Valuation of biodiversity and ecosystem services to improve spatial management of near-shore marine areas in New Zealand

Sophal Chhun

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Abstract

Ecosystem-based management (EBM) is a holistic approach that is most reliable for achieving sustainability of complex, coupled social-ecological systems. An EBM approach to marine fisheries can be put in practice by implementing marine reserves and Customary Protection Areas (CPAs) in addition to conventional fishing regulations (input and output controls). Marine reserves are 'no-take' areas where all fishing is completely banned; whereas CPAs provide a flexible mechanism that enables local indigenous people and communities to enact responsibilities and protect their long-term interests. Spatial conflicts between these additional management tools with existing uses (especially fishing) and between the tools themselves have been a major obstacle to practical application of EBM. This has resulted in conflicts of interest and a 'race for space' for prime sites chosen for marine reserves and CPAs.

This thesis reports analyses of testimony from forty interviews and four focus groups involving key stakeholders to two case-study marine ecosystems in New Zealand. The results show that polarisation of goals and values, the race for space, and social conflicts have actually been induced by perceived declines in fish stocks and biodiversity. Marine reserves are perceived to be more reliable than CPAs (Taiāpure and Mātaitai) for protecting existing and restoring declining biodiversity and fish stocks. Biodiversity is highly coveted for its own intrinsic value and for long-term human benefits. However, Māori have vigorously opposed marine reserves due to the concern over the cumulative loss of traditional fishing grounds, the loss of opportunity to gain control over these areas, and the threat to cultural practices. Recreational and commercial fishers have opposed any greater restriction that has potential to accumulatively threaten their fishing. These fishers tend to support taiāpure in a way that forms a coalition with its proponents to make more effective opposition to a marine reserve that has greater impact on fishing. Impact assessment tests are insufficient for making sound decisions about the allocation of space in marine areas. Therefore, information about the large public's preferences for the trade-offs between reductions in current uses and a greater chance of achieving sustainability induced by implementation of marine reserves and/or CPAs are needed.

An online survey-based choice experiment was implemented using *1000Minds* software to obtain information about relative values held by the public towards four major competing uses of marine resources (i.e. socio-ecological attributes) under debate. They include commercial fishing, recreational fishing, Māori cultural management, and biodiversity. A tax attribute was also included in the choice experiment to allow estimation of values in dollars. One thousand and fifty five New Zealanders participated in the choice experiment. Each individual respondent made on average twenty seven choices. Each choice puts the respondent in a situation where he or she must trade-off one better level of an attribute of a near-shore marine area for a better level of another attribute. Data from choices made allow estimation of a complete set of 'part-worth utilities' for each respondent using a linear programming routine. The results reveal that improved biodiversity is, on average, the change most valued by the general public, whereas restoring Māori cultural practices is roughly as important as maintaining the current relatively light restrictions on recreational and commercial fishing. Logistic regression analysis identifies some of the influences on the variation across respondents in the relative values of each socio-ecological attribute. This information allowed estimation of population-weighted average utility values. These values were used to estimate net changes in welfare from implementation of various management scenarios currently under consideration. The results suggest that any management alternative that restores either biodiversity or both biodiversity and Māori culture will yield a substantial welfare gain.

The functional relationship between changes in taxes and utility values estimated from the choices made by each respondent allows estimation of willingness to pay (WTP) for any change in any other attribute. WTP constitutes the dollar value to the respondent of such a change. The results are highly correlated with those based on the utility values discussed above. Annual population-weighted WTP is estimated at roughly NZ$224/household (NZ$370 million for the nation) or NZ$128/household (NZ$212 million for the nation) for improving biodiversity from poor to good or from poor to medium condition, respectively. Mean population-weighted WTP to maintain Māori culture or current light restrictions on commercial or recreational fishing is almost half as large. By applying these WTP estimates, an annual net benefit equivalent to roughly NZ$165 million or NZ$66 million at a minimum can be generated by policy that either restores biodiversity or both biodiversity and Māori culture. With dollar values, it is possible to suggest that there is potentially sufficient money

to buy back commercial quota required for the policy implementation, while still making New Zealanders 'economically' better-off.

The results from this general study provide a strong justification for the joint implementation of marine reserves and taiāpure (or mātaitai in areas of greater cultural significance for Māori). This joint implementation in the form of Marine Protected Areas (MPAs) or more broadly Biosphere Reserves offers perhaps the best chance of success in achieving sustainability of the complex, coupled social-ecological marine systems and resolving the race for space over the long-term. These results provide support for implementing New Zealand's MPAs Policy, which has been delayed for almost a decade.

Choice experiments are a developing type of valuation technique that can generate information about social preferences for aspects of competing policy options and contribute to improving the efficiency and sustainability in resource allocation. However, there is still much to be learned about the limitations and possibilities of choice experiments, so future applications should routinely include methodological experiments as part of their study design. Both monetary and non-monetary metrics may be used to complement each other because each has its own strengths and weaknesses. For instance, dollar values are easier to interpret, but estimating them requires more effort and care about associated uncertainty. For guiding public policy, results from choice experiments or any economic modelling need to be complemented by those from biological/ecological and sociological studies to achieve a sustainable and desirable future.

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Abbreviations

Bio-Good	Good condition of biodiversity
Bio-Medium	Medium condition of biodiversity
Bio-Poor	Poor condition of biodiversity
CBA	Cost-benefit analysis
Com-High	Commercial fishing not allowed in the coastal marine area
Com-Low	No changes to the current restrictions on commercial fishing
Com-Medium	More restrictions on commercial fishing
CPA	Customary protection area(s)
DEC	Discrete choice experiment(s)
EBM	Ecosystem-based management
ITQ	Individual transferable quota(s)
MCA	Multi-criteria analysis
MCul-Exclusive	Māori cultural management practiced exclusively by Māori
MCul-No	Māori cultural management no longer practiced
MCul-Partner	Māori cultural management practiced in partnership with the locals
MPA	Marine protected area(s)
MSY	Maximum sustainable yield
NZ	New Zealand
PAPRIKA	Potentially All Pairwise RanKings of all possible Alternatives
QMA	Quota management area(s)
QMS	Quota management system
Rec-High	Many more restrictions on recreational fishing
Rec-Low	No changes to the current restrictions on recreational fishing
Rec-Medium	More restrictions on recreational fishing
TAC	Total allowable catch(s)
TEK	Traditional ecological knowledge
TMK	Te Tiaki Mahinga Kai
WTA	Willing to accept
WTP	Willingness to pay

Glossary of Māori terms

Unless otherwise referenced, definitions are sourced from Moorfield (2003-2013)

Hapu	Sub-tribe
Iwi	Tribe
Kai	Food
Kai moana	Seafood
Kauwheke	Ancestor
Kererū	New Zealand pigeon (*Hemiphaga novaeseelandiae*) – A large green, copper and white native bush pigeon which was eaten by Māori.
Mahinha kai	Food gathering place
Mana	Influence, prestige, power, authority and control
Manaaki	Hospitality
Māori	New Zealand's indigenous people
Marae	Tribal gathering place
Mātaitai	A traditional fishing ground that is managed by a local committee proposed by Māori. The committee may exclusively involve only Māori, and commercial fishing is excluded from the area (Ministry of Fisheries, 2010b).
Mātauranga	Education, knowledge, wisdom, understanding, skill.
Ngāi Tahu	Tribal group of much of the South Island
Pā	Fortified village
Pākehā	New Zealander of European descent
Pāua	Abalone
Rahui	Traditional temporary closure
Rangatiratanga	Chieftainship, right to exercise authority (Jackson, 2011, 2013)
Raruraru	Conflict, argument
Rūnanga	Tribal council
Taiāpure	A traditional fishing ground that is managed by a local committee proposed by Māori. The committee often involves both Māori and other interest parties, and no fishing is excluded from the area (Ministry of Fisheries, 2010c).
Tāngata Whenua	Indigenous people of the land

Tapu	Sacred
Tiaki	Guardian
Wāhi	Location
Whenua	Land, ground

Chapter 1 General introduction

1. Problems in natural resource allocation

Humans have made unprecedented changes to ecosystems in recent decades to meet growing demands for food and other materials needed to support human well-being. These changes have in fact improved the lives of billions of people, but at the same time have weakened nature's ability to deliver other key ecosystem services, e.g., purification of air and water, protection from disasters, and provision of medicines (Costanza et al., 1997; Millennium Ecosystem Assessment, 2005b). This indicates that conservation is needed in order to safeguard the many ecosystem goods and services (especially those 'public' ones) and apportion them equitably across generations.

Nearly all conservation concerns and advocacy boil down to ensuring trans-generational equity, i.e., making choices for current use and consumption of natural resources that do not reduce the choices available for unborn generations (Common & Stagl, 2005). Sustainability and restoration of degraded ecosystems are not just about bio-economic considerations; they are also about using resources in traditional ways that maintain the culture and connection of local communities to their culturally significant areas to lock in social-ecological resilience (Berkes, Colding, & Folke, 2003). Environmental valuation (see e.g. Champ, Boyle, & Brown, 2003; Garrod & Willis, 1999) is increasingly being used to inform and justify decision-making about conservation (TEEB, 2010). Conservation can be expensive in the sense that there can be large 'opportunity costs' from allocating an area to a conservation purpose, and the values associated with alternative uses of the area are often contested among competing stakeholders (Stephenson & Moller, 2009; Taiepa et al., 1997). The conflict between conservation and the various developed uses of the environment has become starkly apparent, implying that trade-offs are inevitable and environmental valuation is needed to supply information about the value of conservation if it is to be objectively justified (Bennett & Blamey, 2001). New Zealand's Department of Conservation, for example, is investigating opportunities to adopt ecological economics as a discipline to demonstrate the value of biodiversity conservation to sceptical stakeholders and guide choices about resource allocation among the contested

alternative uses (Phipps et al., 2011). TEEB[i] (2010, p.42) concludes that "if we fail to value these [ecosystem] services, the economic systems we rely on will remain biased toward ecosystem degradation and over-exploitation".

2. Environmental valuation to improve efficiency and sustainability

The lack of information about particular values, especially related to intangible ecosystem services, leads to these services being perversely treated as having "no value" or at least to be given less weight relative to tangible values (e.g., of marketed goods) in most decision-making when trade-offs between these values are made (Biological Diversity Advisory Committee, 2005; Costanza et al., 1998; TEEB, 2010). This has resulted in overexploitation of natural resources. Figure 1 illustrates the nature of this overexploitation using a standard externalities analysis. Let MB and MC represent the marginal benefit and cost, respectively, of extracting units of service from a natural resource. This could, for example, be extracting fish from a near-shore marine area. The MB represents the marginal benefit the resource extractors gain from each successive unit extracted. Assume initially that MC properly accounts for the full social cost of extracting each additional unit of the resource, including that of the impact on intangible ecosystem services other than extraction (i.e. it includes environmental externalities). This means that MC represents the true marginal cost curve. Economically efficient resource allocation is achieved at point Q where the marginal benefit from the use of the resource equals the true marginal cost. (It is, of course, difficult in practice to identify Q with precision). The allocation at Q generates a total benefit graphically equal to OQEP (the area under the marginal benefit curve, MB) and incurs a total cost graphically equal to OQE (the area under the true marginal cost curve, MC). The net benefit obtained by resource extraction at Q is accordingly equal to OEP (OQEP – OQE), which is the highest net benefit that can be generated from the resource extraction.

The problem is that some costs are difficult to value and are often not properly taken into account in the allocation of natural resources. These costs are usually associated with 'public goods': an aspect of the resource that many people value collectively, but that value is difficult to estimate and is often not reflected in market prices. Public goods

[i] TEEB (*The Economics of Ecosystems and Biodiversity*) is a global initiative focused on drawing attention to the economic benefits of biodiversity. Its objective is to highlight the growing cost of biodiversity loss and ecosystem degradation. For more details about TEEB, visit http://www.teebweb.org/.

include, for example, the values that many people place on an intact ecosystem or on the preservation of traditional cultural practices. Thus, the MC curve reflects the vertical sum of private user costs, such as those incurred in extracting services from the resources, and the 'external' social costs. Without accounting for these 'external' social costs, the marginal extraction cost is definitely lower than the full social marginal cost.

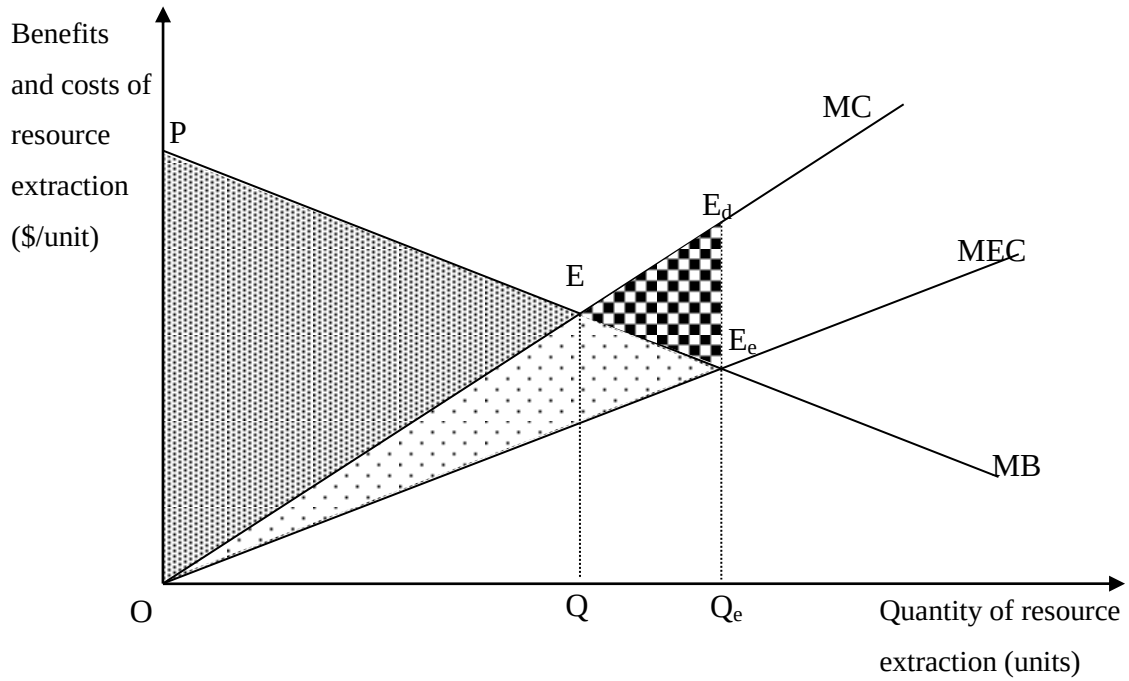


Figure 1: Efficient resource extraction

Adapted from Tietenberg (2004)

Let us assume that MEC represents the marginal extraction cost curve and that the extractors do not consider any additional social costs that their extraction imposes on others. To maximise the extractors' net benefit, extraction continues until Q_e where a marginal benefit is equal to a marginal extraction cost. This allocation generates a total benefit graphically equal to OQ_eE_eP (the area under the marginal benefit curve, MB) and incurs a total extraction cost graphically equal to OQ_eE_e (the area under the marginal extraction cost curve, MEC). However, the true social cost of resource extraction at Q_e is in fact graphically equal to OQ_eE_d (the area under the true marginal cost curve, MC). The net social benefit obtained from resource extraction at Q_e equals $OQ_eE_eP - OQ_eE_d$ (= $OEP - EE_eE_d$). Notice that OEP is the net social benefit that can be obtained from resource extraction at Q. Therefore, the net social benefit obtained by resource extraction at Q_e is

lower than that obtained by resource extraction at Q by an amount equal to EE_eE_d. This is the dollar loss to the economy due to 'overexploitation' of the resource.

