	-.187**	.182**	.164**	.113*	-.178**	-.135**	.069	.057	.080
Voices	-.157**	-.226**	.046	.020	-.047	-.196**	.170**	.042	-.171**	.343**
Info_quality	-.239**	-.205**	.181**	.131*	-.121*	-.293**	.132*	.037	-.095	.282**
Info_wild	-.259**	-.203**	.258**	.218**	-.085	-.284**	.065	-.035	-.044	.169**
Info_tax	.206**	.168**	-.269**	-.253**	-.020	.197**	.153**	.033	-.101	-.008
Manage	-.342**	-.335**	.309**	.279**	-.117*	-.343**	.078	.039	-.134**	.321**

* The correlation was significant at the $p<.05$ level, ** $p<.01$

The trust scores used for correlation were the Bayesian estimated individual zero-centred raw scores. Income= Combined before tax household income, Age= Age in years, Gender= female/male, Town_RuralUrban= respondents closest town (1= Rural centre, 2= Urban centre), Knowledge= How would you rate your understanding and knowledge of how the authorities manage catchment and waterways?, Voices= The voices of the people are being heard by the managers of the Tukituki catchment, Info_quality= Information about water quality in rivers, streams and wetlands is well communicated to the public, Info_wild= Information about the populations of native wildlife in Hawke's Bay catchments is well communicated to the public, Info_tax= If I was more informed about the state of catchments, I would be more trusting of the taxes charged by the authorities managing them, Managed= All things considered, the Tukituki River catchment is being well managed, FB= Royal Forest & Bird, FG= Fish & Game, FF= Federated Farmers, HNZ= Horticulture NZ, IWI= Ngati Kahungunu Iwi Inc, EDS= Environmental Defence Society, DOC= Department of Conservation, NIWA= National Institute for Water and Atmospheric Research, LCT= Landcare Trust, HBRC= Hawke's Bay Regional Council.

Of the Statutory-power group, almost all correlation signs were positive. However, only DOC and the HBRC had any variables in common. Those with higher levels of trust for *DOC* and *HBRC* felt that information about catchment state and wildlife was well communicated. Those trusting HBRC also felt that the catchment was well managed and that the voices of the public were being heard, implying that they felt all outward-facing functions of the HBRC were going well. Correlations for *NIWA* imply greater trust by males with higher education and incomes.

There were only three correlations each for *IWI* and *LCT*. Those with higher trust in *IWI* felt more positive about their knowledge of how the catchment was managed but felt more negatively about how it was being managed. They were also less likely to feel that more information would make them more trusting of the taxes charged by the authorities. Those with higher trust in *LCT* were likely rural, felt that the catchment was not well managed, and felt that the publics voice was not being heard with regard to managing the catchment.

These results reinforce the view of a factionalised trust economy with largely overlapping categorical correlation profiles between organisations within each group. The *LCT*, *IWI*, and *NIWA* were satellite organisations based on their correlations with the categorical variables.

5.3.4.5 Regression estimation for WTP and trust utility scores

Regression estimation was conducted in order to determine the shape and significance of the relationship between WTP, trust scores, and categorical variables. The first variable set estimated was for WTP with raw trust utility scores and is summarised in Table 5.34.

Of the trust variables, *FB*, *FG*, *FF*, *HNZ*, *IWI*, *EDS*, and *DOC* all had regression equations modelling significant relationships at the $p < .05$ level. Using the F-statistic criterion, a linear equation was preferred for all but *DOC*, which had a quadratic relationship. For the significant variables, the relationship between trust and WTP was positive for all but *FF* and *HNZ*. The R^2 values report that all significant models explained a low proportion of the variance, with scores ranging from 13.9% for *FF* down to 3.3% for *IWI*. Graphical output for Table 5.34 can be found in Appendix M - Regression estimation graphs for Objective 3, *Figure M.1*.

Table 5.34 *Regression Estimations for Organisational Trust Scores with Willingness to Pay for Improved Water Quality in the Tukituki River Catchment.*

	Model Summary						Parameter Estimates			
Organisation	Equation	R^2	F-stat	df1	df2	p-value	Const†	b1	b2	b3
Forest & Bird (FB)	Linear	.046	17.525	1	367	p<.001***	-.878	.219		
	Quadratic	.047	8.950	2	366	p<.001***	-1.209	.349	-.009	
	Cubic	.049	6.256	3	365	p<.001***	-1.612	.735	-.087	.004
Fish & Game (FG)	Linear	.010	3.654	1	367	.057	-.532	.085		
	Quadratic	.014	2.538	2	366	.080	-1.062	.294	-.015	
	Cubic	.014	1.688	3	365	.169	-1.081	.312	-.019	.000
Federated Farmers (FF)	Linear	.139	59.489	1	367	p<.001***	1.263	-.519		
	Quadratic	.154	33.312	2	366	p<.001***	2.934	-1.176	.047	
	Cubic	.158	22.795	3	365	p<.001***	3.641	-1.853	.183	-.007
Horticulture NZ (HNZ)	Linear	.128	54.101	1	367	p<.001***	.379	-.297		
	Quadratic	.142	30.192	2	366	p<.001***	1.327	-.669	.026	
	Cubic	.143	20.243	3	365	p<.001***	1.546	-.879	.069	-.002
Ngati Kahungunu Iwi Inc (IWI)	Linear	.033	12.436	1	367	p<.001***	-2.285	.159		
	Quadratic	.036	6.843	2	366	p<.001***	-1.784	-.038	.014	
	Cubic	.036	4.579	3	365	.004**	-1.675	-.143	.035	-.001
Environmental Defence Society (EDS)	Linear	.047	18.214	1	367	p<.001***	-.574	.173		
	Quadratic	.047	9.087	2	366	p<.001***	-.612	.188	-.001	
	Cubic	.068	8.830	3	365	p<.001***	-1.549	1.087	-.181	.009
Department of Conservation (DOC)	Linear	.015	5.467	1	367	.020*	.411	.104		
	Quadratic	.039	7.372	2	366	.001**	-.920	.627	-.037	
	Cubic	.039	4.939	3	365	.002**	-1.039	.741	-.060	.001
NIWA	Linear	.006	2.339	1	367	.127	3.176	.055		
	Quadratic	.006	1.176	2	366	.310	3.225	.035	.001	
	Cubic	.006	.786	3	365	.503	3.258	.004	.008	.000
Landcare Trust (LCT)	Linear	.000	.016	1	367	.900	.340	-.003		
	Quadratic	.004	.783	2	366	.458	.625	-.115	.008	
	Cubic	.004	.539	3	365	.656	.581	-.073	-.001	.000
Hawke's Bay Regional Council (HBRC)	Linear	.001	.216	1	367	.642	-1.300	.024		
	Quadratic	.016	2.913	2	366	.056	-2.525	.505	-.034	
	Cubic	.019	2.322	3	365	.075	-2.069	.068	.054	-.005

* Significant at p<.05, ** p<.01, *** p<.001
Const† = Constant
Note. Table shows regression estimation output statistics for each variable using individual Bayesian trust utility scores regressed willingness to pay for improved water quality. The regression with the best fit statistic (F-stat) for each organisation is highlighted.

Regression estimation was undertaken for all categorical variables with a correlation coefficient for WTP that was significant at the p<.05 level. These were *Income*, *Education*, *Covid-19*, *Info_wild*, *Info_tax*, *Manage*, and *Town_RuralUrban*. All variables had significant regression equations at the p<.05 level and for all the preferred relationship was linear. The model summary and parameter estimates are shown in Table 5.35.

Table 5.35 *Regression Estimations for Categorical Variables with Willingness to Pay for Improved Water Quality in the Tukituki River Catchment*

	Model Summary						Parameter Estimates			
Organisation	Equation	R^2	F-stat	df1	df2	p-value	Const†	b1	b2	b3
Income	Linear	.041	15.660	1	367	p<.001***	1.969	.062		
	Quadratic	.041	7.865	2	366	p<.001***	2.021	.042	.001	
	Cubic	.042	5.274	3	365	p<.001***	1.974	.087	-.008	.000
Education	Linear	.035	13.498	1	367	p<.001***	2.049	.047		
	Quadratic	.036	6.803	2	366	.001**	2.096	.028	.001	
	Cubic	.039	4.937	3	365	.002**	1.982	.138	-.021	.001
Covid19	Linear	.071	28.183	1	367	p<.001***	1.555	.031		
	Quadratic	.083	16.532	2	366	p<.001***	1.679	-.018	.003	
	Cubic	.088	11.794	3	365	p<.001***	1.750	-.086	.017	-.001
Info_wild	Linear	.029	11.110	1	367	.001**	3.550	.038		
	Quadratic	.034	6.518	2	366	.002**	3.393	.100	-.004	
	Cubic	.037	4.611	3	365	.004**	3.478	.019	.012	-.001
Info_tax	Linear	.060	23.511	1	367	p<.001***	2.643	-.065		
	Quadratic	.076	15.059	2	366	p<.001***	2.974	-.195	.009	
	Cubic	.084	11.151	3	365	p<.001***	3.168	-.380	.046	-.002
Manage	Linear	.044	16.929	1	367	p<.001***	3.375	.053		
	Quadratic	.044	8.463	2	366	p<.001***	3.401	.043	.001	
	Cubic	.054	6.905	3	365	p<.001***	3.603	-.151	.039	-.002
Town_Rural Urban	Linear	.012	4.300	1	367	.039*	1.589	.014		
	Quadratic	.020	3.816	2	366	.023*	1.470	.060	-.003	
	Cubic	.030	3.748	3	365	.011*	1.369	.158	-.023	.001

* Significant at p<.05, ** p<.01, *** p<.001
Const† = Constant
Note. Table shows regression estimation output statistics for each variable using categorical variable scores regressed willingness to pay for improved water quality. The regression with best fit statistic (F-stat) for each organisation is highlighted.

5.3.4.6 Exploratory Regression modelling for WTP and trust utility

For this analysis, both willingness to pay (WTP) and trust are conceptualised as being measures of individual utility as described by McFadden (1974b). The first, WTP, being a measure of the utility associated with a physical realm, and the second being, trust, associated with the socio-political realm. WTP is taken to be a holistic measure of aggregated utility through the contingent valuation technique applied in the survey. Trust will be considered as a choice, as described in section 2.5, and demonstrated by Hamm (2017). The null and alternate hypotheses are:

H_0: The level of trust in organisations involved in freshwater management is not predictive of an individual's willingness to pay for improvements in water quality.

H_1: The level of trust in organisations involved in freshwater management is predictive of an individual's willingness to pay for improvements in water quality.

A partial least squares-1 (PLS1) main effects regression model was chosen and undertaken in SPSS v26, with the principal interest being to determine if the pursuit of a predictive model was warranted. PLS1 was selected for two main reasons; i) it is robust to the already proven collinearity between the variables (see section 5.3.4.1), and ii) it is focused primarily on the amount of variance explained rather than model fit.

The model was specified with WTP as the dependent variable and the independent variables as the trust scores of the five organisations; *FF*, *FB*, *HNZ*, *IWI*, and *EDS*, with significant linear regression equations (see section 5.3.4.5). The initial model was run using all five of the independent variables. This first model explained 64.8% of the variance in the independent variables and 12.5% of the variance in WTP, with an adjusted R^2 of 0.123, for the first latent factor. A second latent factor increased the variance explained by a further 14.8 percentage points for the independent variables, and the variance in WTP by just 2.4 points, with an R^2 of 0.145. Given the model's low apparent explanatory power, the first model was treated as base results. An iterative elimination process was then undertaken in pursuit of the most parsimonious model with the highest explanatory power. Full result tables from the base model can be found in Appendix N - Exploratory partial least squares base model results. The model for the regression is shown in Equation 12.

$$\text{WTP} = f\,(\text{FB, FF, HNZ, IWI, EDS}) \tag{12}$$

The iterative process followed a rule of progressive elimination of the variable with the lowest score for 'variable importance in the projection' until the point at which no appreciable increase in the proportion of variance explained in WTP was achieved. Following the elimination rule, variables were removed from the model in the following sequence, *IWI*, *FB*, and *EDS*, with results summarised Table 5.36. The final model was *FF* and *HNZ*, which explained 95.4% of the variance in *X* with one latent factor, however, only 13.8% of the variance in *Y(WTP)*. The addition of a second latent factor only increased explanation of WTP to 14.2%. There was a constant of 6.025, with *FF* and *HNZ* having parameters of -.197 and -.133 respectively. Factor-1 weights were -.721 for *FF*, -.692 for *HNZ*, and .271 for *WTP*. Factor-1 loadings were -.708 for *FF* and -.707 for *HNZ*. In summary, the most parsimonious model contained only variables *FF* (Federated Farmers) and *HNZ* (Horticulture NZ), which both had a negative relationship with WTP. However, respondent's trust in these organisations only accounted for 13.8% of the variance in their willingness to pay for improved water quality. As such, we reject H_1 and accept H_0: The level of trust in organisations involved in freshwater management is not predictive of an individual's willingness to pay for improvements in water quality. Further exploratory regressions were conducted in the same iterative manner incorporating the categorical variables with the trust variable. This led to a marked reduction in the explanatory power for the independent variables, and as it was not part of Objective 3, it has not been reported.

Table 5.36 *Proportion of Variance Explained by the Partial Least Squares Regression Model During the X-Variable Elimination Sequenced from the Lowest Variable Importance Score.*

X variables in equation	Latent Factor	Proportion of Variance Explained			
		X Variance	Cumulative *X* Variance	*Y* Variance	Cumulative *Y* Variance R^2
FB, FF, HNZ, IWI, EDS	1	.648	.684	.125	.123
	2	.148	.796	.024	.145
FB, FF, HNZ, EDS	1	.787	.787	.119	.116
	2	.107	.894	.155	.150
FF, HNZ, EDS	1	.801	.801	.133	.131
	2	.17	.971	.008	.136
FF, HNZ	1	.954	.954	.141	.138
	2	.046	1.000	.001	.137

Note. Table shows the iterative output of variance explained by a partial least squares regression of organisations individual Bayes estimated trust utility scores with willingness to pay for improved water quality. Each iteration shows the variance explained by the first two latent factors. The variable with the lowest importance score is removed from the subsequent iteration.

5.4 Chapter summary

In summary, the results of the first survey, designed to capture and quantify perceptions of the Tukituki River catchment, showed an overwhelming perception among respondents that the catchment is currently in a poor state. Respondents perceived that low summer flows, weed growth, unsafe swimming, and low biodiversity were all a problem. The majority of respondents also held a future vision of the common good in which the catchment has demonstrable improvements in all the areas perceived as currently problematic. Almost all respondents had visited the catchment in the past 24 months, and they had engaged in a wide range of recreational activities (see Table 5.2). A particular focus was placed on comparing *Fishers* and gamebird *Hunters* with the wider public. The results of this study have shown that there is little or no difference between the current and future perceptions of *Fishers* and *Non-fishers*. *Hunters*, however, hold perceptions that are significantly different from *Non-hunters*. *Hunters* tend to have perceptions that the catchment is in better health and are also more in support of water abstraction to support irrigation.

Latent Class Cluster analysis of the first survey results showed that, although perceptions of the catchment's current state appear to be similarly held by the majority of respondents, there was in fact, a moderate degree of heterogeneity. In total, five different classes of individual with differing perceptions and profiles emerged from the data. The profile characteristics of these classes led to the labelling of them as; i) the *Recreationist*s, ii) the *Pessimists*, iii) the *Non-committe*rs, iv) the *Pro-irrigators*, and v) the *Biodiversity Positive*. This heterogeneity then diminished with only two classes holding differing visions for Tukituki River catchment's future. These were the *Pro-quality* class representing 85% of individuals whilst the remaining 15% were *Pro-irrigators*. The pro-quality appeared be characteristically urban and the pro-irrigators appeared to be characteristically rural. Once again due to the funding support for this research being a *Fisher* or a *Hunter* was tested for its effects on class membership. Being a *Fishe*r had no significant influence on either current or future state perception class membership at the $p<.05$ level. Being a *Hunter* had a significant influence on class membership for both current and future state perceptions at the $p<.05$ level.

The first element of the second survey was designed to capture and quantify the marginal value of improved water quality in the catchment using a contingent valuation exercise. Specifically, the level of improvement was aligned with that anticipated by the successful delivery of freshwater policy contained in Regional Plan Change 6 by its target date of 2030. The mean household WTP for this improvement was \$6.67 per month (\$80 per year). This figure was very stable when sensitivity tested for the effects of outliers and varied by only 0.4%. There was some geographic variation of WTP with those living nearest an urban township willing to pay more than those living closest to rural townships. In particular the affluent township of Havelock North was willing to pay a 30% premium.

The second element of the second survey was designed to capture and quantify public trust in organisations active in the freshwater policy space. This was achieved using a best-worst choice experiment which captured individual respondent utility associated with their ranking of trust in organisations (see Table 5.30). The most trusted organisations were the science-oriented crown research institute *NIWA* and the public service Department of Conservation (*DOC*). The least trusted were Ngati Kahungunu Iwi (*IWI*) Inc and Horticulture New Zealand (*HNZ*). The environmental organisations Forest and Bird (*FB*), Fish & Game (*FG*), and the Environmental Defence Society (*EDS*) were all trusted more than the Hawke's Bay Regional Council (*HBRC*) and Federated Farmers (*FF*). Levels of trust in the Landcare Trust (*LCT*) fell between the environmental organisations and the agricultural organisations. Individual Bayesian trust utility scores were used in correlation analyses with WTP for improved water quality and between organisations. Trust in environmental organisations was positively correlated with WTP and trust in agricultural organisations were negatively correlated. A bivariate correlation analysis of public trust in organisations revealed positive relationships between trust on one environmental organisation and trust in the others. It also revealed a positive relationship between trust in one agricultural organisation and the other. In contrast trust in environmental organisations was negatively related to trust in agricultural organisations. Trust in *NIWA*, *DOC* and *HBRC* was positively correlated, and these organisations had varied relationships with agriculture and environment. The *LCT* had a unique position in that it held positive correlations with both some environmental organisations and some agricultural organisations and with *IWI*. *IWI* was found to be somewhat isolated in terms of public trust with those trusting *IWI* having a negative trust relationship with most other organisations, although positive correlations with *LCT*, *FB* and *EDS* were found.

The relationship between WTP and trust in organisations was investigated using regression estimation and exploratory regression modelling using partial least squares. Regression modelling explained a very low portion of the variance in WTP, and this was not improved with an iterative variable elimination process in an attempt to improve the model's explanatory power. No useful predictive model of the relationship between WTP and trust in organisations was found. The next chapter discusses the results from chapter five in the sequence with which they relate to the three study objectives.

6 Discussion

6.1 Introduction

The aim of this study was to factor community welfare estimates into freshwater allocation decision making in New Zealand. This was undertaken through the application of two surveys, the first in the Tukituki catchment and the second in the wider Hawke's Bay region. This chapter discusses the survey results. The results of the first survey relate to Objective 1: 'To define the common good of freshwater and determine perception heterogeneity in the study area (a particular focus is placed on comparing fishers and gamebird hunters with the wider public)' and are discussed in section 6.2. The results of the second survey as they relate to Objective 2: 'To estimate the marginal welfare benefits generated by improved water quality in the study area', are discussed in section 6.3. The results of the second survey as they relate to Objective 3: 'To quantify the willingness to pay for improved water quality as a function of welfare based on public trust of freshwater advocates and policy-oriented organisations', are discussed in section 6.4. In this chapter, I advance the idea of a 'social trust economy' in the natural resource context where stocks of trust reflect social capital and flow around organisations. The social trust economy became apparent through the correlation analysis, which provided insight into the flows of trust around organisations.

6.2 Objective 1: Defining the common good of freshwater and comparing perceptions of anglers and the wider public

The results in *Figure 5.1*, p. 103 have shown an overwhelming perception that low flows, unsafe summer swimming, and nuisance weed growth in the Tukituki River catchment pose a problem to those seeking to enjoy its benefits. Perceptions of the catchment determined by this study were considerably more negative than perceptions of waterways at a national level as determined by Hughey et al. (2019, p. 10); where a more moderate 42% of the New Zealand public had negative perceptions of the state of the nation's rivers and lakes compared with 78% in this study. The poor perception of the study catchment's management (*Fishers* 80% negative and *Non-fishers* 67%) also had a strong negative skew. Again sentiment was far more negative when compared with the findings of Hughey et al. (2019), where approximately 40% of respondents had poor perceptions of river and lake management. This skewness may be explained by the very high rate of catchment engagement through recreational amenity use (93.5%), due to the targeting initially of trout fishing licence holders and then a self-selection bias among the general public responses. However, the high visitation rate has likely provided respondents with a deeper insight into the state of the catchment. Alternatively, it could be that the catchment state is possibly worse than others with similar amenity values. The negative skewness could potentially be due to limitations introduced by a self-selection bias, which has led to a sample that is representative of active catchment users and not the general public in a broader sense. A more focussed discussion on self-selection bias can be found in section 6.5.1.

A repeat survey may find that negativity can be moderated by including greater numbers of disengaged and less informed individuals. This could be achieved by offering survey incentives with wide appeal such as supermarket vouchers or, with appropriate funding for door-to-door surveys. Ultimately, however, without compulsion, all surveys are self-selecting, and efforts can only be made to give the widest opportunity for the community to participate. Negative ratings reflect on the regulator, and it is important to consider these in context. In both this study and Hughey et al (2019), it is unclear what proportion of negative ratings came from those believing the freshwater resources are underutilised or those believing it is overburdened. Negative perceptions of catchment management, therefore, are a two-edged sword with the potential to cut from both directions against the regulator. Nevertheless, given the heavily negative perceptions of catchment health (*Fishers* 80.5% and *Non-fishers* 74.2%) it must be concluded that poor management perceptions equate with dissatisfaction over poor water quality. Environmental perceptions and attitudes are shaped by many influences, including various channels and styles of communication. Freshwater is a consistent and contentious media topic in Hawke's Bay, and attitudes are reinforced by persistent and effective national media narratives regarding declining water quality. Firm opinions can also be formed based on influences deep within the cognitive hierarchy, such as upbringing, trusted relationships, and world view, that do not rely on first-hand knowledge (Salancik & Pfeffer, 1978). At a national level, Hughey et al. (2019) determined that 80% of the population feel they have adequate or good environmental knowledge, and yet they consistently rate the state of our environment as being better than the wealth of scientific evidence supports. Whether this view is based on education, experience, exposure to media narrative, or other factors is unclear, but given the nation's propensity for a falsely positive view, the high levels of negative ratings in the case study are all the more compelling.

6.2.1 Safe swimming

Perceptions identified in this survey relating to the current ability to swim safely were overwhelmingly negative, and support for a future catchment with safe swimming was overwhelmingly positive. On reflection, the wording of this variable in the survey may have become vague when editing to reduce question length, which may have impacted the result. Given that there is a lack of specificity regarding what exactly is unsafe, it is presumed that the respondent has in mind safety as being health-related and not related to unsafe flows. It is also presumed that respondents have in mind at the time of survey completion that the swimming will occur during the 'normal' season for doing so. If respondents did not follow these assumptions, it might have led to an overstatement of negative sentiment regarding safe swimming. There are three monitored swimming sites reported through Land Air Water Aotearoa[15] (LAWA), and although no data on the exact number of days under warning notices were available from the regional council, the issuing of notices due to Phormidium (toxic algae) is frequent in the summer months (Hawke's Bay Regional Council, 2020). Notices are also issued on LAWA for overall bacterial risk during the winter months. Again, aetiologically, respondent sentiment may be based on first-hand experience of illness or disrupted recreational plans or based on the prevailing narratives.

In order to constrain cognitive load and respondent time investment, this survey did not pursue factors underlying respondent perceptions. There has also been ongoing media coverage of failing wastewater infrastructure in the catchment towns of Waipawa, Waipukurau, and Otane, and subsequent breaches of discharge consents relating to coliform bacterium (Radio New Zealand, 2016; Sharpe & Anselm, 2020). Media reporting of Phormidium in the catchment is also a perennial occurrence. Nonetheless, the results reflect the positive values for improved safe healthy swimming found by Marsh and Mkwara (2010); Tait, Baskaran, Cullen, and Bicknell (2011); Marsh (2012), and Miller (2014). Marsh and Mkwara (2010) used safe swimming as an attribute when

[15] The Land, Air, Water Aotearoa (LAWA) is an institution with the goal of informing communities about the state of natural resources so they may strike a balance between their productive use and maintaining their quality and abundance. It is based on a collaboration between New Zealand's 16 regional councils, the Cawthron Institute (New Zealand's largest independent science organisation), and the Ministry for the Environment. It has additional support from Massey University and the Tindall Foundation (a philathropic organisation).

valuing water quality in the local streams in the Karapiro[16] catchment. In their pre-assessment of community perceptions, they found that 29% of respondents had no idea about how safe local streams were for swimming. Of those remaining, 49% of those in the urban township of Tokoroa agreed with the status quo assessed by the researchers, this being that the local streams were only safe 30% of the time. In contrast, only 24% of rural respondents agreed with the researcher's assessment. They subsequently found that increasing the percentage of water contaminant readings that were suitable for swimming had a positive effect on values associated with local streams in the Karapiro catchment. They found that preferences were for water that was suitable for swimming 90% of the time.

Tait et al. (2011) valued the effects of agriculture on water quality in Canterbury[17] and used the risk of illness from contact recreation as a water quality attribute. They used a proportional representation, with the baseline being 60/1000 people becoming ill from microorganisms in the water. They found that households were willing to pay a mean of $27 a year to reduce this risk to 10/1000 people. Marsh (2012) used the chance of health warnings due to algal blooms in summer as levels for a swimming suitability attribute in Lakes' Karapiro and Arapuni, with a baseline of a 50% chance of health warnings for 1-2 weeks. He found that respondent's utilities significantly increased as the chances of health warnings dropped to 10% and 1%. Miller (2014) valued improvements to water quality in the rivers of Canterbury. In her choice study, she used a recreation attribute based on the percentage of river sites suitable for swimming and contact recreation. This was modelled on a 90 day summer period and relative *E. coli* levels. She found that increasing the percentage of safe swimming sites had a significant positive effect on individual utility. At a subgroup level, environment-oriented respondents valued even a low level of improvements, and agriculturally oriented respondents expressed apparent disutility from improved swimming. However, it is unclear if the agricultural response was actual disutility or an unwillingness to pay.

[16] The Karapiro catchment is situated in the Waikato province which lies in the upper central North Island of New Zealand. Land use in the Karapiro catchment is predominantly pastoral dairy farming.

[17] Canterbury is New Zealand's largest province. It is situated along the central section of the east coast of the South Island, extending inland to the Southern Apls. It has the largest area of land under irrigation in the country and has experienced rapid growth in pastoral dairy farming in the past twenty years.

6.2.2 Flows

This survey found that increased summer flows were widely perceived to be in the common good, even though this outcome does not necessarily improve water quality. Cocklin et al. (1994); Weber et al. (1991), and Kerr et al. (2003) all found that increased minimum flows were perceived as desirable for water quality improvements. Cocklin et al. (1994) assessed the recreational value of increasing in-stream flows in the upper Whanganui and Whakapapa Rivers[18] from a theoretical reduction in the offtake for hydroelectric generation. Using the travel cost method, they estimated substantial increases in recreational user numbers over the following twenty-five years and a substantial concurrent increase in recreational value. Weber et al. (1991) compared the benefits of water allocation in the Ashburton/Hakatere River[19] between irrigation and recreational angling. They found that increasing flows would deliver \$9-\$9.6 million of value to angling annually. Kerr et al. (2003) used contingent valuation to contrast options for augmenting the water supply for the city of Christchurch[20]. One option was to divert water from local rivers and streams to recharge the stressed aquifer. Respondents returned a mean willingness to pay of \$359-\$449 per year to avoid reduced flows in the local waterways.

Consistent with the positive sentiment towards increased future flows in this research was the negative sentiment regarding future support of irrigation at current levels. The two states are mutually exclusive without substantial augmentation of summer flows. Augmentation of low summer flows in conjunction with episodic 'flushing-flows', and a postulated reduction in surface-water abstraction were positive attributes promoted by

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[18] The Whanganui and Whakapapa Rivers are part of the Whanganui catchment in the Whanganui province on the central west coast of the North Island. Water from several tributaries in this catchment is diverted and piped to a hydroelectric power station before being discharged into Lake Taupo, a separate catchment, in the central North Island. The Whanganui River is of special interest having being recognised as a living entity and granted the legal status of a person in 2017. New Zealand Parliament. (2017). *Innovative bill protects Whanganui River with legal personhood* [Web page]. New Zealand Parliament. Retrieved August 5th 2020 from https://www.parliament.nz/en/get-involved/features/innovative-bill-protects-whanganui-river-with-legal-personhood/.

[19] The Ashburton/Hakatere River is in the province of Canterbury on the east coast of the South Island and runs beside the township of Ashburton. It is fed from the Southern Alps used to be a significant salmon fishery.

[20] Christchurch is the largest city in the South Island and New Zealand's second largest city. It is situated in the province of Canterbury and half way down the east coast of the South Island.

supporters of the proposed water storage scheme that failed in a 2017 Supreme Court ruling (see section 3.2). Supporters of the scheme promoted the idea that pressure on flows would be relieved by supplying an alternate source of water through the dam. It was also posited that some stored water could be used to maintain ecological flows, albeit likely to be carrying the hugely increased nitrogen load for which consent was being sought. The survey revealed that there were increased levels of uncertainty around the idea of continuing to support irrigation at current levels compared to the other future state variables (see *Figure 5.2*, p. 104). Whilst we know uncertainty in this study stems mainly from a lack of information (see Appendix G), there may also be an underlying conflict for respondents who might be uncomfortable inflicting restrictions on such a direct agricultural input since they know how important agriculture is to the local economy. Hawke's Bay is still substantially an agrarian economy, and as shown by Marsh (2012), the idea of inflicting agricultural job losses on reliant communities attenuates preferences for improved water quality. However, the proportion of uncertain respondents diminishes, and negative sentiment strengthens against a future where agricultural irrigation is increased. This suggests that the prospect of increased activity in the agricultural sector is not enough to offset negative sentiment towards low flows. This may be explained by the apparent concentration of benefits from increased water use to landowners whilst the community carries the amenity and ecological costs of low flows.

6.2.3 Biodiversity

The high levels of uncertainty in responses regarding the status of native fish and wetland birds (see *Figure 5.1*, p. 103) in the catchment shows a clear deviation from the high level of certainty displayed in the responses to the other variables. It demonstrates that the questions rating the catchment's current state were carefully considered by respondents. It is possible that the slightly older and more educated sample were as cognisant of their knowledge limits as they were attentive to the questions. Marsh and Mkwara (2010) conducted a pre-assessment of community perceptions of local water quality. They used the presence of eels, bullies, and smelt as they related to the percentage of excellent water quality readings to be representative of ecological health. In their study in the Karapiro catchment, Marsh and Mkwara (2010) assessed the status quo as being <40% of streams having an excellent water quality reading, which equated to the presence of only small eels. They found that only 32% of respondents correctly assessed current stream conditions and that 28% of respondents incorrectly assessed ecological health as being high and believed that 70% or more of streams would have excellent water quality readings. Forty-one percent of respondents gravitated to the middle option of medium ecological health, with 40-70% readings being excellent. This movement towards the middle ground was fairly similar across the urban sample from the township of Tokoroa (41%), and the rural sample (43%). Given that the majority of responses were for the middle option, which was an overly optimistic view of ecological health, the results, in fact, reflect a similar uncertainty to that found in this study. Notably, only 33% of those from Marsh and Mkwara's (2010) rural sample assessed current stream ecology as being high (with 70% or more excellent readings). This was more than double the 14% of those in urban Tokoroa. The difference between the two populations may reflect markedly different levels of biodiversity understanding among the populations, or it may reflect strategic responses from the rural community.

In contrast, there was relative certainty that more native fish and wetland birds were in the wider common good (see Figure *5.2*, p. 104). Given the demonstrated ecological knowledge gap of respondents, it is likely an intuitive belief that more native species equates to enhanced ecological health. This sentiment signals a profound paradox between the recreational desire for stocks of introduced salmonids and gamebirds that either displace or predate native species and the desire to enhance populations of native fauna. This paradox may be balanced in the minds of anglers and gamebird hunters with the recognition that habitat enhancement and pest control for sporting species also benefit the wider ecology. Nevertheless, it reflects the positive values for ecological improvement found by Kerr and Sharp (2003a), Marsh and Phillips (2012), Tait (2010), and Miller (2014). Kerr and Sharp (2003b) found positive part-worth utility associated with increased native fish populations and streamside vegetation as attributes of stream restoration in Auckland city, although the level of utility varied for some attributes depending on the area of the city sampled. Marsh and Phillips (2012) assessed willingness to pay for improvement and willingness to accept a decline in water quality in the Hurunui River[21] catchment as a trade-off with jobs. They applied an ecological health attribute based on the life-supporting capacity of the river. The attribute included "aquatic ecosystems, associated significant habitats of indigenous fauna and areas of significant indigenous vegetation" (Marsh & Phillips, 2012, p. 9). They also included a separate salmon and trout attribute. They found that respondents would pay a mean $44 a year for

[21] The Hurunui catchment is situated in the northern part of the Canterbury province on the east coast of the South Island and is sourced from both Lake Sumner and the Southern Alps. The Hurunui River is 150km in length and passes through diverse landscapes.

an improvement in ecological health that ranged from 'satisfactory' to 'good' and would accept receiving $254 a year to move downward to 'not satisfactory.' When contrasted with a potential gain in jobs in the region, respondents would only pay a mean $29 for 500 more jobs and would accept only $205 a year to lose 250 jobs from the region. Also, of interest is that willingness to pay for improved salmon and trout populations was much lower ($25) than ecological improvements grounded on populations of indigenous fauna ($44). Tait (2010) and Miller (2014) both used the macroinvertebrate community index as a quantitative attribute representing environmental/ecological river health. Although not directly representative of native fish and wetland birds, the index represents good water quality and the wider ecology this would support. Both studies found positive willingness to pay values for improvements in environmental/ecological health.

6.2.4 Regulator's capacity to represent the community vision

A confounding factor in this study is that respondents were asked to consider the current state of the catchment over the past five years[22], whereas the regional council electoral cycle is three years. Sentiment regarding the regulator's capacity to represent the community vision may change if the perceived power balance of elected councillors shifts from pro-environment to pro-development, or vice versa. There was also no survey mechanism to determine if criticism of management was founded on perceptions of poor historical or current management or if it was based on a view that a poor current state reflects poor current management. Equally, it did not distinguish between satisfaction with governance and satisfaction with operational performance. Perceptions of how keenly the regulator represents respondent's personal visions of how the catchment should be managed, were determined through the response rates of the different groups of respondents. 19.5% of *Fishers*, 24.2% of *Non-fishers*, and 21.8% overall, positively supported the statement. Strengthening of support for the regional council's management vision was observed when respondents were asked to take a citizen perspective to their vision holding in mind the best interest of the wider community and future generations. The increased support for the Regional Council came chiefly at the expense of Fish & Game and somewhat unexpectedly from *Fishers* themselves. It is at least plausible that a proportion of *Fishers* saw themselves as having selfish interests and 'moderated' themselves towards the regulator, believing it to be a more justifiable choice.

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[22] The five-year time frame was chosen because all the target indicator values used to monitor water quality in the study catchment are calculated as five-year averages.

6.2.5 Fishers versus non-fishers

The analysis of means has shown little or no difference between anglers and other catchment users when it comes to current and future perceptions of the Tukituki River catchment. When looking to compare these findings and other work, there appear to be very few studies that look solely at angler perceptions of environmental quality. Hunt et al. (2019) completed a meta-analysis of angler site choice research across 114 studies worldwide, based on 96 unique data sets over the thirty years preceding 2017. In Hunt et al.'s study, descriptions of environmental quality were the third most frequently applied attribute of site preference, behind cost and catch related factors, and were used in only half of the freshwater studies they reviewed. Of the measures used to represent environmental values, water quality (typically represented by clarity, flow, chemistry, or general quality) and aesthetics were most associated with positive influences on angler site choice, and in particular on angler willingness to pay for the opportunity to fish. In aggregate, the preferences of anglers for better water quality, as outlined in the analysis by Hunt et al. (2019), is consistent with angler preferences in the Tukituki River catchment. Although not directly comparable, the harvest-related factors of angler preference found in Hunt et al. (2019) may themselves reflect the interconnected nature between healthy fish stocks and good water quality.

A shared understanding of the connection between water quality and ecological health was also shown by Hampson et al. (2017). They used a choice experiment to separate ecological water quality, chiefly compromised by diffuse nutrient pollution, from microbial water quality, chiefly compromised by faecal contamination from livestock or urban wastewater. They found both the general public and anglers to have a clear preference for ecological quality, albeit with anglers having a higher willingness to pay for improvements. In contrast, rowers and swimmers preferred recreational quality over ecological quality. The approach taken by Hampson et al. (2017) epitomises the anthropocentric disaggregation of water attributes to firstly commodify nature, followed by their reconstruction to follow a 'social recipe' grounded solely in human use-values. Nonetheless, it does reinforce a relative congruency in the environmental perceptions of anglers and the general public. Comparing the study outlined in this thesis with Hunt et al. (2019) and Hampson et al. (2017) demonstrates support for the assertion that the only 'interests' that can truly be considered to be angler specific are site choices related to the harvest experience. Essentially, they are: i) the type of fish preferred, and the daily bag limit, ii) the site with the highest probability of catching target species, and iii) the cost of the trip. This does not mean that anglers do not connect ecological health with recreational utility, but given the public nature of good water quality, the same ecosystem services that enhance the outdoor experience for anglers also improve it for non-anglers.

In the Tukituki River catchment, this is clearly demonstrated by the fact that *Fishers* were only significantly different to *Non-fishers* at $p<0.05$ for current and future perceptions of the single variable *weed growth*. *Fishers* felt *weed growth* was slightly more of a problem than non-fishers and that it would be slightly more in the interests of the wider public to have less weed in the future. The elevated angler interest in weed is intuitive as excess weed makes angling either difficult or intolerable: a sentiment supported by the positive values that anglers place on reduced weed found by Beville and Kerr (2008, 2009) and Beville et al. (2012). The degree to which *Fishers* desire for less weed growth is self-serving can be placed in context when the aetiology of high weed growth is considered. The same sources of nitrogen and phosphorus driving the presence of excessive weeds also drive toxic algae, which in turn drive the frequency of contact health warning notices affecting swimmer welfare (Gluckman, 2017). Notably, when *Hunters* were removed from the sample there was no difference between *Fisher* and *Non-fisher* perceptions of the catchment's current state. These findings are significant for the New Zealand Fish and Game Council. In the author's discussions with Bryce Johnson[23] at the commencement of this research, he expressed frustration that those opposing Fish and Game, in resource deliberations and litigation, would repeatedly characterise the organisation as representing views on water quality that were particular to anglers alone and not shared by others.

6.2.6 Hunters versus non-hunters

Perceptions of the much smaller *Hunter* sub-sample were statistically different to those of non-hunters on all variables at the $p<0.05$ level other than current and future *weed growth* and on future support of *increased irrigation*. Although the comparison between populations of disparate size is problematic, this suggests that not only are their perceptions and visions distinct from *Non-hunters* but also from *Fishers*. When combined with demographic data showing *Hunters* to be more rural, higher earning, and less educated than the other sub-samples, this lends credence to the notion of them being a

[23] Bryce Johnson was the CEO of New Zealand Fish and Game since its establishment in 1991 through to October 2017. He was the first national director the Acclimatisation Societies, which preceeded the Fish and Game Councils, from1980.

distinct group. *Hunter* tastes appear to reflect a preference for the private agricultural benefits of water use with less regard for the wider ecosystem services offered by the catchment. *Hunters* also appear to have a positive view of the catchment's ecology and the safety of swimming and see less need for future improvement. Despite their positive views, their lack of support for increased future abstraction shows they do appreciate that ecological flow limits have been reached or surpassed. Their distaste for *weed growth* may be amenity based, or they may recognise the link to excess nitrogen and phosphorus, as this concern is communicated vigorously towards rural communities by regional council catchment managers, the Landcare Trust, and through the legal requirement for nutrient management budgets as part of their Farm Environmental Management Plans. With this in mind, the *Hunter* group's support for current irrigation may be less a product of ignorance or peculiar amenity tastes and more a reflection of their rural association and the rational defence of a key agricultural input.

6.2.7 Heterogeneity of catchment perceptions

Latent Class cluster analysis undertaken in this study has shown itself to be a useful tool to enrich the understanding of the categorical data obtained from the survey. Analysis revealed five classes of individuals emerging from the data with differing current state perceptions, refining to two classes of individuals with differing future state perceptions (see section 5.2.6.1, p. 111). This study shows a high degree of convergence towards a common vision for catchment management. The near-common future vision is one of increased water quality, quantity, and enhanced biodiversity. This is the same vision for waterways that has been advanced in international reports such as Brundtland (1987) and Russi et al. (2013), the intent of New Zealand's own RMA (1991) and National Policy Statement for Freshwater Management (2014), and the Regional Plan for the catchment (Hawke's Bay Regional Council, 2015). It also reflects an understanding at a community level that ecological limits have been exceeded and that the outer ring of Raworth's (2017a) doughnut (see section 2.2.1) has been breached with regard to freshwater. Clearly, there is not complete convergence of opinion, with 15% of the sample outside the otherwise common vision.

From a Pareto (1927) optimality perspective, the small number of mostly rural *Pro-irrigators* are likely to be made worse off financially by reducing water abstraction and meeting the vision of the mostly urban *Pro-quality*. In bearing that cost, there appears to be an urban/rural skew between classes, which is supported by the variable describing the degree of rurality by where a respondent lives (*Dwell*) having a significant relationship with class membership. More than double the expected proportion of farmers are *Pro-irrigators.* This raises the spectre of a strategic bias where agricultural respondents give strong responses supporting irrigation. This assertion is supported by the survey results, which showed that of the 8.2% of respondents with a business that took surface water from the catchment, most water taken was for stock water.

Given the wealth of evidence regarding the catchment's degraded state, it is unknown if some rural responses are genuine perceptions or if they are strategic responses driven by McFadden's (1974b) rational utility seeking, where choices are made based on the prospect of personal gain. Certainly, perceptions are considered unobservable contributors to taste palates and choice, which means they help drive rational choice without necessarily being grounded in rationality (McFadden, 2001). It is also, therefore, possible that the substantial minority of urban-based *Pro-irrigators* are indirectly reliant on agricultural prosperity. Marsh (2012) established that even the prospect of a negative economic impact on agriculturally reliant communities could reduce or reverse household utility associated with improved water quality. If the responses are genuine perceptions, for example, if these respondents' solemn view is that the river is in good health, it points to a fundamental difference in core social-environmental values and basic beliefs described by Ives and Kendal (2014). This would mean behavioural intentions are driven by far less tractable forces, which are embedded deeply in the cognitive hierarchy (Ives & Kendal, 2014). If so, catchment managers and pro-environment proponents will face a much more difficult task moving attitudes of pro-irrigators towards sustainable environmental stewardship.

From a Kaldor-Hicks (1939) perspective, the utility gained by the *Pro-quality* would need to outweigh that lost by the *Pro-irrigators* such that compensation could theoretically be paid. Several studies show New Zealanders do value improvements in water quality (Marsh & Mkwara, 2010; Miller, 2014; Tait et al., 2011; Tait et al., 2008). However, actual payment to farmers may be less than palatable politically as it infers a Coasian quasi-right to pollute. It also does not account for the one-off windfall value associated with a successful consent granted by the regional council to abstract surface water from the river nor the concentrated benefits from the water's unpriced productive use. It does nevertheless recognise that consents were granted legally under the RMA (1991) by the regional council through its powers as a public entity, thus committing the public it represents to responsibility for the overallocation of water. In pursuit of the new water quality targets, the Hawke's Bay Regional Council has significantly increased its property taxation. It spends 40% of its budget on integrated catchment management across the region (Hawke's Bay Regional Council, 2019a). The regional taxation schedule is administered by the Hawke's Bay Regional Council, which is responsible for freshwater management. It is nuanced and has a much heavier loading on rural properties than urban. This reflects the high cost of managing landscapes associated with rural businesses and that a relatively low urban household charge becomes a significant contribution when aggregated. In addition, landowners bear compliance costs and are left to manage regulatory impacts on production practices. This approach to apportioning the cost of landscape management seems to balance urban public and rural landowner responsibility for delivering the current regional plan, which is largely aligned with the common vision for the catchment revealed in this study.

Conducting an investigation into the effects of being a *Fisher* or *Hunter* on class membership was an important feature of this study. There are two facets: i) with its high number of *Fishers* and *Hunters*, the sample may be considered unrepresentative of the wider community, and ii) in natural resource deliberations, bodies representing the interests of fishers and hunters are often portrayed as 'special interest.' *Fisher* was not a significant determinant of class for current state perceptions and only very weakly significant at the $p<.10$ level for the future vision, which demonstrates that fishers' perceptions are not different from the wider sample. Being a member of the much smaller *Hunter* group was a significant determinant of class membership for both current and future state perceptions. *Hunter* was overrepresented in *Pro-irrigators* for both analyses and in the *Biodiversity Positive* group.

6.2.8 Comparison of results with current policy

Fulfilment of Objective 1 has defined perceptions of the Tukituki River catchment's current state and defined the common good vision for the catchment shared by 85% of the community. It is, therefore, germane to briefly compare the regulatory and non-regulatory components of management with the community vision. The regulatory response is governed by PC6 (2015) and its accompanying implementation plan (Hawke's Bay Regional Council, 2019b). Above and beyond PC6 is the National Policy Statement (NPS) For Freshwater Management (Ministry for the Environment, 2014) and its subsequent 2017 amendments, and although not gazetted policy, the Te Mana o te Wai report by Smiler et al. (2019) informs policy directions, as well as the proposed new NPS for 2020. Although not yet released at the time of writing this thesis, the government has signalled the new NPS will not have a bottom line for dissolved inorganic nitrogen (DIN) of 1mg/L as recommended by the Ministry for the Environment Science and Technology Advisory Group (Ministry for the Environment, 2020a; Mitchell, 2020). For ease of access, the comparison has been presented in Table 6.1. It is a broad summary of PC6 as relitigating the document line by line was not considered productive in this context. The Hawke's Bay Regional Council (HBRC) website, PC6 (2015), and individual input from catchment management staff were used as resources for the comparison. The objectives stated in s5.9.1 of PC6 should improve water quality towards the common good vision of the community if the accompanying nutrient, bacterial, and sediment targets are met. In particular, the catchment benefits from a dissolved inorganic nitrogen limit of 0.8mg/L compared to the highly contentious NPS range for nitrates of 2.4-6.9mg/L. It also benefits from a dissolved reactive phosphorus limit of 0.01-0.015mg/L compared to the national bottom line of 0.05mg/L (Ministry for the Environment, 2014). Ambiguity in PC6 surrounding stock exclusion from rivers may impact the ability of HBRC to deliver on targets. The NPS excludes waterways <1m wide, which can contribute on average 77% of water contaminant load in lowland pastoral landscapes (McDowell et al., 2017). The provision under PC6 allowing farms to seek consent if they exceed their nitrogen leaching targets by 30% or less is a juncture point for the HBRC to demonstrate a commitment to driving adaptive management forward. The extent to which non-regulatory 'riders' are attached to consents and enforced will be critical in maintaining on-farm momentum towards achieving nutrient targets.

Table 6.1 *Current and Future State Perceptions Relative to the Regulatory and Non-regulatory Management Response in the Tukituki River Catchment*

Current State Perceptions	**Future State perceptions**	Regulatory Response Under Plan Change 6		Non-regulatory Response	
Low summer flows are a problem.	Summer flows should be higher.	- Staged increases in minimum flows. - Stage 1 in effect as of 2018 and Stage 2 in 2023.		N/A	
Swimming not safe.	Swimming should be safe.	- *Phormidium* and *E. coli* targets and monitoring and management with design flows aligned with the National Freshwater Policy Statement. - Exclusion of bovine stock from all permanent and intermittent waterways. - Stock movement across waterways must be on formed crossings preventing entry to the waterway. - Improvement required to urban wastewater treatment and discharge protocols.	Farm Environmental Management Plans	- Promotion of 'good farming practices'. - Stock exclusion advice service. - Targeted information documents. - Education/outreach programs. - Catchment and sub-catchment forums.	Sustainable Land Management Training
Riverbed (in-stream) weed growth in summer is a problem.	There should be less riverbed weed growth in summer.	- Dual nutrient approach with a primary focus on dissolved inorganic nitrogen (DIN) at 0.8mg/L and dissolved reactive phosphorus (DRP) 0.01-0.015mg/L. - Farm nutrient budgets tailored to Land Use Class. - Nutrient leeching management by sub-catchment. - Erosion management plan and stock exclusions to manage soil born phosphorus.		- Erosion control planning assistance. - Land Use Class mapping tool. - Targeted information documents. - Education/outreach programs. - Catchment & sub-catchment forums. - Supply of HBRC riparian plants prioritised for Tukituki catchment along with planting advice.	
Uncertainty around the status of native fish populations.	Native fish populations should increase.	- Instream pollutant targets providing 95-99% species level protection†. - Oxygenation levels shall not fall below 80% saturation other than in areas of groundwater upwelling. - sediment coverage between 10 & 20% in naturally hard bottomed waterways managed by water zones 1-5.		- Identification and fencing of inanga spawning sites. - Erosion control planning assistance.	

Uncertainty around the status of native wetland bird populations.	Native wetland bird populations should increase.	- no specific provision within PC6. Presumed to benefit from the wider ecological health associated with improved water quality.	- Improved gravel management practices that recognise the breeding cycles of ground nesting birds. - Advice service for increasing on-farm biodiversity. - Hawke's Bay Biodiversity Strategy 2015-2020 - Formation of Biodiversity Hawke's Bay as an umbrella group to advance the biodiversity strategy††.
Not enough water to support current irrigation without causing problems.	Irrigation should not be supported at current levels and there should be no increases in irrigation.	- No additional consents for abstraction to be issued. - Existing consents reviewed as they fall due for renewal. - Provision for development of private & community agricultural water storage facilities. - Recognition of the significant investment supported by current abstraction consents.	- Updated 3D mapping of regional aquifers with analysis in progress supported by the Provincial Growth Fund (PGF). - Investigating possible managed aquifer recharge in Central Hawkes Bay supported by PGF. - Increased efforts to identify alternate above ground water storage sites and conduct feasibility studies supported by the PGF. - Irrigation check-up programme 2017-2019. - Working with industry towards capacity building for irrigation checks. - Investigation of sustainable farming and horticultural practices through the governments Future Farming Fund.

Note. Table shows an account of the current perceptions of the Tukituki River catchments state and perceptions of a future state vision in the common good versus the regulatory and non-regulatory responses to the water quality issues and native fish and native wetland bird population management. In particular the regulatory response is heavily summarised to avoid a line by line re-litigation of the entire Plan Change 6 document. Non-regulatory responses have a temporal component to them with some responses having periods of greater activity in the earlier part of plan implementation.

† Based on the Australian and New Zealand Guidelines for Fresh and Marine Water Quality

†† There are many non-governmental groups involved in conservation and restoration work in Hawke's Bay outside of the HBRC and the Department of Conservation. In particular the Cape to City and predator free Hawke's Bay initiatives overlap the catchment as do the potential benefits from the riparian restoration of the neighbouring Maraetotara River and of the Cape Sanctuary

6.3 Objective 2: To estimate the marginal welfare benefits generated by improved water quality in the study area.

Despite responses being geographically dispersed from Takapau in the south to Wairoa in the north, there was still a high level of catchment visitation (90%) among respondents, which, even with the incentive offer, was very similar to that of the first field study (97.4%). This means the sample was biased towards catchment users. The efficacy of incentivisation was uncertain as approximately half of the respondents for this study did not register for the incentive draw. However, given the engagement level, it is not unreasonable to assert that motivation to respond was likely driven by an interest in the catchment. In spite of this, the sample had an almost perfectly normally distributed response to the question 'How would you rate your understanding and knowledge of how authorities manage catchments and waterways', which infers that the sample was not dominated by the predilections of those deeply embedded in the political or scientific arenas of catchment management. This is compared to 80% of the population feeling that they have adequate or good environmental knowledge at a national level which was found in the study by Hughey et al. (2019).

6.3.1 Marginal welfare of improved water quality in the Tukituki River catchment

Both mean and median welfare values for improved water quality have been reported in this study. The comparison between the mean and median willingness to pay (WTP) gives additional information on the proportion of respondents who are actually willing to pay increased regional taxes. For example, only 39.1% of respondents placed bids that exceeded the lower bound mean WTP of $6.67 per month ($80.04 per year), whereas 69.5% placed bids that equalled or exceeded the lower bound median $5 per month payment. Clearly, there is a far greater regional appetite for funding improvement at the median price point. In contrast, 56.6% of Havelock North households are prepared to pay the elevated median price of $6.50 per month. The median annual WTP of $60 per household for the next ten years falls well within the bounds of past New Zealand non-market water quality valuation studies (see section 2.4), with the exception of Marsh (2012). This must be tempered with the knowledge that nearly a quarter of all respondents said the Covid19 Level-4[24] lockdown period had reduced the amount they chose to pay.

[24] In response to the global Covid-19 pandemic New Zealand closed its borders and comitted its citizens to 'at-home' self-isolation for the period 25th March – 27th April 2020. This was officially termed 'Level-4 lockdown'. During this time, all businesses were closed, other than those considered essential services,

This survey was delivered directly following the Level-4 lockdown and over the entire Level-3 lockdown.

The only comparison from Hawke's Bay is the contingent valuation study by Ndebele (2009), who found WTP between $30 and $76.89 a year for improvement to the Pekapeka wetland. In a similar contingent valuation of improved water quality in the Rotorua Lakes by Bell and Yap (2004) it was found that the WTP was between $84.76 and $97.81 per household per year for a long term increase in taxation. In comparison, the $80.04 per year from this study does not signal respondent bid largess and inflated values that critics of the contingent valuation method typically cite. Instead, it lends credence to the view of Carson et al. (1996), which was that contingent valuation studies can be grounded in reality. In this study, WTP also displayed a definite difference in the median and mean demand price relative to population affluence, with the Havelock North population prepared to pay a 30% premium above the wider population. The same difference in WTP was evident in an apparent rural/urban divide with urban households WTP a premium over rural. Whilst it is possible to interpret this as rural communities having less demand for improved water quality, it may also have been the result of income effects as urban-oriented respondents had a higher proportion of households in the higher income brackets.

6.4 Objective 3: To quantify the willingness to pay for improved water quality as a function of welfare based on public trust of freshwater advocates and policy-oriented organisations.

This study has applied Hamm's (2017) characterisation of trust as a choice in which individuals hold an expectation of personal utility, as described by McFadden (1974b). The best-worst approach, adapted from Erdem (2018), has provided results in this study that are closely aligned with the *a priori* understanding of the political economy surrounding freshwater management in the Hawke's Bay area. The relationship between organisations in Hawke's Bay was demonstrated during the 2013 Board of Inquiry (BOI) process (see section 3.2), where a pro-environment group supporting improved water quality emerged. This consisted of Forest and Bird (*FB*), Fish and Game (*FG*), and the Environmental Defence Society (*EDS*) with Ngati Kahungunu Iwi Inc (*IWI*) aligned but separate with a core cultural motivation. *FB* had a further profound effect on the water

and many citizens were placed on emergency income benefits. This was followed by a period of 'Level-3 lockdown' from 28th April – 14th May which allowed construction workers and those in some other sectors to resume work with social distancing measures.

storage consent process by bringing a successful Supreme Court appeal against the legality of swapping land protected by the Conservation Act (1987) for a substitute block. The conservation land would then have been flooded by the water storage scheme. On the other side of the argument, the pro-agricultural development group emerged chiefly as an amalgam of Federated Farmers (*FF*), Horticulture NZ (*HNZ*), Irrigation NZ, and Dairy NZ, with the latter two being dropped from the choice tasks for reasoning described in section 4.3.5. The Landcare Trust (*LCT*) was not operational in Hawke's Bay at this time.

The results of this study have shown that rescaled mean utility scores (see Table 5.30) can be used to quantify trust in these organisations relative to the sample population's profile. When those trust scores were viewed as a stock of social capital, they provided a unique snapshot of how that stock was distributed. Additionally, when Bayesian raw utility scores are correlated, it provided a picture of the flows of this social capital between and around organisations.

Viewing the rescaled mean trust utility scores in Table 5.30, and using the established political economy as a reference point, a picture of social trust, as it relates to the sample population, emerges. The pro-environment group of *FB*, *FG*, and the *EDS* held a total of 31.6% of the total available trust, and the pro-agriculture group of *FF* and *HNZ* held a total of 13.1% (see Table 5.30). The Power-group consisting of *NIWA*, the Department of Conservation (*DOC*), and the Hawke's Bay Regional Council (HBRC) held a total of 39.9% of the total available trust with 32% being held by the science organisations *NIWA* and *DOC* (see Table 5.30). Although *DOC* is primarily an operational management organisation, it also functions as a repository and promoter of conservation science. The high degree of trust allocated to these 'science' organisations infers that the Hawke's Bay public sees science as a substantial and trustworthy element of freshwater management.

This trust in these types of scientific institutions is consistent with the findings of Brewer and Ley (2012) and MacKeracher et al. (2018). Brewer and Ley (2012) investigated trust in sources of science with a survey of the Milwaukee metropolitan area in the U.S.A. They measured trust in eight sources of information about the environment and found respondent's trusted science television programmes the most, with 47% trusting them a great deal or a good deal, followed by university scientists (42%) and then the U.S Environmental Protection Agency (27%). Only 14% trusted the television news a good deal or a great deal as a source of science, and the daily newspaper had the same response.

MacKeracher et al. (2018) studied the degree to which stakeholders in the Great Barrier Reef Marine Park Authority trusted information from five different sources. Using a 10-point scale, their results showed that research institutions were the most trusted source of information with a mean score of 7.66, followed by a respondent's peer group (6.29), non-government organisations (6.11), the Park Authority itself (5.82), and industry groups (5.51). With the exception of science television programmes, environmental trust seems to fall with institutions traditionally regarded for academic rigor and political independence, which to a fair extent is the case in this study. *NIWA* and *DOC* both rate in the top 10 among 54 organisations in the New Zealand Public Sector Reputation Index 2020 (Langley & Fuller, 2020). The overall rating is a combined measure of trust, social responsibility, leadership, and fairness. Neither organisation rated in the Reputation Index top five for the singular 'trust' attribute, although *DOC* rated third for 'social responsibility.' Notably, the single greatest source of *NIWA* and *DOC's* reputation was news media (Langley & Fuller, 2020).

Given the role of scientific organisations, and the high levels of public trust they hold, any political interference designed to constrain or completely curtail their participation would have a profound effect. It would mean that a substantial portion of social trust capital would be misdirected or withheld from the deliberative process. As a result, a large proportion of the population would be under-represented, and that their social contract with government, as described in 1651 by Hobbes, would be subverted. Such interventions were widely claimed to have occurred during the 2013 Regional Plan Change 6 (PC6) resource consent hearing as reported by Shaw (2013). In this case, there was alleged ministerial interference with a substantial submission from the Department of Conservation on the negative environmental effects associated with the proposed water storage scheme and the fact that the single nutrient management approach proposed by the regional council would likely kill the rivers. The leaked 32-page draft submission was never formally made and was substituted with a brief two-paragraph neutral submission instead (Radio New Zealand, 2013)[25]. The media narrative surrounding these claims is likely to have affected public trust in central and regional government. It portrayed wilful deceit of the public by officials charged with managing the environment for the common good.

[25] It is recognised that this source is credible but not academically substantive.

Stern and Baird (2015, p. 1) coined the term 'trust ecology' regarding institutional resilience with a focus "on the interactions of trust types and functions within institutional settings". They take a sociological approach and define institutions as when groups of people work together to influence natural resource management outcomes. These are represented by groups such as non-governmental organisations, special interest groups, or government agencies. Their reference to types of trust recognises the multidimensionality of trust. They posited that when an institution holds total trust as a rich diversity of trust types, this makes them more resilient to trust disturbances. For example, an institution would be more resilient to an internal breach of interpersonal trust if there were strong systems-based trust to buffer against its negative effects. The term 'trust economy' has been applied to the economic prospects of e-commerce based on consumer trust (Diekhoner, 2017). I advance the idea of a 'social trust economy' in the natural resource context, where stocks of trust reflect social capital and flow around organisations. The social trust economy became apparent through the correlation analysis, which provided strength and sign to the flows of trust stocks around organisations. It is important to note that lack of trust means no trust exists, and distrust is an actively formed antithesis of trust (Stern & Baird, 2015). Therefore, in the social trust economy, a significant negative relationship between organisations may infer either a lack of trust or distrust and is parallel with a lack of utility or disutility. The social trust economy appeared to mirror the political economy and was once again highly factionalised. It would seem that, in this instance at least, the social trust economy can be taken as a proxy for the political economy.

6.4.1 Trust and the Advocacy Coalition Framework

The political economy of freshwater resource management in Hawke's Bay may be characterised as a protracted interaction between groups of organisations, some of which have aligned superordinate goals, and where science is a key area of conflicting beliefs, interpretations, and contested information. This makes the Advocacy Coalition Framework (ACF), a major theory of the policy process advanced by Sabatier (1987), a very close fit. The ACF offers an explanatory framework for long-running disputes, with relatively stable parameters, between factions with different core values. In this study, the core values may be characterised as those driven chiefly by the protection of public good values such as amenity, ecological, option, and bequest values, and those driven chiefly by the protection of private use-values. Sabatier asserts the framework to be most suitable to disputes where technical or scientific data is a central policy element. Pierce et al.

(2017) reviewed 161 applications of the ACF from 2007 to 2014 and concluded that the ACF provides a widely used and applicable framework, which is a reliable, tested, and contemporary framework on which to overlay the concept of a social trust economy.

The ACF is built on three pillars, first, a premise that policy is formed largely among specialists acting in a policy subsystem that is influenced by a wider social and political system (Sabatier & Weible, 2007). This description fits the policy conflict in the case study area as it endures under the naturally adversarial Resource Management Act ("Resource Management Act 1991," 1991), where well-resourced and organised groups dominate the water resource subsystem. The second pillar of the ACF is a model of individual behaviour and belief systems relying on social psychology. The system has three tiers: i) core beliefs which are normative and not policy grounded, ii) policy core beliefs which are policy grounded and context-specific and linked to policy preferences, and iii) secondary beliefs which may relate to only a part of the policy subsystem or the means to achieve policy outcome (Sabatier & Weible, 2007). The third pillar is the assertion that when there are many actors in a subsystem, a natural rationalisation is the aggregation into coalitions (Sabatier & Weible, 2007).

Parallels can be drawn between these belief systems and the four types of institutional trust described by Stern and Coleman (2014) and Stern and Baird (2015): i) dispositional trust based on factors influencing an individual's predisposition to trust, ii) rational trust based on evaluating trustees past performance, behaviours and predictability, iii) affinitive trust based on a perception of shared values or other affinity with a trustee, and iv) systems based predicated on robust and fair systems that can lower the risks associated with trust. In the case study, there was no attempt to capture core respondent beliefs nor identify trust types. However, rating prior knowledge of catchment management practices did capture individual capacity to formulate core policy beliefs and rational trust, albeit self-assessed.

6.4.1.1 Dispositional trust

In terms of a baseline for dispositional trust, the New Zealand public do not habitually assign high levels of trust. The well-being statistics from the 2018 New Zealand General Social Survey by Statistics New Zealand (2019b) undertaken to measure the population's general trust in each other and in the institutions of state, including police, education, courts, health, parliament, and media. They employed a ten-point scale adopted from the USA General Social Survey, with one being the lowest rating and ten the highest. The

New Zealand General Social Survey trust profile for Hawke's Bay (combined with Gisborne) revealed its population had the third lowest mean rating (6.6) for trust in other people. The region's institutional mean trust scores were 6.7 for both the courts and education, media 4.7, parliament 5.7, police 7.7, and health 6.5 (Statistics New Zealand, 2019b). This demonstrates the region's population does not generally hold high levels of trust in organisations, perhaps with the exception of the police. Trust in all three organisations in the pro-environment group (*FB*, *FG,* and *EDS*) and with *DOC* had a weak negative relationship with prior knowledge of catchment management practices, indicating that respondents trusting those organisations were less likely to have the capacity to form policy-based beliefs or rational trust. The pro-agriculture group and *IWI* were the opposite, and so those individuals trusting them were more likely to have policy-related beliefs and rational trust.

The effects of catchment policy implementation are increasingly part of the daily management of rural businesses. Therefore, it is logical that individuals living closest to rural towns would have a greater probability of a neutral or better knowledge of management practices, although this is predicated on an accurate self-assessment. A distinction should be drawn between knowledge of policy and beliefs based on an assessment of catchment state as a policy outcome. For example, knowledge of nutrient targets is not a prerequisite to having beliefs about the level of weed growth in rivers, and both positions are consistent with rational trust. It is also unlikely that all individuals will rationalise the information they have at hand in the same way, although they may reach similar conclusions. Certainly, the quality of information will vary and few, if any, will have perfect information or expansive knowledge. This was reflected in the results where there was no significant relationship between prior knowledge of catchment management and ratings of how well the catchment is managed.