Two important implications can be drawn from the above demonstration. First, the efficiency of resource extraction could be improved if information about the values of ecosystem services (especially those that are intangible) is available and these values are properly taken into account. Second, improving the efficiency of current resource extraction improves the sustainability of use of the natural resources (i.e. less extraction).

3. Goal, objectives and significance of this research

The overarching goal of this study is to identify opportunities to improve efficiency in the long-term allocation of near-shore marine resources. An allocation of a resource is more efficient if an alternative use of the resource yields a net gain in 'welfare' or 'social well-being' (Tietenberg, 2004). Welfare is the sum of 'utility' (i.e. amount of happiness, satisfaction) across individuals or net present economic value (usually measured by total willingness to pay, WTP) of a project or policy to the community or society at a broad scope (Boardman, Greenberg, Vining, & Weimer, 2006; Freeman, 2003; Perkins, 1994).

This study involves analysis of New Zealand residents' preferences for some of the key trade-offs that potentially occur across alternative systems for managing near-shore marine fisheries. Practically, the study seeks to identify and estimate the magnitudes of changes in social well-being associated with changes in socio-ecological attributes (i.e. attributes of society's interaction with marine ecosystems) that potentially occur under current management regimes and several alternatives under consideration. The analysis provides insight into the direction policy changes from the status quo could take to increase net social benefit. Of particular interest are the values the New Zealand public places on relatively intangible aspects of management of near-shore marine areas, such as conservation of biodiversity and protection of Māori cultural practices relative to the predominant focus on commercial and recreational fishing.

This research employs both qualitative and quantitative approaches. The latter approach involves an application of a technique known as a "stated discrete choice experiment" (DCE, which is a form of "choice modelling") (Adamowicz, Louviere, & Swait, 1998;

Bennett & Blamey, 2001; Hanley, Mourato, & Wright, 2001; Louviere, Hensher, & Swait, 2000). Alternative management systems influence the characteristics, or 'attributes', of near-shore marine areas of interest and value to New Zealanders. For example, marine reserves protect marine life, allowing for conservation and restoration of biodiversity, but limit opportunities for commercial and recreational fishing. A DCE provides information about respondents' willingness to trade off one attribute for others by presenting them with multiple combinations of attributes (i.e. profiles) of hypothetical near-shore marine areas and asking them to choose which combination(s) they prefer. The combinations of attributes are chosen so that choice requires the respondent to make trade-offs across attributes.

A key step in developing the DCE is the choice of attributes to include. To this end, qualitative methods (based primarily on interviews and focus group discussions (Robson, 2002)) were employed to identify fundamental attributes of near-shore marine areas that are of relatively deep value to the stakeholders involved in the debate about how declines in biodiversity and fish stocks could be treated and how such restoration could affect existing uses. These include values of attributes that are at best indirectly involved in market transactions, such as preservation of cultural traditions or of non-commercial natural characteristics. If not established in the first place, these deep values (especially related to cultural stewardship) might be misunderstood, misinterpreted, or overlooked during the design and implementation process of ecological restoration (Phipps, Akins, Moller, Kahui, & Towns, 2013; Phipps et al., 2011). Though difficult to observe directly, these values are potentially important to include in any cost-benefit analysis of competing policy options.

Insights from this qualitative work were then used to determine the attributes and their levels for the proposed choice experiment. Such a determination represents an innovative approach. Focus group discussions with some subsets of the target population have been commonly used to identify attributes and their levels that reflect the interests of prospective respondents (Champ et al., 2003; Garrod & Willis, 1999). This is so as it seems pointless to ask people making choices involving trade-offs between changes in attributes that do not matter to them. Balancing between attributes of interest to the target population and those of relevance to policy, if mismatched, are then made in order to make

use of the findings from choice experiments in policy-making (Adamowicz et al., 1998; Bennett & Blamey, 2001; Blamey, Rolfe, Bennett, & Morrison, 1997; Wang, Bennett, Zhao, & Liang, 2005). Attributes and levels identified through interviews and focus group discussions with stakeholders involved in policy debate (employed in this study) are likely to be policy-relevant and perhaps represent the public interests given the issue being investigated in this study has been acrimoniously debated (Department of Conservation, 2013; Taiepa et al., 1997). Although stakeholders are just part of the population, their interests can be expected to capture most of the important interests of the public. A pretest of the choice experiment was further used to confirm whether the chosen attributes and respective levels in general reflected the interests of the public.

The application of *1000Minds* decision-making software[ii] represents another innovative approach of this study. A method of presenting choices to respondents by 1000Minds is known as "Potentially All Pairwise RanKings of all possible Alternatives" or PAPRIKA (Hansen & Ombler, 2009). With this method, respondents to a choice experiment are asked to make a series of the simplest possible choices, those that involve only pair of alternative profiles formed by two attributes at a time. The series of choices is constructed to provide information sufficient to estimate each individual respondent's relative values of each attribute. This contrasts with the more common elicitation method known as a "full profile choice experiments" (see e.g. Adamowicz et al., 1998; Bennett & Blamey, 2001; Louviere et al., 2000). With such a method, respondents typically are asked to choose one from several options, each of which is characterised by all attributes at once. This provides potentially richer set of information (e.g., about interactions across attributes) at the cost of obtaining less respondent-specific information. Thus, the choice of elicitation methods itself involves trade-offs. This study presents one of very few applications of a choice experiment approach to environmental valuation in New Zealand, and is the first application of 1000Minds for such valuation. 1000Minds software has been applied in various contexts and reported in numerous peer-reviewed publications[iii], but none involves valuing the goods at hand in dollar terms.

The UN has recently passed a resolution urging governments across the globe to start measuring happiness and well-being "with a view to guiding public policy" (Musikanski &

[ii] http://www.1000minds.com/
[iii] http://www.1000minds.com/researchers/peer-reviewed-publications

de Graaf, 2013). This study provides an example of how such a resolution can be put into practice.

4. Structure of thesis

This thesis was written as a collection of stand-alone chapters, each prepared as close as possible to the standard and style required for subsequent publication in journals (one already submitted). This inevitably led to some repetition of the material among chapters. There are overall six chapters, including this one. Chapter 2 sets the background for the following chapters. It provides a review of the evolution of marine policy aimed at sustainably utilising marine resources. Spatial conflicts and a consequent 'race for space' are identified as a major obstacle in shifting the current management regimes towards a promising ecosystem-based management, and choice experiments are proposed as a potential approach to better inform policy change.

Chapter 3 examines in detail how spatial conflicts and the race for space have occurred using two case studies in New Zealand. This provides a better understanding of the values and interests of stakeholders involved the race for space. The study reveals a perception of a lack of balance across biodiversity, cultural, recreational, and commercial fishing interests. This perception has led to calls for a more sustainable management strategy. Marine spatial allocation required for implementing management alternatives or balancing the various interests is challenged by the lack of effective decision-support tools.

Chapters 4 and 5 demonstrate how choice experiments can be used to support decision-making about the marine spatial allocation. Values of changes in socio-ecological attributes to be induced by management alternatives under debate are measured in comparable terms. The values of socio-ecological attributes in terms of changes in relative utility appear in Chapter 4. Values in dollar terms (willingness to pay, WTP) appear in Chapter 5. The results reveal relative values New Zealanders place on the allocation of near-shore marine areas across commercial and recreational fishing, cultural and biodiversity interests. The results also provide information useful for cost-benefit analyses of specific management alternatives under debate.

Chapter 6 synthesises findings from all chapters. Implications for the implementation of New Zealand's Marine Protected Areas Policy are discussed, and an economic model for efficient marine spatial allocation is proposed. The significance of environmental valuation studies, epistemological challenges, pros and cons of non-monetary and monetary valuation, and how to achieve a sustainable and desirable future are discussed.

Chapter 2 Towards marine spatial allocation and ecosystem-based management: A potential application of choice experiments

Abstract: This review concludes that input and output controls are insufficient for managing complex marine systems and achieving sustainable utilisation of marine resources. This shortcoming stems mainly from a predominant focus on commercial exploitation and has motivated the emergence of spatial management tools such as marine reserves and customary management areas (CMAs) to provide varying degrees of marine protection. The integration of these spatial management tools into existing management regimes in a network of marine protected areas (MPAs) is credited with playing a crucial role in advancing an Ecosystem Based Management (EBM) concept that takes into account interests of multiple stakeholders and aims for sustaining social-ecological linkages as well as the fish stocks themselves. Adopting a nested approach with the environmental precautionary principle and adaptive management offers a practical way to overcome our obvious limited knowledge of marine systems and the mismatches between ecological and social governance scales. Choice experiments provide a useful tool to guide decision-making about spatial allocation between contested goals and priorities of fishers, biodiversity advocates and the general public. An alternative management system induced by implementation of marine reserves, CMAs, or MPAs is economically justified and implemented if its net social benefit is positive. Although choice experiments alone do not provide a panacea for solving the conflicts of interest between all stakeholders, they provide an objective metric for decision-making and reflect society's choice.

1. Introduction

Marine fisheries are a scarce common-property resource, the unregulated access to which leads to its inefficient use. Hardin's metaphor of the "tragedy of the commons" (Hardin, 1968) and Gordon's analysis of an "open access fishery" (Gordon, 1954) expose the fundamental causes. Unrestricted access leads to economic inefficiency as fishers individually lack incentive to respond to detrimental effects on stock levels, and subsequently on future catch rates and economic returns. The fundamental challenge in fisheries has been to reduce the resulting overexploitation to maintain the fish population within optimally sustainable levels (Schaefer, 1954). Initially, controls on inputs (catch effort) were widely adopted for managing the catch of particular species. However, fishers took advantage of inputs left uncontrolled to continue the "race for fish" among fishers (Gordon, 1954). This triggered the emergence of more direct controls over outputs (e.g., catch limits) (Pearse, 1981; Wilen, 2000).

There is growing concern that these controls on fishing remain insufficiently effective. One problem is that fisheries worldwide continue to suffer from inadequate management of the catch of target species leading to stock depletion (FAO Fisheries and Aquaculture Department, 2009; Greenberg, 2010; WB & FAO, 2009). Another problem, however, is that even when controls effectively limit the catch of target species, efforts by fishers to minimise the cost of that catch lead to damage to other non-target species and more generally impact marine ecosystems. Many studies (e.g. Chen, Qiu, Jia, & Xu, 2008; Dhoray & Teelucksingh, 2007) have concluded that fishing has adversely impacted multiple trophic linkages (i.e. feeding relations between organisms) across ecosystem components.

These concerns have generated a continuing call for a paradigm shift to a more holistic approach, known previously as ecosystem management (Grumbine, 1994) and more recently as ecosystem-based management (EBM) (Curtin & Prellezo, 2010). The overarching goal of EBM is to sustain social-ecological systems. Humans inter-act with natural systems, and technological and social developments have been changing that interaction over time, frequently to the detriment of the functioning of natural systems. Changes in the functioning of natural systems feed back to affect human social systems (Millennium Ecosystem Assessment, 2005a, 2005b). The objective, then, is to refocus

fisheries management from managing the catch rates of target species to ensuring that the interactions of humans with the ecosystems are sustainable (Curtin & Prellezo, 2010; Grumbine, 1994).

One could argue that achieving sustainable social-ecological systems in the long-term requires a "seismic shift in the mind-set of humans" that ecological integrity is the norm (Grumbine, 1994). Change in policies in the short term probably has to be more incremental. One option is to extend the principles of land-use planning to marine areas. The objective in the short to medium term could be design and implementation of a continental-scale biodiversity protection network built around a system of core reserves, buffer zones and habitat corridors (Gilliland & Laffoley, 2008; Grumbine, 1994; Macleod, Lynch, & Hoagland, 2009). Marine protection, especially in the form of no-take marine reserves, is a critical part of EBM. The implementation of zoning within a framework of Marine Protected Areas (MPAs) or more broadly Biosphere Reserves that take the interests of multiple stakeholders has been credited with playing a crucial role in putting the EBM concept into practice (Angulo-Valdés & Hatcher, 2010; Bridgewater, 2002; Douvere, 2008). However, establishing marine reserves has proven difficult in many parts of the world, especially because of opposition from fishers (see e.g. Grafton, Van, & Kompas, 2004; Suman, Shivlani, & Milon, 1999; Taylor & Buckenham, 2003; Wolfenden, Cram, & Kirkwood, 1994). The slow progress of the EBM paradigm shift has been reported in a number of papers (e.g. Arkema, Abramson, & Dewbury, 2006; Curtin & Prellezo, 2010; Garcia & Cochrane, 2005).

In this chapter, I first present the principles and practices underpinning the implementation of conventional management tools (input and output controls) and additional spatial management tools (marine reserves and customary management areas) advocated for advancing EBM. I then discuss in Section 3 the constraints to the advancement of EBM and potential ways to overcome these constraints. The discussion largely focuses on the implications of two competing philosophical approaches to decision-making about marine spatial allocation. An intrinsic right approach is based on the right to exist and prosper, whereas an anthropocentric approach is based on comparisons between costs and benefits. A potential application of choice experiments to generate information about these costs

and benefits is also discussed. I synthesise these strands and discuss limitations of this economic tool in Section 4.

2. The evolution of marine policy for sustaining social-ecological systems

2.1. Input controls

One of the earliest and most commonly employed regulations, and still in use in many (especially developing) countries, are "input controls". This family of management interventions aims to regulate the methods and efforts expended by fishers ("inputs" in an economic sense) in an indirect attempt to control what is actually being caught ("outputs"). The fundamental problem with fisheries exploitation has been "excess fishing mortality" or "overfishing" that occurs when catch is larger than recruitment or the "maximum sustainable yield" (MSY). Input controls include restrictions on fishing technologies, times and areas. Examples include restrictions on the size and number of boats, the types of equipment allowed, and the times of year in which fishing is allowed (Wilen, 2000).

In essence, input controls work to reduce the size of the catch by increasing the cost of catching additional fish (i.e., by increasing marginal production cost). There are two major problems with input controls. First, artificially raising production cost is wasteful; if the goal is a catch of a certain size, why not do it as cost effectively as possible? Input controls dissipate the net benefits of fishing, which is known as 'resource rent' (Copes, 1986; Gordon, 1954; Wilen, 2000). The second problem is that input controls incentivise expansion of any (relatively expensive) inputs left unregulated, e.g. expanding the capacity of boats in any left unrestricted or adopting expensive methods to locate fish more quickly, in order to competitively race for fish. Notable examples include the failures of the limitation of the number of vessels in the Western Australian rock lobster fishery and the British Columbia salmon licensing programs (Pearse, 1981). It has become apparent that input controls are a needlessly expensive and often ineffective solution to the problem of overfishing.

2.2. Output controls

Output controls, where the amount and type of fish harvested are controlled directly, have been brought into the regulatory agenda since the 1970s (Pearse, 1981; Wilen, 2000). The

theoretical premise is that individual rights to catch a pre-specified amount of fish *a priori* to harvest eliminates the race for fish and allows fishers to concentrate on minimising production and thereby profit maximisation (Pearse, 1981; Wilen, 2000). Economists postulate that the fundamental problem with fisheries and other natural resource management has been the lack of well-defined property rights. Fishing quota or quota management systems (QMS) have emerged since 1973 as a favoured solution for fisheries management; QMS is now employed by many countries, such as Australia, Canada, Chile, Iceland, Netherlands, the United States and New Zealand (Pearse, 1981; Wilen, 2000).

The characteristics of individual quotas, also known more generally as catch shares, vary in terms of length of tenure, tradability and associated limits across countries. For example, under New Zealand's QMS, a total allowable catch (TAC) is identified by the Ministry of Fisheries (now Ministry of Primary Industries) under some criterion such as MSY. Quotas, known as individual transferrable quotas (ITQs), are defined as a share of the TAC, and as the name suggests are traded in a competitive market. ITQ holders with high fishing costs tend to sell quotas, while those with lower costs tend to buy quotas until a market equilibrium[iv] is reached and the TAC is caught by the most efficient fishing agents (Tietenberg, 2004). Newell, Sanchirico, & Kerr (2005) find support for a competitive market for commercially important fish species in New Zealand and conclude that its ITQ system is a potentially effective instrument for efficient fisheries management. Furthermore, ITQs create incentives for technological advancements because fishers who have adopted new cost-reducing technologies can increase profits from existing and additional ITQs (Tietenberg, 2004). Thus, the QMS provides the incentive to maximise economic rent given the choice of TAC[v], which capitalises into the values of ITQs.

Comprehensive QMSs have been shown to halt and even reverse declines in some fish stocks (Costello, Gaines, & Lynham, 2008). However, QMS implementation has not always been simple and often controversial. For example, the use of the "rights" terminology evokes strong feelings of possession and exclusion and raises questions of justice, which are unacceptable to some people. Hence in some cases, the terms "access

[iv] A market equilibrium is reached when marginal fishing cost is equal to marginal benefit and equal to the quota price.
[v] TACC (total allowable commercial catch) in the New Zealand context. TACC is a share of TAC. Other shares of TAC include allowances for customary and recreational fishers.

privileges" or "quantitative use permits" have been used instead (Huppert, 2005). Another example concerns the initial allocation of ITQs. Most QMS-implementing countries adopted the grand-parenting approach (as opposed to auctioning) where ITQs were gifted to fishers in proportion to their historical catches (Tietenberg, 2004), which amounts to a rather valuable gift. But grand-parenting has not always been straightforward. For example, New Zealand had no official records for most customary and recreational fishing and therefore allocation of quotas for these fishers remains a critical challenge for fisheries management (Ministry of Fisheries, 2008a).

A fundamental issue inherent in the QMS implementation concerns the appropriate setting of TACs, which are normally derived from stock estimates. This has proven to be practically difficult due to at least three forms of uncertainties: random fluctuations; uncertainty in parameter estimates and states of nature; and structural uncertainty (Charles, 1998). TACs are often set at an unsustainably high level. Some have argued that a buy-back scheme could help adjust the total catch level (Pearse, 1981; Tietenberg, 2004), but unacceptably large budget implications often make this corrective option unworkable. For example, New Zealand has found it to be too expensive to buy back sufficient ITQs to force massive quota reductions. This problem has led New Zealand's QMS to change from a specific quantity share to a percentage share of TACs (Huppert, 2005; Lock & Leslie, 2007).

There are several other significant problems discussed in the literature (e.g. Clark & Major, 1988; Copes, 1986, 1995; Helson, Leslie, Clement, Wells, & Wood, 2010; Lock & Leslie, 2007; Symes & Crean, 1995; Tietenberg, 2004). The problem known as 'high-grading' occurs because ITQs specify the catch in terms of weight for a particular species; however, the value of the catch can be significantly affected by modal sizes of particular fish species. Fishers can increase the revenue from a given quota by keeping only the most valuable (typically larger) fish and dumping the less valuable ones. For fish species with a low probability of survival once caught, dumping represents a waste by reducing stock levels and wasting harvested fish (Tietenberg, 2004), and threatens the validity of stock estimates to the extent that dumped fish are not quantified or built into mortality estimates.

Two other problems relate to the incentive the QMS generates to minimise production cost: by-catch and damage to the wider ecosystem. Fishers own species-specific ITQs, i.e., the right to catch a certain quantity of certain types of fish, but non-targeted species are frequently caught as part of the catch. Avoiding this by-catch is costly. Destructive fishing gear, such as that used by trawlers and some other types of fishing activity, reduces the cost of catching the target species but have proven to profoundly and adversely affect habitat structures, invertebrate benthos (the community of invertebrates which live on, in, or near the seabed) and ecological interactions (Mangi & Roberts, 2006; Reiss et al., 2010). Therefore, implementation of a QMS is not sufficient for optimal management (Straker, Kerr, & Hendy, 2001).

New Zealand has tried to address the by-catch and high grading problems through a number of add-on catch balancing mechanisms, such as surrendering catch to the Government, leasing or buying additional quotas from other quota holders, borrowing and banking quotas, etc. These mechanisms have met with mixed success, and in some instances, fishing levels significantly exceed TACs (Reiss et al., 2010). To prevent this from happening, overfishing thresholds and tolerance limits have additionally been put in place. These two mechanisms have so far been applied only to sedentary species (Lock & Leslie, 2007) and their effectiveness remains unknown. Nevertheless, if regulations are prevailingly based on catch limitations, the impacts of fishing on the wider marine ecosystems remain problematic (Reiss et al., 2010).

2.3. Marine reserves

The limitations of conventional management tools (i.e. input and output controls) in delivering sustainable use of marine resources has led to recommendations for creation of no-take marine reserves. Benefits of marine reserves have been extensively established in the literature (e.g. Agardy, 2000; Ami, Cartigny, & Rapaport, 2005; Apostolaki, Milner-Gulland, McAllister, & Kirkwood, 2002; Botsford, Lockwood, Morgan, & Wilen, 1999; Chen, Xu, Qiu, Lin, & Jia, 2009; Conover, Travis, & Coleman, 2000; Dalton, 2004; Farrow, 1996; Gilliland & Laffoley, 2008; Grafton & Kompas, 2005; Grafton, Kompas, & Schneider, 2004; Grafton, Van, et al., 2004; Roberts, 2000; Skewgar, Simeone, & Boersma, 2009; Smith & Wilen, 2003). The main ones include: (i) protecting ecosystem structure, function and integrity, conserving biodiversity, and preventing species

extinction; (ii) restoring overexploited stocks, increasing resilience or the speed it takes a fish population to return to a former state after exploitation, and increasing fish stocks (i.e. population density, biomass, and/or fish size) within the reserves; and (iii) increasing stocks outside the reserves. The first two bundles of benefits are derived from either accumulated evidence (Apostolaki et al., 2002; Chen et al., 2009; Francini-Filho & Moura, 2008; Roberts, 2000; Skewgar et al., 2009; Smith & Wilen, 2003) or are based on the assumption (Agardy, 2000; Conover et al., 2000; Grafton & Kompas, 2005; Grafton, Kompas, et al., 2004) that fishing pressure damages fish habitats and their ecosystems, threatens biodiversity, creates negative shocks to a fish population, and thus reduces fish stocks (Agardy, 2000; Conover et al., 2000; Grafton & Kompas, 2005; Grafton, Kompas, et al., 2004). The third benefit (spill-over of benefits to surrounding fishable areas) can be realised only if the first two benefits are achieved within a marine reserve. The underpinning assumption is that the health of ecosystems can be maintained if there is no disturbance (i.e. fishing), and that healthy ecosystems would over time result in an increase in fish density inside marine reserves and movement of larval, juvenile and adult (especially migratory) fish to adjacent fishable areas. Evidence on density-dependent export has accumulated in the literature, i.e., where build-up of stocks within the reserves triggers net flow of fish to the surrounding meta-population (e.g. Abesamis & Russ, 2005; Chen et al., 2009; Francini-Filho & Moura, 2008; Roberts, 2000).

Debates over where to place a marine reserve to optimise these multiple benefits are common. Spill-over benefits depend very much on location of a marine reserve because they are highly dependent on the number of population sources and their advection and diffusion processes (Grafton & Kompas, 2005). Scientific knowledge about such processes is limited due to the variability and uncertainty in marine ecosystems. Many people are uncomfortable with designing a marine reserve given this limited knowledge and argue that better scientific knowledge needs to be acquired to optimise reserve placement. However, the risk of delaying the establishment of a marine reserve due to the requirement of lengthy studies is considered to outweigh the risk of establishing a marine reserve with limited knowledge today and managing it in an adaptive process (Grafton & Kompas, 2005; Roberts, 2000). It is argued that in the absence of marine reserves providing a ‘non-disturbance state’, knowledge about natural processes of marine ecosystems will never be gained. Experimentally and adaptively managed marine reserves

would provide an opportunity to study the difference in marine ecosystems between disturbance and non-disturbance states, thereby helping generate evidence regarding the potential benefits of marine reserves (Grafton & Kompas, 2005). It follows that increasing knowledge and understanding of marine ecosystems is another fundamental benefit of marine reserves. Scientific research is the primary purpose of protecting an area with a marine reserve in New Zealand[vi].

Another debate concerns the trade-off between fisheries and biodiversity benefits. More and smaller marine reserves are most often better for maximizing larval export and fisheries benefits, whereas fewer and larger marine reserves are better for biodiversity conservation (Hastings & Botsford, 2003). This suggests that the benefits of marine reserves depend on their design and not all the benefits can be maximised at the same time. Therefore, the objectives of marine reserves should be decided in the earliest stage and balancing between all the benefits (especially fisheries and biodiversity) might be best for setting the objectives.

There is also debate about whether the benefits of marine reserves can offset the associated costs. Fishing closure for establishment of marine reserves would lead to displacement of some fishing activities and the concentration of fishing effort in a smaller area, thereby increasing fishing costs. Dynamic sink-source modelling shows that a marine reserve will overall generate a higher discounted net return from fishing than no reserve if two forms of uncertainty (i.e. environmental stochasticity and negative shocks) are taken into account (Grafton, Van, et al., 2004). An analysis of a real-world case study of a *pāua* (abalone) fishery in New Zealand shows that the benefits of fishing closure could offset the increased fishing costs when a spill-over gradient of 40% is assumed or if a stochastic model is used (Kahui & Alexander, 2008; Schneider, 2006). Therefore, economic analyses that take into account environmental benefits could potentially provide justifications for establishment of marine reserves.

2.4. Customary management areas (CMAs)

CMAs have recently been rediscovered as a form of marine protection that can be tailored to local aspirations. Failure to implement broad scale no-take areas has been a major

[vi] New Zealand Marine Reserve Act 1971

driver to use some form of CMAs as part of larger MPAs (Cinner & Aswani, 2007). CMAs (known as customary protection areas or CPAs in New Zealand) have also been the foundation of many community-based management projects (Cinner, Sutton, & Bond, 2007; Ken, 2003). Customary management involves "local practices that are designed to regulate the use, access, and transfer of resources" (Cinner & Aswani, 2007, p.202). Management of local environments in accordance with customary knowledge is called "Adaptive Co-management" (Berkes & Turner, 2006; Olsson, Folke, & Berkes, 2004; Turner & Berkes, 2006). These local practices are formed by knowledge, practice and belief about the relationship of living beings (including humans) with one another and with their environment, which have evolved through adaptive processes and have been handed down through generations by cultural transmission (Berkes, Colding, & Folke, 2000; Berkes & Turner, 2006; Moller, Kitson, & Downs, 2009; Turner & Berkes, 2006; Walters & Holling, 1990). The accumulated body of knowledge, practice and belief is known as "traditional ecological knowledge" (TEK) (Berkes, 2008; Berkes et al., 2000). Practices used in CMAs have been found to often include spatial, temporal, gear, effort, species, and catch restrictions enforced by local users. Payment of cash, compensation in the form of livestock, social exclusion and gossiping as well as spiritual sanctions (e.g. taboos) are used to penalise violations. Despite a lack of governmental intervention, compliance is relatively high (Cinner & Aswani, 2007).

Social-ecological resilience is argued to be one of the key advantages of customary management over modern management techniques. Resilience refers to the capacity of ecosystems to absorb recurrent natural and human perturbations and continue to regenerate without slowly degrading or unexpectedly flipping into alternate states (Gibbs, 2009; Hughes, Bellwood, Folke, Steneck, & Wilson, 2005). To maintain resilience in ecosystems, two separate processes are required: (i) resistance to the disturbance that causes a change in their structure and (ii) recovery in terms of the speed of return to the original structure (Côte & Darling, 2010). Given the characteristics of relatively unstructured adaptive management schemes (Moller et al., 2009), customary management can be more flexible and responsive to dynamic changes in complex marine ecosystems than highly structured management techniques promulgated by western fisheries management. Therefore, customary management is considered more apt for maintaining social-ecological resilience (Berkes et al., 2000).

Debates over whether customary management will be resilient to socio-economic transformations persist. It has been argued that customary management may only be effective in low population and subsistence societies, and is generally unable to cope with socio-economic changes such as modernisation, population growth, increase in human dependence on resources and market conditions (Thornburn, 2001). An investigation of this issue in fifteen coastal communities in Papua New Guinea found evidence in support of the argument that customary management was vulnerable to socio-economic changes (Cinner et al., 2007). However, the literature suggests the implementation of CMAs is motivated by a variety of drivers operating at different scopes and scales (Cinner et al., 2007). For example, CMAs have been implemented in New Zealand not only to make use of customary practices as inputs for guiding fisheries management but also to give effect to the Treaty of Waitangi (Fisheries Claims) Settlement Act 1992, which recognises Māori commercial and customary fishing rights over areas of cultural and spiritual importance (Lock & Leslie, 2007). Much of the value of CMAs in this context is the reconnection of people to local areas (Hepburn, Scott, McCarthy, Moller, & Schweikert, 2013; Jackson, 2011, 2013; Phipps et al., 2013; Phipps et al., 2011).

There has been no consensus on the efficacy of customary management in improving the fisheries themselves. While some studies have found that CMAs would result in improved harvest (e.g. total yield, size of fish), *in-situ* increase in target species, and improved wider ecosystem benefits; some other studies have found no significant impacts (Cinner & Aswani, 2007).

Despite on-going debate, CMAs can be an integral part of EBM, primarily due to TEK as input to an adaptive management scheme (Berkes et al., 2000). By adjusting and evolving through long-enduring trial-and-error, TEK has served to improve a community's chance of survival in the past (Berkes et al., 2000; Berkes & Turner, 2006; Moller et al., 2009; Turner & Berkes, 2006; Walters & Holling, 1990) and may guide the sustainable management of a complex, social-ecological marine system. A recent meta-analysis of common-pool resource case studies concluded that self-organising institutions often perform better than governmental institutions in managing common property, especially in settings where trust can evolve and institutional rules are well matched to the ecological systems being used (Ostrom, 2010).

3. Towards EBM: Constraints and potential solutions

Accomplishing the overarching goal of EBM in marine fisheries requires consideration of all impacts on marine ecosystems (including land-based activities and climate change) and various forms of uncertainty in the natural systems. Despite this, integration of various management tools in a network of MPAs offers a practical step to move EBM forward. (Protection mechanisms such as marine parks, marine life sanctuaries fall under the framework of MPAs where the degrees of protection vary from "no-take" in core zones through restricted uses in buffer zones to normal uses.) In light of a model suggested by Grumbine (1994, p. 33), marine reserves can protect critical habitats and biodiversity, maintain the ecosystem structure and functioning, and serve as breeding stocks for surrounding areas. CMAs can provide some form of lower degrees of marine protection and flexible management to secure access to the marine resources by local people and maintain their cultural connection with local areas to lock in social-ecological resilience. CMAs can accordingly serve as buffer zones to the core no-take marine reserves. Input controls can minimize impacts from fishing equipment, while output controls can limit the catch within the MSY or prevent overexploitation in normal use zones. This model holds potential for delivering sustainable utilization of marine resources (Douvere, 2008; Gilliland & Laffoley, 2008). However, implementation of this model has been complex and constrained by at least three factors: the obvious limited knowledge about marine systems, the mismatches between ecological and social governance scales, and spatial conflicts between the various management tools.

3.1. Overcoming limited knowledge and matching ecological and social governance

Boundaries of ecosystems on a large scale are difficult to identify due to our limited knowledge of marine systems. Even if such large-scale ecosystems were to be identified, ecosystem boundaries rarely align with those of socio-political and administrative jurisdictions, thereby complicating management arrangements (Curtin & Prellezo, 2010).