The results also showed that opinions about how well the catchment is managed did have a significant relationship with where the public places their stock of trust. Trust in the pro-water quality group and *LCT* and *IWI* had a significant weak negative relationship with agreement that the catchment is well managed, and once again, the opposite was true for the pro-agriculture group and logically for those placing trust in *HBRC*. If the role of state-based beliefs as a component of trust is independent of knowledge, then the mechanism through which state-based beliefs are formed needs to be clarified. Given the 90% catchment visitation rate of the sample, it is probable that the beliefs of many are chiefly based on first-hand experience.

6.4.1.2 Rational trust

Beliefs based on the catchment's state, and the associated rational trust, have an underlying temporal component unlikely to be captured by those grounding their trust solely on current state experiences. When consideration is given to lead times between policy formation, successful implementation, and the desired state change, rational trust may alter. This is especially the case with regard to the regulator (*HBRC*), which held only 7.9% of available trust stocks. There needs to be some regard for the context of the regulator's position when considering its share of public trust. Firstly, the dispositional trust of the Hawke's Bay public towards parliament is only just above neutral, and it is not unreasonable to transfer some of this sentiment to the elected regional council (Statistics New Zealand, 2019b). Secondly, policy will likely always have at least one or more partly or wholly aggrieved parties. Therefore, damage to affinitive trust in one direction or another is likely to be unavoidable. Thirdly, the Hawke's Bay Regional Council has an unusual recent history with the PC6 process in which it was both the regulator and the developer, which for many, was a troubling relationship to reconcile. Finally, the power structure of the regional council can change across electoral cycles, which can affect both policy formation and its implementation. The hanging threat of a dispositional change in the regulator is likely to affect people's rational, affinitive and systems-based trust regardless of environmental ideology. It is also important to differentiate between trust in an organisation and trust in its agents. When investigating relations between the community and the water regulator in New South Wales, Sharp and Curtis (2014) found that the community was more likely to trust the organisation's staff than the organisation itself. They concluded that trust might be a multi-level as well as a multi-faceted proposition.

6.4.1.3 Trust and communication

As modelled by Edwards et al. (2019), one of the areas in which the natural resource sector can generate trust is by passing information, of good rigour, effectively and regularly to the public. The relationship between information and trust was explored in this study using the three variables *Info_quality*, *Info_wild*, and *Info_tax*. Agreement that *Info_quality* (information about water quality in rivers, streams, and wetlands is well communicated to the public) was very low with only 21.9% positive responses. It had a significant weak positive relationship with trust in *FF*, *HNZ*, *DOC*, and *HBRC*. In contrast, *Info_quality* had a weak negative relationship with *FB*, *FG*, *EDS*, and *IWI*. This points towards a perhaps unrecognised failure to communicate catchment water quality information well with the public. The regulator (*HBRC*) has put considerable resources into engaging and communicating with the agricultural sector as part of their non-regulatory approach to policy implementation in the catchment. It is rational, therefore, that pro-agriculture's positive relationship with agreement in *Info_quality* is influenced by *HBRC's* elevated effort and may have also contributed to the weak positive relationship pro-agriculture has with trust in *HBRC*. The apparent failure to meet the public's desire for catchment information may have contributed to reducing both affinitive and rational trust in *HBRC* and increasing affinitive trust with the pro-environment group and *IWI*.

Positive ratings for agreement that *Info_wild* (information about the populations of native wildlife in Hawke's Bay catchments is well communicated to the public) was just 7.6%, and negative ratings 70%, and the significance of relationships were the same as for *Info_quality* with the exception of *DOC* which had no significant relationship. This reflects the results for Objective 1, where high frequencies of neutral responses regarding perceptions of native wetland bird and native fish populations were driven by a perceived lack of information (see section 5.2.2 and Appendix G). The strong negative ratings confirm that information on wildlife in the catchment is not well communicated. It is logical that those for whom native wildlife populations are important are more likely to place affinitive trust in organisations with an effective narrative covering their concerns.

The only direct trust question related to the regulator was *Info_tax* (if I was more informed about the state of catchments, I would be more trusting of the taxes charged by the authorities managing them). The overwhelming agreement (72.7%) is a clear signal that information is lacking and linked broadly to trust. The relationship between agreement with *Info_tax* and the pro-agriculture group was weak and negative. The relationship between pro-environment as well as *DOC* was weak and positive. Once again, this fits with the established pattern of trust as it relates to the communication of information to the public in the catchment.

6.4.1.4 Trust and Devil-shift

The final component influencing individual behaviour in a subsystem of the ACF is the concept of 'devil shift.' Borrowed from prospect theory, where negative outcomes are most keenly remembered, 'devil shift' leads actors to overestimate the opposition's ferocity (Sotirov & Memmler, 2012). Actors view each other as increasingly malicious, and a culture of distrust and suspicion becomes increasingly pervasive (Sabatier &

Weible, 2007). In this case study, the trust economy is characterised by isolated groups repelling each other with negative trust correlations. The strongest negative public trust relationships are found between those that trust both *FF* and *HNZ* and those that trust *FB*. Whilst the strength of this negative relationship lends itself to the concept of 'devil shift' it may also be grounded in persisting ill-feeling over the ultimate failure of the Ruataniwha Water Storage Scheme (see section 3.2, p. 53), due to successful Supreme Court litigation by *FB* (Radio New Zealand, 2017). The water storage scheme was to support widespread irrigation and land use intensification that was promoted as a means for increasing general prosperity that would be spread throughout the community. The gap between the pro-environment group and the pro-agriculture group is perceived to be considerable. This is evidenced by a quote from the chief executive of Fish & Game NZ, Martin Taylor, at a May 2020 F&G council meeting which stated, "if you look at the submissions and the behaviour of Federated Farmers and DairyNZ and the other advocacy groups, they are diametrically opposed to some of the positions that this council has agreed on" (Williams, 2020).

6.4.1.5 Social Trust Economy and the isolation of Māori

The relative isolation of *IWI* is troubling given the status of Ngati Kahungunu as Hawke's Bay's regional treaty partner. Its significant weak positive relationship with trust in *EDS*, *FB*, and *LCT* may reflect shared affinitive trust with the western ideals of sustainability that intersect with the Māori sense of kaitiakitanga (guardianship) and the mauri (life force) of the awa (water). The significant weak negative relationship with trust of *NIWA*, *DOC* and *HBRC* may reflect an enduring sense of institutional paternalism toward Māori in natural resource management, as described in the historical assessment of state afforestation at Mangatu on the east coast of the North Island by Coombes (2003). A useful and reliable synopsis of the untruthful and manipulative dealings by agents of the Crown leading to the dispossession of lands from Heretaunga and Tamatea hapu in Hawke's Bay can be found in s8 and acknowledgements of the Crown's Treaty failings under s9 of the Heretaunga Tamatea Claims Settlement Act (2018). Mātauranga (traditional knowledge) has historically been cast aside as unscientific. The experience of co-managing environmental research in a way that respects mātauranga as described by Lyver (2006) proved uncomfortable and time consuming for scientists, but did build trust and relationships. The relative angst between scientists and mātauranga may go some way towards explaining the negative relationship with trust in *NIWA* and *DOC*. There is also a deep sense that the Crown failed to implement tino rangatiratanga (right to Māori selfdetermination) with regard to kaitiakitanga of whenua (land) and awa (water). Poor experiences under colonial rule, such as illegal land confiscations and the characterisation of Māori as poor farmers and backward stewards by Crown agents in past decades means Māori and government have a long history of poor trust (Coombes, 2003; Schiele, 2015). The trust economy surrounding *IWI* is not intractable, with Lyver (2006) showing effort and time can equal progress. Crow et al. (2018) also show that incorporating a researcher with intimate knowledge and cultural connection from the outset can assist early connection with iwi and hapu, while Schiele (2015) provides a framework for integrating the voice of Māori in freshwater management.

6.4.1.6 Unique position of the New Zealand Landcare Trust

The New Zealand Landcare Trust (*LCT*) finds itself in a unique position where it holds positive trust relationships with both some pro-environment and the pro-agriculture organisations. It was included as a self-proclaimed agriculture centric organisation, with a view to balancing representation in the choice sets, and also as an organisation with the potential for diverse relationships. The *LCT* works closely with farmers, holds larger trust stocks than either *FF* or *HNZ*, and has a significant weak positive relationship with trust in *FF* and *HNZ*. It also has significant weak positive relationships with *EDS* and *IWI*. This places *LCT* in a privileged position with regard to the diversity of its trust base. It may be, therefore, that *LCT* could moderate tendencies towards 'devil shift.' An important difference between *LCT* and many of the other organisations is that it has a policy of being non-political and does not engage in policy formulation (N. Edgar, personal communication, 31 July, 2020). This lack of politicisation means they do not seek to create a media narrative on water policy, which likely spares them from generating any public ill-feeling, which contributes to their ability to bridge across trust groups. Also of note, is their financial connection with the Ministry for the Environment, which provides $800,000 of funding each year which represents 30-40% of their total annual operating revenue (N. Edgar, personal communication, 31 July, 2020). In practice, this means that although the *LCT* is independent in operation, the Ministry can request that some focus is given to its efforts. For example, although the *LCT* is broadly an environmental improvement organisation, the Ministry may request that a focus is placed on water quality and effort is put into developing management groups, especially for catchments (N. Burkepile, personal communication, July 7, 2020). The LCT seeks to aid regulatory and non-regulatory approaches with a philosophy of supporting the voluntary measures of farmers and communities towards improving water health. This soft-handed approach and the fact that they do not engage in enforcement of regulatory compliance also goes a long way towards explaining their wider trust base. A clear counterpoint is that they are afforded the relative luxury of their approach because the responsibility to enforce compliance falls with the regulator.

6.4.1.7 Social Trust Economy and latent trust coalitions

Although no formal agreement exists between *FB*, *FG*, and *EDS*, their relationship bears the hallmark of a coalition in cases of common interest and reflects Sabatier and Weible's (2007) third pillar of the ACF. Informal understandings allow their combined resources to be deployed efficiently when advocating for water quality (B. Johnson, personal communication, July 2^{nd}, 2020). Coalition behaviour extends to an informal agreement between *FG* and *FB* not to attack each other on issues such as gamebird hunting, but instead focus on the common environmental issues (Johnson, 2016). Whilst the relationship between *FF* and *HNZ* is not known the sign and strength of their public trust relationship would suggest that at least some coalition behaviour is likely to exist. The results from the analysis of public trust endorse this coalition behaviour, and I propose the concept of 'latent trust coalitions' existing, based on mapping the underlying public trust economy. This may be a useful tool for any organisation to assess opportunities for strategic alliances or collective action that fits with the existing flows of trust. Whilst alliances would likely be more durable where significant positive trust relationships exist, observed coalitions that are not matched by latent trust could prove damaging.

6.4.2 Social trust and willingness to pay for improved water quality

Finally, in this case study, trust in organisations has proven to be a poor predictor of willingness to pay (WTP) for improved water quality. Even at its most pared-down form, very little of the variance in WTP was explained by the partial least squares regression model. This may be due to the fact that the payment is made to local government and not to the other organisations. Why would the level of trust an individual has in someone they are not giving money to relate to the amount of money they were prepared to give to someone else? There may be a more definite connection between WTP and respondent's level of confidence in the probity of local government and its agents. Even if the Bayesian trust scores are viewed as a proxy for an individual's social beliefs or political views, the relationship with WTP is still poorly defined. Nevertheless, the trust welfare captured, whatever its makeup, provides logical and expected explanations of the political economy. As such, observed trust is likely a complex amalgam of welfare components and is itself a single factor in a multifactor explanation for WTP for improved freshwater quality in the Tukituki River catchment. If the remaining factors have a cognitive component, then discovering how deep this lies within the cognitive hierarchy will have a direct bearing on how tractable WTP is to management strategies.

There is a body of work (Berg et al., 1995; Hamm, 2017; Li, 2015; Ortmann et al., 2000; Stern & Coleman, 2015; Williamson, 1993) establishing that there is a component of utility in the choice to place trust (see section 2.5.1). How much utility and how great a role choice makes in trust is unclear. However, the lack of demonstrable relationship between WTP and trust utilities, as measured in cash terms in this research, calls into question the validity of labelling trust scores as 'utility'. Nonetheless, it is reasonable to assume the measurement captures an observable component of welfare, as such, the terms 'trust scores' and 'trust welfare' will be used in place of 'trust utility'.

6.5 Evaluation of approach and methods

Data was collected using two separate surveys. The first survey was delivered via an electronic link and was targeted at the population within the catchment boundary including the township of Havelock North. The choice to use hydrological boundaries rather than regional or district boundaries incurred additional time costs. Each entry in the Hawke's Bay database provided by the New Zealand Fish and Game Council had to be address-checked to ensure it fell within the catchment boundary. It also made targeting the wider catchment population problematic. The decision to use a survey company to run both a social media and mail-drop delivery was an expensive option for student research. It did, however, cover the printing cost of 2000 flyers and their delivery to households. There are elements of the data gathering approach that have introduced uncertainty into the results. Although the social media delivery was via targeted Facebook adverts constrained to specified territorial units within the catchment boundary, there is no way of ground-truthing the responses. The same could be said of the mail drop as once the survey link was out within the community, there is no way of knowing if it was circulated by third parties using a range of other channels. The response to the second survey was strong, and Facebook combined with snowballing email proved to be a cheap and effective means to deliver the electronic link to the survey across the region. Excluding incentives ($500), the total delivery cost was $237. Although the Facebook advertisements were constrained to Hawke's Bay residents, once again, a degree of control over who received the electronic link was sacrificed and this introduced uncertainty into the results. A substantial increase in funding would have allowed for increased control through door-to-door interviews for both surveys, all things being equal. However, as the second survey was delivered during the Covid-19 pandemic levels 4 & 3 lockdowns, such an approach would not have been possible. It is likely that in an active Covid-society contactless data gathering techniques will be regarded as the standard for some time to come.

6.5.1 Self-selection bias

Both surveys delivery methods were open to self-selection bias. Self-selection is where respondents with a particular interest in the subject matter become over-represented in the sample, and the effect of this causes what is called avidity bias. This can mean that inferring statistical results as representative of the general population may be flawed. Controlling exactly who answers internet surveys is extremely difficult, and ultimately, even door-to-door survey respondents are self-selected, as demonstrated by Kerr and Sharp (2003a). They delivered two door-to-door surveys in Auckland and achieved only a 40% and 44% participation rate from those contacted. This means that the vast majority were not interested enough to spend time answering the survey. It is likely, therefore, that those who did answer had an affinity for the subject.

The first survey conducted as part of this study contained a variable to identify special environmental affinity through respondents being asked whether they donate to, or volunteer for, an environmental organisation. This is distinct from being a recreational user of the catchment, as nearly all respondents had some interaction with the catchment in the past twenty-four months. Overall, 33.4% of respondents were identified as environmentally oriented. Thirty-five percent of *Fishers* were environmentally oriented, as were 43.5% of *Non-fishers*. It is clear that although the proportion of the general public that donates to or volunteer for environmental organisations is unknown, it is highly unlikely to be 43.5% and unlikely to be 33.4%. In contrast, Hughey et al. (2019) use an extensive block of questions to gauge environmental orientation and found that the rate of volunteering and donation was between 10% and 30%, depending on the sampling method. Hughey et al. (2019) found that rates of volunteering and donation started to increase when the survey changed from paper-based to electronic delivery. It is probable, therefore, that the mean scores have been influenced by an avidity bias and may differ from the general population. However, it does not preclude the possibility that this profile accurately represents catchment users. Phillips (2014) reported on the non-market values of freshwater in Waikato, New Zealand. Using a 5-point Likert scale, she found that recreational users rated the importance of lake and river water quality compared to other public issues more highly than other respondents. Considering the likely avidity bias in this study with the findings of Phillips (2014), an interesting proposition of layered avidity bias emerges. This would be based on the proven avidity bias in recreational users over non-users and then within the recreational user groups a bias of elevated environmental orientation, as shown in this study.

Self-selection bias is left largely unaddressed in the contingent valuation exercise of the second survey of this study. This is because no specific variable was included to identify the environmental orientation of respondents. The variable was removed as part of an overall strategy to constrain survey length. On reflection, and given the unexpectedly strong response, it would have been prudent to have kept this variable as it allows additional context around welfare estimates. It is possible to take some inference from the fact that catchment engagement rates are almost identical between the first and second surveys. This would suggest firstly that the proportion of respondents in the second survey with a positive environmental orientation is likely higher than the general population. Secondly, it would suggest that a higher proportion of environmentally oriented individuals may, in fact, be typical of a catchment user population.

Whitehead (1991) compared contingent valuation benefit estimates associated with wetland preservation in Kentucky, USA, from a general population sample and an environmental interest group sample. Using a dichotomous choice bid elicitation format, Whitehead found that estimates from the two samples varied and that those from the environmental interest group could be up to 50% larger than the general population. Whitehead (1991) also points out that over-representation can also occur that results in a bias that lowers benefit estimation. He concludes that if data is not available defining environmental interest group membership as a proportion of the general population, then weighting a sample is not possible. Whitehead (1991) concludes that other methods to try and mitigate self-selection involve using screener surveys or follow-up surveys and that these can be cost prohibitive. The findings of Lindhjem and Navrud (2011) suggest internet delivery may reduce the effects of self-selection biased towards pro-environmental respondents. When investigating the effects of internet delivery versus face-to-face interviews on environmental welfare values in Norway, they found that willingness to pay in contingent valuation scenarios was as much as 20% lower for internet surveys than face-to-face interviews. They postulate that anonymity may mitigate interviewer bias where respondents give positive values to meet the perceived expectations of the interviewer. Tait (2010) compared postal surveys with internet-based surveys when valuing improvements to water quality in the rivers of Canterbury, New Zealand. He found no differences in the unconditional welfare estimates from either delivery method, although he did find the profile of respondents had some differences. In particular, the internet respondents had a more informed and accurate view of the state of waterways than the mail sample, which Tait (2010) attributes to a more intrusive self-selection bias amongst internet respondents.

Without perfect information about the proportional representation of the self-selected group in the general population, compensating for their effects would require researchers to introduce speculation into the results. In their study of the willingness of dairy farmers to participate in a subsidy scheme for pesticide-free buffer zones, Christensen et al. (2011) noted the potential for self-selection in their sample. They felt that farmers with a specific interest in agri-environmental subsidy schemes were likely overrepresented, as they had no variable to help identify the extent of potential bias. They chose instead to simply report its potential influence. Moore et al. (2011) used an internet survey to deliver a contingent valuation study of forest protection programmes in the southern Appalachian Mountains, USA. They also found that census data did not allow for the identification and correction of self-selection bias and so were able only to report its likely existence. Kerr (2019) sampled New Zealand deer hunters to model the marginal benefits of different levels of harvest with a view to bag limit allocation. He acknowledged a self-selection bias in the sample based on the likelihood that the most avid hunters were likely overrepresented and that without information about the prior habits of each hunter in New Zealand, there was no way of correcting this.

In this study, the decision was made to acknowledge the likelihood of self-selection and some avidity bias in both surveys. Like others, and in the absence of census data that allows comparison with the general public, I have chosen to report the proportion of respondents with a specific environmental affinity and not seek to compensate for it. Furthermore, I put forward that whilst an avidity bias may differentiate the sample from the general population, it may well be typical of a profile that fits catchment users.

6.5.2 Payment elicitation format

Iterative bidding appeared to provide a payment elicitation platform that was easily understood with a tolerable cognitive load, as once respondents started the bid process, few dropped out of the survey. Of those that did drop out, it is unknown if this was due to cognitive load or protest. It is recognised that the dichotomous choice format (see section 2.4.8) is currently still the most widely favoured elicitation format as promoted in the contemporary guidance for contingent valuation by Johnston et al. (2017). Its main failing, however, remains that it requires large numbers of responses in order to derive a demand function. In contrast, iterative bidding builds the demand function through the bidding process itself and is, therefore, more forgiving of sample size. Iterative bidding was chosen in this study due to the uncertainty surrounding likely response numbers using a social media platform across a relatively small provincial population.

Bateman et al. (1995) compared the open-ended bidding format with iterative bidding and the dichotomous choice format in a contingent valuation of a wetland in the Norfolk Broads, England. They used a large sample of 2897 interviews and followed the Arrow et al. (1993) NOAA reports contingent valuation best practice guidelines (see section 2.4.8). They concluded that iterative bidding provided a middle ground, with its chief negative effect being a likely starting point bias. Carson et al. (2001) also point out starting point bias in iterative bidding. Bateman et al. (1995) also firmly recommended that reporting of mean welfare estimates be accompanied by a series of truncated/trimmed means to test for sensitivity to the effects of outlier bids. Weber et al. (1991) compared iterative bidding and the dichotomous choice elicitation approach across a sample of 1000 respondents in a contingent valuation of increased flows in the Ashburton River. They found iterative bidding delivered a mean value of $9.6 million per year versus $9 million from the dichotomous choice logit function. When they 'trimmed' the iterative bids by removing the upper and lower ten percent of bids, they derived a significantly lower value of $7.2 million. The trimmed mean delivered a value 20% less than the logit model, whereas the untrimmed mean exceeded the logit model by only 6.7%. Based on the findings of Weber et al. (1991) an untrimmed iterative bidding method would seem justified. The welfare estimate in this study was very robust when tested for sensitivity to outliers. The mean willingness to pay of $6.67 varied by only three cents across 5%, 10%, and 20% trimmed mean calculations using Microsoft Excel 365. This points to a negligible incidence of non-attendance to cost and overbidding and that, in this case, iterative bidding has delivered a fair distribution of welfare. The median welfare estimate of $5 (which was close to the $4 start price) does conform with expectations of a starting-point bias, although it should be remembered that 80% of bidders moved off the starting bid. It should also be remembered that the choice of the starting bid was grounded in real-life expenditure (see section 4.3.2.3).

6.5.3 Starting point and range bias

An obvious concern in the result is the spectre of starting point bias as the median WTP for the whole sample was close to the starting bid. There is no escaping that iterative bidding is associated with starting point bias, as shown by Boyle et al. (1985). This is especially so given that the iterative bidding was in a single block with a static $4 starting point. Testing this would require a second study with different starting points in either divided survey blocks or a randomised starting bid for each respondent. In response to the suspicion of starting point bias, it should be emphasised that 84% of respondents moved off the start bid. This, however, does not alter the anchoring effect the starting bid has as a perceived 'reasonable value' for the good (Whitehead, 2002). A range bias was also introduced with a constrained bid ceiling of $12.50, thus limiting those wishing to pay more (Mitchell & Carson, 1989). Arguably, the range bias is less important than the starting point bias, especially if trimmed means are introduced to mitigate the effects of any non-attention to cost.

6.5.4 Consequentiality

Another key component of a successful contingent valuation survey is installing a sense of consequentiality to the bid placed (Carson & Groves, 2007). There were two main ways a sense of consequence was installed in this study. Firstly, the use of a cheap talk script prior to the iterative bidding, and secondly, the final survey question asking if the survey result should be passed on to the authorities. Both of these were found to be equally effective at constraining respondent bids when implemented by Bulte et al. (2005), and both of which satisfy incentive compatibility as described by Carson and Groves (2007). Almost all of the respondents (93.8%) felt the survey results should be passed on to the authorities. This was taken to signal they understood that their bids could be seen by the authority that set regional household taxes and so had a reasonable chance of consequence. This direct binary approach was favoured over other techniques, such as the scale used by Bennett et al. (2018) to gauge respondent perceptions of the likelihood of consequence. On reflection, the effectiveness of the binary technique is presumptive that a negative response does not also signal perceived consequence. It raises the possibility that a 90% negative result may have equally indicated a high level of perceived consequence. A third indication of a sense of consequence was the effect of Covid19 on bids. Nearly a quarter of respondents claimed to have modified their bid downward due to the economic stress and financial uncertainty resulting from the Level-4 lockdown period. This gives a second clear indication that respondents were actively weighing bids against their household's real ability to pay.

6.5.5 Warm glow bidding

Warm glow bidding occurs when an individual ignores the scope of the environmental good being valued and pays simply for moral satisfaction (Nunes & Schokkaert, 2003). For example, if the valuation scenario was improving one wetland or two wetlands, this would not influence their bid. Instead, they bid what they are willing to donate to what they see as a good cause. Grammatikopoulou and Olsen (2013) investigated warm glow bidding in contingent valuation surveys of environmental management. They used a set of questions designed to identify and model warm glow bidding associated with the valuation of a wetland in Greece. Grammatikopoulou and Olsen (2013) found that respondents that rated more highly on their scale of environmental consciousness were more prone to warm glow behaviour. They also found that over half of the positive bids they received had some warm glow associated with them. The contingent valuation exercise in this study did not contain an environmental indicator variable. This means that warm glow bids arising from a moral desire to donate to an environmental cause must be accepted as a legitimate part of the welfare estimates in this study. Such an approach to the warm glow effects was proposed by Nunes and Schokkaert (2003). The effects of the global Covid-19 pandemic on individual perceptions of social and environmental responsibility are yet to be determined. If a positive effect is postulated, then this may also have had an upward bias on willingness to pay somewhat akin to warm glow bidding. It is assumed that all negative effects were captured by the survey question directly addressing the impact of Covid-19 level 4 lockdown on bids.

6.5.6 Scope effects and part-whole bias

This study was focussed entirely on valuing the change in welfare from the current catchment state to the state as it would be if the targets in the regional plan were successfully delivered by 2030, as intended. This narrow focus has left an issue of part-whole bias and two issues of scope untested. The scope effect is when willingness to pay (WTP) does not vary relative to the amount of the good supplied. Economic theory assumes that WTP will increase when more of a good is consumed (Carson & Mitchell, 1993). Part-whole bias is when individual elements valued separately sum to exceed the amount when they are valued collectively as a single good (Bateman et al., 1997).

The first issue of scope and the part-whole bias can be explained by looking at catchment water quality in Hawke's Bay (the provincial location of the study area, see *Figure 3.1*) as a whole. This study valued the marginal welfare associated with water quality improvements in a single catchment. Although it is one of the most significant catchments in the region, there are five other significant river catchments. There is no way of knowing the extent to which respondents allocated their hypothetical water quality improvement budget to the study area. It is possible that some respondents allocated the majority or all of their total WTP for improvements to this one study. This may be due to warm-glow payments or a lack of consideration for the state of other catchments. If the study had been singularly focussed on valuation, and improvements to the other five catchments were added to the scenario, respondent WTP may not have increase commensurate with the increased scope. It is important to note, however, that public demand for water quality across the region is very unlikely to be linear and that once a reasonable amount of environmental amenity has been provided, WTP is likely to drop away (Rollins & Lyke, 1998). A part-whole bias may also expose potential over valuation of the study catchment. This could be tested by firstly valuing each catchment individually and then in a follow-up study testing for an aggregate value where WTP was intended to cover improvement in all six catchments. If no part-whole bias existed, the sum of the individual catchment WTP would equate with the WTP of the aggregate study.

The second issue of scope is that the future state scenario was presented as the only possible option. This means there is no ability to test for increased WTP for an even better outcome. The future state scenario presented to respondents was carefully crafted (see section 4.3.2.1) to be a realistic interpretation of the catchment state resulting from the successful implementation of regional Plan Change 6 by the 2030 target delivery date. In this instance, the portrayal of a second 'possible future state' markedly better would have been propagating a known falsehood. On reflection, the future scenario used in this study, although grounded in reality, may have been better presented explicitly as 'hypothetical'. Adding a second even more improved hypothetical scenario may, therefore, have had very little potential to mislead the public. It would, however, have increased cognitive load in a survey already carrying two choice exercises.

6.5.7 Best-worst scaling as a tool for estimating trust

Best-worst scaling proved to be a versatile tool for gathering trust scores. Its relatively low cognitive load was an important aspect of its performance in this study, given that it was used in a survey containing two choice exercises. Given that two choice exercises were used, the number of best-worst choice sets was constrained to contain the survey completion time and therefore increase the number of complete responses. Due to this and the need for the number of choice sets faced being at least equal to the total number of items to be ranked when planning to use Bayesian utility scores, the number of items (organisations) was reduced from twelve to ten (Sawtooth Software, 2013). Future use of the technique to focus only on trust would mean that a larger item list and a subsequent greater number of choice sets could be used without risking respondent fatigue. This would allow for more complex social trust economies to be modelled. As the only other apparent use of best-worst to estimate trust utility, Erdem (2018) used sixteen items in her investigation of trust in sources of information about nano-technology use in foods. She applied eight choice sets, each with five items, and did not estimate individual Bayesian utilities. In marketing applications, respondents can be asked to face over a hundred choice sets in a single survey, which means there is plenty of scope for use of this method in complex systems (Chrzan & Orme, 2019).

On several occasions, feedback to the researcher was that a respondent "did not know some of the organisations." In order to include a reasonable cross-section of organisations it was inevitable that some would be better known to some sections of the community than others. It is not clear if that meant these respondents found themselves entirely guessing in the forced-choice sets. The negligible proportion of responses below the random response cut-off criteria would suggest that not knowing all the organisations was not an impediment to stable choices. It may be that in some instances respondents employed heuristics where only the most known to them were chosen between or that word associations were made to guide choice. For example, 'Environmental Defence Society' is self-descriptive as pro-environment and 'Federated Farmers' self describes as agricultural. It is possible coupling word association with the decade long media narrative regarding the role of agriculture in freshwater pollution may also have played a role in determining the likelihood of affiliated trust and, therefore, choice.

6.6 Monetisation of water quality, is it appropriate in New Zealand?

Monetisation of nature is ideologically polarising, nevertheless, it can be useful when improvement to water quality is contemplated (Bergstrom & Loomis, 2017; Kerr & Sharp, 2003a). This is particularly so in New Zealand, where regional councils are tasked with delivering the improvement, and the resources required to implement solutions will be either partially or totally publicly funded. Regardless of how enfolding the approach is of non-use values, monetisation still plays to a discordant neoliberalisation of nature. It perpetuates the utilitarian approach, and in New Zealand, it excludes the Māori view of water as a taonga (treasure) with a mauri (life force) of its own that requires nurturing and kaitiakitanga (guardianship) as described by Wakefield et al. (2012).

Schieles' (2015, p. 25) thesis on the voice(s) of Māori in integrated freshwater management posits a continuum of freshwater management with the exploitative/utilitarian approach at one end and the esoteric/spiritual approach at the other. In the post-colonial New Zealand context, she notes the four key pivots for this continuum between treaty partners[26]; i) world view, ii) manifestation, iii) rights, and iv) consumption. Although the contingent valuation method used in this study has attempted to provide a holistic comparison with a wide bundle of attributes, it still could not escape the reductionist descriptions required to contain the cognitive load faced by respondents. It is recognised, therefore, that the cultural investment of tangata whenua cannot hope to be adequately captured in this study's valuation construct, which by its very nature is divorced from a Māori worldview. It is likely that this sentiment will hold for all non-market constructs. This may be especially so for those utility focussed applications where the initial reduction of values into a handful of attributes is followed by breaking the attributes down into multiple step changes intended to represent levels of supply.

Tipa and Teirney (2006) developed the Cultural Health Index (CHI) for the Ministry for the Environment. Developed across a number of river types, including the Tukituki River, it was intended to be an instrument of empowerment enabling iwi/hapu to use the index to assess the cultural and biological health of any stream, river, or catchment in New Zealand. The index has three components: i) Site status - identifies the traditional significance of the site and whether it is likely to be returned to that in the future, ii) Mahinga kai (as a tangible representation of mauri) - assessment of indigenous flora and fauna, fitness for cultural usage and its productive capacity, and iii) Cultural stream health measure - applying eight individual indicators (Tipa & Teirney, 2006, pp. 1-2). Whilst

[26] The Treaty of Waitangi signed in 1840 between The Crown and many (but not all) Māori chiefs. Copies of the document were made in English and translated to Māori, and most chiefs signed the Māori version. Differences of intent between the two versions continue to fuel controversy especially with regard to the accession of sovereignty and its effect on rangatiratanga (chiefly authority) Ministry of Culture and Heritage. (2020). *New Zealand history: The treaty in brief* [Web page]. Ministry of Culture and Heritage. Retrieved June 21st 2020 from https://nzhistory.govt.nz/politics/treaty/the-treaty-in-brief.

this may appear to provide a reliable resource for valuation studies, it does not bridge the significant leap between a framework for the assessment of cultural values and the monetisation of its selected components.