EBM advocates suggest a 'nested approach' coupled with 'environmental precautionary principle' and 'adaptive management' as a solution to overcoming these information and political constraints. With the nested approach, the largest scale (e.g. global) ecosystem (i.e. nest) is divided into a hierarchy of lower levels (e.g. national, regional, local) of ecosystems and each level provides context for lower levels so that different issues at each

level can be addressed (Curtin & Prellezo, 2010; Garcia & Cochrane, 2005; Gilliland & Laffoley, 2008). In practice, EBM could be developed from small to large: starting from heavily used and high conflict areas such as harbours, bays and estuaries (i.e. the lowest level of the nest) and build up towards upper levels such as regional, national, and global levels. Designing EBM at this smallest scale would be most effective and least complicated (Gilliland & Laffoley, 2008), but knowledge constraints in developing effective management plans that can maintain ecosystem functioning still remain (Frid, Paramor, & Scott, 2006). Both an environmentally precautionary principle and an adaptive approach could overcome such constraints (Curtin & Prellezo, 2010). The precautionary principle states that a "lack of knowledge must not be used as an excuse to prevent the implementation of plans that have the potential to reduce harmful effects on ecosystem functioning" (Curtin & Prellezo, 2010, p.828). In data poor regions, traditional knowledge and natural history can be used to create precautionary no-take areas, which can be modified in size and scope as new knowledge becomes available as part of an adaptive management scheme (Curtin & Prellezo, 2010).

3.2. Spatial conflicts: How to legitimatise decisions about spatial allocation

Implementation of MPAs has been politically difficult due to opposition from particular groups of local resource users whose actions have the most potential to influence decision-making (Emerton, 2003). Although in some instances where resource users may generally support MPA proposals, they do not necessarily support imposition of the restrictions on resource uses in their back yards. The "Not-In-My-Back-Yard" attitude (as called by Grafton & Kompas, 2005) has been observed in the cases of no-take marine reserves proposed in New Zealand (Wolfenden et al., 1994), Florida (Sant, 1996), and New South Wales, Australia (Suman et al., 1999).

The opposition to spatial marine protection leads to a "race for space" among its advocates (Bess & Rallapudi, 2007). Countries such as Australia, Canada, China, the US and many European nations have adopted strategies such as marine spatial planning and zoning in the process of implementing MPAs networks (Douvere, 2008). Negotiation among stakeholders is a critical step to gaining consensus on zones for particular uses (Gilliland & Laffoley, 2008; Halpern, McLeod, Rosenberg, & Crowder, 2008; Macleod et al., 2009) and therefore can be promising as a way to overcome the problem of the race for space.

Nonetheless, there is no point in proceeding with negotiation until there is a need to implement spatial marine protection and a decision for spatial allocation for that purpose is made.

At least two competing philosophical approaches can be applied for decision-making relative to such spatial allocation. Decisions based on an *intrinsic rights approach* are made with respect to the right (especially of marine species) to exist and prosper, whereas those based on an *anthropocentric approach* require comparisons between costs and benefits from a human social perspective (Kareiva, Tallis, Ricketts, Daily, & Polasky, 2011). The former implies any spatial marine protection tool will out-compete existing management regime measures in most cases where fish stocks are depleted and ecosystems are degraded. Some space would be allocated for marine reserves in order to conserve biodiversity, maintain ecological functioning and prevent species extinction. Similarly, some space would be allocated for CMAs in order to maintain traditional cultural values. The argument for CMAs has become particularly relevant in the context of indigenous cultures and due to a need to cast uncertainty in favour of cultural protection, known as the "cultural precautionary principle" (Phipps et al., 2011). Nonetheless, decision-making based on an intrinsic rights approach might lack applicability where marine reserves and CMAs compete for the same marine area.

This gives rise to an anthropocentric approach. The anthropocentric approach is advocated for decision-making in most instances (Justus, Colyvan, Regan, & Maguire, 2009; Kareiva et al., 2011; TEEB, 2010). This in essence requires comparisons of the social costs and benefits of the various alternative uses of marine space. The cost-benefit criterion has been broadly used in national environmental agencies of the UK and many other countries (Hanley & Barbier, 2009; TEEB, 2010). A decision based on this criterion is economically justified if benefits can be estimated, added up, and weighed against costs (including the opportunity cost of alternatives that are not chosen) to give a net benefit. However, it is practically difficult to measure all the costs and benefits required for calculating the net benefit. For example, the costs to commercial fishing due to the implementation of a marine reserve or CMA (often in terms of more restrictions) may be estimated using historical fishing data and economic models that capture the effect of effort redistribution. Biodiversity values associated with marine reserves and cultural

values associated with CMAs, in contrast, are intangible and more difficult to measure because these 'goods' are not traded in the market. The difficulty in establishing credible values of intangibles (especially biodiversity values) has been a barrier to providing justification for conservation since the lack of information about a particular value is often treated as 'no value' (TEEB, 2010).

3.3. Prospects for choice experiments

Revealed and stated preference techniques are the only two available tools that can be used to value intangible benefits that are not traded in markets. Revealed preference techniques (e.g. travel cost and hedonic pricing methods) have been extensively applied and have established their theoretical and practical credentials. However, their applications are not only limited to the provision of information regarding the values that have been experienced, but also constrained by a limited number of cases where non-market values exhibit a quantifiable relationship with a market good (Bennett & Blamey, 2001; Louviere et al., 2000). This means that valuation of the intangible benefits in many circumstances (especially where a change to resource allocation is proposed) depends on stated preference techniques.

A developing technique, known as a discrete choice experiment (or choice modelling for some scholars), is more promising than the alternative stated preference technique (i.e. contingent valuation methods) (Adamowicz, Boxall, Williams, & Louviere, 1998; Bennett & Blamey, 2001; Boxall, Adamowicz, Swait, Williams, & Louviere, 1996). Choice experiments are a type of multi-attribute decision analysis or multi-criteria analysis (MCA), which has evolved in response to the need to study social rankings of alternative multidimensional policies. MCA is increasingly used in circumstances where trade-offs between several potential criteria (or attributes) of management alternatives are being investigated in order to determine the relative values of these attributes and thereby identify a most favourable management alternative (Kiker, Bridges, Varghese, Seager, & Linkov, 2005; Linkov et al., 2006). The relative values can (but do not necessarily have to) be expressed in monetary terms by including a monetary attribute in the choice model (Bennett & Blamey, 2001). The monetary values contribute to cost-benefit analysis, which has been argued to be better than MCA for informing policy (Dobes & Bennett, 2009).

There are various approaches to conducting a choice experiment, each with its own strengths and weaknesses (Hanley et al., 2001). One approach, known as PAPRIKA (Potentially All Pairwise RanKings of all possible Alternatives), involves asking each survey respondent to make a series of choices, each of which requires the respondent to trade-off a better level of one attribute for a better level of one other attribute (Hansen & Ombler, 2009). The attributes and their levels can be selected to mimic various aspects of society's interactions with marine ecosystems (i.e. costs and benefits) affected by establishing a marine reserve and/or CMA under consideration. In this way, costs and benefits regardless of whether they are tangible or intangible can be objectively weighted against each other by the respondent. The choices made by each respondent provide information about the individual's and, collectively, the group's preferences for changes in the attributes. The choices essentially reveal the social values of the various stakeholders who undertake the choice experiment. This information can then be extrapolated to estimate the social value of the net benefit of each alternative management system, compared to the status quo.

4. Discussion and conclusions

EBM holds potential for achieving sustainable utilisation of marine resources. A practical step to move EBM forward is to integrate various management tools, such as marine reserves, CMAs, and input and output controls in a spatial network of MPAs that take into account the interests of multiple stakeholders and aim for sustaining social-ecological linkages as well as the fish stocks themselves. Combining a nested approach, an environmental precautionary principle, and adaptive management offers a practical way to overcome constraints associated with our obvious limited knowledge about marine systems and the mismatches between ecological and social governance boundaries.

The challenge is in gaining political acceptance for re-allocating space in marine areas to marine reserves and CMAs needed to form MPAs. Those stakeholders who gain tangible benefits from the status quo often exercise out-size political influence (Emerton, 2003). Nevertheless, the larger public are also stakeholders, and these people may gain considerable intangible benefits from more sustainable management of marine resources. The public benefits in aggregate may be larger than the impacts of the alternative management systems on fishers (which can be translated into the loss of benefits to

fishers). While the loss of benefits to fishers is concentrated, the public benefits are diffuse. Each individual non-fisher has accordingly little incentive himself/herself to work to accommodate the public benefits, which is consistent with the logic of collective action discussed by Olson (1965). A key input in political decision-making, therefore, is a measure of the social value of these intangible benefits. Choice experiments, in which representative samples of a population of interest participate, provide estimates of social values. To date, however, no choice experiments have been formally used to facilitate marine EBM approaches.

Of course, the results from a choice experiment may be challenged. Firstly, responses to the choice experiment may reflect ignorance rather than revealing the true values of attributes and alternatives under consideration. Respondents may treat the choice survey as hypothetical, and/or they may not have good knowledge about the attributes and about how these attributes affect their well-being. This criticism indicates that considerable effort needs to be made in designing, and conveying through, a questionnaire to survey respondents what a policy-maker or a researcher wants them to take into account (Bennett & Blamey, 2001). Secondly, it can be argued that preferences observed from a choice experiment only represent consumer preferences, whereas individuals have in fact two sets of preferences: consumer preferences guide private choices, whereas civic preferences guide public or group choices. However, inconsistency between private and public choices has not been tested and proven. The economic concepts of preference and value do not either preclude altruistic concerns (Freeman, 2003). Thirdly, it is argued that the net benefit criterion fails to account for equity or fairness relative to the incidence of costs/benefits across different income levels and the redistribution of well-being (Freeman, 2003). "These [criticisms] are valid but we [TEEB[vii]] would argue that they do not constitute a reason to not apply the [cost-benefit] framework" (TEEB, 2010, p.53).

Redistribution of well-being across different individuals in the society is unavoidable because it is impossible to implement a policy without any impact or cost. Negotiations among stakeholders are necessary if a need to allocate space for implementing marine reserves, CMAs or MPAs is economically justified; i.e., the potential Pareto efficiency is

[vii] TEEB (*The Economics of Ecosystems and Biodiversity*) is a global initiative focused on drawing attention to the economic benefits of biodiversity. Its objective is to highlight the growing cost of biodiversity loss and ecosystem degradation. For more details about TEEB, visit http://www.teebweb.org/.

satisfied. Some way that can reduce the cost or redistribute some of the benefit (e.g. through compensation) to the losers might be identified during the negotiations. If that happens, a win-win solution would eventuate.

Chapter 3 People, profit and the environment: Conflicting goals and values surrounding spatial allocations of near-shore marine management in New Zealand

Abstract: Forty interviews and four focus group discussions with key stakeholders to marine ecosystems show that polarization of values and goals, a "race for space", and political conflicts challenge consensus on how best to allocate near-shore marine ecosystem management. Customary Protection Areas (CPAs) such as taiāpure and mātaitai promote Māori cultural aspirations and contain many of the design principles necessary to build successful community-based natural resource management. Some stakeholders believe that marine reserves can be more reliable than CPAs for protecting existing and restoring declining biodiversity and fish stocks. Biodiversity is supported for its own intrinsic value and for long-term human benefits. However, Māori have vigorously opposed marine reserves due to the concern over the cumulative loss of traditional fishing grounds, loss of management control, and their threat to cultural practices. Recreational and commercial fishers oppose any restriction in access to CPAs and especially to marine reserves. These are perceived threats to their ability to catch their quotas or bag limits. However, fishers tend to support taiāpure to form a coalition with Māori for more effective opposition to a marine reserve. One strategy to resolve the race for space, polarization and political conflicts is to maximize the chance of restoring biodiversity and fish stocks so that everyone gains. This can be most reliably achieved by joint implementation of marine reserves and taiāpure (or mātaitai in areas of greater cultural significance to Māori) within a "Biosphere Reserve" model.

1. Introduction

Sustainable utilisation of marine ecosystems is fundamentally important for New Zealand. Marine ecosystems provide valuable commodities, a culturally important source of food, and recreational activities and are highly coveted by those who value biodiversity (Ministry of Fisheries, 2008a). Commercial fishing has substantially contributed to the country's economy. Annual seafood exports weighed almost 300,000 tonnes and earned approximately NZ$ 1.35 billion between 2008 and 2010 (Ministry of Fisheries, 2010a). The seafood industry was reported to be the fourth or fifth largest export earner for the country, while directly and indirectly providing an important source of domestic employment and economic activities (Helson et al., 2010). Recreational fishing is obviously popular: One paper suggests that over 30 per cent of New Zealanders participate (Källqvist, 2009), but another estimates participation to be 19.5 per cent (Ministry of Primary Industries, 2010).

There is considerable concern that the interests and expectations of many stakeholders (especially *Māori*, New Zealand's indigenous people) are not met due to declining biodiversity and inshore fisheries (Dick, Stephenson, Kirikiri, Moller, & Turner, 2012; Schweikert et al., 2012). The depletion of fish stocks can lead to a loss of traditional practices (Hepburn et al., 2013) and fishing management rights are associated to issues of identity and loss of power for some Māori (Dick et al., 2012; Jackson, 2011, 2013). Local communities are particularly vulnerable to the depletion and respond in different ways. Some Māori communities have sought to employ a form of Customary Protection Areas (CPAs) to achieve sustainability of their local fisheries as CPAs provide a flexible mechanism that enable these people to enact responsibilities and ensure local interests (Jacobson & Moller, 2009). *Taiāpure* (Ministry of Fisheries, 2010c) and *mātaitai* (Ministry of Fisheries, 2010b) are two national Māori mechanisms of CPAs that have been strongly promoted over recent years. Many people have casted doubt about the efficacy of CPAs and some seek the establishment of marine reserves to provide for full protection of biodiversity. Marine reserves (where all fishing is permanently banned) are based on a euro-centric or preservation-style approach (Gardner & Bell, 2008). The choice between the Māori and euro-centric approaches to conservation has been acrimoniously debated over recent decades (Taiepa et al., 1997).

Marine fisheries management in New Zealand is characterised by spatial conflicts and a "race for space" between biodiversity, Māori cultural, recreational, and commercial fishing interests (Bess & Rallapudi, 2007). Each group, for instance, has sought control over areas of interests to that group regardless of the interests of other groups (Ackroyd & Beattie, 1998). Such a race for space would probably be prolonged and conflict will become acrimoniously entrenched due to the need for more (and perhaps larger) CPAs and marine reserves as biodiversity and fish stocks decline. For instance, larger CPAs might be applied for in the future due to a concern over the inadequate sizes of already established CPAs that hamper their ecological efficacy to achieve sustainable fisheries goals (Jacobson & Moller, 2009).

In this chapter, I define and interpret goals, values, and perceptions of key stakeholders involved in the debate surrounding the implementation of CPAs (taiāpure and mātaitai) and marine reserves. Interests in a particular management strategy are driven by people's goals and values and induced by perceptions of how their goals and values are affected or can be effectively achieved by that strategy. Maximising accommodation of different community interests is a prerequisite for all bottom-up co-management (Hein, van Koppen, de Groot, & van Ierland, 2006; Moller et al., 2000). Hence, my primary aim herein is to highlight some of the opportunities and obstacles to achieve such accommodation and trade-offs across different management systems under debate.

The remainder of this chapter is set out as follows. The next section describes study areas and methods. Values and arguments for and against CPAs and marine reserves are described in Sections 3 and 4, respectively. Section 5 reports the attitudes of recreational and commercial fishers towards these alternative management systems. Section 6 discusses prospects for integrated management, followed by concluding remarks in Section 7.