Miller (2014) made novel use of the cultural values of Māori in a water quality choice experiment based on the Selwyn/Waikirikiri River[27] catchment. Whilst she found significant positive values for the Māori cultural attribute, it was based solely on mahinga kai to proxy for mauri as described in the CHI. This was selected on the premise that no scientific construct to measure mahinga kai existed and was subsequently taken to embody Māori culture investment in freshwater. Even when best efforts, such as those by Miller (2014), are made to construct representations of Māori culture, the failings are clearly apparent when the need to reduce information means a single cultural element is elevated to represent an entire culture. In this study (see *Figure 4.1*) mauri was represented as the abundance of taonga species such as tuna (eel) and inanga (whitebait) as well as more general mahinga kai and so it too provided a very limited representation of Māori cultural investment in the study catchment.

Anderson et al. (2012) investigated cultural differences in environmental valuation as it related to the Waikato River[28]. They examined the influence of being Māori on water quality choice behaviour and found that there was no difference between Maori and Non-Māori, although their sample was a small and narrow demographic of university students. They conclude the findings should be inferred only as being representative of a young and westernised sample of Māori.

Awatere (2008) used a contingent valuation of increased roadside biodiversity in Auckland to test the ability to capture Māori cultural values in non-market valuations. He concluded that with fine-tuning and backup questions, it is possible to incorporate cultural values for those Māori happy to participate. Awatere (2008) is clear that this will fulfill only the motivation to produce a non-market value for an environmental good. It will not reduce Māori philosophy and ideology to a number that natural resource managers can

[27] The Selwyn/Waikirkiri River runs from the foothills of the Southern Alps in Central-Canterbury to Lake Ellesmere/Te Waihora on the east coast. The middle reaches dry off on the surface during summer, and the lower reaches continue to flow as they are fed by a series of groundwater springs.

[28] The Waikato River is New Zealand’s longest river and drains Lake Taupo situated in the centre of the North Island. The river runs 425 km north to the sea on the west coast, has a catchment of 14,260 km^2, and has nine hydroelectric power stations along its length.

use to represent Mātauranga Māori in a cost-benefit analysis. Instead, Awatere (2008) reasons that Māori values should have a legitimate place on their own and advises caution in the use of non-market valuation when for many Māori, the thought of placing a dollar value on what are culturally their whanaunga (relative) and tīpuna (ancestors) is abhorrent.

In summary, monetisation of freshwater values is an important part of an economic analysis focused on efficiency. The overall contribution of non-market valuation to freshwater management, however, is limited in the context of indigenous cultural values. As such non-market valuation in New Zealand should be treated as a fragment rather than the full embodiment of social value.

6.7 Contribution to natural resource management

This study makes a direct and timely contribution to freshwater management in Hawke's Bay. The case study approach contextualises the findings with time and place, which provides the potential to assess and adapt some of its findings more broadly at a national level. Findings from this study will give catchment managers and decision-makers further insight into public perceptions of the overall health of the Tukituki River. It should leave them with no doubt that the overall perception of catchment users is that it is currently in poor health. The Hawke's Bay Regional Council (HBRC) has acknowledged the unacceptable state of the catchment and the public's expectation of water quality improvements. Whilst catchment managers endeavour to implement policies designed to deliver improved water quality, the regional council continues to face pressure from multiple organised factions with varying degrees of public and private good orientations.

This study provides a clear picture of the typologies of catchment users to decision-makers charged with delivering freshwater for the common good. It shows that although there are five classes of individuals with differing perceptions of the catchment's current state, and that this converges down to two classes of individuals with differing perceptions of a future state in the common good. It also shows that a majority of the public (85%), have a public good orientation towards water and water quality, while the remainder, which have a substantial rural membership, have a private good orientation. For natural resource managers, this is a reminder that when production benefits of a resource accrue to a few, and the negative effects of its use are externalised to the many, then support for its continued use will also come from only a few. This study has also found an apparent public knowledge gap regarding the status of native fish and native wetland birds in the catchment. There is one small class of individual characterised by low educational achievement and a rural orientation that have particularly unrealistically positive ecological views. This information will help catchment managers revisit their educational efforts and strategies regarding these aspects of ecological health. It will also alert managers of other natural resources to the need for targeted education.

This study has found that the public feels the catchment is poorly managed. Given that the HBRC spends 40% of its budget on integrated catchment management, this information provides them with an opportunity to reassess how they communicate their management approach as well as the timeline to demonstrable change in the catchment state. This disconnect between the resources applied to management and the public perception of poor management provides insight to managers of catchments both in New Zealand and internationally. It shows that upscaling resources and implementing policy is not enough to generate public perceptions of good management. Accordingly, regulators should be mindful of public engagement strategies that complement the operational delivery of policy.

The ten-year WTP for an improved catchment state has shown there is still headroom to raise any additional resources required to meet the pollution targets for the catchment by 2030. The variation in mean WTP between urban and rural communities and the premium offered by residents of Havelock North provides decision-makers with a nuanced view of the potential to raise resources. Finally, WTP estimation has expressed public value for the catchment to decision-makers in a clear and common metric that augments rather than supplants deeper cultural values, particularly those of Māori.

Estimating the welfare associated with community trust in organisations involved in the catchment water quality space has delivered a novel representation in the form of a social trust economy. Metrics of public trust are of interest to central government, local government, Crown entities, industry groups, environmental non-governmental organisations, and Māori. The findings may be transferable, and the approach itself offers the ability to model social trust economies in natural resource settings across the globe and has the potential to provide insight into any multi-organisation system. At a local level, the measure of public trust in the HBRC provides useful feedback to the organisation, however, low trust in the organisation should not be conflated with low trust in their individual agents. Furthermore, the study provides additional information that should help grow public trust through improved communication about the state of catchments. This study has highlighted the importance of the two Crown entities, the National Institute for Water and Atmospheric Research (NIWA) and the Department of Conservation (DOC), as quasi-public representatives in the freshwater management debate. The factional shape of the social trust economy of freshwater should give all freshwater organisations and central government pause for thought. The apparent grouping of organisations into pro-agriculture, pro-environment, and those linked to statutory power mirrors the observed political economy and an apparent polarity of positions. Of particular concern to freshwater managers is the isolation of Ngati Kahungunu from the Crown entities of NIWA, DOC, and the HBRC. This concern should extend through to the Ministry for the Environment given the obligation of the Crown to consult and co-manage. At an international level, it is possible that the application of this approach by natural resource managers may reveal the social trust isolation of other indigenous peoples among factionalised policy systems.

There was a lack of any useful predictive relationship between WTP and trust scores with modelling explaining very small variances in WTP with only some explanatory variables. This should dispel any preconceptions decision-makers and managers may have about the effect of affinitive trust in organisations. For example, trusting Forest & Bird does not necessarily translate into an elevated WTP for improvements in water quality.

At the time of this research, a general finding was the lack of demographic and household data at a catchment level. Additionally, there was an apparent lack of HBRC financial data regarding management expenditure at a catchment and sub-catchment level. This implies that managerial focus is late to the task and/or that the HBRC lacks adequate resources to capture this information. Highlighting this finding as an impediment to catchment-based research is important given the expected effects of climate change on water security and the continued push for catchment and sub-catchment level management.

6.8 Contribution to the New Zealand Fish and Game Council

An informal interview was conducted with New Zealand Fish and Game Council (NZFGC) executives at the commencement of this study. It revealed a strong feeling that the organisation is portrayed as an association of ‘recreational users’ or as an ‘interest group’ with an implied focus on a narrow set of freshwater benefits, whereas they feel their advocacy benefited the wider common good of New Zealanders. The findings of this study make several contributions to the New Zealand Fish and Game Council with regard to their activity as an advocate for freshwater quality, trout and salmon fishing, gamebirds and the wider protection of habitat. The findings from the first survey showed that the Fish & Game stance on the current state of the Tukituki River catchment and their vision for the future state of the catchment are aligned with those of the public. It also shows that the perceptions of its local fishing licence-holders are largely indistinguishable from those of the wider public and are aligned with the NZFG advocacy activity.

The NZFG provided significant legal funding to support the Hawke's Bay Fish & Game Council as a lead advocate in the Board of Inquiry and as a High Court appellant in the deliberations delivering Plan Change 6. The non-market valuation of improved water quality in the catchment was based on achieving the targets contained in Regional Plan Change 6 by the 2030 deadline. The aligning of the valuation scenario with the policy document and the ten-year time payment horizon to 2030 gives the NZFGC some basis on which to conduct an internal calculation regarding a non-market return on their advocacy expenditure. Modelling catchment user's trust was intended to give the NZFGC a nuanced understanding of trust across other relevant organisations and should provide some metrics that may help inform future activity.

6.9 Contribution to the literature

The major contribution that this study makes to the international literature is through the use of trust welfare scores to model a social trust economy. To the author's best knowledge, Erdem (2018) is the only published paper currently that applies best-worst scaling to the measurement of public trust. This study, therefore, makes a significant contribution to the trust literature by advancing the use of this technique. Once again, to the author's best knowledge, the use of individual Bayesian trust scores to model a social trust economy is an entirely novel approach to trust modelling. The results suggest this technique has the ability to be applied widely across a number of fields outside of natural resource management. In particular, it may hold potential in the disciplines of political science and commerce. In this thesis (see section 6.4.1), the Advocacy Coalition Framework (ACF) of Sabatier (1987) is used to underpin the discussion of the social trust economy (STE). There seems the possibility to develop a relationship between the unobserved STE of a policy system and the observed political economy of the ACF. A relationship between the two need not be predicated on the assumption that observed coalitions should reflect the STE. Discordant coalitions may well exist, however, given the long-running nature of ACF policy systems, the underlying STE may relate to coalition longevity and/or success. The exploratory modelling of the relationship between the utility of social trust in organisations involved in the freshwater policy system and the marginal welfare of improved water quality, also appears to be novel. Although there was no useful model output, it has raised further questions about the role of trust in willingness to pay.

The contingent valuation of marginal welfare associated with improved water quality in the Tukituki River catchment makes a contribution to the New Zealand non-market valuation studies. It also makes a timely contribution by applying the contingent valuation method after a period in which it appears to have been passed over in favour of discrete choice experiments. The welfare estimate is very robust to sensitivity testing for outliers, and its magnitude fits well within the bounds of other comparable studies. Although discrete choice provides more granular values that allow managers to choose environmental improvements that yield the most cost-efficient welfare gains, they apply an anthropocentric 'recipe for success' to a complex ecological system. Whilst this serves economic efficiency, it may not serve societal expectations of ecological resilience. By revisiting contingent valuation in the New Zealand setting, it is hoped that this will encourage other researchers to reconsider this flexible, cost effective and holistic valuation method. Particularly, it may hold the best hope for incorporating a portion of Māori cultural values as demonstrated by Awatere (2008).

This project was funded by Fish and Game New Zealand to help contextualise their role in freshwater advocacy against the wider societal wellbeing. Consequently, special attention has been given to understanding angler and hunter perceptions as compared to those of other catchment users. Little or no literature exists to date comparing the common good vision of interest groups with the general public. Little evidence exists of literature modelling the evolution of a population's perception heterogeneity over two related resource scenarios.

6.10 Chapter summary

In summary, the negative perceptions of the Tukituki River catchment's current state conform broadly with public opinion about the generally poor state of waterways in New Zealand. The respondent's desire for a future where swimming has a low risk to health, there are higher summer flows, and greater native biodiversity, are also broadly consistent with the findings in non-market valuation literature. There was little or no difference between the environmental perceptions of *Fishers* and *Non-fishers*. When contrasted with the literature, this showed that although catch-related factors have an elevated interest for anglers, they also hold a concern regarding water quality and biodiversity commensurate with other users.

Convergence towards a near common vision for the future state of the catchment, underpinned by improvements to water quality, means agricultural users would likely be financially worse off. They would either lose income from a reduced capacity to crop, incur the cost of adapting their farming practices, or the cost of on-farm water storage. They may also suffer a capital loss in property value due to the reduced value of their water rights. This reduction in welfare can be contrasted with the concentrated benefits gained from the productive use of catchment water and the adverse effects of agricultural production. Nonetheless, there is a wider public liability to correct the relative overallocation of surface water by the regulator. As a result, the public should be contributing to water quality improvements. Comparing the results with current policy in the study area showed the regulatory and non-regulatory responses to water quality problems appear aligned with the common good vision. Successful delivery will, however, depend on adequate resources and effective implementation of policy. The level of catchment and environmental engagement among respondents to the first survey points to a self-selection bias. The sample, therefore, can be regarded as representative of catchment users only and not the general public.

There is a household mean willingness to pay (WTP) of \$6.67 per month (\$80.04 per year) for the next ten years to improve water quality in the Tukituki River catchment to a level commensurate with successful delivery of current policy. Although the sample exhibits self-selection and has a very high catchment engagement rate, the mean WTP was very robust to the removal of outliers with trimmed means of 5, 10, and 20% creating a maximum difference of three cents from the mean. WTP was of similar magnitude to other comparable studies although it was not tested for issues of scope or part-whole bias. Starting point bias has likely played some part in the payment elicitation technique, however, 80% of bids moved off the starting point. The monetisation of water in New Zealand must be accompanied by some explanation of its narrow economic focus and its marked failings when trying to capture Māori cultural values. Moreover, when efforts are made, they should be considered as representing only a fragment of Māori values.

Best-worst scaling proved an effective technique for measuring social trust in organisations involved in the water quality policy space. Estimation of individual

Bayesian utility scores followed by a correlation analysis revealed a novel STE based on the flows of social trust stock. The ACF of Sabatier (1987) provided an ideal structure with which to discuss the STE in a natural resource setting. The STE appeared to accurately map the known political economy in the study area policy space and has the potential to provide insights at a national level. Of particular concern was the relative social trust isolation of Māori, whilst of particular interest was the ability of the New Zealand Landcare Trust to hold stocks of social trust with both pro-agriculture and pro-environment groups. Although the latter may be associated with the Landcare Trust's ethos of not engaging in debates surrounding policy formation. It is postulated that the STE could provide a valuable addition to the Advocacy Coalition Framework by enabling the identification of latent social trust coalitions and relate to coalition performance.

This study has contributed to natural resource management by delivering a detailed picture of the current perceptions and future vision of the Tukituki River catchment held by its users. It provides insight into the typologies of individuals holding common views about the catchment and through demonstrating a convergence towards a common good vision. This will help inform future stakeholder engagement and management decisions. The contingent valuation has provided managers with a monetised value for the marginal welfare of the improved water quality to be delivered through the regional plan by its 2030 deadline. This will allow managers to assess this aspect of value with other productive uses in a common metric. Estimating the welfare associated with trust in organisations involved in the freshwater policy system has provided a detailed picture of a social trust economy. This has provided insight into a fractured and siloed economy of social trust and has helped identify barriers to developing a common good approach to freshwater management. It has also shown there is no useful predictive relationship between trust in organisations and WTP for improved water quality. This means managers should look towards motivations for WTP outside of an individual's alignment with a particular organisation. The following chapter draws conclusions from the analysis and discussion of results and offers recommendations based on the study findings.

7 Conclusions and recommendations

The aim of this research was to factor community welfare estimates into freshwater allocation decision making in New Zealand. The findings of this study support this aim by providing new understanding. It has evaluated aspects of the common good of freshwater in New Zealand and determined preference heterogeneity in the Tukituki River catchment (particularly focussing on the fisher and gamebird hunter community perceptions). It has estimated the marginal welfare benefits generated by improved water quality in the study area and has estimated welfare associated with trust in freshwater advocates and policy-oriented organisations. Finally, it has determined the impact of an individual's trust in organisations on their willingness to pay for improved water quality.

The results show that the environmental interests of anglers in the Tukituki River catchment do not appear to be practicably distinguishable from those of non-anglers. The results confirm the findings of Hunt et al. (2019) regarding freshwater angler preferences for improved environmental quality, but at the same time, this study shows those preferences are largely indistinguishable from other catchment users. The research falls short of providing ethnic comparisons as the participation rates of minority groups, notably Māori, were very low.

Overall, the Tukituki River catchment was perceived to be in poor condition in terms of the state indicators of summer flows, aquatic weed growth, safe swimming, and populations of native wetland birds and native fish. The vast majority of respondents indicated that they wanted improvements in all of the state indicators. Despite low levels of uncertainty across most indicators, there was a demonstrable gap in knowledge of the current state of native bird and fish populations. There was negative sentiment from respondents towards current levels of water use for irrigation and very negative sentiment towards increasing this offtake.

Although the perceptions of *Fishers* and *Non-fishers* in the study area are largely indistinguishable, *Hunters* appear to be a separate interest group with a rural character. It is therefore not unreasonable to assert that in effectively representing the vision of sportfishing licence holders, Fish & Game will be representing the interests of a much wider user group if not the public at large. Therefore, when Fish & Game challenges the regulator, it's unique place under the Resource Management Act (1991) lends resources, organisational structure, and statutory voice to a diverse, unstructured, and significant section of the public reflective of Olsons' (1971) latent majority.

This research demonstrates a high degree of convergence in perceptions of what constitutes the common good in the study area. It is also clear that the future vision for the catchment held by the majority of respondents largely centres on public good oriented values. To achieve this vision the minority will have to bear the cost and there is evidence of a rural/urban divide with regard to a future catchment vision, but by no means is this exclusive.

Among a sample dominated by catchment users and spread across Hawke's Bay, there is a household willingness to pay (WTP) a mean $6.67 per month for the next ten years at the lower bound to $7.22 at the upper bound for improved water quality in the Tukituki River catchment. There is also a clear rural/urban divide in the mean amount willing to pay, with those living closest to urban centres willing to pay more than their rural counterparts. The difference between the two populations was chiefly underpinned by residents in Havelock North. The value placed on the catchment by Havelock North residents underscores the relevance of considering this township as part of the case study catchment population.

Best-worst scaling has proven to be a flexible and able measure of the utility associated with trust in the natural resource management sphere and has provided results that bear a close relationship with the known political economy. Rescaled mean utility scores showed the National Institute of Water and Atmospheric Research, a scientific institution, was the most trusted organisation by a substantial margin. As the regulator, the Hawke's Bay Regional Council held the fourth-lowest proportion of trust. The three pro-environment organisations, namely Fish & Game New Zealand, Forest & Bird, and the Environmental Defence Society, and the Landcare Trust, all had higher trust scores than the Hawke's Bay Regional Council. Federated Farmers, Horticulture New Zealand, and Ngati Kahungunu Iwi Inc were the least trusted organisations. NIWA and the Department of Conservation were the most and second-most trusted organisations, respectively.

The politicised and litigious water policy arena in Hawke's Bay lent itself to the Advocacy Coalition Framework. It was used to discuss the novel concepts of trust economy and latent trust coalitions. The public trust economy surrounding organisations involved in water quality management in Hawke's Bay is factionalised. The ability of best-worst scaling to provide Bayesian estimations of individual trust utility was ideally suited to the analysis of trust relationships. Analysis demonstrated clear pro-environment and pro-agriculture groups and a distinct power group consisting of NIWA, the Department of Conservation, and the Hawke's Bay Regional Council. It identifies Ngati Kahungunu Iwi Inc as being relatively isolated but with pro-environment tendencies. The Landcare Trust was in a unique position through its positive trust relationships with those trusting both some pro-agriculture and some pro-environment organisations.

A number of recommendations based on the research outcomes have been made. In order to make easy connections between the current situation, the findings of this research and recommendations, these have been collated into Table 7.1. Recommendations for the future application of the approach have been collated into Table 7.2.

7.1 Assumptions and limitations

A number of assumptions and limitations apply to this research. These assumptions and limitations, along with recommendations for future application of the approach, have been detailed in Table 7.2. It should be noted that combining two tasks with an already increased cognitive load into one survey meant that the design of these elements had to be streamlined and the number of accompanying questions constrained. The following briefly expands on several salient limitations.

The sample population for the first study was almost entirely those that visit the catchment. Clearly, those in the direct email database were catchment users and it is likely that motivation to respond to other modalities was also linked to catchment use. The first study, therefore, cannot claim to represent views of non-users. Self-selection is a feature of most surveys, and in this case, it provided insights from a highly engaged and presumably more informed sample. It is also recognised that the first study was largely about the solidarity of a forward-looking common good vision and did not test the strength of conviction by introducing trade-offs. Trade-offs were introduced in the valuation scenario of the second study.

The second study was delivered during New Zealand's Covid-19 pandemic response Level-3 partial lockdown period from 28th April – May14$^{th.}$ This directly followed the near-total shutdown of business during the four-week period 25th March – 27th April 2020 of the Level-4 lockdown. The pandemic has introduced a level of economic and social uncertainty not seen for a generation. Whilst a quarter of respondents identified the effects of the lockdown on their willingness to pay, there may be an evolving temporal effect as household confidence fluctuates due to the impacts of the ongoing global pandemic.

Despite the wide geographic dispersion, the sample for the second study was again almost entirely of those engaged with the catchment. This implies a self-selection bias in the sample.

Table 7.1 *Research Conclusions and Recommendations*

Category	Current situation	Findings	Recommendations
Perceptions of Catchment state			
Overall health	Hawke's Bay Regional Council (HBRC) acknowledges water quality is a regional issue and a management priority. They also acknowledge the rapidly rising nitrate levels in shallow bore water in central Hawke's Bay.	The overall public perception is that the catchment is in poor health.	1. That the HBRC continues to acknowledge water quality issues as a management priority.
Public Typologies	Multiple organised factions, with varying public & private good orientations, contest both the current and the future vision for the catchment. Little is known about the orientations of the wider public.	There are 5 classes of individuals with differing perceptions of the catchments current state. This converges down to 2 classes of individuals with differing perceptions of a future state in the common good. The major class (85%) has a public good orientation, and the minority class has a private good orientation. The minor class has a majority rural membership.	2. That the near homogeneity of future vision for the catchment be given formal recognition at a governance level and be documented in the regional plan. The proposed Plan Change 7 - Outstanding Water Bodies may provide a vehicle for this. 3. That comparative perceptions assessments and typologies be conducted across regions to build a national picture of catchment community heterogeneity.
Fishers	Fishers are typically portrayed in regional plans, natural resource litigations and research studies as 'recreational users' or an 'interest group'. These descriptions carry with them an implied narrow focus with regard to the benefits of freshwater.	This study finds that although fishers have a specific interest with regard to the act of fishing, this is where the nature of any narrow focus on benefits stops. With regard to perceptions of the current catchment state and a future vision for the catchment there is very little to distinguish fishers from non-fishers.	4. That specific weight continues to be given to the significant amenity values associated with freshwater fisheries including but not limited to species of trout and salmon. 5. That in advocating for the protection of the habitat of trout and salmon it is recognised by decision makers that the public vision with relation to water quality is indistinguishable from the vision of non-fishers.

Ecology	Reflective of most lowland waterways nationally, catchment ecological health has been declining.	There is an apparent public knowledge gap regarding the status of native fish and native wetland birds in the catchment. The *Biodiversity Positive* class (7.5% of respondents) stands out due to their particularly unrealistic positive ecological views.	6. That a rethink on funding, channels and targeting of information regarding the status of native fish and wetland bird populations be undertaken by HBRC. 7. That a true multiagency approach is taken to biodiversity at a catchment level.
Management			
Over the past 5 years to date	HBRC currently allocates 40% of its annual expenditure to integrated catchment management. Regional Plan Change 6 addresses water quality issues in a suite of regulatory water quality targets staged over time.	Overall public perception of catchment management is poor.	8. That timelines towards clear and observable targets that are not aspirational are communicated to the general public. 9. That any expected lag times between policy adoption, implementation and observable outcomes are made clear and are widely communicated. 10. Focus is maintained on achieving an outcome that meets both regulatory requirements and the public vision.
Non-market Valuation			
Willingness to pay (WTP) for improvements in catchment state.	HBRC has sequentially increased regional taxation in the name of improving water quality. Nothing is publicly known about further household willingness to pay for the benefits of improved water quality.	Household mean WTP for the described improvements to water quality is $6.67 per month for the next ten years.	11. The mean and median WTP is considered in conjunction with resource requirements for meeting the public vision for the catchment.
Geographic difference in WTP.	Nothing is known about the geographic spread of WTP. HBRC rates have a degree of nuance reflecting presumed household affluence.	Mean WTP was highest in Havelock North. Overall Mean WTP was higher in urban centres than rural.	12. That any nuanced adjustment of regional taxation takes into account variation in community WTP.

Use of Contingent Valuation Method	The Contingent Valuation Method (CVM) has fallen out of favour in New Zealand as the international trend towards discrete choice experiments (DCE) has grown.	The CVM has proven to be an effective method of soliciting WTP and has not suffered from bid largess.	13. That given a relatively homogenous public vision and low level of litigation a holistic whole-of-catchment approach to valuation be revisited by institutions as an appropriate tool to assess WTP in New Zealand.
Trust			
Trust utility	Nothing is known publicly about the level of community trust in organisations involved in the catchment water quality space other than what is demonstrated by the observable political economy.	Scientific institutions hold the largest share of public trust with *NIWA* holding nearly twice as much as the second highest rated organisation.	14. That *NIWA* and *DOC* are vigorously and visibly active submitters in water policy deliberations both nationally and regionally. 15. That the role of *NIWA* and *DOC* as submitters on the public's behalf is insulated from political influence. Given *DOC* is a government department this is inherently problematic.
		Public trust is heavily factional and demonstrates a pro-environment group, pro-agriculture group and a statutory-power group.	16. Further research be conducted on the natural resource trust economy in different regions and with different natural resource scenarios.
		Trust in *IWI* was demonstrated to be isolated from trust in Crown entities *NIWA*, *DOC* and *HBRC*.	17. Multiagency approach to engagement with tangata whenua using co-managed research programmes that recognise mātauranga and addressing agreed concern(s) reported in Te Mana o te Wai (2019).
		LCT holds a unique position with positive public trust relationships with both pro-agriculture and pro-environment.	18. *LCT* be approached and have their operative methodology studied to identify the traits that enable cross partisan trust.

Trust & WTP	There is no understanding about the relationship between public trust utility and WTP for improved water quality.	No useful predictive relationship between WTP and trust scores.	19. That for practical purposes WTP for improved water quality in the catchment is viewed as essentially independent of influences that may be attributed to any particular organisation.
Communication	There are many active conservation/restoration and biodiversity oriented groups in Hawkes Bay communicating chiefly via electronic media.	The public feels information about water quality in the catchment is not well communicated and they feel particularly strongly that information about populations of native wildlife in the catchment are not well communicated.	20. That a multiagency approach, inclusive of Ngati Kahungunu, be taken to not only share but promote agreed and qualified information about the state of water quality and native wildlife in Hawke's Bay catchments.
		The public feels more information about the state of catchments would make them more trusting of the taxes charged by the authorities managing them.	21. That the HBRC treat improved flow of information to the public as a key strategy to improving public trust and a necessary companion to increased taxation.
General Findings			
Data availability	There are no apparent catchment level data for demographics or household data.	Comparing catchment survey sample demographics with the target population is not possible and those of the wider Hawke's Bay population must be substituted.	22. In light of the increased focus on management at a catchment and sub-catchment level it is recommended that: a) A national review of regional council catchment data collection practices be conducted. b) A national standard for catchment-level data collection be formulated and adopted.
	The Regional Council has no catchment or sub-catchment level data on integrated catchment management expenditure.	There is no ability to use expenditure and outcome data in catchment research.	

As no variable was included in the second survey to identify environmental orientation, there is no indication of self-selection based on affinity for the environment nor of warm-glow bidding. It must be assumed, therefore, that the level of engagement with the catchment indicates self-selection and that the sample population of the second survey may well have the same level of environmental affinity as the sample in the first survey. The effects of both self-selection bias and warm glow bidding are embedded within the welfare estimates for improved water quality.

When inferring the outcomes, it must also be noted that there was a much higher proportion of respondents in the 50-65-year-old age group than the general regional population.

7.2 Future research

In order to build a national picture of catchment community heterogeneity, a comparative analysis of current perception and future vision typologies should be conducted across regions. In particular, catchments that are partially or fully urbanised should be contrasted to pastoral agricultural landscapes. This would help to contextualise the apparent rural-urban divide evident in this study. Firstly, it will test if dichotomous classes persist in the future state visions of other catchment communities. Secondly, it will test if the proportionality of the classes changes along a theoretical continuum from an entirely rural catchment to an entirely urban catchment.

The effect of taking a citizen's perspective on which organisation best represented a catchment management vision in the common good, caused Fish & Game to lose support and HBRC to gain support. It would be useful to investigate if *Fishers* perceive their personal management vision as 'selfish', and what cognitive drivers, if any, altered between a personal and citizen perspective. This is particularly so given their perceptions of the catchment's common good future did not differ from other non-fishing catchment users at the $p<.05$ level.

Public trust is a form of social capital. However, quantification of its stock, and analysis of its flows are new to natural resource management. In order to further test and extend the concept, research should be conducted in different regions and with different natural resource scenarios. A study repeated across nations with similar institutional arrangements, such as Australia and Canada, would provide a useful international test. It would also offer insight into the public trust positions of indigenous cultures in other countries.

Table 7.2 Assumptions, Limitations and Recommendations for Future Application of the Approach

Approach to data collection	Assumptions	Limitations	Recommendations for future application
Survey 1	Inference to the general population is limited by: 1. A selected bias of sportfish and gamebird licence holders. 2. A self-selection bias of respondents to social media and mail-drop.	The high proportion of environmental oriented respondents means the sample can only be characterised as representative of catchment recreational users and not the wider public.	1. The mail-drop proved to be a high cost with a relatively low return. If funds are very limited this should be excluded in lieu of researcher administered social media.
Survey 2	The sample is representative of the Hawke's Bay general public.	Inference to the general population is limited by a self-selection bias inherent in social media surveys.	2. That questions designed to identify respondent orientations that may bias responses be regarded as essential when reviewing survey length.
		There is no ability to determine potential biasing orientations within the sample, other than being a catchment user.	
		High rates of non-response of non-users of the catchment.	3. If funding and public health conditions allow, face-to-face surveys be conducted in an effort to increase the representation of catchment non-users.
	That the level 4 & 3 lockdown periods likely had some effect on survey answers.	That the effects of the Covid-19 pandemic on responses is unknown beyond those stating it impacted on their WTP bids.	4. Surveys delivered during the Covid-19 environment should provide a mechanism for recording the effects of social stress on elements such as attitudes towards the environment.
		There is no way to know if the WTP would be further impacted by the worsening economic effects of Covid-19.	5. Follow-up surveys be used to assess the effect of economic stress on WTP for environmental goods.

Quantitative approach	That responses are a truthful representation of individual perceptions.	The truthfulness of responses is limited by the researcher's understanding and ability to identify protest and strategic responses.	6. That survey logic is used to test the underlying reasons for those respondents delivering a set of extreme answers to a series of Likert questions. That the questions for the above be placed at the end of the survey so as not to introduce bias.
Perception measurement with Likert scales	That a 5-point Likert scale provides enough variability to define respondent preferences.	Use of a 5-point Likert scale may have constrained the variability of responses.	7. That a 7-point Likert scale be used in a similar study to test for any meaningful nuances not revealed by the 5-point scale. This may be especially so for the variables with high levels of neutral responses.
	That the Likert items used in the survey fulfilled the requirements of a Likert scale suitable for parametric analysis.	The suitability of the Likert scale is reliant on the objective judgement of the researcher.	8. That care is taken to ensure Likert items are truly related in both presentation and theme.
Marginal welfare estimation with Contingent Valuation	That all respondents understood the information and framing of the two scenarios and interpreted their differences in the same way.	Respondents facing information novel to them were not able to access additional information outside that contained in the infographic.	9. Given adequate funding and/or researcher skill with the html computer language, an interactive infographic could be used. In this study it may have been helpful if hovering over each attribute image produced a pop-up of additional explanation.
	That bids are a truthful representation of respondent's marginal willingness to pay for improved water quality.	The truthfulness of responses is limited by the researcher's understanding and ability to identify protest bids and test for non-attendance to cost.	None
	That individual WTP conforms with economic theory.	WTP was constrained to a singular and very specific improvement scenario from the status quo. There was no test for scope effects.	12. That a second scenario with further improvement be added and valued in order to test for scope effects and the subsequent compliance with economic theory.

		A part-whole bias may inflate WTP for this catchment relative to other catchments in the region.	13. A second survey be done to elicit a region-wide WTP with mechanisms for apportionment of payment or trade-off across catchments.
Trust utility estimation with best-worst scaling	That trust in the sphere of natural resource management has a basis in utility theory.	It is likely from the modelling of Hamm (2017) that trust also has a dimension based on attitude which is not fully explored in this study.	14. That a study be done solely focussed on trust in organisations and that this have specific attitudinal questions to complement the best-worst utility estimation.
	That the trust/utility relationship conforms with utility theory in that increased perceived utility produces increased trust.	The level of utility expected by respondents in return for their trust is not explored in this study.	15. Further exploration of this will be required if trust and utility are to be linked through utility theory.
	That each respondent has chosen the best item among those in the choice set and then independently chooses the worst item.	Respondent choices may not truly be independent.	None
	That the list of organisations is a valid representation of those involved in the freshwater policy space.	The choice item list was limited to only 10 organisations in order to conform with Bayesian design requirements whilst constraining overall survey cognitive load.	16. A study solely focussed on trust will be able to represent more organisations in the choice experiment without risking respondent fatigue. 17. That care is still taken to meet the choice set requirements for Bayesian estimation of choice scores.
	That respondents have enough information to make non-random choices.	Some of the organisations were unknown to some respondents. Given the low proportion of non-random responses it is almost certain that simplification strategies were used. It is likely these were based on inferences taken from the names of organisations.	18. Respondent could be offered to read more information on each organisation as a link or pop-up option. Care should be taken not to increase cognitive load in an exercise recognised for its low cognitive load.

Investigation into trust in the natural resource management setting, with regard to both its origins within the cognitive hierarchy and its dimensionality, would assist in identifying the tractability of trust. This may offer insights into avenues of suasion and mediation strategies. This would benefit catchment managers by helping to identify pathways most likely to build trust, generate community buy-in, and navigate conflict in the face of policy change.

Given the relatively isolated position of Māori trust stocks and the negative relationships with trust in Crown entities, it would be beneficial for a Māori-pakeha co-managed research project to be undertaken to determine how the concept of a social trust economy relates with tikanga Māori. This may provide valuable information for the interpretation of social trust economies in New Zealand. It may also provide an international reference point for similar co-managed studies with indigenous cultures of other colonial nations.

Conceptualising trust-as-choice with an expectation of benefit is relatively novel and a departure from the dominant trust-as-attitude concept (Hamm, 2017). Whilst the results of this study appear logical and conform largely with *a priori* expectations, clarification that utilities based on trust-as-choice conform to utility theory and general economic theory will be required in order to establish a strong theoretical base for ongoing research. This would need to firstly establish that trust is sensitive to alterations in the perceived benefits that it offers, and secondly that trust and perceived benefits are directly and positively related.

7.3 Final remarks

This study has provided a suite of investigations and outputs that may be viewed by funders, decision makers, and managers as either individual consultancies or as a single linear piece of work. The case study approach means the output is well contextualised to time and place, allowing readers to assess its level of applicability to other locations. Therefore, it has made a valuable contribution to the broader body of knowledge in the discipline of natural resource management. It has provided fresh insight into perceptions of the Tukituki River catchment's current state and defined the community's vision for its future in the common good. It has given new insight into perception typologies within the catchment's community and has provided an estimate of the marginal benefits of improving water quality in line with the regional plan. The non-market valuation has contributed to the body of New Zealand literature on non-market valuation. The application of a relatively new approach to quantifying trust and the novel modelling of a social trust economy has made a contribution to both the natural resource management and trust literatures. Finally, the exploratory analysis showing there is no useful predictive relationship between trust in organisations and willingness to pay for improved water quality has made a novel contribution to the fields of ecological and environmental economics and trust.

This case study has revealed unhappiness among recreational users with the current state of the Tukituki River catchment, a near consensus on a future vision of its management in the best interests of both current and future generations, and a willingness to publicly fund change. It has also shone a light on deep divisions in public trust that must be negotiated in order to achieve that vision. Being representative of agricultural catchments with summer water scarcity, it is likely the social trust economy from this study, along with the issues it identifies, can be extrapolated to other similar catchments elsewhere in New Zealand. I have chosen to end this thesis with the following quote:

> "The secret of change is to focus all of your energy not on fighting the old but on building the new" – Socrates

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Appendix A - Extended review of hedonic pricing, averting expenditure, cost methods, deliberative monetary valuation, and benefit transfer

A.1 Hedonic pricing

With a focus on private good values, White et al. (2001) applied hedonics to the value of groundwater on the Waimea Plains, Nelson. They use the expected drop in land value (based on government valuation data) from a 100% reduction in abstraction to model the marginal value of water to 260 irrigators on the Waimea Plains. The mean land value would drop by \$8,127 ha^{-1}, which factored out to a marginal value of \$240-\$300 per cubic meter or \$38 million to \$48 million. The value of commercial extraction was similarly calculated at \$178 million using business values with and without access to groundwater. Grimes and Aitken (2008) analysed sales price, property valuation, and resource consent data in the Mackenzie Basin against a variety of variables, including access to irrigation water. They found a consent to extract water had a significant positive effect on farm values. Both of these applications estimate the value of water to a very narrow section of society and ignore non-use values. They do, however, illustrate the substantial windfall gain that comes with a successful abstraction consent under New Zealand's first-come, first-served system of freshwater allocation.

The use of house prices to estimate values for environmental goods has the advantage of larger and more active markets than those for farms and businesses. House prices can also be used to value the amenity associated with a range of different water bodies and amenity attributes (Chen, 2017; Leggett & Bockstael, 2000; Mahan et al., 2000; Woodham & Marsh, 2011). Woodham and Marsh (2011) analysed approximately 1200 property sales from 2005 to 2010 across four lakes in the Rotorua Lakes district. Properties were included if their boundary was less than one kilometre from one of the lakes. They found a positive relationship between water clarity, measured using a Secchi disk, and property value. A one-metre improvement precipitated an average seven percent increase in sale price. In a later study, Mueller et al. (2016) applied Woodham and Marsh's (2011) seven percent rate very broadly to 2012 house prices at Lake Rotorua. A somewhat simplistic seven percent multiple of all Rotorua house sales in 2012 was taken to estimate a bundled proxy amenity and aesthetic value. A \$16-\$19.1 million-dollar annual value was estimated. Whilst Woodham and Marsh (2011) estimated a water quality value, it was one dimensional and did not capture welfare associated with changes in the level of other attributes such as chemical or bacterial pollution.

Chen (2017) studied variation in urban property prices in Guangzhou, China, with improvements in water quality to their nearest river section. She included waterway recreation as a proxy for chemical and bacterial pollution, albeit only for a difference between water that was unsafe for any recreation to water safe for non-body contact recreation. Chen (2017) found only a 0.9% increase in property price for this quality change, which likely reflects a lack of utility associated with non-body contact recreation. In contrast, she found a 4.61% increase in property price where a waterway had riparian planting. This was five times the increase for the change in recreation status and showed that the visual enhancement had much higher utility than the level of 'enhanced' recreation on offer.

A focus on the effects of bacterial contamination on property values was modelled by Leggett and Bockstael (2000). They demonstrated a significant correlation between waterfront property values in the Anne Arundel County and water quality in Chesapeake Bay. They analysed waterfront sales between 1993 and 1997 and modelled projected values for a hypothetical decrease in faecal coliform counts and estimate a 2% increase in property value. Chesapeake Bay had characteristics ideal to hedonic application as the number of waterfront properties was high, the market was active, and faecal coliform counts varied widely over the area. Like Woodham and Marsh (2011), this study also has a very narrow focus on recreation and fails to capture welfare associated with other freshwater attributes.

A more generic approach was taken by Mahan et al. (2000) when they assessed urban property prices in Multnomah County, Portland, Oregon. Their metric was property price relative to the size and proximity of the nearest wetland. They found a $24 increase in price for each one acre increase in wetland size and a $436 increase for a 1,000 foot decrease in distance to the wetland. They found prices related to proximity were not influenced by the type of wetland. Mahan et al's. (2000) use of wetland proximity and size also means welfare capture is limited. By not specifying any wetland quality attributes, it remains unclear what aspects of amenity underpin the utility revealed by increased house prices.

In a more unusual application of hedonic pricing, Laitila et al. (2018) focused on the recreational amenity value of fishing and analysed Swedish property prices where fishing rights are embedded in the property right. Their application found a common asset held both by land used for primary production and land used for recreation. They found land with fishing rights was, on average, €6300 or 4.5% more valuable than land without. This premium, however, dropped by 83% if the land was predominantly used for agriculture or forestry. Laitila et al. (2018) concluded that protecting fish habitat, and its potential for income, may not be a financial priority for forest and farm owners compared to the commercial yield from the land. Whilst there is an inference between 'protecting fish habitat' and water quality, the approach has a narrow focus solely on the marginal value to fishers.

A.2 Averting expenditure

Spending money to avert the health consequences of consuming unsafe water is a burden on many households worldwide. As Orgill-Meyer et al. (2018) found, perceptions of health risk are enough on their own to drive averting behaviours. Orgill-Meyer et al. (2018) compared contingent valuation and averting expenditure as techniques for estimating the demand for improved reliability in the water supply in Jordan. They found that although tests suggested the drinking was reliably safe, this was contrary to public perceptions. Approximately 4% of household spending was on averting expenditures like purchasing bottled or tanker water or home water treatment. By comparison, contingent valuation elicited a very low willingness to pay for improved municipal water supply, and so the averting expenditure was not the lower payment bound. Orgill-Meyer et al. (2018) interpreted this as reflecting low confidence in the provision of municipal drinking water. This was because their contingent valuation scenario failed to address public concerns over municipal water quality and instead offered only an improved continuity of supply. Therefore, it is likely that averting expenditures failure to be the lower bounded estimate is due to the inappropriate framing of the contingent valuation scenario.

Averting expenditure is a technique that blends well with spatial analysis to give a more granular picture of welfare, as shown by Wrenn et al. (2016). They assessed averting expenditure in Pennsylvania counties where shale gas extraction, using the ground fracturing process known as fracking, was occurring. Using bottled water purchase as a proxy for averting expenditure and GIS data of shale gas sites, Wrenn et al. (2016) found that expenditure ranged from $10.74 to $15.64 and aggregated across these counties to

$19 million for the 2010 year. By applying spatial analysis, they found that rural households more reliant on groundwater were likely to have a higher yearly expenditure. This meant that they were bearing a higher cost of the perceived environmental impact from shale gas extraction on water quality.

Averting expenditure can also be applied at scale if similar averting behaviours are demonstrated across many different communities, as shown by Robak and Bjornlund (2018). They used an electronic survey to look at averting expenditure and the quality of reticulated municipal water supply in New Zealand. They found that nearly 50% of consumers spend money on averting behaviours such as bottled water purchase. They found households spent $184 pa or an aggregated $280 million on potable reticulated water supply averting behaviour. Households spent $74 pa boiling water, $44 filtering, $52 storing, $8 sourcing better water, and $6 adjusting the pressure. They also found that lower income households spent the most. It must be noted that the reasons for aversion were not just based on water quality. Respondents also spent money augmenting their volume of water.

A.3 Cost methods

The replacement cost approach requires an accurate estimation of the cost of built capital needed to substitute the ecosystem service. For example, Kirkland (1988) estimated the value of flood protection provided by the Whangamarino Wetland as part of the Lower Waikato-Waipa Flood Control Scheme by calculating the cost of alternative flood control works. He takes the estimated capital and maintenance cost of providing equivalent flood protection with new stopbanks. Using an arguably very high 10% discount rate over 50 years, Kirkland (1988) arrived at a present value for the flood control of $9 million (1987 dollars). It should be noted that Kirkland's build and maintenance cost estimates appear to have been sourced from just one individual and so are not peer reviewed.

The compensation approach requires estimating the financial cost of negative outcomes if the ecosystem service was no longer available. For example, Watson et al. (2016) estimate the flood mitigation value of the Otter Creek floodplains and wetlands to Middlebury, Vermont. They modelled the potential impact of Tropical Storm Irene and nine other flood events by quantifying avoided damages to buildings. Damage to infrastructure, farmland, and business interruption was not included in the estimates. Using three levels of flooding scenarios, the average value of flood mitigation across the ten events was estimated to be between $126,000 and $450,000 pa. For tropical Storm

Irene alone, it was between $627,000 and $2,000,000. The average damage reduction was estimated to be between 54-78% across the ten events, with the greatest reductions being for smaller events. Watson et al. (2016) used net present value calculations applying discount rates ranging between 0.9% and 7% to derive a return on the wetland's conservation. Based on the site's potential land value, the return on their conservation ranged from 12% to 95%. The vastly different rates of return show how prone cost methods are to the choice of discount rate. The higher the discount rate the less value is attached to future costs and benefits, and the greater the emphasis on near term events. It also shows that even when valuing a singular ecosystem service, benefits are only partially captured if the initial terms of reference ignore some sectors of the economy.

In a bid to capture a wider set of costs, Foote et al. (2015) applied what was essentially an abatement cost approach to value wide ranging externalities associated with dairy farming in New Zealand. These included removal of nutrients from rivers and lakes but also included soil compaction as well as the forecast cost effects of a greenhouse gas emissions tax, and the possible effects pollution would have on New Zealand's export image. They concluded that the external costs of dairy production in New Zealand would exceed the $16.6 billion export value of the dairy sector. Given a number of gaps in the required data and a high degree of site-specificity a number of estimations and generalisations were required in order to arrive at cost estimates. At times the error in these estimates is compounded when they are applied as factors and again when they are aggregated. It is likely the intent (and greatest value) of such studies is their ability to grab attention, raise public awareness, and generate debate in much the same way as Costanza et al. (1997) (see section 2.4.5).

The widely varying site-specificity, cost of substitute ecosystem services with built capital, and the value of assets protected, makes generalising cost-based values challenging. In an attempt to create an index of cost-based values in a common currency, Brander et al. (2013) conducted a meta-analysis of four hundred wetland valuation studies. This was reduced to just thirty-eight studies with directly comparable estimates. Concentrating on flood control, nutrient cycling, and water supply value estimates for wetlands in agricultural settings, they established a database of sixty-six estimates and standardise them to $USD per hectare per year. The majority of estimates were from the USA and Europe, but many were also from developing nations. No estimates were from Latin America, most of Asia, and Oceania.

The most common method used in the studies was the replacement cost of regulating services with human-made infrastructure such as flood control schemes or water treatment, followed by damage cost avoidance. Brander et al. (2013) found significant differences existed between mean and median values. For example, flood control had a mean value of $6923 and a mean value of $427 USD/ha/yr, water supply had a mean value of $3389 and a median value of $57 USD/ha/yr, and nutrient cycling had a mean value of $5788 and a median value of $243 USD/ha/yr. The stark difference between mean and median values reflects the differences in built capital between developed and developing nations as well as the heterogeneity of site characteristics.

There was a positive population effect where wetlands near larger populations had higher values. This is logical, given the larger amount of capital at risk and higher dependence on water supply. Brander et al. (2013) developed a value function to account for explanatory variables and then used this to conduct benefit transfer (see section 2.4.5) to estimate the global value of wetlands at approximately $26 billion USD/yr. The more nuanced approach offered greater accuracy, but ultimately, the approach requires considerable generalisation of values. The exclusion of values from such a large portion of the world also brings into question the validity of applying the final benefit function globally. Once again, the final result should be viewed in the same context as Costanza et al. (1997) (see section 2.4.5).

Similar to cost methods are productivity and market price methods. The productivity or 'net factor income' estimates the value of commercial goods produced from the ecosystem at a particular site (Birol et al., 2006). It uses estimates of production costs and demand for outputs and is very applicable to water use in irrigation, industry (including fishing), and municipal supply. It is attractive because of the relative ease of obtaining real market data; however, it does not capture any non-use values, or any externalities associated with the production process.

The market price method relates price to the opportunity cost of the water through a demand function (Birol et al., 2006). It can be applied to water consumption by examining the market price of water rights. This may be a short-term lease of these rights or their sale and permanent transfer. It has the same site-specific commercial applicability and benefit of real-world willingness to pay as the productivity method and can also be applied where rights are purchased for environmental gains. It does, however, rely entirely on the market, and so presumes perfect competition and that the price reflects the total cost.

A.4 Deliberative monetary valuation

Álvarez-Farizo et al. (2007) applied DMV using a market-stall approach in conjunction with choice modelling to a water quality management case study of the Cidacos River in Navarra, Spain. The study group had three separate sessions, each with discussion and the same choice model administered at the end. The first session was completed individually and focussed on the river's contribution to personal wellbeing. The second session, also completed individually, focussed on the river's contribution to community wellbeing. The third session replicated the first two sessions but was completed as a group. They found little evidence to support a difference in outcome from framing participant perspective or group response.

Vargas et al. (2016) apply DMV, in conjunction with contingent valuation, to forest conservation in Columbia. They also instituted multiple sessions like Álvarez-Farizo et al. (2007), except that a moderator was absent. They found that DMV had the most impact on the WTP values when decisions were made collectively and publicly. The authors reinforced concerns that drivers of social conformity may have influenced the deliberative democracy within the group sessions such that those with opinions considered outside of current social norms may have had their opinions diluted or excluded entirely. Vargas et al. (2016) suggested that using a moderator for the sessions could have alleviated this.

DMV can integrate well with contingent valuation (CV); however, the basic principles of the underlying valuation technique must still be followed. Kenter, Jobstvogt, et al. (2016) use DMV with CV to estimate values for proposed marine protected areas in the UK. The CV scenario was delivered in a block to marine anglers, divers and snorkelers, and characterized sites with attributes in a way reflective of choice experiments. They compared results from an online CV survey with those of a series of deliberative workshops that included the same CV exercise. In the first workshop round, they used narrative to present the background of the study area and a wider discussion on marine landscapes and biodiversity. In the second round, they introduced transcendental values[29]

[29] Transcendental values are conceptualised as those that transcend individual values and are characterised as those values that have a moral regard for others. They are often associated with ethics and normative beliefs about what is part of a desireable life. These values are often shared among a community or culture

and wider life goal aspirations as guiding principles for deliberation. In each workshop, participants first had to decide on WTP as an individual and then use group discussion to arrive at a collective decision on WTP. In all, the CV exercise was repeated five times. They found that individual WTP after transcendental deliberation was lower than individual online WTP. They also found little difference between online responses and post information individual deliberation after round one of the workshop. Group valuations were also lower than online individual WTP.

Kenter, Jobstvogt, et al. (2016) used a voluntary donation to a management trust as the payment vehicle for the online survey, which, although recommended by their focus groups, goes against contemporary guidance for contingent valuation (Johnston et al., 2017). It is usual for the payment vehicle to be compulsory to satisfy the incentive compatibility criteria for payment elicitation (Mitchell & Carson, 1989). The authors were unclear about how well insulated workshop participants were from comments and suasion by other participants during the background information round and prior to their individual WTP bids. It is possible that individual bids were moderated towards the perceived emergence of a social norm within the group. This influence would not have impacted online respondents.

A.5 Benefit Transfer

To test the efficacy of a pooled benefit transfer model, Morrison and Bennett (2004) conducted choice modelling studies of improvements to use and non-use values of five rivers in New South Wales and then compared their welfare values. In all, seven different populations were targeted, one from inside each catchment and a population outside the catchment for two of the five sites. Morrison and Bennett (2004) found that welfare values were significantly different across catchments for those living within the catchment but that the pooled model provided statistically equivalent estimates for the two populations outside of the catchment. Therefore, they conclude that primary data is less critical for the assessment of mainly non-use values held by populations outside of catchments.

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and may not be explicitly expressed but held as latent or underlying values. Kenter, J. O., O'Brien, L., Hockley, N., Ravenscroft, N., Fazey, I., Irvine, K. N., Reed, M. S., Christie, M., Brady, E., Bryce, R., Church, A., Cooper, N., Davies, A., Evely, A., Everard, M., Fish, R., Fisher, J. A., Jobstvogt, N., Molloy, C., Orchard-Webb, J., Ranger, S., Ryan, M., Watson, V., & Williams, S. (2015, Mar 01). What are shared and social values of ecosystems? *Ecological Economics, 111*(C), 86-99. https://doi.org/10.1016/j.ecolecon.2015.01.006 .

The need for a good match between the site and demographic characteristics is made clear in applications by Kerr and Woods (2010) and Kerr and Sharp (2003b). Kerr and Woods (2010) estimated the value of big game to recreational hunters in New Zealand. Since very few local studies existed, they used primary data from sixty-seven study sites, mostly from the United States and Canada. They found that hunting trips in New Zealand had values below those found in the comparable international studies. They also found that weighting had a strong effect on both point transfers and meta-analysis models. Even when sites are geographically close, populations may be heterogeneous making the transfer of values difficult. Kerr and Sharp (2003b) tested the transfer of CV values across two sites studied in Auckland. They found that the use of point estimates could produce very biased results and that pooled models showed potentially large errors could arise when transferring benefits between sites, even in near ideal conditions.

Efforts can be made to compensate for transfer error by introducing transfer functions and regression models. However, this is also fraught with sources of error. Vista and Rosenberger (2013) analysed 140 sportfishing valuation studies across the United States and Canada using differing meta-regression models to adjust for within-study dependency[30] and generate values for benefit transfer. They found that transfer estimates and errors varied depending on the regression model applied.

In applications where accuracy is not the primary goal, benefit transfer can provide useful values even though they are valid in only the broadest terms. Patterson and Cole (2013) applied rapid assessment BT in a fashion after Costanza et al. (1997) to value New Zealand's land-based ecosystem services on a national scale. Like Costanza et al (1997). the non-market estimates were coarse and typically just fixed value transfers of mean WTP from primary studies. These were sourced nationally and internationally with some effort to translate international values. Costanza et al. (1997) can be viewed as a call to action with a singular aim of trying to shock global sentiment regarding the value of nature. Patterson and Cole (2013) look to strike the same chord with a figure of $57 billion (27% of GDP) for the annual contribution of land-based ecosystem services to national welfare in New Zealand.

[30] Vista and Rosenberger (2013) defined 'within-study dependency' as point values derived from the same sample and as such originating from the same underlying data. This compares to studies where multiple point estimates are reported using two or more sets of underlying data.

Appendix B - Surface water quality limits, targets, and indicators for the Tukituki River catchment

Table 5.9.1A: Surface Water Quality Limits and Targets[18] for the Tukituki River Catchment – Catchment Wide

Parameter	Limit or Target
Temperature	The temperature of the water shall be suitable for sustaining the aquatic habitat.
Dissolved Oxygen	The concentration of dissolved oxygen shall exceed 80% of the saturation concentration except in areas of groundwater upwelling including the Porangahau, Maharakeke, Kahahakuri, Mangaonuku, Papanui sub-catchments.
E. coli	260 *Escherichia coli* per 100 millilitres for the 1 November to 30 April bathing season (for flows below the median flow). 550 *Escherichia coli* per 100 millilitres for the 1 November to 30 April bathing season (for flows between the median flow and three times the median flow). 550 *Escherichia coli* per 100 millilitres for the rest of the year (for flows below three times the median flow). The methodology for compliance is a maximum 95th percentile calculated as a minimum of 20 sampling points.
Total Ammoniacal Nitrogen (TNH_3-N)	99% species protection level for total ammoniacal nitrogen (TNH_3-N) as stipulated in the most recent version of the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (the ANZECC guidelines) and as tabulated in Schedule XXIII.[19]
Other Toxicants	95% species protection levels for toxicants (other than nitrate-nitrogen and total ammoniacal nitrogen) as stipulated in the most recent version of the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (the ANZECC guidelines) for Water Management Zones 1, 2, 3 and 5. [19] 99% species protection levels for toxicants (other than nitrate-nitrogen and total ammoniacal nitrogen) as stipulated in the most recent version of the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (the ANZECC guidelines) for Water Management Zone 4.[19]

18 The numerical values in Table 5.9.1A are to be treated as "limits" at locations where the existing water quality is better than the relevant numerical value and as "targets" at locations where the existing water quality is worse than the relevant numerical value.

19 For clarity this limit requires that the risk evaluation process set out in the ANZECC Guidelines will be followed on the basis of the specified protection level (99% or 95%). It does not mean that default trigger values defined in the ANZECC Guidelines will be used as limits.

Table 5.9.1B: Surface Water Quality Limits, Targets[20] and Indicators for the Tukituki River Catchment – Zone Specific.

The Water Management Zones referred to in Table 5.9.1B are mapped in Schedule XV.
The key to Table 5.9.1B is provided below Table 5.9.1C.

Water Management Zone	Mainstems/ Tributaries[21]	Periphyton Limits and Targets				DRP Limits and Targets	Nitrate-nitrogen Limits and Targets		DIN Limits and Targets	Indicators	
		(a)	(b)	(c)	(d)		(a)	(b)		Water Clarity	MCI
Zone 1 Lower Tukituki and Waipawa Rivers and Tributaries (excluding Papanui Stream catchment)	Mainstems	120	30	60	50	0.010	2.4	3.5	0.8	2.8	100
	Tributaries					0.015				1.6	100
Zone 2 Middle Waipawa River and Tributaries above SH2	Waipawa River	120	30	60	50	0.010	3.8	5.6	0.8	3.0	120
	Mangaonuku Stream									4.0	
	Tributaries					0.015				1.6	100

[20] The numerical values in Table 5.9.1B are to be treated as "limits" at locations where the existing water quality is better than the relevant numerical value and as "targets" at locations where the existing water quality is worse than the relevant numerica value.

[21] Mainstems include the following rivers:
- Zone 1 mainstem of the Tukituki River
- Zone 3 mainstems of the Tukituki and Tukipo rivers, and the Maharakeke, Porangahau, Makaretu and Kahahakuri streams.

Water Management Zone	Mainstems/ Tributaries[22]	Periphyton Limits and Targets				DRP Limits and Targets	Nitrate-nitrogen Limits and Targets		DIN Limits and Targets	Indicators	
		(a)	(b)	(c)	(d)		(a)	(b)		Water Clarity	MCI
Zone 3 Middle Tukituki River and Tributaries above Tapairu Road	Mainstems	120	30	60	50	0.010	3.8	5.6	0.8	3.0	120[23]
	Tributaries					0.015				1.6	100
Zone 4 Upper Tukituki and Waipawa Rivers	All	50	30	60	50	0.004	n/a	1.5	0.150	3.3	120
Zone 5 Papanui Stream	All	120	30	60	50	0.015	2.4	3.5	0.8	1.6	100

The Water Management Zones referred to in Table 5.9.1B are mapped in Schedule XV.
The Key to Table 5.9.1B is provided below Table 5.9.1C.

22 Mainstems include the following rivers:
- Zone 1 mainstem of the Tukituki River
- Zone 3 mainstems of the Tukituki and Tukipo rivers, and the Maharakeke, Porangahau, Makaretu and Kahahakuri streams.

23 Except that in the Maharakeke and Porangahau sub-catchments the MCI target is 100.

Table 5.9.1C: Surface Water Quality Deposited Sediment Indicators for the Tukituki River Catchment – Zone Specific.

The Water Management Zones referred to in Table 5.9.1C are mapped in Schedule XV.
The key to Table 5.9.1C is provided below.

Water Management Zone	Deposited Sediment Indicators (% sediment cover)
Zone 1 Lower Tukituki and Waipawa Rivers and Tributaries (excluding Papanui Stream)	10% in the Waipawa and Tukituki Rivers and 20% in all other naturally hard bottomed streams and rivers
Zone 2 Middle Waipawa River and tributaries above SH2	10% in the Waipawa River and Mangaonuku Stream and 20% in all other naturally hard bottomed streams and rivers
Zone 3 Middle Tukituki River and tributaries above Tapairu Road	10% in the Tukituki, Tukipo and Makaretu rivers and 20% in all other naturally hard bottomed streams and rivers (including Maharakeke, Porangahau and Kahahakuri Streams)
Zone 4 Upper Tukituki and Waipawa Rivers	10% in all naturally hard bottomed streams and rivers (including Tukituki, Waipawa and Makaroro Rivers)
Zone 5 Papanui Stream	20% in the Papanui Stream and all other naturally hard bottomed streams and rivers

Key to the Table 5.9.1B and C limits, targets and indicators:

Periphyton:

(a) Zone 4: Annual maximum algal biomass (mg Chlorophyll *a*/m^2). The annual maximum algal biomass shall be calculated as the maximum of monthly monitoring results obtained within an accrual period of 30 days over a period of 1 year.

Zones 1, 2, 3 and 5: Annual maximum algal biomass (mg Chlorophyll *a*/m^2). The annual maximum algal biomass shall be calculated as the annual maximum of monthly monitoring results obtained within an accrual period of 30 days over a period of 1 year.

(b) Annual maximum cover of visible river bed by periphyton as filamentous algae more than 2 cm long. The annual maximum algal cover shall be calculated as the annual maximum of monthly monitoring results obtained within an accrual period of 30 days over a period of 1 year.

(c) Annual maximum cover of visible river bed by periphyton as diatoms or cyanobacteria mats more than 0.3cm thick. The annual maximum algal cover shall be calculated as the annual maximum of monthly monitoring results obtained within an accrual period of 30 days over a period of 1 year.

(d) Annual maximum cover of visible river bed by periphyton as cyanobacteria mats more than 0.3 cm thick. The annual maximum algal cover shall be calculated as the annual maximum of monthly monitoring results obtained within an accrual period of 30 days over a period of 1 year.

Phosphorus:

Maximum average concentration of dissolved reactive phosphorus (DRP) when the river flow is at or below 3 times the median flow (mg DRP/L). The average concentration of DRP shall be calculated as the average of monthly monitoring results obtained over a period of 5 consecutive years.

Nitrate Nitrogen:

(a) Maximum median concentration of nitrate-nitrogen (mg NO_3-N /L). The median concentration of nitrate-nitrogen shall be calculated as the median of monitoring results obtained over a period of 1 year.

(b) Maximum 95th percentile concentration of nitrate-nitrogen (mg NO_3-N /L). The 95th percentile concentration of nitrate-nitrogen shall be calculated as the 95th percentile of monitoring results obtained over a period of 1 year.

Dissolved Inorganic Nitrogen:

Average concentration of dissolved inorganic nitrogen (mg DIN /L) at all river flows. The average concentration of DIN shall be calculated as the average of monthly monitoring results obtained over a period of 5 consecutive years.

Water Clarity Indicator:

Minimum median visual water clarity at or below median flow (m), measured as the horizontal sighting range of a black disc. The median visual clarity shall be calculated over a period of 5 consecutive years, filtered to exclude data points collected at river flows exceeding the median flow.

MCI indicator: Minimum average macro-invertebrate community index. The average MCI shall be calculated over a period of 5 consecutive years.

% Sediment Cover indicator: Maximum average % fine sediment cover where ‘fine’ is defined as particles less than 2 mm in diameter (excludes naturally soft bottom streams). The average % Sediment Cover shall be calculated over a period of 5 consecutive years.

Appendix C - Values overlay maps

This appendix contains a series of overlayed maps for the Tukituki catchment. All of the maps have a common base map showing the surface water allocation zones under Plan Change 6 taken from the Hawke's Bay Regional Council (2014). The overlay maps are taken from seven commissioned reports using the RiVAS river value assessment system. They cover native fish, irrigation, swimming, natural character, angling, riverine birds and whitewater kayaking.