2. Study areas and methods

This chapter reports testimony from forty interviews and four focus group discussions involving key stakeholders to marine ecosystems in two case studies on the Banks Peninsula: Akaroa Harbour and Koukourarata/Port Levy in New Zealand (Figure 2). Both case studies were chosen in order to capture the whole debate surrounding taiāpure,

mātaitai and marine reserves that have either been proposed or recently established in the areas. Enduring debate since 1990 eventually led to establishment of Pohatu (Flea Bay) Marine Reserve and Akaroa Harbour Taiāpure. A proposed Akaroa Marine Reserve (located on the outer eastern side and covering most of the remaining part of the harbour) was being debated at the time of my interviews and has subsequently been approved by the Minister of Conservation (Department of Conservation, 2013). The marine reserve also needs the concurrence of the Ministers of Transport and of Primary Industries. The Minister of Transport has given the concurrence. By November 2013, recreational fishers and Ngāi Tahu were continuing to lobby the Minister of Primary Industries to reject the proposal.[viii] Koukourarata Mātaitai was created in Port Levy some years before my study. A second Mātaitai has recently been established nearby at Te Kaio (Figure 2) and its prospect was also mentioned by some interviewees.

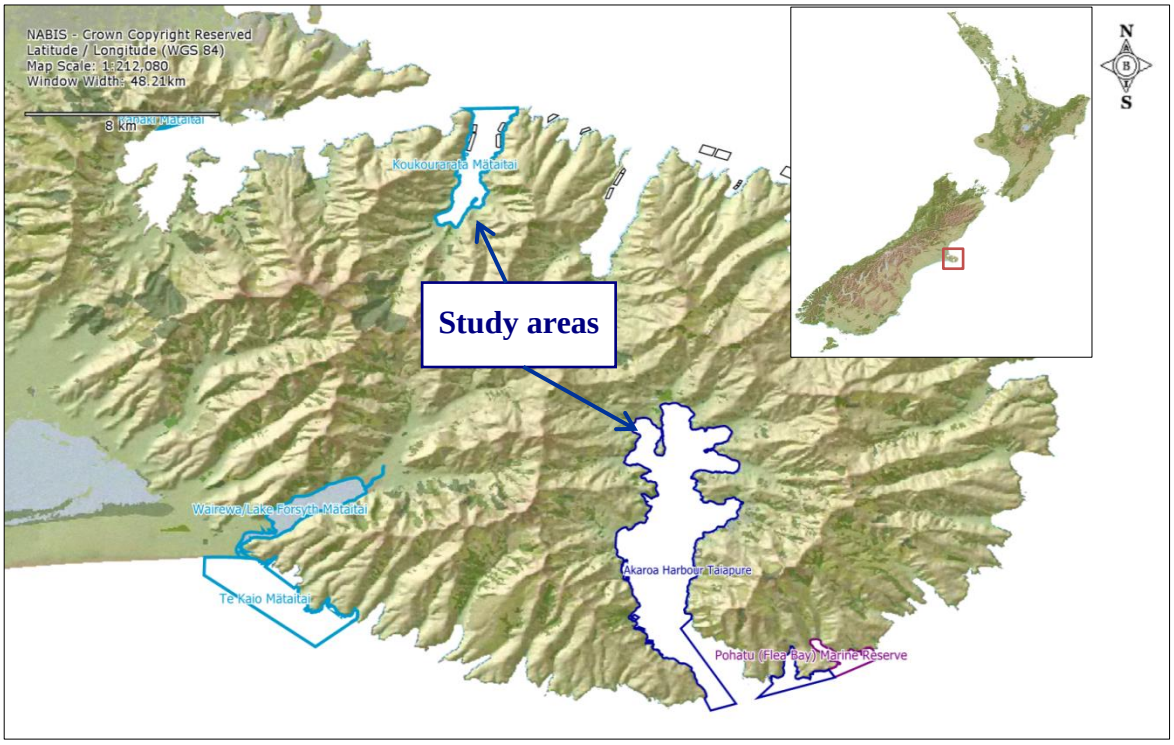


Figure 2: Map of study areas

Adapted from Ministry of Primary Industries (2013)

The Interviews were undertaken in two phases. Phase 1 was conducted by a TMK (*Te Tiaki Mahinga Kai*) team at Akaroa in January 2009 and at Koukourarata in November

[viii] Personal communication with an expert planning witness in this case

2008 and January 2009. TMK is a collaborative research project seeking to support communities to apply Māori knowledge and ecological science for restoring ecosystem health[ix]. The interviews by the TMK team asked a series of open-ended questions around the past and present state of *mahinha kai* (food gathering place), ecosystem health, current and proposed management and governance issues, and long-term goals of each community. Professor Henrik Moller and I conducted additional interviews (Phase 2) at Akaroa in October 2011 to complement the earlier material and especially to extent the information about marine reserves rather than taiāpure and mātaitai.

Altogether the interviews involved fifty one stakeholders (Table 1). Full details of the interviews and interviewees appear in Appendix A. The interviews purposefully targeted those who had good knowledge of the subject matters, hence the interviewees can be considered as key informants (Robson, 2002). "Snowball sampling" was employed for selecting the interviewees (Robson, 2002). Some interviewees were first identified by the researchers. Thereafter the initial interviewees identified other local interviewees who played important roles in the local community or proposed CPAs or marine reserves. All interviewees had been involved in some type of fishing in the study areas or were associated with some form of marine utilisation or interests (e.g. tourism, marine farming, or conservation). Most interviews were with one stakeholder or occasionally of a couple. They were nearly all conducted in the interviewees' houses and always in private.

Analysis of interviewees was supplemented by analysis of four focus group discussions (Table 2). Focus group discussions create multiple lines of communication and offer participants with a safe environment where they can share ideas, beliefs, and attitudes in the company of people from the same socio-economic, ethnic, and gender backgrounds (Madriz, 2000). This way of communication is particularly useful for accessing to research participants who may find one-to-one, face-to-face interaction "scary" or "intimidating". Only one of the four focus groups was called just for my study and facilitated by Professor Henrik Moller and myself. It was made up by the same interviewees (Phase 2) so that we could report back the findings from the individual interviews and stimulate detailed discussions about conflicts and common ground that emerged across all the interviewees. The other three discussions were conducted by the

[ix] http://www.csafe.org.nz/te_tiaki_mahinga_kai_subprojects

Department of Conservation and I analysed the minutes recorded from each. I referred these discussions as focus groups because all of the discussions were actually used to assess the likely response made in a group context to the proposed marine reserve like the one particularly conducted for this study.

Table 1: Summary characteristics of interviews/interviews

Interviews/interviewees	Number
Interviews at:	
Akaroa Harbour	30
Koukourarata/Port Levy	21
Female	19
Māori (M)	24
Interest groups:	
Recreational fishers (RF)	7
Commercial fishers and fish farmers (CF)	10
Tour operators (TO)	4
Akaroa Taiāpure Committee and Marae (ATCM)	8
Koukourarata Mātaitai Committee and Marae (KMCM)	9
Akaroa Marine Protection Society (AMPS)	10

Interviews lasted between 30 and 150 minutes and my focus group lasted 135 minutes. All discussion was recorded and transcribed, and the transcripts were returned to the interviewees for cross-checking. Qualitative analysis (Miles & Huberman, 1994) aided by a software package NVivo™ (QSR International Pty Ltd, 2010) was used to analyse the transcripts of the interviews and focus group discussions. With this software package, texts of similar themes can be gathered into a 'node' (which can be subsequently broken down into sub-nodes) using a technique known as "coding" (Beekhuyzen, Nielsen, & von Hellens, 2010; Hutchison, Johnston, & Breckon, 2009). Three nodes (including "taiāpure", "mātaitai" and "marine reserves") were primarily created to contain associated texts. As the coding developed, some more nodes (e.g. "top-down *vs.* bottom-up approaches", "Māori vs. western concepts", "sustainability vs. conservation", "ecosystem services") were created to contain associated emerging themes. These generic nodes were then investigated one at a time to acquire in-depth understanding of the subject matters and decomposed, where necessary, into sub-nodes ("coding on"). For instance, sub-nodes (such as "why support", "why against") were created under the "marine reserves" node.

Note that the same texts can be coded and contained into many nodes and sub-nodes. Matrix coding (i.e. cross-referencing) was then used to explore how a node/sub-node was associated with another and how a node/sub-node was associated with particular groups of interviewees. For example, matrix coding was used to explore how taiāpure and mātaitai were related and how they differed.

Table 2: Profile of focus groups

Focus group discussion	Number of participants	Venue	Date	Tag
Meeting between Department of Conservation (led by the Minister) and applicants of the Akaroa Marine Reserve Proposal, members of the Akaroa Marine Protection Society, Forest and Bird, and individual members of the public	27	Boatshed, Akaroa	7 August 2009	FG1
Meeting between Department of Conservation (led by the Minister) and members of Te Runanga o Ngāi Tahu, Onuku Marae (and other marae), and Akaroa Taiāpure Committee	27	Onuku Marae	7 August 2009	FG2
Meeting between Department of Conservation (led by the Minister) and members of Te Runanga o Ngāi Tahu, Onuku Marae, and some other marae	19	Onuku Marae	18 June 2010	FG3
Our meeting with applicants of the Akaroa Marine Reserve Proposal and members of the Akaroa Marine Protection Society	13	Akaroa Restaurant	18 October 2011	FG4

The analysis was exploratory with an attempt to understand factors (including goals, values, and perceptions) that have driven certain individuals/groups of stakeholders to support or oppose particular management tools (taiāpure, mātaitai or marine reserves). Many direct quotes are used to support the arguments made and fully convey emotions and deep values of the interviewees. I have reported selected quotes with a tag that identifies an interview number, the identity and main stakeholder group of the interviewees (Appendixes A) or with a tag that identifies a focus group number (Table 2).

3. Customary Protection Areas (CPA) and fisheries management

This section is organised as follows. Section 3.1 discusses ownership and management control induced by CPAs (taiāpure and mātaitai). Section 3.2 reports Māori cultural

values, aspirations and concerns. Sections 3.3 through 3.6 discuss key features that can make CPAs successful. Section 3.7 compares and contrasts taiāpure and mātaitai. Finally, Section 3.8 reports some perceptions that CPAs might not be effective for restoring biodiversity and fish stocks.

3.1. Ownership and management control

Taiāpure and mātaitai (CPAs) are two major formal mechanisms available for Māori to retain ownership and management control over their customary fishing grounds. Māori are empowered under both mechanisms to set up management committees who may formulate management plans and regulations (or by-laws) and recommend these to the Minister of Fisheries (now Minister of Primary Industries) for implementation (Ministry of Fisheries, 2010b, 2010c). It was reckoned that Māori would gain more ownership and management control over the areas designated as mātaitai than those designated as taiapure:

> The mataitai would have been all *tangata whenua* [indigenous people of the land], and it's up to us whether we want to include other people; whereas the taiapure you have to be inclusive… We went the inclusive way, whereas it would have been easier to go the exclusive way and then just bring them [other stakeholders] on a committee for suggestions. But in the end the tangata whenua have the right over it (INT10-M-ATCM).

Members of mātaitai committees may be exclusively Māori, but many of the committees (including Koukourarata Mātaitai Committee) have actually involved non-Māori as well. Despite this, it was admitted by at least a Māori interviewee that:

> "I don't think Māori want non-Māori involved [in the mātaitai committee]" (INT25-M).

One of the reasons why non-Māori were included in those mātaitai committees was stated to be a strategy to reduce opposition from these people and get the mātaitai established.

Inclusive management arrangements can reduce Māori's controlling power, thereby potentially compromising their cultural values and aspirations. A discourse analysis shows that Māori values and aspirations have often been compromised in order to get consensus in an inclusive taiāpure committee (Jackson, 2011). Such compromise was also reported to have happened in mātaitai due to the inclusion of non-Māori in the committee:

> Some time ago when we [non-Māori] were still working on the plan a suggestion was put forwards by one of the Māori members of the mātaitai committee that other species besides

> cockle [clam] might come under the management of the mātaitai and this was greeted with almost universal dismay … Essentially it would mean that none of us could go down to the beach and the rocks and get a dozen mussels without first having to get permission from someone around at the pā [fortified village] (INT29-KMCM).

This example does not mean to touch upon whether the suggestion by the Māori member was in any way right or wrong. It is just used to demonstrate the compromise of a Māori aspiration under an inclusive committee. Nevertheless, compromise might not be a major problem with mātaitai because final decision-making in the mātaitai committee lies at the discretion of Māori. It is argued that mātaitai is a Māori mechanism for the benefit of Māori, whereas taiāpure is a Māori-led initiative that incorporates both Māori and Pākehā (New Zealander of European descent) perspectives (Jacobson & Moller, 2009).

3.2. Māori cultural values, aspirations, and concerns

Customary fishing was considered fundamentally important to Māori for securing food sustenance, manifesting cultural identity and maintaining cultural heritage and social cohesion. Customary fishing has supplied traditional food for individual families, special events such as funerals, weddings, tribal gatherings, and for offering hospitality to guests at *marae* (tribal gathering places). It was argued that:

> Manaaki [hospitality] … is an integral part of upholding mana [influence, prestige, power, authority and control] of the marae. Therefore it is important for the marae to have access to kai moana [seafood]" (FG3).

Some Māori even perceived customary fishing as their cultural identity, e.g.:

> It is something intrinsic to my Māoriness that I can go and collect kai [food], which is my right and I can do it the right way and bring it home for my family … I was going to give him [a Māori fellow] some mussels I had in an ice cream container. They were extra from the gathering in the hall … I asked him if he wanted those mussels and he said, 'Oh, yeah,' and I said, 'Where do you normally get your kai, your mussels?' He said, 'PAKńSAVE [a supermarket].' That just blew me out of the water that any Māori actually buys mussels. I thought only Pākehā people did that! (INT25-M-KMCM)

Many Māori aspired to having secure access to and retaining ownership and control over their traditional fishing grounds. A mixture of option use (i.e. holding resources for future uses) and non-use values (i.e. holding resources for future generations) were expected. Some quotes below report this aspiration:

> It was traditionally farming and fishing … The dynamics in the town have definitely changed over the last 20 odd years. But people like to protect what's their own. They'll fight for it … Everybody on the [taiāpure] committee is happy about it [reducing daily bag limits] and

> wanting to do it … I think it's the fact that, we want to look after the harbour. We want the fish to come back (INT15-M).
>
> What drives me, what drove my father, what drove my grandfather is that the people looked after the area ... It's to look after something that has been passed down from Kauwheke [ancestor] to my grandmother, grandfather and passed down to my kids (INT20-M-CF).
>
> It's not just for us, it's for our kids. That's where our ancestors collected their kaimoana (INT8-M-ATCM).

Many Māori customs (e.g. food sharing) and social cohesion within *Iwi* (Māori tribes) or *hāpu* (subtribes) were perceived to have revolved around food, especially some "cultural keystone species" such as *pāua* (abalone), cockle and mussel. Without these species, the society they support would be completely different (Garibaldi & Turner, 2004). Concern over the alienation of customary practices and break-down of social cohesion due to the depletion of these cultural keystone species was explicitly expressed, e.g.:

> If there is no kai here, if eventually we run out of mussels and pāua, this place falls to pieces. There will be water sports. If you are young, there will be tramping and looking at beauty, but part of it is sharing that kai with the community ... I think we all actually revolve around the kai (INT25-M-KMCM).