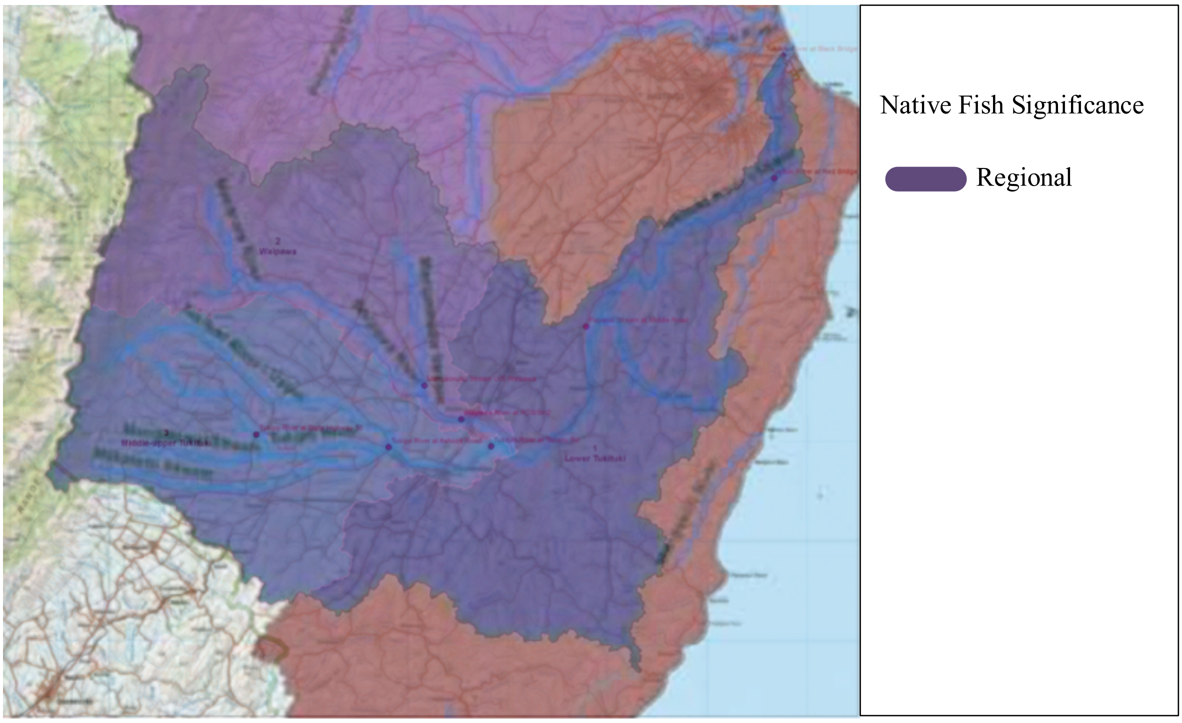


Figure C.1 *Significance of Native Fish Overlayed on Tukituki Catchment Surface Water Allocation Zones. Sourced from Hawke's Bay Regional Council (2014) and Hughey et al. (2013)*

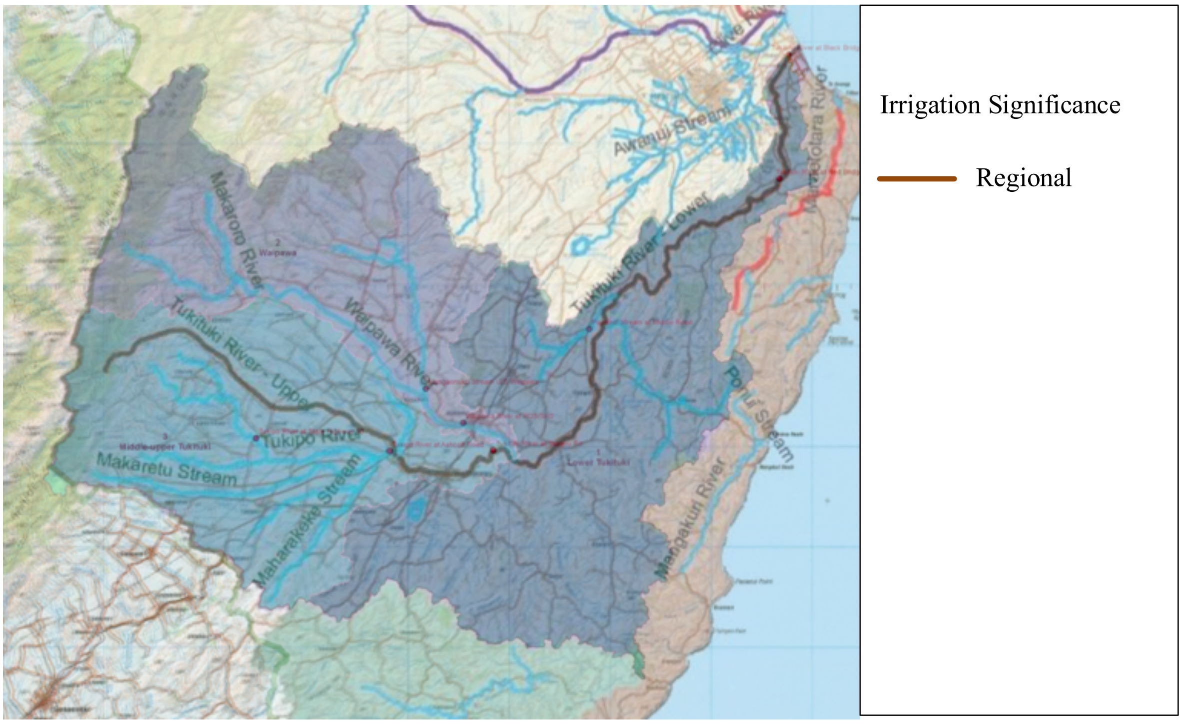


Figure C.2 Significance of Irrigation Overlayed on Tukituki Catchment Surface Water Allocation Zones. Sourced from Hawke's Bay Regional Council (2014) and Harris (2012)

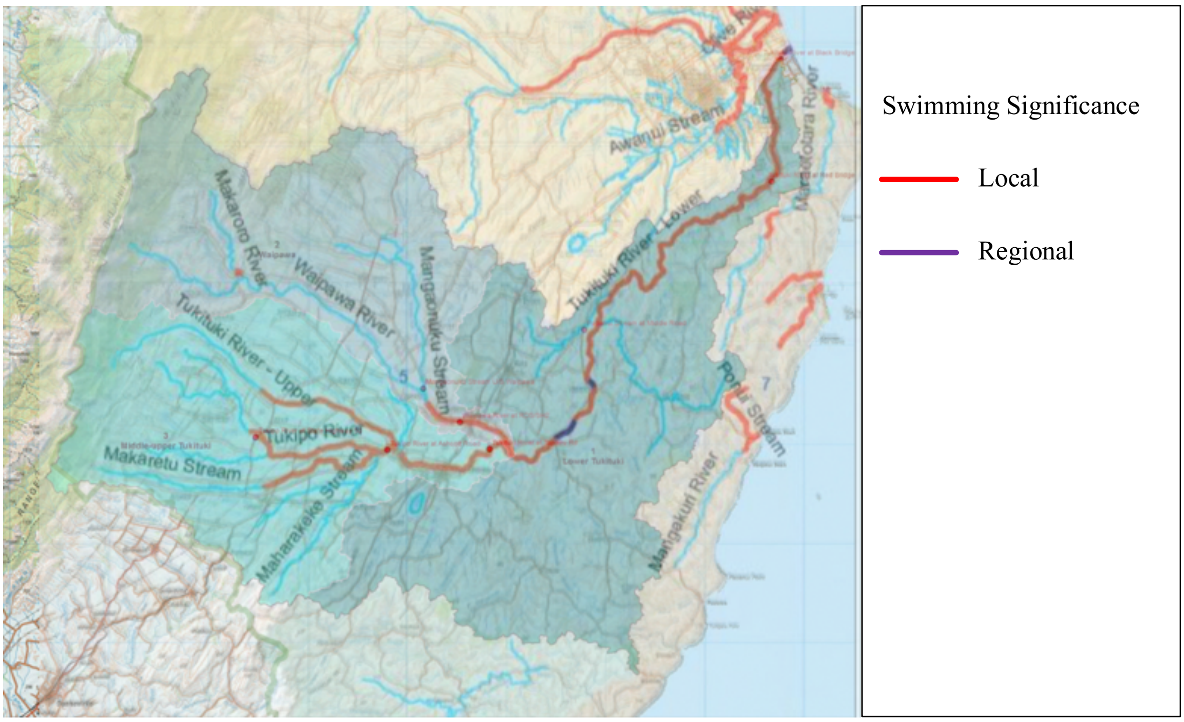


Figure C.3 Significance of Swimming Overlayed on Tukituki Catchment Surface Water Allocation Zones. Sourced from Hawke's Bay Regional Council (2014) and Booth, Madaraz-Smith, et al. (2012)

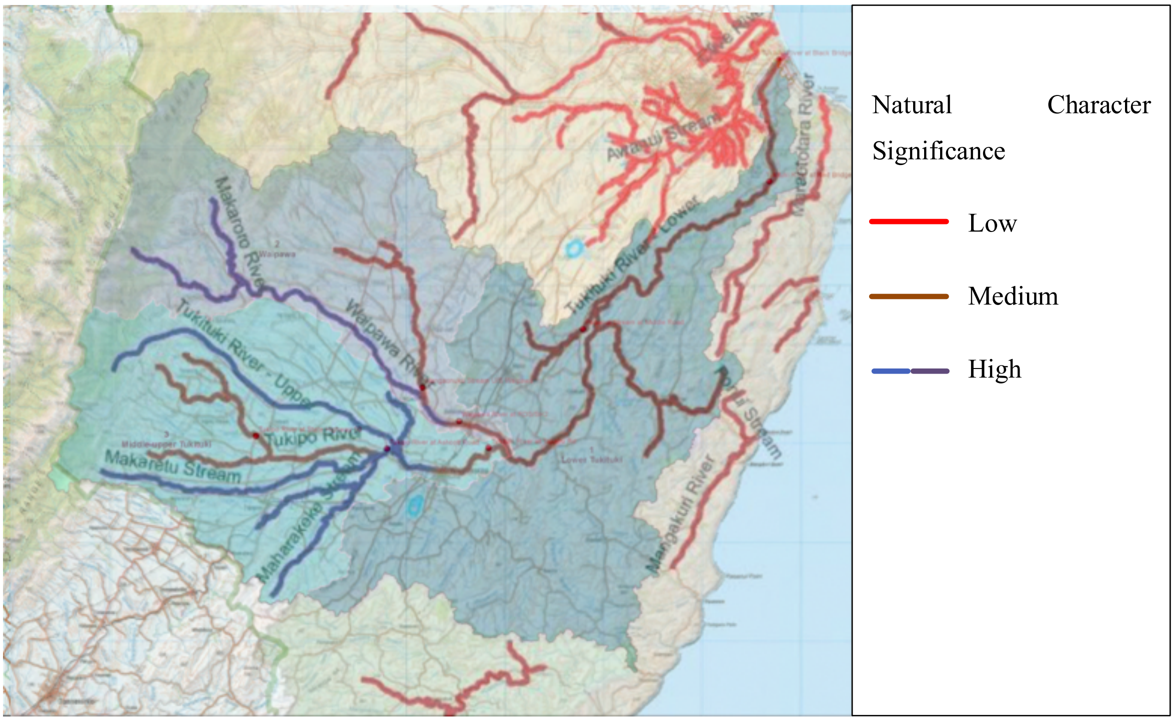


Figure C.4 Significance of Natural Character Overlayed on Tukituki Catchment Surface Water Allocation Zones. Sourced from Hawke's Bay Regional Council (2014) and Booth (2012)

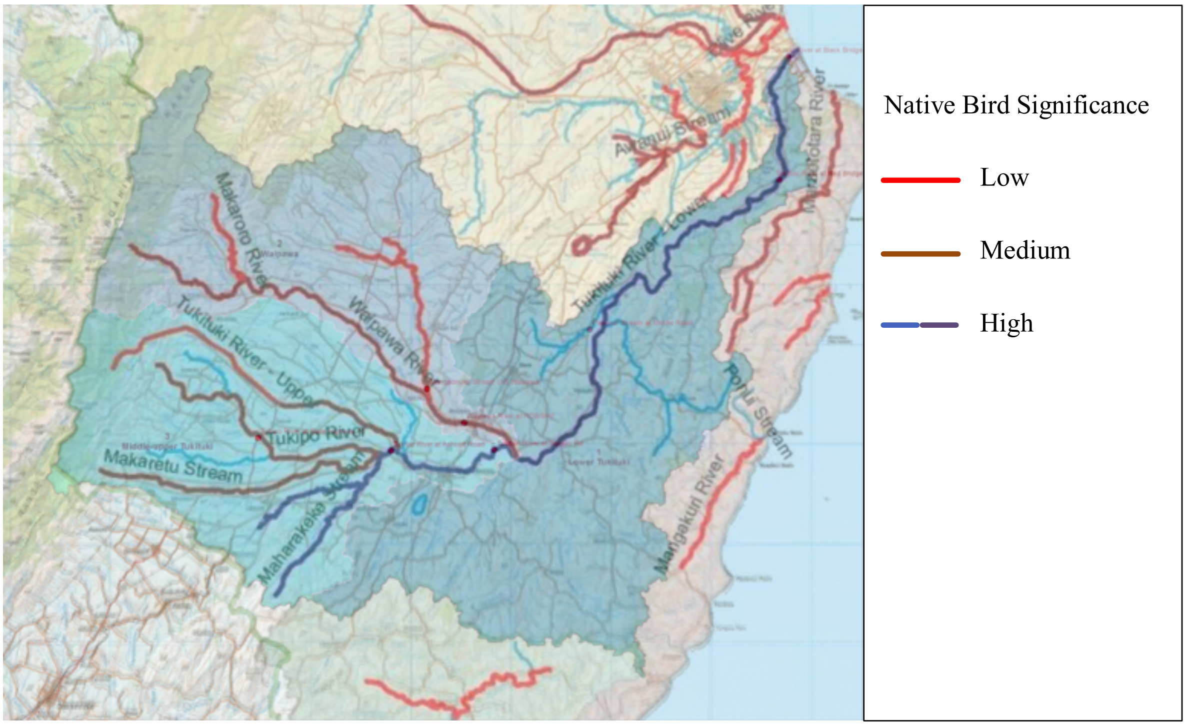


Figure C.5 Significance of Native Bird Life Overlayed on Tukituki Catchment Surface Water Allocation Zones. Sourced from Hawke's Bay Regional Council (2014) and Booth, Cameron, et al. (2012)

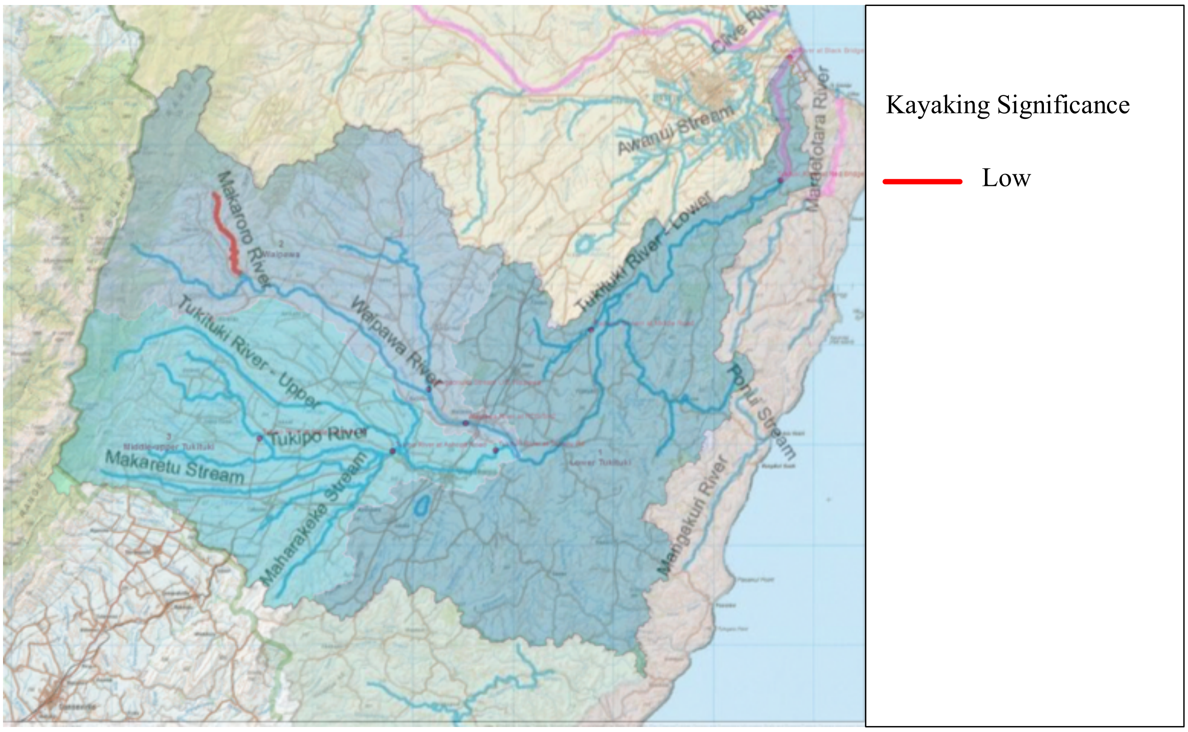


Figure C.6 Significance of Whitewater Kayaking Overlayed on Tukituki Catchment Surface Water Allocation Zones. Sourced from Hawke's Bay Regional Council (2014) and Booth, Bellamy, et al. (2012)

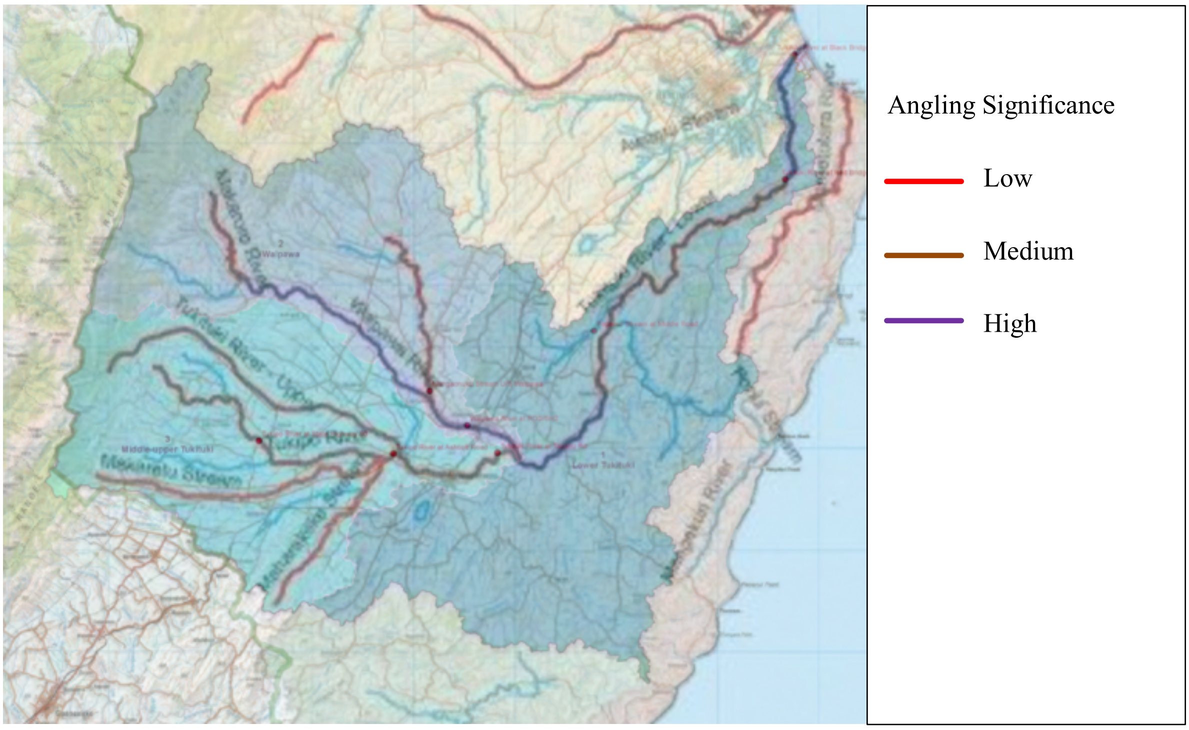


Figure C.7 Significance of Angling Overlayed on Tukituki Catchment Surface Water Allocation Zones. Sourced from Hawke's Bay Regional Council (2014) and Booth, Bull, et al. (2012)

Appendix D - Survey instrument for Objective 1

This appendix contains the full survey instrument for the delivery of Objective 1 as designed in Qualtrics XM.

EPGFW - 23_07_2019

Survey Flow

Block: Introduction and Consent (2 Questions)
Standard: Demographic Information (7 Questions)
Standard: Catchment Engagement (7 Questions)
Standard: Environmental Activity (1 Question)
Standard: Income dependancy on taking water (4 Questions)
Standard: Perceptions of the Tukituki River catchment (7 Questions)
Standard: Perceptions of the Public Good (8 Questions)
Standard: Perceptions of Tukituki River catchment management (5 Questions)
Standard: Block 8 (2 Questions)

Page Break

Start of Block: Introduction and Consent

Q1 Dear Respondent,

This survey is about your perceptions of the Tukituki River catchment and the importance you place on it's different values. The survey is completely confidential and anonymous and should take a around 9 minutes to complete. Please complete all questions.

Participation in this survey implies your consent to do it.

Thank you.
Sincerely
Humphrey Walker
(Massey University Doctoral Candidate)

If you have any concerns regarding research please contact:
Humphrey Walker (Doctoral Candidate)
School of Agriculture and Environment,
Environmental Science Group,
Massey University,
Palmerston North.
Humphrey.walker.1@uni.massey.ac.nz
or
Professor Diane Pearson (Supervisor)
School of Agriculture and Environment,
Environmental Science Group,
Massey University
Palmerston North
D.Pearson@massey.ac.nz
0800 627 739

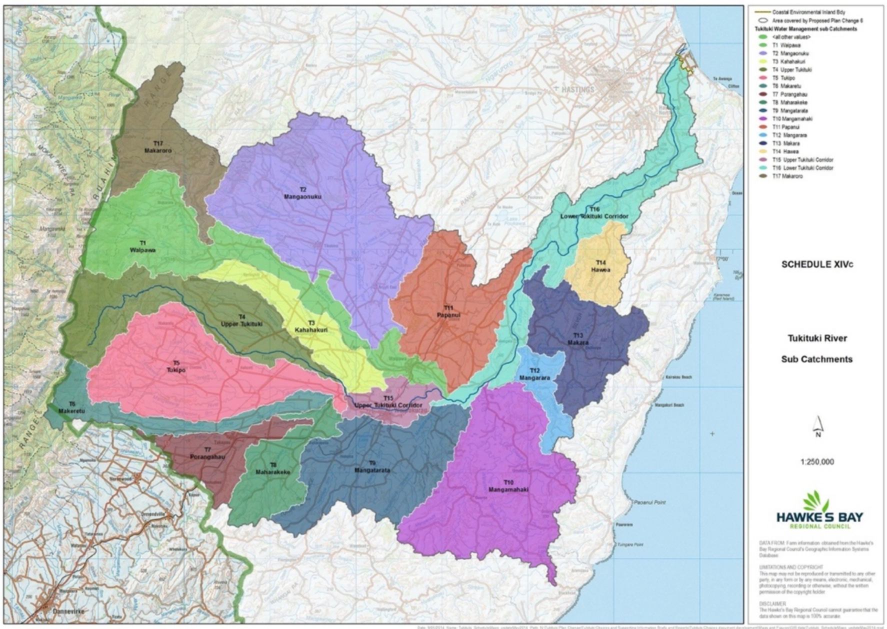
This project has been evaluated by peer review and judged to be low risk. Consequently, it has not been reviewed by one of the University's Human Ethics Committees. The researcher(s) named above are responsible for the ethical conduct of this research.

If you have any concerns about the conduct of this research that you wish to raise with someone other than the researcher(s), please contact Prof Craig Johnson, Director, Research Ethics, telephone 06 356 9099 x 85271, email humanethics@massey.ac.nz

Q2 Background Information
The Tukituki River catchment (see map)

- 2,500km2

- It extends east from its headwater in the Ruahine Rangers across Central Hawke's Bay. Smaller tributaries converge near Waipawa township to form the greater Tukituki river.
- It is joined by many more small tributaries as it flows North-east.
- Notable population centres are Waipukurau, Waipawa and Hamoana.
- Havelock North is adjacent to the catchment and the Tukituki is considered its ‘local’ river.
- The entire coloured-in area is the full catchment and the different colours show the smaller sub-catchments. In this survey when we refer to the "catchment" we mean the full catchment.



End of Block: Introduction and Consent

Start of Block: Demographic Information

Age What is your age in years?

____

Gen Gender

- ◯ Female (1)
- ◯ Male (2)
- ◯ Transgender Female (3)
- ◯ Transgender Male (4)
- ◯ Gender variant/non-conforming (5)
- ◯ Self describe (6) ____

Eth Ethnicity

- ◯ European (1)
- ◯ New Zealander (2)
- ◯ Māori (3)
- ◯ Pasifika (4)
- ◯ Other (5)

Inc$ Including all sources, which of the following best describes your pre-tax household income?

- ◯ $0-$50,000 (1)
- ◯ $50,001-$100,000 (2)
- ◯ $100,001-$150,000 (3)
- ◯ $150,001-$200,000 (4)
- ◯ $200,000 or more (5)

Edu What is your highest academic qualification?

- ◯ Secondary school (1)
- ◯ Post-secondary school certificate or diploma (2)
- ◯ University Bachelor's degree (3)
- ◯ Post-graduate degree (4)

Dwell Where do you live?

- ◯ On a farm (1)
- ◯ On a lifestyle block (2)
- ◯ In town (3)
- ◯ In town and own a farm (4)

Dwell-t How many years have you lived in or near the Tukuituki catchment.

____

End of Block: Demographic Information

Start of Block: Catchment Engagement

Vis Have you visited a waterway in the Tukituki River catchment in the past 24 months?

○ Yes (1)

○ No (2)

Display This Question:

If Vis = No

Vis2 Are you likely to visit the Tukituki River catchment in the next 24 months?

○ Yes (1)

○ No (2)

Skip To: End of Block If Vis2 = No

Display This Question:

If Vis2 = Yes

VisReas2 Which of the following would best describe the main reasons you intend to visit the Tukituki River catchment?
(You may select more than one)

- [ ] Swimming (1)
- [ ] Walking (2)
- [ ] Picnic or similar (3)
- [ ] Camping (4)
- [ ] Trout fishing (5)
- [ ] Game bird hunting (6)
- [ ] Whitebaiting (7)
- [ ] Rafting or kayaking (8)
- [ ] Gathering food other than trout fishing, game bird hunting or whitebaiting (9)
- [ ] Wildlife watching (10)
- [ ] Spiritual or cultural observance (11)
- [ ] Other (12)

Display This Question:

If Vis = Yes

VisReas Which of the following would best describe the main reasons you visited the Tukituki River catchment?(You may select more than one)

- ☐ Swimming (1)
- ☐ Walking (2)
- ☐ Picnic or similar (3)
- ☐ Camping (4)
- ☐ Trout fishing (5)
- ☐ Game bird hunting (6)
- ☐ Whitebaiting (7)
- ☐ Rafting or kayaking (8)
- ☐ Gathering food other than trout fishing, game bird hunting or whitebaiting (9)
- ☐ Wildlife watching (10)
- ☐ Spiritual or cultural observance (11)
- ☐ Other (12)

Display This Question:

If Vis = Yes

Vis-n How many times did you visit the Tukituki River catchment in the last 24 months?

____

Fish Do you fish in the Tukituki River catchment for...?
(You may select more than one)

▢ Trout (1)

▢ Whitebait (Inanga) (2)

▢ Eel (Tuna) (4)

▢ Flounder (Patiki) (5)

▢ No, I don't fish. (6)

Hunt Are you an active game bird hunter?

○ Yes (1)

○ No (2)

End of Block: Catchment Engagement

Start of Block: Environmental Activity

Enviro Have you donated money or volunteered for an environmental organisation (eg. Royal Forest & Bird, Green Peace, World Wildlife Fund, NZ Landcare Trust) in the past 24 months?

○ Yes (1)

○ No (2)

End of Block: Environmental Activity

Start of Block: Income dependancy on taking water

Sect In which sector do you work?

- ◯ Manufacturing (1)
- ◯ Construction (2)
- ◯ Agriculture (3)
- ◯ Retail (4)
- ◯ Wholesale (5)
- ◯ Hospitality (6)
- ◯ Finance and insurance (7)
- ◯ Education (8)
- ◯ Real estate (9)
- ◯ Government (10)
- ◯ Transport, communications, public utilities (11)
- ◯ Healthcare (12)
- ◯ Work in the home (13)
- ◯ Retired (14)
- ◯ Other (15)

Bus-water Do you take water from the Tukituki River catchment?

- ◯ Yes (1)
- ◯ No (2)

Display This Question:

If Bus-water = Yes

Bus-use What is the water mainly used for?

- Dairy farming (1)
- Arable cropping (2)
- Pipfruit (3)
- Process cropping (4)
- Stone fruit (5)
- Vineyard (6)
- Manufacturing (9)
- Food processing (11)
- Stock water (7)
- Drinking water (8)

Display This Question:

If Bus-water = Yes

Quant Has there been enough water?

- Yes (5)
- No (6)

End of Block: Income dependancy on taking water

Start of Block: Perceptions of the Tukituki River catchment

Q28 In the following section please respond to the statements about the state of the Tukituki River catchment over the past 5 years?

Flow In the past 5 years water levels in the Tukituki River catchment during the summer posed no problem.

- ◯ Strongly agree (1)
- ◯ Somewhat agree (2)
- ◯ Neither agree nor disagree (3)
- ◯ Somewhat disagree (4)
- ◯ Strongly disagree (5)

Swim In the past 5 years waterways in the Tukituki River catchment were safe to swim in.

- ◯ Strongly agree (1)
- ◯ Somewhat agree (2)
- ◯ Neither agree nor disagree (3)
- ◯ Somewhat disagree (4)
- ◯ Strongly disagree (5)

NatFsh In the past 5 years native fish populations in the Tukituki River catchment were plentiful.

- ◯ Strongly agree (1)
- ◯ Somewhat agree (2)
- ◯ Neither agree nor disagree (3)
- ◯ Somewhat disagree (4)
- ◯ Strongly disagree (5)

NatBrd In the past 5 years native wetland bird populations in the Tukituki River catchment were plentiful.

- ◯ Strongly agree (1)
- ◯ Somewhat agree (2)
- ◯ Neither agree nor disagree (3)
- ◯ Somewhat disagree (4)
- ◯ Strongly disagree (5)

Irr In the past 5 years there was enough water over summer in the Tukituki River catchment to continue irrigating agricultural crops at current rates without causing any problems.

○ Strongly agree (1)

○ Somewhat agree (2)

○ Neither agree nor disagree (3)

○ Somewhat disagree (4)

○ Strongly disagree (5)

Weed In the past 5 years weed growth on the beds of waterways in the Tukituki River catchment over summer posed no problem.

○ Strongly agree (1)

○ Somewhat agree (2)

○ Neither agree nor disagree (3)

○ Somewhat disagree (4)

○ Strongly disagree (5)

End of Block: Perceptions of the Tukituki River catchment

Start of Block: Perceptions of the Public Good

Q36 Thinking about society as a whole and keeping in mind future generations, to what extent do you agree with the following statements?

PG-Swim The Tukituki River catchment should be safe to swim in summer?

- ◯ Strongly agree (1)
- ◯ Somewhat agree (2)
- ◯ Neither agree nor disagree (3)
- ◯ Somewhat disagree (4)
- ◯ Strongly disagree (5)

PG-Flow The Tukituki River catchment should have higher minimum flow levels than in past years?

- ◯ Strongly agree (1)
- ◯ Somewhat agree (2)
- ◯ Neither agree nor disagree (3)
- ◯ Somewhat disagree (4)
- ◯ Strongly disagree (5)

PG-NatBrd The Tukituki River catchment should support larger populations of native wetland birds?

- ○ Strongly agree (1)
- ○ Somewhat agree (2)
- ○ Neither agree nor disagree (3)
- ○ Somewhat disagree (4)
- ○ Strongly disagree (5)

PG-NatFsh The Tukituki River catchment should support larger populations of native fish?

- ○ Strongly agree (1)
- ○ Somewhat agree (2)
- ○ Neither agree nor disagree (3)
- ○ Somewhat disagree (4)
- ○ Strongly disagree (5)

PG-Weed The Tukituki River catchment should have greatly reduced weed growth on their beds?

- ○ Strongly agree (1)
- ○ Somewhat agree (2)
- ○ Neither agree nor disagree (3)
- ○ Somewhat disagree (4)
- ○ Strongly disagree (5)

PG-Irr The Tukituki River catchment should provide water to support agriculture through irrigation at current levels?

- ○ Strongly agree (1)
- ○ Somewhat agree (2)
- ○ Neither agree nor disagree (3)
- ○ Somewhat disagree (4)
- ○ Strongly disagree (5)

PG-IncIrr The Tukituki River catchment should support more agriculture by providing more water for increased irrigation?

◯ Strongly agree (1)

◯ Somewhat agree (2)

◯ Neither agree nor disagree (3)

◯ Somewhat disagree (4)

◯ Strongly disagree (5)

End of Block: Perceptions of the Public Good

Start of Block: Perceptions of Tukituki River catchment management

Rep-PvtG Thinking about how <u>you</u> want the Tukituki River catchment to be managed, which one of the following organisations do you think represents your vision the most?

◯ The Regional Council (1)

◯ Fish & Game (2)

◯ Ngati Kahungunu Iwi Incorporated (3)

◯ Federated Farmers (4)

◯ Royal Forest & Bird Society of New Zealand (5)

◯ Horticulture NZ (6)

◯ The Environmental Defense Society (7)

◯ Other (11) ____

Rep-PG Think about the management of the Tukituki River catchment again, this time thinking about society as a whole and bearing in mind future generations. Which one of the following organisations do you think represents this vision the most?

- ◯ The Regional Council (1)
- ◯ Fish & Game (2)
- ◯ Ngati Kahungunu Iwi Incorporated (3)
- ◯ Federated Farmers (4)
- ◯ Royal Forest & Bird Society of New Zealand (5)
- ◯ Horticulture NZ (6)
- ◯ The Environmental Defense Society (7)
- ◯ Other (8) ____________________

Q59 To what extent do you agree with the following statements?

ConHealth All things considered, the Tukituki River catchment is in good health.

- ◯ Strongly agree (1)
- ◯ Somewhat agree (2)
- ◯ Neither agree nor disagree (3)
- ◯ Somewhat disagree (4)
- ◯ Strongly disagree (5)

Conf-Fut All things considered, the Tukituki river catchment is well managed.

- ○ Strongly agree (1)
- ○ Somewhat agree (2)
- ○ Neither agree nor disagree (3)
- ○ Somewhat disagree (4)
- ○ Strongly disagree (5)

End of Block: Perceptions of Tukituki River catchment management

---

Start of Block: Block 8

NutResp Did you answer "neither agree nor disagree" for any questions?

- ○ Yes (1)
- ○ No (2)

Display This Question:

If NutResp = Yes

NutResp-Reason Was this mostly because?

- ○ I feel I don't know enough to decide (1)
- ○ I feel the decision was too hard (2)
- ○ I genuinely had no opinion (3)
- ○ I did not understand the question (4)

End of Block: Block 8

Appendix E - Survey instrument for Objectives 2 and 3

This appendix contains the full survey instrument as designed and generated in the Sawtooth Software Lighthouse Studio 9 for the delivery of Objectives 2 & 3. This is a text fields are edited using html which is included in the design output. Images are inputted as graphics paths from the local drive before being uploaded to the host servers. Back end design of the best-worst component is shown in Appendix F - Best-worst choice experiment design.

```
================================================================
====
============
Study Name: Tuki_Full_30_04_2020
Date: Monday, August 3, 2020 - 6:33:46 PM
================================================================
====
============
TABLE OF CONTENTS:
        * STUDY NOTES
        * QUESTIONS
        * SKIP SECTION
        * LIST SECTION
        * STUDY SETTINGS
        * MAXDIFF SECTION
        * PASSWORD FIELDS
        * MERGED FIELDS
        * PASS-IN FIELDS
========================================
Questionnaire
========================================
===========================
Question Name: Start
===========================
Type: Questionnaire Access and Passwords
---------------------------
[Header 2]:
Tukituki River Catchment Research.jpg"

Please help!

This is a survey to safeguard our Hawke's Bay Water
It belongs to all of us.

We wish to reassure you that your individual answers are
completely
confidential and anonymous.

Better still, you can choose to enter the draw to win one of ten
supermarket vouchers!

Participation in this survey implies your consent to do it.
<br />
```

Thank you<
Humphrey Walker<
Doctoral Candidate
Massey University
===========================
Question Name: Q41MoreInfo
===========================
Type: Select (Radio Button)
Required: YES

[Header 1]:
Would you like more information on the researcher, supervision, contact information and ethics approval?
[Response Options]:
List Name: Q41MoreInfoList
Type: Predefined

1 Yes

2 No

[Post-Skips]:
Post-Skip: Skip from Q41MoreInfo to Q1Age if Q41MoreInfo=2
===========================
Question Name: Q41Fullstartinfo
===========================
Type: Text

[Header 1]:
Welcome...
Thanks for agreeing to participate in our survey!
We wish to reassure you that your individual answers are completely confidential and anonymous.
Research has shown that water quality is on the mind of many New Zealanders. This survey is about the value you place on improved water quality in the Tukituki River catchment and your trust in organisations shaping its future.
Please complete all questions.

Participation in this survey implies your consent to do it.

Thank you.
Sincerely
Humphrey Walker
Massey University Doctoral Candidate)

If you have any concerns regarding this research please contact: Humphrey Walker (Doctoral Candidate); School of Agriculture and Environment, Environmental Science Group, Massey University, Palmerston North. Email: Humphrey.walker.1@uni.massey.ac.nz

Professor Diane Pearson (Supervisor), School of Agriculture and Environment, Environmental Science Group, Massey University, Palmerston North. Email: D.Pearson@massey.ac.nz. Phone: 0800 627 739

[Footer]:

This project has been evaluated by peer review and judged to be
low risk. Consequently, it has not been reviewed by one of the
University’s Human Ethics Committees.
The researcher(s) named above are responsible for the ethical
conduct of this research. Participation in this survey implies
your
consent to do it.
If you have any concerns about the conduct of this research that
you
wish to raise with someone other than the researcher(s), please
contact Prof Craig Johnson, Director, Research Ethics, telephone
06
356 9099 x 85271, email humanethics@massey.ac.nz.
===========================
Question Name: Q1Age
===========================
Type: Numeric
Required: YES
Min Value: 0
Max Value: 100

[Header 1]:
[Question]:
What is your age to the nearest year?
[Post-Skips]:
Post-Skip: Skip from Q1Age to Q35teminateUnder18 if Q1Age <18
===========================
Question Name: Q2BillPayer
===========================
Type: Select (Radio Button)
Required: YES

[Header 1]:
[Question]:
Are you responsible for paying any of the household bills?
[Response Options]:
List Name: BillPayerList
Type: Predefined

1 Yes 2 No

[Post-Skips]:
Post-Skip: Skip from Q2BillPayer to Q34TeminateNonpayer if
Q2BillPayer = 2
===========================
Question Name: Q3Income
===========================
Type: Select (Radio Button)
Required: YES

[Header 1]:
[Question]:

```
Including all sources, which of the following best describes
your
pre-tax household income?
[Response Options]:
List Name: IncomeList
Type: Predefined
```

1. 1 $0-$50,000
2. 2 $50,001-$100,000
3. 3 $100,001-$150,000
4. 4 $150,001-$200,000
5. 5 More than $200,000

```
===========================
Question Name: Q4Education
===========================
Type: Select (Radio Button)
Required: YES
---------------------------
[Header 1]:
[Question]:
What is your highest academic qualification?
[Response Options]:
List Name: EducationList
Type: Predefined
```

1. 1 High School
2. 2 Certificate or diploma
3. 3 Bachelor's Degree
4. 4 Post Graduate Degree

```
===========================
Question Name: Q5Gender
===========================
Type: Select (Radio Button)
Required: YES
---------------------------
[Header 1]:
[Question]:
Gender
[Response Options]:
List Name: GenderList
Type: Predefined
```

1. 1 Female
2. 2 Male
3. 3 Transgender Female
4. 4 Transgender Male
5. 5 Gender non-specific

```
===========================
Question Name: Q6Town
===========================
Type: Select (Radio Button)
```

Required: YES

[Header 1]:
[Question]:
Which is your closet town?
[Response Options]:
List Name: Q17TownList
Type: Predefined

1. 1 Bridge Pa
2. 2 Clive
3. 3 Haumoana
4. 4 Hastings
5. 5 Havelock North
6. 6 Napier
7. 7 Ocean Beach
8. 8 Ongaonga
9. 9 Otane
10. 10 Takapau

11. 11 Taradale
12. 12 Te Awanga
13. 13 Tikokino
14. 14 Tuitira
15. 15 Waimarama
16. 16 Waipukurau
17. 17 Waipawa
18. 18 Wairoa

===========================
Question Name: Q7Visit24mnth
===========================
Type: Select (Radio Button)
Required: YES

[Header 1]:
[Question]:
Have you visited a waterway in the Tukituki River catchment in
the
past 24 months?
Image reproduced with permission from
HBRC.
[Response Options]:
List Name: Visit24mnthList
Type: Predefined

1 Yes 2 No

===========================
Question Name: Q8Knowledge
===========================
Type: Select (Radio Button)
Required: YES

[Header 1]:
[Question]:
How would you rate your understanding and knowledge of how the authorities manage catchments and waterways?
[Response Options]:
List Name: Q7KnowledgeList
Type: Predefined

1. 1 Very good
2. 2 Good
3. 3 Neither good nor poor
4. 4 Poor
5. 5 Very poor

===========================
Question Name: Q9CVMINtro
===========================
Type: Text

[Header 1]:
[Body]:
In the next part, look at an infographic and think about what the
difference between the two sides means to you.
===========================
Question Name: Q40CatchmentInfo
===========================
Type: Text

[Header 1]:
[Header 2]:
Firstly, there is much debate over water quality in
Hawke's Bay so here's some information to help you understand more
about the Tukituki River catchment.
[Body]:
===========================
Question Name: Q10Infographic
===========================
Type: Text

[Header 1]:
[Header 2]:
In the infographic below, the left side shows what the
Tukituki catchment is like at the moment and right side shows what
it could be like in the future. Please look carefully and think
about what the difference means to you
[Body]:
===========================
Question Name: Q11Cheaptalk
===========================
Type: Text

[Body]:

The next set of questions asks you to place a value on the improvement shown above. Please bear in mind your total after tax
household income and all the other bills you have to pay.

===========================
Question Name: Q12Pay50
===========================
Type: Select (Radio Button)
Required: YES

[Header 1]:
[Header 2]:
In order to improve the described current state to the possible future state...
[Question]:
Would you pay $4 a month more in regional tax for the next 10 years?
[Response Options]:
List Name: BillPayerList
Type: Predefined

1 Yes 2 No

[Post-Skips]:
Post-Skip: Skip from Q12Pay50 to Q13Pay60 if Q12Pay50=1
Post-Skip: Skip from Q12Pay50 to Q18Pay40 if Q12Pay50=2
===========================
Question Name: Q13Pay60
===========================
Type: Select (Radio Button)
Required: YES

[Header 1]:

[Header 2]:
In order to improve the described current state to the possible future state...
[Question]:
Would you pay $5 a month more in regional tax for the next 10 years?
[Response Options]:
List Name: BillPayerList
Type: Predefined

1 Yes 2 No

[Post-Skips]:
Post-Skip: Skip from Q13Pay60 to Q14Pay70 if Q13Pay60=1
Post-Skip: Skip from Q13Pay60 to Q38Covid19 if Q13Pay60=2
===========================
Question Name: Q14Pay70
===========================
Type: Select (Radio Button)
Required: YES

[Header 1]:
[Header 2]:
In order to improve the described current state to the possible future state...
[Question]:
Would you pay $6.50 a month more in regional tax for the next 10
years?
[Response Options]:
List Name: BillPayerList
Type: Predefined

1 Yes 2 No

[Post-Skips]:
Post-Skip: Skip from Q14Pay70 to Q15Pay80 if Q14Pay70=1
Post-Skip: Skip from Q14Pay70 to Q38Covid19 if Q14Pay70=2
===========================
Question Name: Q15Pay80
===========================
Type: Select (Radio Button)
Required: YES

[Header 1]:
[Header 2]:
In order to improve the described current state to the possible future state...
[Question]:
Would you pay $8 a month more in regional tax for the next 10 years?
[Response Options]:
List Name: BillPayerList
Type: Predefined

1 Yes 2 No

[Post-Skips]:
Post-Skip: Skip from Q15Pay80 to Q16Pay90 if Q15Pay80=1
Post-Skip: Skip from Q15Pay80 to Q38Covid19 if Q15Pay80=2
===========================
Question Name: Q16Pay90
===========================
Type: Select (Radio Button)
Required: YES

[Header 1]:
[Header 2]:
In order to improve the described current state to the possible future state...
[Question]:
Would you pay $9.50 a month more in regional tax for the next 10 years?
[Response Options]:
List Name: BillPayerList
Type: Predefined

1 Yes 2 No

[Post-Skips]:
Post-Skip: Skip from Q16Pay90 to Q17Pay100 if Q16Pay90=1
Post-Skip: Skip from Q16Pay90 to Q38Covid19 if Q16Pay90=2
===========================
Question Name: Q17Pay100
===========================
Type: Select (Radio Button)
Required: YES

[Header 1]:
[Header 2]:
In order to improve the described current state to the possible future state...
[Question]:
Would you pay $11 a month more in regional tax for the next 10 years?
[Response Options]:
List Name: BillPayerList
Type: Predefined

1 Yes 2 No

[Post-Skips]:
Post-Skip: Skip from Q17Pay100 to Q60Pay110 if Q17Pay100=1
Post-Skip: Skip from Q17Pay100 to Q38Covid19 if Q17Pay100=2
===========================
Question Name: Q60Pay110
===========================
Type: Select (Radio Button)
Required: YES

[Header 1]:
[Header 2]:
In order to improve the described current state to the possible future state...
[Question]:
Would you pay $12.50 a month more in regional tax for the next
10
years?
[Response Options]:
List Name: Q60Pay110List
Type: Predefined

1 Yes 2 No

[Post-Skips]:
Post-Skip: Skip from Q60Pay110 to Q38Covid19 if Q60Pay110=1
Post-Skip: Skip from Q60Pay110 to Q38Covid19 if Q60Pay110=2
===========================
Question Name: Q18Pay40
===========================
Type: Select (Radio Button)
Required: YES

[Header 1]:
[Header 2]:
In order to improve the described current state to the possible future state...
[Question]:
Would you pay $3.50 a month more in regional tax for the next 10

years?

[Response Options]:
List Name: BillPayerList
Type: Predefined

1 Yes 2 No

[Post-Skips]:
Post-Skip: Skip from Q18Pay40 to Q38Covid19 if Q18Pay40=1
Post-Skip: Skip from Q18Pay40 to Q19Pay30 if Q18Pay40=2
===========================
Question Name: Q19Pay30
===========================
Type: Select (Radio Button)
Required: YES

[Header 1]:
[Header 2]:
In order to improve the described current state to the possible future state...
[Question]:
Would you pay $2.50 a month more in regional tax for the next 10 years?
[Response Options]:
List Name: BillPayerList
Type: Predefined

1 Yes 2 No

[Post-Skips]:
Post-Skip: Skip from Q19Pay30 to Q38Covid19 if Q19Pay30=1
Post-Skip: Skip from Q19Pay30 to Q20Pay20 if Q19Pay30=2
===========================
Question Name: Q20Pay20
===========================
Type: Select (Radio Button)
Required: YES

[Header 1]:
[Header 2]:
In order to improve the described current state to the possible future state...
[Question]:
Would you pay $2 a month more in regional tax for the next ten years?
[Response Options]:

List Name: BillPayerList
Type: Predefined

1 Yes 2 No

[Post-Skips]:
Post-Skip: Skip from Q20Pay20 to Q38Covid19 if Q20Pay20=1
Post-Skip: Skip from Q20Pay20 to Q21Pay10 if Q20Pay20=2
===========================
Question Name: Q21Pay10
===========================
Type: Select (Radio Button)
Required: YES

[Header 1]:
[Header 2]:
In order to improve the described current state to the possible future state...
[Question]:
Would you pay $1 a month more in regional tax for the next 10 years?
[Response Options]:
List Name: BillPayerList
Type: Predefined

1 Yes 2 No

[Post-Skips]:
Post-Skip: Skip from Q21Pay10 to Q38Covid19 if Q21Pay10=1
Post-Skip: Skip from Q21Pay10 to Q22Pay0 if Q21Pay10=2
===========================
Question Name: Q22Pay0
===========================
Type: Select (Radio Button)
Required: YES

[Header 1]:
[Header 2]:
In order to improve the described current state to the possible future state...
[Question]:
I would pay nothing.
[Response Options]:
List Name: BillPayerList
Type: Predefined

1 Yes 2 No

[Post-Skips]:
Post-Skip: Skip from Q22Pay0 to Q21Pay10 if Q22Pay0=2
Post-Skip: Skip from Q22Pay0 to Q37WontPay if Q22Pay0=1
===========================
Question Name: Q37WontPay
===========================
Type: Select (Radio Button)

Required: YES

[Header 1]:
[Question]:
What was the main reason for not wanting to pay anything?
[Response Options]:
List Name: Q37WontPayList
Type: Predefined

1. 1 I can’t afford to pay more.
2. 2 I pay enough in rates already.
3. 3 I don't think there is anything wrong with the catchment.

===========================
Question Name: Q38Covid19
===========================
Type: Select (Radio Button)
Required: YES

[Header 1]:
[Question]:
Has the Covid19 Level-4 lockdown period reduced the amount you chose
to pay?
[Response Options]:
List Name: Q38Covid19List
Type: Predefined

1 Yes 2 No

===========================
Question Name: Q24MaxDiffIntro
===========================
Type: Text

[Header 1]:
[Body]:
The next section asks you about your trust in organisations.
It is a series of simple choice tasks that should take just a few
seconds each.
===========================
Question Name: MXD_1
===========================
Type: MaxDiff Set
Additional Settings: See MaxDiff Section

[Header 1]:
Please consider these organisations with regard to freshwater quality in Hawke's Bay.

Considering only your trust in these organisations, tick the one Most Trusted in the left column and the one Least
Trusted in the right column.

[Header 2]:
[Best Label]:
Most Trusted Tick 1 Box
[Worst Label]:
Least Trusted Tick 1 Box
[Items]:
List Name: Q15MAxDiffAnchorList
Type: Predefined

1 The Royal Forest and Bird Society of New Zealand
 (Non-governmental organisation)

2. 2 New Zealand Fish and Game Council (Public entity)
3. 3 Federated Farmers (Industry representative group)
4. 4 Horticulture New Zealand (Industry representative

group)

5. 5 Ngati Kahugnunu Iwi Inc (Regional Treaty Partners)
6. 6 Environmental Defence Society (Independent

environmental watchdog)

7. 7 Department of Conservation (Central Government)
8. 8 NIWA (National Institute for Water and Atmospheric

research)(Crown Research Institute)

9. 9 Landcare Trust (Non-government organisation)
10. 10 Hawke's Bay Regional Council (Local government)

[Footer]:
Click the 'Next' button to continue...
===========================
Question Name: MXD_2
===========================
Type: MaxDiff Set
Additional Settings: See MaxDiff Section

[See MXD_1 for template]
===========================
Question Name: MXD_3
===========================
Type: MaxDiff Set
Additional Settings: See MaxDiff Section

[See MXD_1 for template]
----------------------------------<PAGE BREAK>----------------------------------
===========================
Question Name: MXD_4
===========================
Type: MaxDiff Set
Additional Settings: See MaxDiff Section

```
---------------------------
[See MXD_1 for template]
===========================
Question Name: MXD_5
===========================
Type: MaxDiff Set
Additional Settings: See MaxDiff Section
---------------------------
[See MXD_1 for template]
===========================
Question Name: MXD_6
===========================
Type: MaxDiff Set
Additional Settings: See MaxDiff Section
---------------------------
[See MXD_1 for template]
===========================
Question Name: MXD_7
===========================
Type: MaxDiff Set
Additional Settings: See MaxDiff Section
---------------------------
[See MXD_1 for template]
===========================
Question Name: MXD_8
===========================
Type: MaxDiff Set
Additional Settings: See MaxDiff Section
---------------------------
[See MXD_1 for template]
===========================
Question Name: MXD_9
===========================
Type: MaxDiff Set
Additional Settings: See MaxDiff Section
---------------------------
[See MXD_1 for template]
----------------------------------<PAGE
BREAK>----------------------------------
===========================
Question Name: MXD_10
===========================
Type: MaxDiff Set
Additional Settings: See MaxDiff Section
---------------------------
[See MXD_1 for template]
===========================
Question Name: Q25MaxDiffAnchor
===========================
Type: Select (Check Box)
Checks Required: ANY AMOUNT
---------------------------
[Header 1]:
[Question]:
Which organisations do you trust? You can select as many as you
wish.
```

[Response Options]:
List Name: Q15MAxDiffAnchorList
Type: Predefined
Randomized: YES

1 The Royal Forest and Bird Society of New Zealand
 (Non-governmental organisation)

2. 2 New Zealand Fish and Game Council (Public entity)
3. 3 Federated Farmers (Industry representative group)
4. 4 Horticulture New Zealand (Industry representative

group)

5. 5 Ngati Kahugnunu Iwi Inc (Regional Treaty Partners)
6. 6 Environmental Defence Society (Independent environmental watchdog)

7. 7 Department of Conservation (Central Government)
8. 8 NIWA (National Institute for Water and Atmospheric research) (Crown Research Institute)

9. 9 Landcare Trust (Non-government organisation)
10. 10 Hawke's Bay Regional Council (Local government)

===========================
Question Name: Q50NoTrust
===========================
Type: Select (Radio Button)
Required: NO

[Response Options]:
List Name: Q50NoTrustList
Type: Predefined

1 I don't trust any of these organisations.

===========================
Question Name: Q26Section4Intro
===========================
Type: Text

[Header 1]:
[Body]:
Remember your opinions matter to us.
The last short section asks you to rate your agreement with statements regarding the Tukituki River catchment.
===========================
Question Name: Q27BeingHeard
===========================
Type: Select (Radio Button)
Required: YES

[Header 1]:

[Question]:
The voices of the people are being heard by the managers of the Tukituki catchment?
[Response Options]:
List Name: QManagementList
Type: Predefined

1. 1 Strongly agree
2. 2 Agree
3. 3 Neither agree nor disagree
4. 4 Disagree
5. 5 Strongly disagree

===========================
Question Name: Q28InfoQuality
===========================
Type: Select (Radio Button)
Required: YES

[Header 1]:
[Question]:
Information about water quality in rivers, streams and wetlands is
well communicated to the public.
[Response Options]:
List Name: QManagementList
Type: Predefined

1. 1 Strongly agree
2. 2 Agree

3. 3 Neither agree nor disagree
4. 4 Disagree
5. 5 Strongly disagree

===========================
Question Name: Q29InfoWildlife
===========================
Type: Select (Radio Button)
Required: YES

[Header 1]:
[Question]:
Information about the populations of native wildlife in Hawke's Bay
catchments is well communicated to the public.
[Response Options]:
List Name: QManagementList
Type: Predefined

1. 1 Strongly agree
2. 2 Agree
3. 3 Neither agree nor disagree
4. 4 Disagree

5. 5 Strongly disagree

===========================
Question Name: Q30InfoTax
===========================
Type: Select (Radio Button)
Required: YES

[Header 1]:
[Question]:
If I was more informed about the state of catchments, I would be more trusting of the taxes charged by the authorities managing them.
[Response Options]:
List Name: QManagementList
Type: Predefined

1. 1 Strongly agree
2. 2 Agree

3. 3 Neither agree nor disagree
4. 4 Disagree
5. 5 Strongly disagree

===========================
Question Name: Q32Management
===========================
Type: Select (Radio Button)
Required: YES

[Header 1]:
[Question]:
All things considered, the Tukituki River catchment is being well
managed.
[Response Options]:
List Name: QManagementList
Type: Predefined

1. 1 Strongly agree
2. 2 Agree
3. 3 Neither agree nor disagree
4. 4 Disagree
5. 5 Strongly disagree

===========================
Question Name: Q31InfoPreff
===========================
Type: Select (Radio Button)
Required: YES

[Header 1]:
[Question]:
How would you most prefer to be informed about the state of

Hawke's Bay catchments?
[Response Options]:
List Name: Q14InfoPreffList
Type: Predefined

1. 1 Email
2. 2 Social media
3. 3 Radio
4. 4 Mobile App
5. 5 Newspaper
6. 6 Mail
7. 7 Council websites
8. 8 I'm not interested

===========================
Question Name: Q23Consequence
===========================
Type: Select (Radio Button)
Required: YES

[Header 1]:
[Question]:
Do you think the results of this survey should be brought to the attention of the authorities?
[Response Options]:
List Name: Q23ConsequenceList
Type: Predefined

1 Yes 2 No

===========================
Question Name: Q42DrawRegsitration
===========================
Type: Free Format

[Header 1]:
[Header 2]:
If you wish to enter the draw for one of ten $50 supermarket vouchers you will need to give us your name and contact information.
Providing this information implies your consent and that you understand your response will no longer by anonymous.
[Variable 1]:
Name: Q42DrawRegsitration_NewVar
Type: textarea
Required: NO
Min Length: 1
Max Length: 50
[Variable 2]:
Name: Q42DrawRegsitration_NewVar1
Type: textarea
Required: NO
Min Length: 1
Max Length: 50

```
[HTML]:
Please enter your name
Please enter your email address
Please Note:</b> Those receiving a voucher will be notified from
>Humphrey.walker.1@uni.massey.ac.nz
===========================
Question Name: Q33Termination
===========================
Type: Terminate
Terminate Respondent: YES
Termination Status: Qualified / Complete (5)
---------------------------
[Header 1]:
[Header 2]:
Thank you, your survey has been sent!
Thank you for participating in our survey today.
Your opinions are important to us and we hope that you will be
able
to offer them to Massey University via our online surveys in the
future.
===========================
Question Name: Q34TeminateNonpayer
===========================
Type: Terminate
Terminate Respondent: YES
Termination Status: Qualified / Complete (5)
---------------------------
[Header 1]:
[Header 2]:
Thank you!
Thank you for participating in our survey today.
We needed to speak to a certain sub-section of the population.
To do
this we usually ask a few screening questions at the beginning
of
the survey. In this instance you were not eligible for the
survey.
Thank you for considering our survey. Your opinions are
important to
us and we hope that you will be able to offer them to Massey
University via our online surveys in the future.
===========================
Question Name: Q35teminateUnder18
===========================
Type: Terminate
Terminate Respondent: YES
Termination Status: Qualified / Complete (5)
---------------------------
[Header 1]:
[Header 2]:
Thank you!
Thank you for participating in our survey today.
We needed to speak to a certain sub-section of the population.
To do
this we usually ask a few screening questions at the beginning
of
```

```
the survey. In this instance you were not eligible for the
survey.
Thank you for considering our survey. Your opinions are
important to
us and we hope that you will be able to offer them to Massey
University via our online surveys in the future.
```

Appendix F - Best-worst choice experiment design

This appendix contains the back-end design for the best-worst choice experiment used to generate part-worth utilities associated with respondent trust in a set of ten organisations involved in freshwater management in the Hawke's Bay.

Number of Items (Attributes): 10

Number of Items per Set: 4

Number of Sets per Respondent: 10

Number of Versions: 300

Number of Iterations: 1000

Random Number Seed: 1

Iteration 599 was chosen

One Way Frequencies:

Item	Times Used
1	1200
2	1200
3	1200
4	1200

5	1200
6	1200
7	1200
8	1200
9	1200
10	1200

Mean = 1200

Std Dev. = 0

Two Way Frequencies:

Item	1	2	3	4	5	6	7	8	9	10
1	1200	400	400	401	400	400	399	400	400	400
2	400	1200	400	400	400	400	400	400	400	400
3	400	400	1200	399	400	400	401	400	400	400
4	401	400	399	1200	400	400	400	400	400	400
5	400	400	400	400	1200	400	400	400	400	400
6	400	400	400	400	400	1200	400	400	400	400
7	399	400	401	400	400	400	1200	400	400	400
8	400	400	400	400	400	400	400	1200	400	400
9	400	400	400	400	400	400	400	400	1200	400
10	400	400	400	400	400	400	400	400	400	1200

Off Diagonal Non-prohibited Elements

Mean = 400

Std Dev. = 0.29814

Positional Frequencies:

	Pos. 1	2	3	4
Item 1	300	301	299	300
2	300	300	300	300
3	301	300	299	300
4	300	300	300	300
5	300	299	300	301
6	299	300	301	300
7	300	300	301	299
8	300	300	300	300
9	300	300	300	300
10	300	300	300	300

Mean = 300

Std Dev. = 0.5

Appendix G - Analysis of neutral responses to the survey of perceptions of the Tukituki River catchment.

Table G.1 *Distribution of Respondents Giving a Neutral Answer to a Question*

	Fishers		**Non-fishers**		**Hunters**		**Non-hunters**	
	% Distribution							
	Yes	No	Yes	No	Yes	No	Yes	No
Did you answer 'neither agree nor disagree' for any questions?	65.1	34.9	66.9	33.1	70.6	29.4	64.5	35.5

Table G.2 *Distribution of Respondents Main Reason for Giving a Neutral Response to a Rating Question*

		Fishers	**Non-fishers**	**Hunters**	**Non-hunters**
		% Distribution			
Was this mostly because?	I feel I didn't know enough to decide.	74.1	85.5	69.4	80.5
	I feel the decision was too hard.	5.6	-	-	4.0
	I genuinely had no opinion.	18.5	14.5	27.8	14.8
	I did not understand the question.	1.9	-	2.8	0.7

Appendix H - Additional tables for the analysis of perceptions of the Tukituki River catchment's current and future states

Table H.1 *Total Respondent Profile Compared to the Hawke's Bay Population*

	Total Sample (N=293)		**Hawke's Bay**
	n	%	%
Gender			
Female	108	36.9	51.3
Male	183	62.5	48.7
Transgender female	1	0.3	-[a]
Self-described	1	0.3	-[a]
Age			
18-49[b]	89	30.4	47.5
50-64	113	38.6	27.1
65+	91	31.1	25.3
Ethnicity[c]			
European	87	29.7	75
New Zealander	200	68.3	NA
Maori	19	6.5	27
Pasifika	1	0.3	6.7
Other	15	5.1	9.4
Education			
Secondary school	60	20.5	26.1
Post-secondary school certificate or diploma	89	30.4	56.4
University Bachelor's degree	80	27.3	11.3
Post-graduate degree	62	21.2	6.2
Where do you live?			
Farm	21	7.2	-[d]
Lifestyle block	81	27.6	-[d]
Town	183	62.5	-[d]
Town and own a farm	8	2.7	-[d]
Household income			$
$0-$50,000	58	19.8	
$51,000- $100,000	98	33.4	$99,719[e]
$101,000-$150,000	74	25.3	
$151,000-$200,000	34	11.6	
$200,000 or more	29	9.9	

[a] Available National Census data does not support categories for gender fluidity.

[b] The 2018 National Census data for this bracket differs in that it start from age 20 not 18.

[c] The 2018 National Census and this survey allow for respondents to select more than one ethnicity, consequently percentages sum >100.

[d] No data is available for comparison.

[e] Mean household income for 2020 taken from Infometrics (2020).

Table H.2 *Comparison of Demographic Variables Between Hunter/Fishers and Hunter_Only*

	Fisher/Hunters (Fishes and hunts gamebirds)		**Hunters_Only** (Hunts gamebirds only)	
	n	%	n	%
Gender				
Female	-	-	-	-
Male	37	94.6	12	100
Transgender female	1	2.6	-	-
Self-described	1	2.6	-	-
Age				
18-49	15	38.5	6	50.0
50-64	19	48.7	6	50.0
65+	5	12.8	-	-
Ethnicity[a]				
European	9	23.1	2	16.7
New Zealander	27	69.2	9	75.0
Maori	3	7.7	1	8.3
Pasifika	-	-	-	-
Other	3	7.7	1	8.3
Education				
Secondary school	15	38.5	2	16.7
Post-secondary school certificate or diploma	10	25.6	5	41.7
University Bachelor's degree	8	20.5	4	33.3
Post-graduate degree	6	15.4	1	8.3
Where do you live?				
Farm	5	12.8	3	25.0
Lifestyle block	11	28.2	5	41.7
Town	21	53.8	3	25.0
Town and own a farm	2	5.1	1	8.3
Household income				
$0-$50,000	4	10.3	-	-
$50,001-$100,000	9	23.1	2	16.7
$100,001-$150,000	12	30.8	8	66.7
$151,001-$200,000	11	28.2	-	-
$200,001 or more	3	7.7	2	16.7

[a] The 2018 National Census and this survey allow for respondents to select more than one ethnicity, consequently percentages sum >100.

Table H.3 *Fisher and Non-fisher Perceptions of the Tukituki River Catchment's Current State: t-test for Independence with all Hunters Removed from the Sample*

		$\bar{x}$	SD	*t*	df	p-value	Cohen's d
In the past 5 years water levels in the Tukituki River catchment during summer posed no problem.	Fisher	4.22	1.15	0.078	232	.938	0.010
	Non-fisher	4.21	1.08				
In the past 5 years waterways in the Tukituki River catchment were safe to swim in.	Fisher	4.15	1.05	-0.675	232	.500	-0.089
	Non-fisher	4.24	1.07				
In the past 5 years native fish populations in the Tukituki River catchment were plentiful.	Fisher	3.49	1.11	-1.094	232	.275	-0.144
	Non-fisher	3.64	0.97				
In the past 5 years native wetland bird populations in the Tukituki River catchment were plentiful.	Fisher	3.15	0.95	-1.465†	204	.145	-0.196
	Non-fisher	3.35	1.10				
In the past 5 years there was enough water over summer in the Tukituki River catchment to continue irrigating agricultural crops at current rates without causing any problems.	Fisher	4.21	0.98	0.416	232	.678	-0.203
	Non-fisher	4.15	0.99				
In the past 5 years weed growth on the beds of the Tukituki River catchment over summer posed no problem.	Fisher	4.48	1.01	1.959	232	.051	-0.001
	Non-fisher	4.22	1.03				

Note. This table shows the results of a t-test for independence of the means for respondents split into *Fisher* and *Non-fisher* groups. All those Fishers that were also *Hunters* were removed from the *Fisher* sample to test for any bias the *Fisher/Hunters* may introduce.

† Levene's Test for equality of variances between populations was significant at $p < 0.05$. This means equal variances between populations for that variable could not be assumed and the alternative t-test p-value provided in SPSS was used.