Concern over accumulative loss of access to traditional fishing grounds and food due to degrading ecosystems and restrictions more restrictively imposed (even if by Māori protection mechanisms) was also expressed, e.g.:

> I was a bit wary about whether it was a good idea or not, because we were so used to it [fishing]… we were brought up down here that we only take what we want, then all of a sudden there were these restrictions that there was only once a year when we could get the cockles. I was sitting on the [mātaitai] committee that made that decision, but it was quite mind-blowing to think that: 'What? We could only go down once a year?' … A lot of our old people were missing out, because they were getting older and they wanted a meal, not just in one particular time. In times when they weren't well, they needed some sustenance (INT35-M-KMCM).
>
> I was all against the [marine] reserve in the harbour because the area that they were going to put it was the last area that we could get to for the big pāua. That was going to take all that area up, but the big pāua are still there, just not as many as there used to be (INT20-M-CF).

Māori were in strong opposition to marine reserves, not just because of the concern over the loss of access to traditional food and cultural depreciation, but also because of concern over the loss of opportunity to gain ownership and control over marine areas if more marine reserves were created. A marine reserve would take up a piece of marine space and put it under control of the Crown forever. Without a marine reserve, this piece might otherwise fall under Māori ownership and management in a form of CPAs (taiāpure or mātaitai). Any additional marine reserve would reduce the chance to get a CPA established even if their proposed locations do not overlap. The more marine reserves are

established, the less fishable areas would remain, further impacting the success of traditional food gathering, customary practices and opportunity for Māori ownership and management of inshore areas. Cumulative impacts on (especially commercial) fishing due to marine reserves might trigger the "Prevent Test", i.e., if a mātaitai application is expected to cause unreasonable impacts and prevent a commercial fisher from catching his or her quota, the application will fail such a test and be rejected (Ministry of Fisheries, 2008b). The concern over cumulative impacts can be clearly seen in several quotes, e.g.:

> "The displacement of the combined fishing effort in this area as well as that that was applied in the Flea Bay area will contribute to the cumulative effect on the mātaitai application at Te Kaio (Tumbledown Bay) – which may trigger the prevent test" (FG2).

Furthermore, marine reserves were considered as a western concept and culturally unacceptable to many Māori. At least one Māori interviewee explicitly said:

> I don't like having a specific tag as a marine reserve. It is a Pākehā thing" (INT35-M-KMCM).

In contrast to the traditional Māori approach of rāhui (temporary closures if needed), marine reserves were repeatedly referred to as "locking up [resources] and throwing the key away", i.e. current and future fishing in areas designated as marine reserves would be impossible. Many interviewees believed that restrictions under taiāpure and mātaitai could in the same way restore fish stocks and the health of marine ecosystems, while ensuring on-going fishing and traditional practices. For example, it was argued that traditional rāhui could play a role like marine reserves but the former would definitely reopen:

> If the fish stocks came back up again it would have to be a success, wouldn't it? And still allowing people to have a feed, they need to get their fish ... Block off this part and let them fish there for a few years then, block off other parts (INT15-M).

> Once it [marine reserve] is in place, that's the finish. With the taiāpure, we can shift the closure to different areas for a certain period of time and move it around. That's what has got a lot of people backs up. When we started mentioning about the taiāpure, they thought we were closing the whole harbour off. No, that's not it at all. A lot of people changed their minds when they heard that. Only a small portion would be closed off at any one time (INT15-M).

> With mātaitai and those kind of tools, it's more about "let's close it down for a while and make it sustainable, then we can open it up" … We keep saying our bottom line is sustainability. We want the Kererū [NZ pigeon] to be like rats. We want them so badly that you want us to harvest them, so we can continue and get back to some traditional practices (INT10-M-ATCM).

3.3. Incentives to manage and protect local stocks

An incentive to look after the resources is a prerequisite to overcome a tragedy of the commons (Chapter 2). Without such an incentive, resources are prone to be depleted by

competing uses and overexploitation (Hardin, 1968). Testimony from many interviewees suggests that fishers do not have such an incentive in the current fisheries management regimes. Under the Quota Management System (QMS), commercial fishers are allowed to catch their quota anywhere in respective quota management areas (QMAs). A large QMA was attributed to have driven competing uses, overexploitation of good fisheries and local area depletion, e.g.:

> If there is a good run of fish down here you'll get guys [other commercial fishers] coming down and bombing the area and it's no good for anybody ... If the areas were smaller and we had just our quota for that part there, obviously it's going to be our home ground ... that makes me look after my area because it's my home ground and I got quota for that area. I know that if I farm that area and look after it, it's going to be good for me and it's going to be good for my son. But if every Tom, Dick, and Harry's down there bombing the shit out of it, who cares? He's going to do it, so I'm going to do it too … What is the point of trying to look after an area while you get other people moving in (INT13-CF-ATCM).

This quote suggests that the "race for fish" or "race for space" has still occurred under QMS because of the lack of ownership over a sufficiently local part of the fisheries. This finding contradicts the assumption that QMS eliminates the race for fish as fishers are guaranteed by well-defined property rights to catch a pre-specified amount of fish (Pearse, 1981; Wilen, 2000). Of course QMS guarantees *a priori* rights to catch quota, but individual profit maximisation incentivises fishers to competitively locate their fishing effort in good fisheries. For this reason, even local fishers pay little care about the fisheries and concentrate on catching their quota as quick as possible before fish get caught and cleaned out by other quota holders.

Under amateur fishing regulations, recreational fishers are allowed to catch their daily bag limits of particular species anywhere in the country. Such a fishing freedom was attributed to have caused overdue exploitation (especially by non-locals) of near-shore fisheries because of the lack of an incentive to protect the fisheries, as reported:

> Everyone always has mixed feelings about regulations; there is always this tension. On the one hand, "the sea is common property and public property and we think it is our birth right to go anywhere around the country and drop a fishing line into the water or gather some shellfish", but at the same time, when you live in a particular locality, you think to yourself "I am a local and I have in some indefinable way, some special right". So we all resent the idea of people coming from outside this area and coming over and certainly exploiting the resource unduly. Even if they were to take no more than their legal bag limits we might resent that also. On the other hand when we go to other parts of the country we don't want to be subject to regulations (INT29-RF-KMCM).

> They'll come in for a few weeks, they'll do what they have to do and then they'll go again. But we [the locals] are the ones that have to live here and deal with it [resource depletion] later. I think, well we actually want it for our kids and grandkids later on. We've had a few people that

> have moaned and groaned about the tightening down of numbers [daily bag limits]. But you know, some of these people might only be here for a couple of years, then sell off and move away (INT15-M).

These quotes reflect the concern of the locals over the depletion of local stocks and recognition of their special roles to protect local stocks. These people care most for the resources as they and their descendants are the ones who have to bear the costs of depletion. How and the extent to which local people throughout New Zealand care for local resources are reported in detail in McCarthy et al. (2013).

3.4. Efficacy of bottom-up initiatives

The inclusive management arrangements adopted under taiāpure and many mātaitai in theory enable cross-cultural accommodation. Initiatives (including management plans and regulations) by local committees created under such arrangements can be ascribed to follow a "bottom-up approach" (Agrawal, 2005; Ostrom, 2010). With such an approach, local needs, knowledge and customs are likely to be reasonably reflected in any management initiative. People (especially the locals) from different cultures may have their inputs into an initiative through their representatives in the committees, even though the Minister of Fisheries must formally ratify and can veto local proposals.

> We talked about the bylaws for about nine months, and the taiāpure committee itself just came up with ideas and had brainstorms; what do we want to do? You have been fishing, what you think? You go and talk to your recreational committee; you go and talk to the commercials; us customary guys we're going to go back to the marae to see what we want; and then just come back and say okay, see what we think, then it goes to the minister (INT10-M-ATCM).

In the eyes of the locals, such an initiative is likely to be more legitimate in some ethical sense than those introduced by a government agency (often based on a top-down approach) and accordingly engender compliance:

> I like the rules made in the local [community]. They probably go through a lot before they make it a rule though. You've got to have a lot of information (INT4-M-ATCM).

> We have had no complaints [about the customary regulations] coming out from the mātaitai" (INT28-M).

In contrast, any initiative that does not reflect the interests of the users is likely to be illegitimate and accordingly fail:

> The whole thing will fall down even though it's imposed by legislation. You must have the will of the users behind you. If any particular group or course adopted isn't reasoned and has not been subject to a firm and open and fair consultation, it's doomed to fail. The individual will say 'Stuff it. I can't catch a 30cm fish, so I'll take a 27cm today' (INT2-RF-ATCM).

It was argued that the current management regimes have been ineffective in enforcing poaching due to insufficient enforcement effort (i.e. not enough patrolling officers), whereas more effective enforcement could result with participation from the locals:

> They [patrolling offers] are limited because there's only one here now. There used to be about three. They can't be there all the time. They've got a big area to cover, round the peninsula and that. When you see something happening you can always get them on the phone (INT15-M).

> From what I hear on the ground over there, Auntie Meri because she lives there keeps a pretty close eye on things. And Meri is pretty good at just going out and pointing out [about regulations] to them [poachers] (INT28-M).

> The community is really good too, because they give me a ring and say, "Look, I can't get around to help you but I've noticed that there's been a car that's come down, they've collected mussels and they're dragging up so many mussels and could you stop them at this end to see if they've got a permit" (INT35-M-KMCM).

> They [locals] love talking on cell phones about guys out getting mussels and pāua and even just people cruising up their harbours. People are looking after their harbours. It's well policed (INT4-M-ATCM).

> Some divers got caught at the top of the hill top, because somebody had seen them out diving ... That was me, out in front of our marae. I said to them, "Hang on, you know you've got too much there", and they just said, "What are you going to do about it?" I didn't say a word, just contacted the police who stopped them at the top of the hill ... I'm not the only one who has done that. There've been other locals that have spotted them [poachers] (INT15-M).

These quotes reflect the will of the locals to participate in rule enforcement and the power of a collective action (e.g. more eyes watching poaching) in making such enforcement more effective. Trusteeship has also started to evolve, as reported:

> It's like trusteeship now. You go to court, stand up in front of the judge ... The same with this fishing thing, they've got a good team" (INT4-M-TC).

The evolvement of trusteeship is a sign of a management success of the local ecology (Ostrom, 2010). And reduction of poaching is a recurring advantage of a wide range of co-management initiatives around the world (Moller et al., 2000; Taiepa et al., 1997).

3.5. Value of local and traditional ecological knowledge

Regulations formulated by local committees could be apt to address real problems in local fisheries due to the use of local knowledge. It was believed that having good knowledge

of an area was a prerequisite for making good rules, and locals (especially fishers) knew the best:

> The group that we are on will make the rules and recommend it. They've got a good team … a good range of knowledge. They've got a farmer, detectives, and weekend fishermen that have been fishing all their lives. The fishermen made the recommendation, not the government … They know what's going on. Those in Wellington don't know the day to day running of it (INT4-M-ATCM).

Local knowledge embedded in Māori culture can be considered as traditional ecological knowledge (TEK). Examples of TEK discussed during the interviews include traditional practices associated with harvesting (periods, sizes), stock enhancement (shifting, planting, reseeding) and management (catch, size, temporal, spatial restrictions). Taiāpure and mātaitai may enable such practices to continue to grow and adapt to new ecological challenges. Some Māori were enthusiastic about forging their traditional practices in local (taiāpure or mātatitai) regulations. Despite lack of scientific rigour, local knowledge was believed to offer some advantages over science for managing complex marine systems. Local knowledge was considered as an accurate reflection of the past and particularly useful for monitoring changes in fish stocks. Concern over the depreciation of such useful knowledge was also raised:

> In a lot of cases, it [local knowledge] is an accurate reflection of the past. It's actually been seen to happen. Whether it's factual or not is another thing, but it is certainly an acceptance that those who are advocating it have at least had that perception somewhere back in their own life experience ... I am still a very firm believer that there is a lot of useful knowledge in the past gone to the grave. And there is going to be a lot to go in the future, simply because people consider that their knowledge is not important (INT2-RF-ATCM).

> I don't necessarily think you need to measure it. If we set the limits low, in time people will be talking, "I went out and in five minutes I had my bag limit" whereas it may have used to have taken an hour. There're plenty of people around that could measure that kind of stuff. I think it's important in this taiāpure process, don't get bogged down with too much bullshit science (INT21-CR-ATCM).

It was further argued that science was not only costly and often time consuming, but that it was also not infallible. This necessarily suggests that problems might not be addressed in a timely manner if regulations depend mainly on science. There is no guarantee either that the science-driven regulations would effectively provide a solution to the problems. Despite this, it was acknowledged that science was needed in some areas to assist local committees in achieving their objectives. In this sense, management arrangements under taiāpure and mātaitai would accordingly enable the best use of science and local knowledge, an approach which is increasingly acknowledged for providing a significant

contribution to increased sustainability of local resources and social-ecological resilience (Berkes et al., 2003; Moller et al., 2009; Newman & Moller, 2005). *Ngāi Tahu* (Tribal group of much of the South Island) have recognised the value of incorporating local knowledge into a semi-quantified and formally scored Marine Cultural Health Index (Schweikert et al., 2012).

3.6. Value of mandated active management

Taiāpure and mātaitai were considered as an active form of management for which local committees were mandated. It was argued that such active management would work better than a passive form of management like marine reserves:

> One of the beauties of the taiāpure process is it's about nurture. We can do stuff, we can actively promote stuff. It's not a marine reserve where you sit back and observe (INT21-CF-ATCM).

> Does it [Flea Bay Marine Reserve] really feed the rest of the fish population for the rest of the Peninsula? Not really. It would be far better if all the land owners took some extra responsibility, be a bit more proactive whilst getting a sense of pride and ownership out of minimising any adverse effects possibly going into the water way. I think it [mātaitai] is a tool that could promote that concept and that is why we have always advocated it (INT37-CF-KMCM).

These arguments were associated with the perception that fisheries (especially when depleted) could not be enhanced by simply allowing nature to run its course (like marine reserves), but that some form of active enhancement was required. Reseeding was an example of an enhancement technique that was discussed during the interviews and accredited to have enhanced pāua in inshore fisheries. There was also some discussion about, for example, a plan to promote artificial fish breeding. Nonetheless, this example does not mean to suggest that those enhancement techniques can effectively enhance fisheries. It is just used to demonstrate that taiāpure and mātaitai provide a provision for active management. The best use of local knowledge and science might help develop some effective enhancement techniques.

It was believed that any new problem (e.g. depletion of a particular stock) would be quickly realised as the locals were there fishing and observing all the time, and some new form of regulations could be accordingly put in place in a timely manner. If ineffective or where necessary, such regulations could be further adapted:

> They [taiāpure committee] get a report of all the fishes caught. If all the moki isn't there, then they can have a ban on it for ten years (INT4-M-ATCM).

> It might take three years before you notice any difference in the stock, if they've built up. And then you could work out, right we'll leave it in this place for five or ten years and build that area up. Then shift it to another area for another ten years or whatever it takes to build them up to a decent level (INT15-M).

With less bureaucracy under such local committees and narrower focus in terms of specific locations, new regulations are likely to get formulated and adopted for implementation more quickly than those promulgated by a highly structured government agency. This approach is known as "active adaptive management" under which societies respond, by adjusting and evolving or through trial-and-error, to the uncertainty and unpredictability of ecosystems (Berkes et al., 2000; Berkes & Turner, 2006; Moller et al., 2009; Turner & Berkes, 2006; Walters & Holling, 1990). Small incremental steps to instigate general "rules of thumb" that broadly promote social-ecological resilience are often the most practical way to move forward in managing complex systems (Darnhofer, Fairweather, & Moller, 2010).