Table H.4 *Fisher and Non-fisher Perceptions of a Future State in the Common Good: t-test of Independence with all Hunters Removed from the Sample*

		$\bar{x}$	**SD**	***t***	**df**	**p-value**	**Cohen's d**
The Tukituki River catchment should be safe to swim in summer.	Fisher	1.11	0.42	-1.034	232	.302	-0.136
	Non-fisher	1.18	0.57				
The Tukituki River catchment should have higher minimum flow levels than in past years.	Fisher	1.41	0.78	-1.898†	199	.059	-0.255
	Non-fisher	1.63	0.95				
The Tukituki River catchment should support larger populations of native wetland birds.	Fisher	1.67	0.89	1.062	232	.289	0.140
	Non-fisher	1.55	0.83				
The Tukituki River catchment should support larger populations of native fish.	Fisher	1.58	0.82	0.264	232	.792	0.035
	Non-fisher	1.55	0.83				
The Tukituki River catchment should have greatly reduced weed growth on their beds.	Fisher	1.31	0.71	-2.386†	199	.018*	-0.320
	Non-fisher	1.56	0.86				
The Tukituki River catchment should provide water to support agriculture through irrigation at current levels.	Fisher	3.52	1.27	1.336	232	.183	-0.083
	Non-fisher	3.30	1.29				
The Tukituki River catchment should support more agriculture by providing more water for increased irrigation.	Fisher	4.12	1.13	1.247	232	.214	-0.094
	Non-fisher	3.93	1.20				

Note. This table shows the results of a t-test for independence of the means for respondents split into *Fisher* and *Non-fisher* groups. All those Fishers that were also *Hunters* were removed from the *Fisher* sample to test for any bias the *Fisher/Hunters* may introduce.

* Significant at $p < 0.05$

† Levene's Test for equality of variances between populations was significant at $p < 0.05$. This means equal variances between populations for that variable could not be assumed and the alternative t-test p-value provided in SPSS was used.

Appendix I - Additional tables for latent class analysis

This appendix contains supplementary tables for the latent class cluster analysis of perceptions of the Tukituki River catchments current state contained in section 5.2.6.

Table I.1 *Future State Model Fit Statistics for the First Iteration Using All Six Indicator Variables*

		LL	BIC(LL)	Npar	L^2	df	p-value	Bootstrap p-value	Class.Err.
Model1	1-Class	-940.61	1941.38	12	341.16	281	.008**		0.00
Model2	2-Class	-868.37	1844.66	19	196.69	274	1	.004**	0.05
Model3	3-Class	-853.29	1854.27	26	166.53	267	1	.022*	0.07
Model4	4-Class	-844.43	1876.30	33	148.80	260	1	.152	0.12
Model5	5-Class	-840.44	1908.09	40	140.83	253	1	.114	0.12
Model6	6-Class	-835.58	1938.12	47	131.10	246	1	.096	0.11

Note. Latent Class Cluster model fit statistics for models containing between 1 and 6 estimated latent classes for perceptions of the Tukituki River catchments future-state in the common good. These statistics are for the first iteration using all six of the state variables.

* Significant at the p<.05 level, ** p<.01

Table I.2 *Future State 4-Class Bivariate Residuals from the First Iteration of Modelling*

Indicators	1	2	3	4	5
1. Water Levels	.				
2. Swimming	0.18	.			
3. Fish Population	0.19	0.31	.		
4. Bird Population	0.81	0.04	0.00	.	
5. Current Irrigation	0.38	0.13	0.06	0.09	.
6. Weed Growth	0.10	0.05	0.01	0.14	0.18

Note. Bivariate residuals for the 4-class model demonstrating that all variables have a satisfactory bivariate explanatory relationship.

Table I.3 *Future State 4-Class Parameter Values from the First Iteration of Modelling*

Indicators	Class-1	Class-2	Class-3	Class-4	Wald	p-value	R^2
Safe Swimming	-0.60	-2.21	1.54	1.27	1.56	.670	0.08
Higher Flows	-3.23	-0.11	1.34	2.00	11.61	.009**	0.40
More Native Birds	-1.82	-1.99	-3.76	3.59	16.65	p<.001***	0.57
More Native Fish	-4.31	3.37	-2.52	3.45	5.03	.170	0.63
Reduced Weed	-1.83	-0.70	1.00	1.53	10.09	.018*	0.24
Continued Irrigation	0.75	0.64	-0.04	-1.34	16.15	.001**	0.17

Note. Table shows model parameters for the accepted 2-class model demonstrating that all variables have significant contributions to the model.
* Significant at the p<.05 level, **p<.01, *** p<.001 level.

Table I.4 *Current-state 5-class Paired Comparisons*

Models for Indicators			Wald	p-value	Models for Indicators			Wald	p-value
Water Levels					**Bird Population**				
Class	1	2	0.70	0.400	Class	1	2	5.39	.020*
Class	1	3	2.13	0.140	Class	1	3	2.72	.099
Class	1	4	3.67	0.055*	Class	1	4	20.07	.000**
Class	1	5	0.28	0.600	Class	1	5	4.42	.036*
Class	2	3	10.26	0.001**	Class	2	3	6.65	.010*
Class	2	4	30.92	0.000***	Class	2	4	10.60	.001*
Class	2	5	0.16	0.690	Class	2	5	9.61	.002*
Class	3	4	11.45	0.001**	Class	3	4	10.30	.001*
Class	3	5	1.93	0.160	Class	3	5	3.19	.074
Class	4	5	4.71	0.030**	Class	4	5	1.03	.310
Swimming					**Current Irrigation**				
Class	1	2	1.18	0.280	Class	1	2	1.39	.240
Class	1	3	0.38	0.540	Class	1	3	10.99	.001*
Class	1	4	31.54	0.000***	Class	1	4	23.33	.000**
Class	1	5	2.87	0.090*	Class	1	5	0.72	.400
Class	2	3	1.45	0.230	Class	2	3	17.40	.000**
Class	2	4	4.23	0.040**	Class	2	4	29.62	.000**
Class	2	5	1.95	0.160	Class	2	5	0.19	.670
Class	3	4	19.81	0.000***	Class	3	4	6.00	.014*
Class	3	5	1.03	0.310	Class	3	5	3.18	.075
Class	4	5	11.27	0.001***	Class	4	5	5.11	.024*
Fish Population					**Weed Growth**				
Class	1	2	4.51	0.034**	Class	1	2	0.34	.560
Class	1	3	0.02	0.880	Class	1	3	1.97	.160
Class	1	4	23.26	0.000***	Class	1	4	3.11	.078*
Class	1	5	10.10	0.002**	Class	1	5	0.02	.880
Class	2	3	4.33	0.037**	Class	2	3	8.79	.003*
Class	2	4	9.09	0.003**	Class	2	4	17.62	.000**
Class	2	5	9.53	0.002**	Class	2	5	0.14	.710
Class	3	4	17.03	0.000***	Class	3	4	13.15	.000**
Class	3	5	8.67	0.003**	Class	3	5	1.34	.250
Class	4	5	0.39	0.530	Class	4	5	2.28	.130

*Significant at the p<.05 level, **p<.01 level
Note. Table shows which pairs of class relationships are significantly distinguished between by each variable.

Table I.5 *Current-state Class Membership by Mean Probabilities*

	Recreationists	*Pessimists*	*Non-committers*	*Pro-irrigators*	*Biodiversity Positive*
Overall	0.402	0.227	0.180	0.116	0.075
Indicators					
Water Levels					
Pose no problem	0.001	0.075	0.298	0.623	0.003
Neutral	0.042	0.038	0.558	0.329	0.033
Are a problem	0.499	0.269	0.126	0.016	0.090
Swimming					
No risk to health	0.162	0.001	0.090	0.628	0.120
Neutral	0.440	0.016	0.315	0.156	0.074
Risk to health	0.444	0.297	0.181	0.012	0.066
Fish Population					
Populations plentiful	0.171	0.000	0.089	0.403	0.338
Neutral	0.582	0.004	0.243	0.121	0.050
Populations not plentiful	0.292	0.561	0.145	0.001	0.002
Bird Population					
Populations plentiful	0.241	0.000	0.197	0.303	0.260
Neutral	0.633	0.008	0.276	0.079	0.005
Populations not plentiful	0.264	0.685	0.051	0.000	0.000
Current Irrigation					
Poses no problem	0.039	0.000	0.298	0.663	0.000
Neutral	0.288	0.084	0.405	0.212	0.011
Poses a problem	0.469	0.290	0.106	0.035	0.100
Weed Growth					
Poses no problem	0.000	0.000	0.226	0.774	0.000
Neutral	0.003	0.035	0.590	0.373	0.000
Poses a problem	0.489	0.273	0.131	0.017	0.091

Note. Table shows the mean probability that members of each latent class selected each variable level. Probabilities sum horizontally to 1 or 100%..

Table I.6 *Current-state Class Membership by Covariate Probability Means*

Model-1	*Recreationists*	*Pessimists*	*Non-committers*	*Pro-irrigators*	*Biodiversity Positive*
Overall	0.404	0.227	0.178	0.117	0.074
Covariates					
Age_agg					
18-49	0.391	0.219	0.194	0.134	0.063
50-64	0.402	0.222	0.166	0.135	0.076
65+	0.420	0.243	0.177	0.078	0.082
Income					
$0-$50,000	0.369	0.258	0.229	0.067	0.078
$50,001-$100,000	0.394	0.238	0.193	0.094	0.081
$100,001-$150,000	0.403	0.217	0.166	0.135	0.080
$150,001-$200,000	0.449	0.205	0.136	0.150	0.060
$200,000 or more	0.460	0.185	0.100	0.211	0.045
Education					
Secondary school	0.307	0.195	0.160	0.150	0.188
Post-secondary school certificate or diploma	0.389	0.234	0.192	0.108	0.078
University Bachelor's degree	0.437	0.234	0.177	0.120	0.033
Post-graduate degree	0.478	0.240	0.175	0.095	0.012
Dwell					
On a farm	0.309	0.209	0.120	0.249	0.113
On a lifestyle block	0.399	0.221	0.144	0.165	0.071
In town	0.415	0.232	0.197	0.084	0.072
In town and own a farm	0.461	0.228	0.225	0.041	0.045
Model-2					
Overall	0.402	0.227	0.181	0.116	0.074
Covariates					
Fisher					
Fisher	0.393	0.078	0.104	0.273	0.152
Non-fisher	0.405	0.259	0.196	0.081	0.059
Hunter					
Yes	0.427	0.204	0.151	0.118	0.100
No	0.368	0.258	0.221	0.113	0.039

Note. Table shows the probability that a member of each latent class selected each level of the covariate variables. Probability scores sum horizontally to 1 or 100%.

Table I.7 *Distribution (%) of Future-state Perceptions by Indicator Variable*

	% Distribution					
	Strongly agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Strongly disagree	Total
The Tukituki River catchment should be safe to swim in summer. **(Safe Swimming)**	85.7	10.9	1.7	1.0	0.7	100
The Tukituki River catchment should have higher minimum flow levels than in past years. **(Higher Flows)**	61.8	24.9	7.2	3.8	2.4	100
The Tukituki River catchment should support larger populations of native wetland birds. **(More Native Birds)**	56.0	25.3	16.0	1.4	1.4	100
The Tukituki River catchment should support larger populations of native fish. **(More Native Fish)**	58.0	22.9	16.4	2.4	0.3	100
The Tukituki River catchment should have greatly reduced weed growth on their beds. **(Reduced Weed)**	67.9	22.5	6.5	2.0	1.0	100
The Tukituki River catchment should provide water to support agriculture through irrigation at current levels. **(Continued Irrigation)**	10.9	20.5	21.8	21.5	25.3	100

Table I.8 *Future-state Class Membership Distribution by Probability Means*

	Pro-quality	Pro-irrigators
Overall	0.852	0.149
Indicators		
Higher Flows		
Should have higher minimum flows	0.937	0.063
Neutral	0.431	0.569
Should not have higher minimum flows	0.141	0.859
More Native Birds		
Should have more native wetland birds	0.923	0.077
Neutral	0.614	0.386
Should not have more native wetland birds	0.138	0.863
Reduced Weed		
Should have reduced riverbed weed	0.912	0.088
Neutral	0.411	0.589
Should not have reduced riverbed weed	0.018	0.982
Continued Irrigation		
Should continue to support irrigation at current levels	0.625	0.375

Neutral	0.891	0.109
Should not continue to support irrigation at current levels	0.985	0.015

Note. Table shows the mean probability that a member of each latent class selected each variable level. Probability scores sum laterally to 1 or 100% of ratings for that variable level.

Table I.9 *Future-state Class Membership by Covariate Probability Means*

Model-1	Pro-quality	Pro-irrigators
Overall	0.854	0.146
Covariates		
Age_agg		
18-49	0.840	0.160
50-64	0.837	0.163
65+	0.889	0.111
Income		
$0-$50,000	0.888	0.112
$50,001-$100,000	0.870	0.130
$100,001-$150,000	0.842	0.158
$150,001-$200,000	0.839	0.161
$200,000 or more	0.778	0.222
Education		
Secondary school	0.858	0.142
Post-secondary school certificate or diploma	0.877	0.123
University Bachelor's degree	0.841	0.159
Post-graduate degree	0.835	0.166
Dwell		
On a farm	0.669	0.331
On a lifestyle block	0.793	0.207
In town	0.898	0.102
In town and own a farm	0.949	0.052
Model-2		
Overall	0.625	0.157
Covariates		
Hunter		
Yes	0.731	0.269
No	0.882	0.118
Fisher		
Fisher	0.885	0.115
Non-fisher	0.811	0.190

Note. Table shows the mean probability that a member of each latent class selected each variable level. Probability scores sum laterally to 1 or 100% of ratings for that variable level.

Table I.10 *Model Statistics for 5-class Current-state Step 3 Models*

	LL	BIC(LL)	Npar	L^2	df	p-value
5-Class Step 3 *Age_agg, Income, Education, Dwelling, Hunter, Fisher*	-410.86	980.76	28	423.59	265	p<.001**
5-Class Step 3 *Age_agg, Income, Education, Dwelling*	-416.94	947.49	20	300.02	273	.13
5-Class Step 3 *Hunter, Fisher*	-416.36	900.88	12	7.16	8	.52

** Significant at the p<.05 level

Appendix J - Additional tables for WTP for improved water quality

Table J.1 *Distribution of Willingness to Pay for Improved Water Quality in the Tukituki River Catchment*

	Response Frequency	
WTP($)	n	%
0	15	4.1
1.00	14	3.8
2.00	12	3.3
2.50	12	3.3
3.50	2	0.5
4.00	58	15.7
5.00	77	20.9
6.50	35	9.5
8.00	22	6.0
9.50	42	11.4
11.00	22	6.0
12.50	58	15.7
Total	369	100

Note. The payment levels are those discrete levels chosen in the iterative bidding design. The starting bid was fixed to $4.00 for all respondents.

Table J.2 *Geographic Distribution of Responses by Closest Township*

	Frequency of Responses %	
Respondent's closest town	n	%
Bridge Pa	7	1.9
Clive	8	2.2
Haumoana	8	2.2
Hastings	76	20.6
Havelock North	76	20.6
Napier	61	16.5
Ocean Beach	4	1.1
Ongaonga	9	2.4
Otane	13	3.5
Takapau	2	0.5
Taradale	30	8.1
Te Awanga	4	1.1
Tikokino	2	0.5
Waimarama	4	1.1
Waipukurau	34	9.2
Waipawa	26	7.0
Wairoa	5	1.4
Total	369	100

Appendix K - Hierarchical Bayes graphical outputs

This appendix shows the difference in graphical hierarchical Bayes output between the random data set, *Figure K.1*, generated in order to define parameters for the identification of random responders and that generated form the final survey data set, *Figure K.2*. The survey data displays well defined non-random utilities.

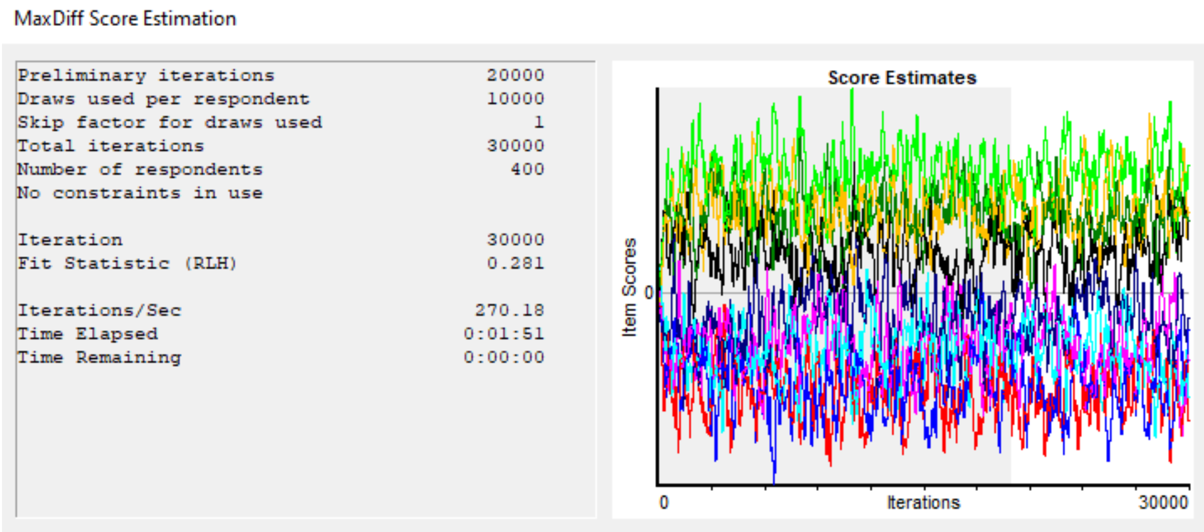


Figure K.1 Hierarchical Bayes Graphical Output for Random Best-Worst Data

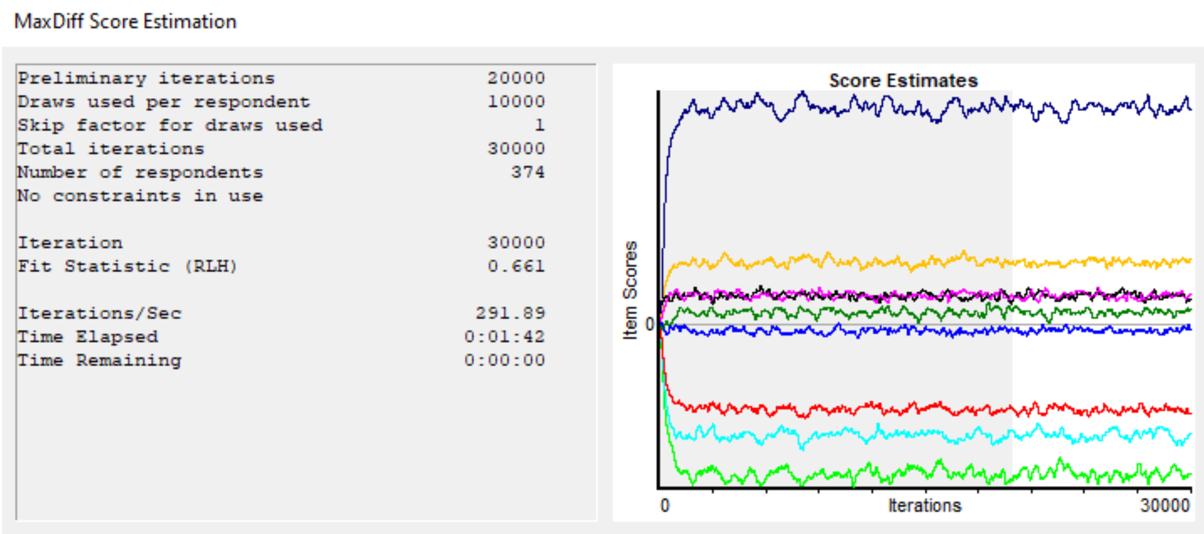


Figure K.2 Hierarchical Bayes Graphical Output for Survey Response Best-Worst Data

Appendix L - Webpage, Facebook post and survey landing-page

This appendix shows the web landing page in *Figure L.1*, use to link respondents to the survey platform for Objectives 2 & 3 as shown in *Figure L.3*, and the Facebook post used as the paid advertisement for the survey, *Figure L.2*.

Figure L.1 Webpage used to link to Objectives 2 & 3 Survey Platform

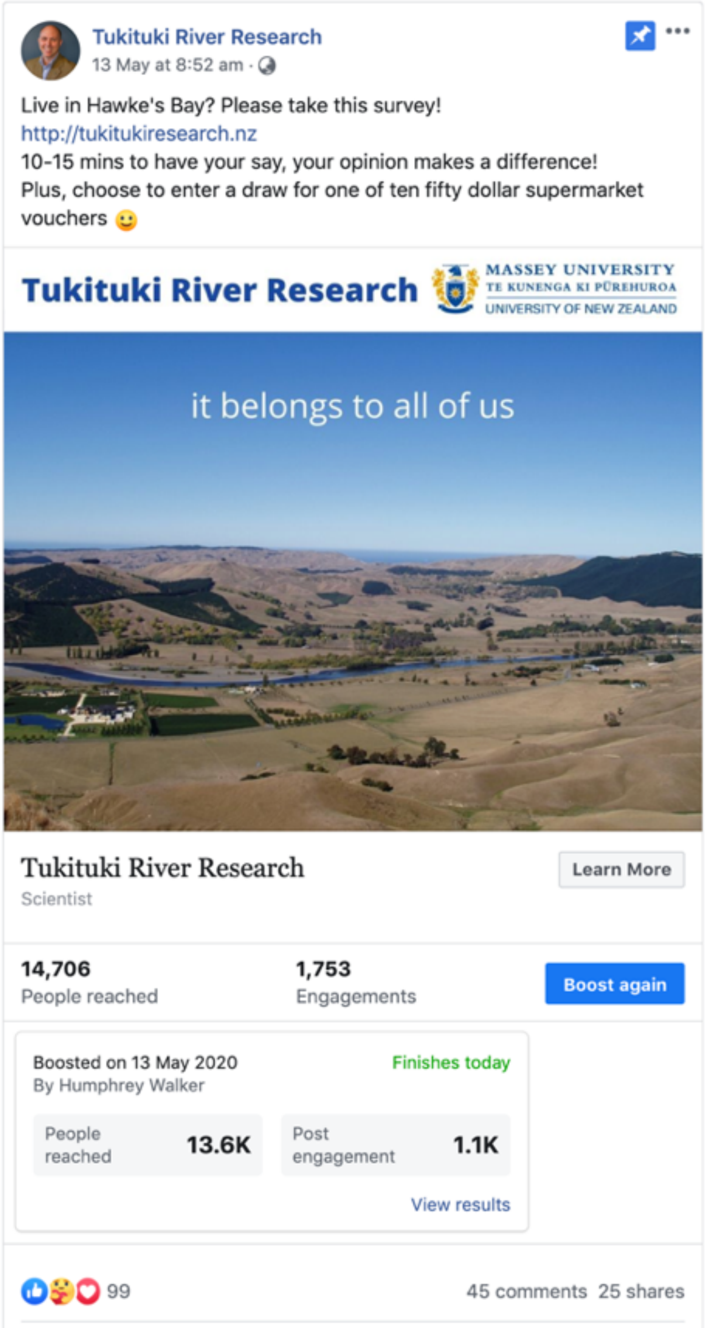
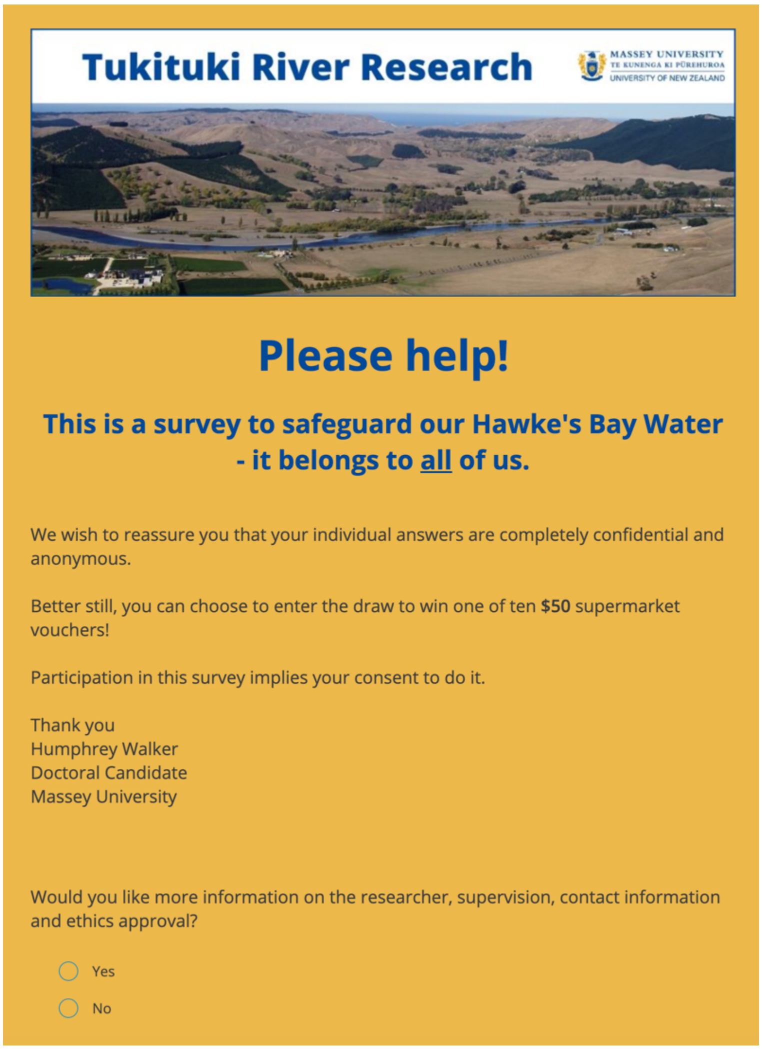


Figure L.2 Example Facebook post to Promote the Survey for Objectives 2 & 3



Tukituki River Research

MASSEY UNIVERSITY
TE KUNENGA KI PŪREHUROA
UNIVERSITY OF NEW ZEALAND

Please help!

This is a survey to safeguard our Hawke's Bay Water - it belongs to all of us.

We wish to reassure you that your individual answers are completely confidential and anonymous.

Better still, you can choose to enter the draw to win one of ten **$50** supermarket vouchers!

Participation in this survey implies your consent to do it.

Thank you
Humphrey Walker
Doctoral Candidate
Massey University

Would you like more information on the researcher, supervision, contact information and ethics approval?

- ○ Yes
- ○ No

Figure L.3 Objectives 2 & 3 Survey Landing Page

Appendix M - Regression estimation graphs for Objective 3

This appendix contains the regression estimation graphs for respondents willingness to pay for improved water quality regressed against the hierarchical Bayes Raw utility scores for each of the ten organisation included in the best-worst choice experiment.

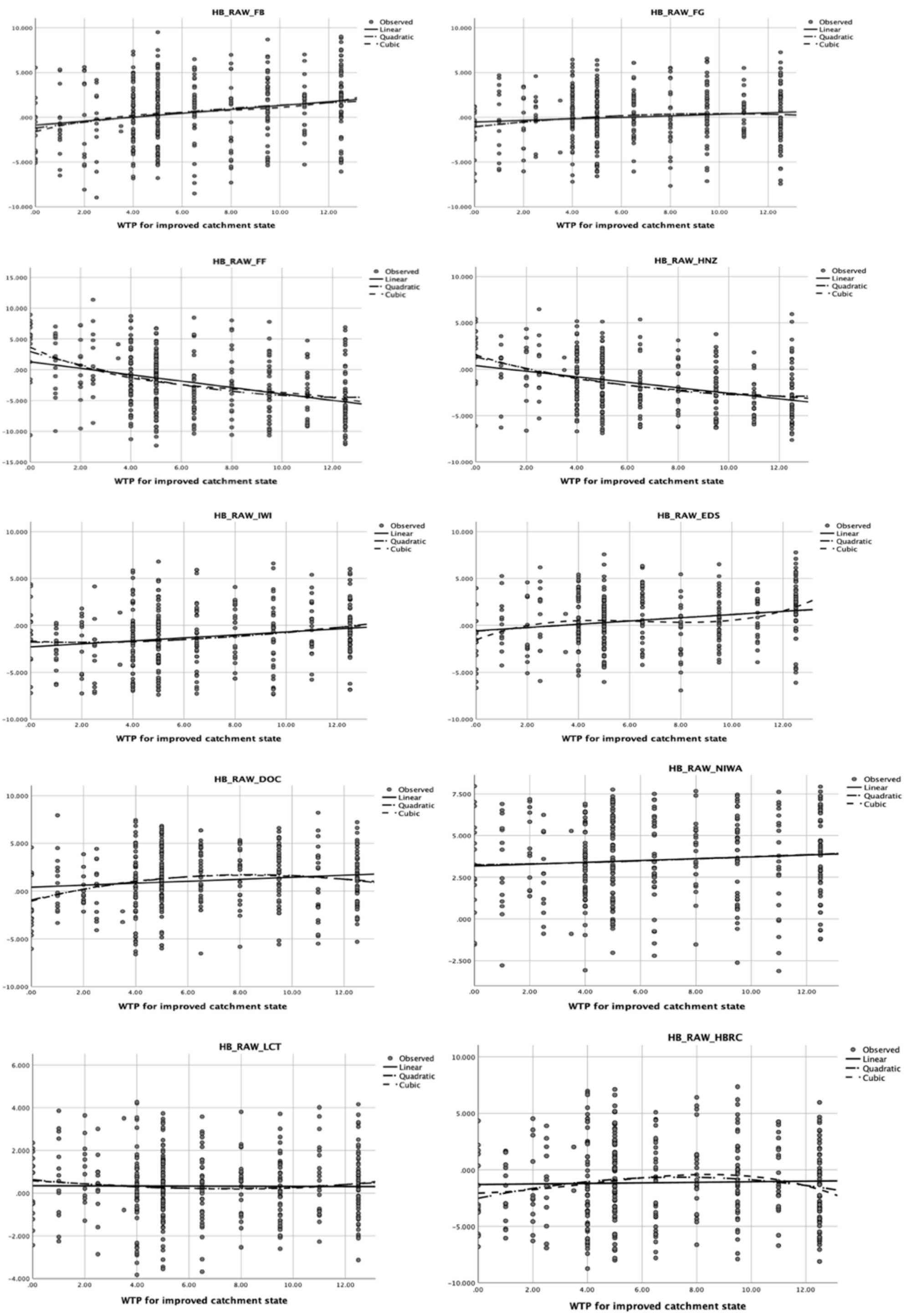


Figure M.1 *Regression Curve Estimation for Organisational Trust Utilities with Willingness to Pay for Improved Water Quality in the Tukituki River Catchment*

Appendix N - Exploratory partial least squares base model results

This appendix contains the partial least squares base model results of willingness to pay for improved water quality (WTP) as the dependant variable and respondent raw trust utilities as the independent variables. Only the five organisation trust variables with significant linear regression equations, as shown in Table 5.34, were used.

Table N.1 *Proportion of Variance Explained by the Partial Least Squares Regression Model of WTP and Trust Utility*

Latent Factors	X Variance	Cumulative X Variance	Y Variance	Cumulative Y Variance	Adjusted R-squared
1	.648	.648	.125	.125	.123
2	.148	.796	.024	.150	.145
3	.104	.900	.012	.161	.154
4	.073	.974	.002	.164	.155
5	.026	1.000	.002	.165	.154

Table N.2 *Partial Least Squares Regression Model Parameters of WTP and Trust Utility*

Independent Variables	Dependent Variable
Constant	5.935
FB	-.253
FF	-.323
HNZ	-.120
IWI	.045
EDS	.059

Table N.3 *Variable Importance in the Projection of the Partial Least Squares Regression Model of WTP and Trust Utility*

	Latent Factor Importance in the Projection				
Variables	1	2	3	4	5
FB	.761	.962	1.042	1.043	1.038
FF	1.331	1.271	1.274	1.272	1.282
HNZ	1.278	1.215	1.182	1.184	1.189
IWI	.645	.652	.727	.724	.720
EDS	.775	.764	.743	.751	.750

Table N.4 *Partial Least Squares Regression Model Factor Weights and Loadings of WTP and Trust Utility*

	Latent Factor Weights					Latent Factor Loadings				
Variables	1	2	3	4	5	1	2	3	4	5
FB	.340	-.736	-.793	-.486	.037	.483	-.595	-.234	-.412	.328
FF	-.595	-.402	-.589	-.500	-.903	-.542	-.082	-.222	.061	-.603
HNZ	-.571	-.369	-.269	.590	.724	-.524	-.249	-.258	.460	.370
IWI	.289	.305	-.610	.197	-.057	.243	.788	-.949	.510	-.175
EDS	.347	-.314	.170	.542	-.276	.414	-.625	.212	.844	-.601
WTP	.200	.217	.158	.094	.114	1.000	1.000	1.000	1.000	1.000