3.7. Taiāpure vs. mātaitai: Different outcomes for cultural values and ecosystems

Taiāpure and mātaitai share many common grounds, which capture many of the design principles needed to make a success of community-based natural resource management (Cox, Arnold, & Tomas, 2010). These principles include recognition of rights, congruence between rules and local conditions, participation of most affected users in monitoring, rule formulation and enforcement, and existence of rapidly accessed conflict-resolution mechanisms (i.e. local taiāpure and mātaitai committees). Nevertheless, it cannot be expected that taiāpure and mātaitai deliver the same levels of outcomes. For example, it was argued that Māori cultural values could be better achieved by mātaitai, whereas ecosystem management could be more effectively achieved by taiāpure:

> Mātaitai is directed in two ways. It is directed towards a specific area because of a greater degree of cultural and traditional significance to the local Māori community for that particular area. That still doesn't include participation by recreational fishers. They can still fish there, but they're not part of initiation. Māori community can apply for that. The other is a mātaitai is more narrowly focused on a particular problem, say, a death of shellfish where there used to be plenty, whereas a tāiapure takes a broader view or ecosystem level [lots of different species and habitats, and a bigger area]. I would expect it to be in practically every case. A mātaitai or rāhui is something not necessarily within a tāiapure, but if it is, then it will be the mātaitai being within the tāiapure rather than the tāiapure being within either of those other two (INT2-RF-ATCM).

The inclusive management arrangements were also considered as an important factor that could make taiāpure more effective than mātaitai for managing the common-pool resources:

> [Taiapure] has been an inclusive process. They have tried to get the best information to do things rather than saying this is a Māori view and this is what we are going to do … The way the taiāpure is set up and who's on the taiāpure means that it's likely to quite well run. I don't have the same confidence in mātaitai (INT21-CF-ATCM).

> For me on one front the taiāpure is about the community, you got to bring everyone in, and you got to work together as a committee. So that's quite powerful. Whereas the mātaitai for me, it just cuts the commercial guys out straight away. And it gives the mana to the marae, to tangata tiaki [guardians], to the mana whenua, but then that could alienate the rest of the community except for the recreational fishers, maybe (INT10-M-ATCM).

> Where you have exclusive or better than normal rights, it's always going to cause division. I think it's not a desirable thing to have. It's desirable to protect the traditional use local communities have had of our resources around the marae, but not to the exclusion of others (INT12-RF-ATCM).

It can be inferred that the use of local knowledge, the likely legitimacy of rules, the incentive of the locals to participate in rule enforcement, and the power of collective action provided by the mātaitai provision are more limited than those provided by the taiāpure provision. Local knowledge may not be best used in mātaitai as in taiāpure because mātaitai committees may be exclusively Māori[x]. Although non-Māori have been often involved in mātaitai, it is not expected that they can deliver the same level of outcomes as taiāpure (especially in terms of incentivising the locals to protect the resources). This is due to the fact the community involvement in mātaitai is not explicitly stated in the legislation:

> I think mātaitai stink in the sense that mātaitai are trying to act like taiāpure and they're not in the legislation. And mātaitai should be exclusively for Māori and everyone else should bugger off (INT21-CF-ATCM).

The involvement of community members in mātaitai is essentially insecure so their inputs into the management might not be seriously taken into account or even overlooked.

Limited knowledge can have implications for the implementation of active adaptive management. The identification of emerging problems and effective enhancement techniques in mātaitai may be less effective than that in taiāpure. Without inputs from a

[x] The inclusive management arrangements may conversely compromise the use of Māori traditional ecological knowledge.

broad community, any initiative is less likely to be legitimate and there is less incentive for the community members to participate in rule enforcement either. Mātaitai committees (if involving only Māori) also have less power than taiāpure committees. This was accepted by Māori themselves, as expressed:

> [Taiāpure] has probably got more bite, I suppose, than a mātaitai as it brings in the whole community" (INT10-M-ATCM).

Although there was some consensus among interviewees that taiāpure are more effective than mātaitai for ecosystem management, the actual results remain to be seen. Commercial fishing is by legislation excluded from mātaitai. This exclusion has led at least one interviewee to suspect that mātaitai might be more effective than taiāpure:

> After the commercial guys come through, there's only undersize pāua. They say [pāua stocks in] the southern bays are kind of stunted anyway so they don't get huge ones… We're [left] trying to put a mātaitai in for that area. We still have to discuss if we get a mataitai but by-laws we can put in to try and see if it negates some of that stuff. Get the commercial guys out and see if the pāua actually start to grow or if they are stunted (INT10-M-ATCM).

3.8. Doubt about the efficacy of CPAs

In theory, co-management has the potential to provide benefits for both Māori communities and conservation goals, but in practice there are few case studies reported about its success in delivering this promise nor evidence that they are not working (Newman & Moller, 2005; Taiepa et al., 1997). The uncertainty about the efficacy of the co-management has formed part of the debate about CPAs and marine reserves. Many people have casted doubt about CPAs and believed that marine reserves are more reliable for restoring biodiversity/ecosystems and fish stocks. The mistrust of CPAs has been induced by the involvement of politic and lack of knowledge about how the process works:

> A lot of people think taiāpure is a very scary thing because there's so much political weight in Christchurch Ngāi Tahu that they won't be able to have any say or any control of what's going on in the marine environment for local people. I don't know who is on the taiāpure board. I don't know how it's run. I don't know who it's run by. I don't know where the meetings are and I don't know how local people can know anything about it (INT17).

Marine reserve advocates perceived that compromise has been a major reason why CPAs might not be effective:

> As long as you get a whole group of people making decisions it's always compromised. A marine reserve is not a compromise. It's no-take, end of story, no negotiations, simple as that and therefore effective" (INT3-AMPS).

There were reports about how compromise has actually happened under taiāpure and mātaitai. People managing taiāpure and mātaitai can get around with regulations even if they are already in place:

> If it [mātaitai] goes through, it takes commercial guys out – unless you put a bylaw in. There was one mataitai, I can't remember where it was. They put a mataitai in, but they negotiated with the [commercial] Cray fishers that the Cray fishers could still fish in that mataitai (INT10-M-ATCM).

> The cockle bed is only open in the weekends of September, but if there's a special event at the marae, I can do a permit for the cockle for that special event (INT35-M-KMCM).

> The agreement between the taiāpure applicants and Sea-Right Investments Ltd [a seaweed harvest company] exempts the seaweed quotas and permits of Sea-Right from any restrictions which might be imposed by the taiāpure. This gives a guaranteed right to harvest regardless of any conservation or fisheries management methods that may be considered necessary by the taiāpure committee in the future. If the taiāpure committee wishes to establish any rāhui or no-take conservation areas it will be unable to do so (FG1).

Further, it was argued that an attempt to reduce fishing pressure through regulations (e.g. reducing recreational daily bag limits) imposed under taiāpure and mātaitai might not be enough on its own for restoring fish stocks and biodiversity. A reduction in fish take due to the drop in bag limits would be well offset by an increase in fish take due to a growing population and an increasing number of recreational fishers (especially in the case of a tourists destination like Akaroa Harbour):

> Taiāpure can set bag limits, but it can't control the overall number of recreational fishermen. Even if much more stringent limits per boat are set, there is no control through the taiāpure mechanism over the absolute number of fish that can be taken. It might seem a quiet place today – but come back over the summer holidays or Easter, and you'll see Akaroa Harbour swarming with the boats of recreational fishers (INT24-AMPS).

In line with this argument, findings from a fishing survey in East Otago Taiāpure shows that recent reductions in bag limits (halving most of them) have had little effect on the number of fish recovered (McCarthy et al., 2013). Even those who were on a taiāpure committee were suspicious about the effectiveness of the reductions in bag limits as well. The resulting potential problem of "high grading" also was reported:

> If you're allowed six fish, you'd normally take the six biggest ones … If you reduce it to three, guys will fish and at the end of the day if they get a nice one, they'll keep it. If they get a little one, they may even keep it on board, and if they don't get a bigger one, they'll take it home because they're allowed three. But if they get a bigger one, they'll throw that small fish back. Now you don't know about it, I don't know about it, nobody knows about it, but it's a dead fish and they go home with two or three nice big fish (INT13-CF-ATCM).

There was a general consensus among interviewees that rāhui could result in recovery of fish species and stocks. Rāhui may be implemented on their own right (Section 186 of the Fisheries Act 1996 (Maxwell & Penetito, 2007)) or under taiāpure and mātaitai to restore depleted fish stocks in particular areas; these areas are then reopen for fishing once restoration is achieved. Only a few rāhui have been implemented. Rāhui might not either provide opportunity for long-term biodiversity regeneration, ecosystem recovery and natural functioning as occurring in marine reserves:

> The purpose of the taiāpure is fisheries management, not the regeneration of biodiversity as a whole. Once stocks improve, rāhui or other measures will be relaxed to allow for a fishery take again. The goal of the marine reserve is different. It is to return this area to a pristine state and keep it that way, not just to see certain species recover. To return this area to the earliest inhabitants of Aotearoa – the native flora and fauna, which existed before any humans arrived here (INT24-AMPS).

At least one Māori interviewee accepted that rāhui would be less reliable than marine reserves:

> I, myself, like the thought of having rāhui, but then there's too much raruraru [conflict, argument] with the rāhui. That's why I would like the marine reserve [in Akaroa Harbour], but a smaller sized reserve [than the one proposed]. I know it's not a Māori approach, but it's going to help for the future anyhow (INT19-M-KMCM).

Further, there was concern about the threat from commercial fishing to fish stocks, if effectively re-enhanced by taiāpure. (Recall that commercial fishing is excluded from mātaitai, but it might be less effective than taiāpure for reasons discussed in Section 3.7.) Interviewees generally agreed that commercial fishing had been a major cause of stock depletion, which has then forced commercial fishers to move elsewhere for non-depleted stocks. For instance, there remains only one local commercial fisher (with a small quota) left in Akaroa, whereas it used to be a thriving commercial fishing port. Nevertheless, it was argued that the recovery of fish stocks (if occurring) would bring commercial fishing back, and that stocks would then once again be depleted once more commercial fishing recommenced:

> They have the quota system for crayfish. They have Cray-Mac 1 or 2, which is virtually the whole East Coast of the South Island. So if you have a permit for Akaroa, you can go and fish at Timaru or Kaikōura in the same area. Last year Ngāi Tahu, who are the biggest owners of the quota, leased seven-tonne quota to a [non-local] fisherman. He came down here and he fished this area just within the headlands of Akaroa Harbour and took out the seven-tonne within a very short time and that annoyed me … Fish are all gone, just like that. It'll take another ten years to get stocks up again and then someone else will just come in and blitz it again (INT9-TO-AMPS).

One could argue that with a flexible management arrangement under taiāpure, some form of effective regulations can be put in place to restrict commercial fishing. Nonetheless, it might be difficult to impose such effective regulations. Under the Quota Management System, commercial fishers are allowed to catch their quota anywhere in a Quota Management Area (Batstone & Sharp, 1999; Lock & Leslie, 2007; Straker et al., 2001), of which taiāpure may be part. There is no blanket regulation excluding commercial fishing from taiāpure (Ministry of Fisheries, 2010c), but theoretically the management committee could apply to the Minister of Fisheries to impose one. One possibility is to impose spatial restrictions, i.e., prohibiting commercial fishing from some sections of taiāpure. However, such spatial restrictions might be either ineffective (if not large enough) or difficult to impose if large enough to affect commercial fishing. The spatial restrictions, mātaitai and marine reserves (if equal in sizes) have the same effects on commercial fishing. So, if it is difficult to implement marine reserves (and perhaps mātaitai) due to opposition from commercial fishers, it is also logically difficult to implement these spatial restrictions within an existing taiāpure. Note that commercial fishers often have their representatives in taiāpure committees to protect the interest of their group.

4. Marine reserves and biodiversity preservation

There was a general consensus among marine reserve advocates that their overarching goal was the preservation of biodiversity so that it could naturally regenerate to a pristine state. It was argued that such natural regeneration could not be achieved by a Māori management mechanism:

> The fundamental divergence between taiāpure, mātaitai (the Māori mechanisms) and marine reserves is whether you are creating your protection structure for the purpose of biodiversity or whether you are creating your protection structure for the purpose of mahinga kai or food harvesting ... I think the Rūnanga [tribal council] are obviously doing an amazing job there [Wairewa[xi]], but the purpose of the issue is to clean up the water and have the eel population there so that people can eat the eels. It is not a purpose of restoring the natural biodiversity necessarily back to that lake or allowing the natural processes to occur (INT24-AMPS).

Marine reserves would definitely reduce some consumptive uses (i.e. reductions in fishing access) at the present and be inconsistent with Māori cultural practices. Nevertheless, a great number of benefits could be realised from marine reserves over the long term.

[xi] This area is part of the Horomaka or Te Pataka o Rākaihautū / Banks Peninsula (http://www.wairewa.org.nz/).

4.1. Future benefits and non-use values of biodiversity

A wide range of future benefits were expected to be realised by biodiversity preservation:

> When I am old I want to still see fish around the harbour and go to the marine reserve and see all the wonders in the water (FG4).
>
> I look at my children and my grandchildren. What's going to be left for them, if the changes we've seen in our lifetime here continue at that rate? We will never be able to take our grandson out to catch a fish (INT3-AMPS).
>
> It's not just for us Pākehās, but for our tangata whenua and for all, for our visitors, for anybody and to bring the joy back and be able to go fishing and have a good feed of fish (INT1-AMPS).

Marine reserves were perceived to be a secure option that biodiversity could be preserved for future uses either by the preservationists themselves, their descendants, or someone else. It was further emphasised that marine reserves could convey a message to children and youth that they were taken care of.

Biodiversity preservation would provide an opportunity to discover in the future the benefits that were currently unknown (i.e. future unknown and speculative benefits (Beaumont et al., 2007). It was acknowledged that there was a considerable gap in the present knowledge about the marine ecosystems and the importance and value of its biological components (including species) to humans. A variety of future unknown and speculative benefits can be expected, but two of them (i.e. pharmaceuticals and new commercial species) were explicitly mentioned:

> We don't really know what's there and we don't know what value, as a resource, that's got in the future for pharmaceuticals. All sorts of things have been discovered all the time … We don't know what the importance of some of those species; even those undiscovered species might have in the future (INT11-AMPS).
>
> He [a young fisherman] was going to fish for paddle crabs and it actually didn't eventuate ... Nobody in my time has potted for paddle crabs. The other commercial guy here on the *Maryanne* [a boat name], the trawler, he's trawling up paddle crabs. They're a commercial species for him ... There're all sorts of things down there that may one day become commercially valuable and there could be another totally different species harvested in this area (INT14-CF-TC).

Existence value was also part of the value inherent in biodiversity preservation. Some interviewees have aspired to protect biodiversity merely because they want to see a natural value of an area maintained:

> Well psychologically for myself, just to know that it's there and I mean there are so few areas left on this planet where things are as they were … It's like just in an odd way I always want to

> go to Martin's Bay [in Auckland], I don't know bloody why. I may not ever get there, but the value in my mind of knowing that it's a piece of wilderness is worth a lot to me (INT23-AMPS).

Another critical part of values inherent in biodiversity preservation was intrinsic value. It was believed that all creatures had their own intrinsic rights or rights to live and prosper on the planet. The existence of these creatures was not just for fulfilling human interests. Biodiversity preservation was considered a necessary step to paying respect for and bringing fairness to those species. Below are some sentiments about this intrinsic value:

> The wild creatures have their own place, their own right to be here and not just to be exploited to the N^{th} degree (INT11-AMPS).

> We're really invaders in the ocean. There're a lot of things that rely on the fish out there that have got more rights to it than we have ... We need marine reserves to give just a few places where these fish have got some respite (INT7-TO-AMPS).

> Well it's a respect for other creatures on this planet. I mean I don't hold with the view that human interest absolutely comes first ... It's just a matter of fairness to all other species (INT3-AMPS).

Intrinsic value resonates with existence value in the sense that both concern about the existence of non-human species. A major difference is that it is not acceptable to put a dollar value on the former in the way practised for the latter. Such difference has been long debated in the literature (Justus et al., 2009; Maguire & Justus, 2008). Nonetheless, in this study those who held intrinsic value did not show negative reaction to such valuation. Rather these people suggested attempting for estimation of a full economic value:

> I think all information is a good. A dollar value of biodiversity can be useful (INT1-AMPS).

> I think that you're better to try [valuing]. It's a bit like saying how much value do you put on breathing clean air? I guess that could have a value because you do not have to pay for hospitals and drugs and for things to keep further alive in a smog-ridden city. Like if we had this marine reserve, potentially this is going to put another $5 or 10 or 20 million into the economy of Akaroa (INT9-TO-AMPS).

> If you're doing an economic study and an economic model, I think the first thing that really needs to be done is that it needs to be fully economically valued (INT17).

4.2. Environmental benefits

Biodiversity preservation was considered fundamentally important for generating supporting and regulating ecosystem services and maintaining human existence on the only life-supporting system of the planet:

> I think it's the healthy cycle of life. When you have healthy water, then the sea is healthier; and when you have healthy sea, your air is healthier and your water is healthier. It's just incorporating that cycle of life back into our existence so I think that's really a cool thing if people can start seeing how everything's interconnected (INT17).
>
> It's the protection of biodiversity … Well looking after the planet. We've all got to live here. It's the only place we can live, isn't it? The wise guys haven't found us another place to live yet (INT3-AMPS).
>
> Pohatu Marine Reserve is not going to save the world, basically. We need more marine reserves, not just a little, tiny marine reserve like this (INT7-TO-AMPS).

These quotes highlight some of the indirect environmental benefits (e.g. clean air and water) humans have received from biodiversity. Although the scale of biodiversity protection required for maintaining the well-functioning of marine ecosystems and broader ecosystems remain debatable, marine reserves can be considered as a critical part of the effort to maintain these benefits.

4.3. Benefits of marine reserves for recreation and tourism

There was a firm belief that marine reserves would be beneficial for recreation and tourism. Recreational benefits were reported on the potential increase in recreational experience and the enjoyment with nature. These benefits were considered as important as or even more important than catching fish to many recreational fishers:

> A lot of people had baches because they were keen on fishing, but there're more. David goes hunting and sure, he shoots things and kills them, but I mean it's an excuse to get into the high country or up into the Kaikouras. It's about getting out there. And fishing's like that for a lot of people too. It's an excuse to go out on the water (INT11-AMPS).
>
> Fishing is just to go out and have the relaxation on the water. If it's just a nice day out there you'll be surprised what you might see ... it's such an awesome country side out there. Around the heads there it's pretty awesome stuff when you're looking back, pretty rugged country. So you don't have to go out to catch fish to have a good time. If you get a feed it's more or less a bonus really (INT18-RF-TO).

Tourism benefits were reported on the expectation that biodiversity and nature protection would contribute to meeting the expectation of international tourists, add another visiting attraction, and create more visiting satisfaction:

> It [marine reserve] was just another thing that we could attract people here ... Personally I think the reason people come to New Zealand in the first instance is because we've got this clean green image ... So if you had a marine reserve, it just gives them that warm fuzzy feeling that they're visiting an area that's put aside and protected forever and nothing's ever going to be disturbed or taken (INT9-TO-AMPS).

> I was always a great proponent of Dan Rogers[xii] basically on the basis that every tour boat in town can drop people there and you can be sure the second that there was a marine reserve everybody would have updated their websites and all their publicity pamphlets with 'Marine Reserve' plastered over them and Marine Reserve would be the star attraction of the commentary (INT24-AMPS).

A site proposed for a marine reserve inhabiting endangered species (e.g. penguin, dolphin, and seal) would be even more beneficial for tourism. It is obvious that endangered species would be much more valuable and have more drawing power to tourists than common species.

4.4. Fishing benefits from spill-over effect

There was a general consensus among many interviewees (including both advocates and non-advocates of marine reserves) about the spill-over benefits of marine reserves. Evidence of fish reproduction within marine reserves and the resulting spill-over effect was repeatedly emphasised:

> My understanding from listening to other people who've been there [Pohatu Marine Reserve] doing regular observations like our primary school teacher who does a fieldtrip there every two years with his class is that they can see the changes in front of their eyes … So I think Pohatu's been successful. I also have been snorkelling at Leigh and seen what's in the Leigh Marine Reserve. So we've just got the evidence everywhere that if you leave an area alone it regenerates (INT24-AMPS).

> There's no fence around the reserve. The fish don't know that they're not allowed to swim out and the evidence for an increase in the abundance of fish on a much wider area than the reserve itself is so convincing everywhere (INT1-AMPS).

> It's like up at Marlborough Sounds there, with Long Island [Kokomohua Marine Reserve[xiii]]. I can remember that we dived there before it was a reserve. You'd be lucky if you saw a fish, and if you saw a crayfish, then that was even luckier. But five years ago we went out there with a camera and stuff and you've got to push blue cod out of the way so you can take a photo of something else, it was just unbelievable. I've got a friend up there; he's got a bach not far from there about 12-13 years now. When he first went up there to his bach, he got way out there and he said he'd fish for five or six hours to get a couple of blue cod that he could take home and have a lot of undersized stuff. He said now, he can go out there and spend about an hour in the same spot and catch three or four good sized blue cod then go home again (INT18-RF-TO).

These comments reflect the experience that fishers have benefited from the spill-over effect of marine reserves. However, the existence of the spill-over effects (especially for sedentary species) is much debated in the scientific literature. Such an effect depends largely on the location and size of marine reserves (Grafton & Kompas, 2005). The spill-over benefits in some cases are not enough to offset the fishing effects of marine reserves

[xii] A location proposed for Akaroa Marine Reserve

[xiii] http://www.doc.govt.nz/parks-and-recreation/places-to-visit/marlborough/sounds-area/long-island-kokomohua-marine-reserve/

without accounting for other environmental benefits (Kahui & Alexander, 2008; Schneider, 2006). Marine reserves that are designed for the purpose of biodiversity conservation do not fully benefit fisheries, and vice-versa (Hastings & Botsford, 2003).

4.5. Benefits of marine reserves for Māori

Marine reserves (albeit not a Māori cultural practice) could be beneficial for Māori in many ways. One of the benefits discussed by interviewees was the use of marine reserves to protect sacred areas from human disturbance. This was not only claimed by marine reserve advocates, but also acknowledged by many Māori, as expressed:

> Because so many people died, we don't eat from there anyway. So much blood got spilt on to those reefs that we just don't eat [food from there]. So what we're saying is if you make that a marine reserve, we'd be happy, we'd support it, because we don't want anyone to take food from around there … For us it's tapu [sacred]. It's tainted with the blood of our ancestors (INT10-M-ATCM).

> That area [Dan Rogers] many years ago was occupied by my Māori ancestors. For that reason there were lots of ancestral bits and pieces in the caves that were found by local explorers. So they claimed that was wāhi tapu, which is a sacred area. On saying that, Dad thought that it would be a good idea to put a reserve there because of its significance ... They [Māori fellows] say it's not cultural for us to have a marine reserve. But if they intend to have one, then we say, we'll have it where it can protect the wāhi tapu (INT19-M-ATCM).

Marine reserves could also make the long-term continuity of Māori cultural practices possible. There was a general consensus that: marine reserves have been scientifically proven to be effective, whereas CPAs have not been proven yet. Given this, customary fishing, social cohesion within Māori communities and associated traditions (as discussed in Section 3.2) is susceptible to alienation due to the depletion of fish stocks if CPAs do not work. Nevertheless, it was argued that both tools (marine reserves and CPAs) should not be compared due to their different objectives (biodiversity preservation *vs.* fishing control). Rather, both tools need to complement each other:

> A marine reserve is a complete no-take area for biodiversity protection, restoration, etc. A taiāpure is a totally different method. It's a harvest control. I don't like the thought of people saying, 'Do you prefer this or would you prefer that?' There definitely is a place for them both and I don't think you can put one above the other. They sit beside each other and they each have a different purpose (FG4).

The need for marine reserves to help taiāpure achieve restoration of depleted fish stocks and maintenance of Māori culture was explicitly mentioned by at least a Māori interviewee:

> My father had a lot of visions. One of them was hopefully to have a taiāpure and a marine reserve in the harbour, so we could protect our fish species in the harbour and hopefully grow for the future for our children … Fish are culture, very much part of what is for the future (INT19-M-ATCM).

There were a whole lot of discussions about the intention of the Koukourarata community to take pāua (a cultural keystone species for Māori) from Pohatu Marine Reserve for reseeding. Many interviewees (predominantly Pākehā) argued that it was in principle not right to take seeds from marine reserves unless the seeds did not exist anywhere else. Some Māori likewise asserted the value of the exception as itself being important. In fact, very few pāua were to be collected from Pohatu Marine Reserve, so the ecological impact would be miniscule. They were requested to test traditional Māori pāua reseeding methods. Much of this debate was about philosophical stances about what a marine reserve represents, not an ecological risk debate concerning biodiversity restoration. However, it can be inferred that marine reserves can prevent species extinction by reserving seeds for other areas in case of management failure, thereby maintaining Māori traditional reseeding methods and broader cultural practices.

4.6. Drawback of marine reserves

Marine reserves might fail to achieve their goals in protecting biodiversity and restoring fish stocks and ecosystems for at least two reasons. Firstly, enforcement might be difficult:

> The very thing that you're trying to protect fails to happen. As much as you're trying to improve the environment but you don't improve sustainability, it's a lot of wasted effort" (INT2-RF-ATCM).

With too much focus on protection, marine reserves might not meet the material needs (especially food) and cultural aspirations of local people and therefore fail to gain their support and cooperation. Continuous poaching can be expected:

> They have had people in the marine reserve. They've rung in, and DOC [conservation officers] have gone out and found them. But the people that have rung in, they don't want to go through the court procedures. So they couldn't do anything with the poachers, they couldn't charge them with anything. My own thought of a marine reserve in the harbour is going to be no different to what it is out there (INT8-M-ATCM).

The failure to implement broad scale no-take areas due to the lack of support from local communities has also been evident (Cinner & Aswani, 2007). Nonetheless, the failure is not always the case as many marine reserves have been successful. Enforcement might be

difficult in a remote area or where an unreasonably large proportion of an area is taken up by a marine reserve. But it is unlikely that enforcement is an issue in a marine reserve that is small and located near townships or highly populated tourist destinations (e.g. Akaroa Harbour). For example, it was argued that:

> Dan Rogers or somewhere within the [Akaroa] Harbour itself is somewhere that every tourist who comes here will go to … You would have a self-policing situation because who's going to fish in an area where every ten minutes a tour boat's turning up and pointing out that you're fishing [in a marine reserve] (INT24-AMPS).

Secondly, marine reserves might cause depletion of fish stocks in surrounding areas. A "ripple effect" was reported to have occurred in places where marine reserves have been established. Fishers who had normally fished in an area of a marine reserve (before it was established) have moved to fish in other (often nearby) areas. As a result, those fishable areas have been fished harder. It was argued that such a ripple effect would cause depletion of those fishable areas. The ripple effect was put forward as an argument against, for example, a proposed Akaroa Marine Reserve:

> If it does come into force, it means that people who would normally fish there will not be able to spread their fishing around the harbour, but will concentrate it on the other side of the harbour. This means there will be more fish in the reserve, but all the fish outside it are going to be fished much harder. So it'll be not only cutting off one of your areas, but reducing the availability of fish on the other. It's a lose-lose situation as far as fisheries management (INT12-RF-ATCM).

Hence, marine reserves might not deliver sustainable fisheries. If fish stocks in fishable areas are depleted due to the ripple effect, enforcement of marine reserves might become even more difficult.

The countering argument proposed by marine reserve advocates in my case study was that reserves should be established immediately to avoid depletion of stocks in the area nearby the established taiāpure (which they consider will displace fishers):

> The new taiāpure rules will come into effect on 1st October this year and this will leave the Dan Rogers area [proposed for a Marine Reserve] without protection and may get hammered by fishers endeavouring to avoid the taiāpure rules (FG1).

It can be thereby inferred that marine reserves or any other form of marine protection could be more effective if implemented with other tools to minimise the ripple effect and maximise the chance of restoring fish stocks and biodiversity. Implementing a marine

reserve next to taiāpure also provides the opportunity for doing research on the outcomes of each tool.

5. Attitudes of recreational and commercial fishers towards more restrictions

Recreational and commercial fishers have opposed any management alternative that would result in more restrictions than the current ones and cumulatively induce threat to their fishing, e.g.:

> We've got an interesting situation here. Through the tāiapure committee and through our advocacy, there are specific limits for the majority of species that have been applied for. They have yet to be added. That's going to be down to three fish/person/day. Now there's going to be those [recreational] fishermen who are not going to be happy with that (INT2-RF-ATCM).

> From a commercial point of view, I wouldn't want to see any more restrictions on my activity to be able to catch fish, commercially fish along the coast there. You've got to remember that they've not only got marine reserves, but they have now told the commercial sector that there's no set netting. So what's going to be next? … Are they going to ban Cray pots? I don't know. That's probably never going to happen, but that's the way they think, 'Oh Cray pots are killing whales, can't have that.' (INT14-CF-ATCM)

The opposition does not necessarily mean that fishers do not care about sustainability of the fisheries. Rather, it just reflects the concern of these fishers over the effects of greater restrictions on their fishing. If more restrictions had to be put in place to restore fish stocks and ecosystems, fishers chose to support a management mechanism (e.g. taiāpure) that would have least effects on their fishing and allow them to have inputs in the management:

> If you put that under a marine reserve, those little boats aren't going to be able to do anything. I don't think that's right, they shouldn't be able to take that right away from the average New Zealanders. I'm all in favour of reserves and stuff like that, but I don't think Dan Rogers is the place to put it. I think it could be done and managed in a way by dropping those numbers down that I was talking about earlier on (INT18-RF-TO).

> There were a lot of issues coming to the fore that were going to affect recreational fishers. We formed a fishing club in Akaroa. We were incorporated with a view to ensuring that recreational fishers at least had an input to what was occurring ... There was a major issue at the time that was the catalyst. That was the establishment of the Marine Reserve in Akaroa. Rather than just oppose the Marine Reserve, we thought we'd take a constructive approach and look closely at the situation. We would select a place to conform to the provisions of the Marine Reserves and we put forward Flea Bay as an alternative. It followed onto the Māori community, who we approached with our thoughts (INT2-RF-ATCM).

Fishers tend to support taiāpure in a way that forms a coalition with Māori to make more effective opposition to a marine reserve that has greater impact on their fishing. The behaviour of fishers opposing marine reserves in their vicinity is known as NIMBYISM

(Not In My Back Yard) (Grafton & Kompas, 2005). This behaviour has been a major barrier to implementing marine reserves (Sant, 1996; Suman et al., 1999; Wolfenden et al., 1994).

Surprisingly, commercial fishers did not express tension against taiāpure. This might be due to the difficulty in imposing more restrictions on commercial fishing under taiāpure (as discussed in Section 3.8). However, commercial fishers expressed strong opposition to both mātaitai and marine reserves not just because of the NIMBYISM. However, they fear unlimited expansion of these reserves and the concern over cumulative loss of fishing grounds. A clause "it's the thin edge of the wedge" was repeatedly used when discussing reserves. Commercial fishers suspected that those reserve advocates would not accept what they had as a final reserve. If a reserve was established, those advocates would keep applying for some more. For such a reason, commercial fishers had to oppose any application for a reserve even if it was not in their fishing grounds. It was believed that future applications would be invaded into their fishing grounds. The tension of commercial fishers against the closing of fishing grounds for either creating reserves or any other purpose can be clearly seen below:

> I've got in my office out there a paper that they [commercial fishers] have prepared an objection to the mātaitai area at the bottom of the peninsula. I object to it because it's the thin edge of the wedge ... You've got the Flea Bay [Marine Reserve], and the mātaitai in the next few years. There's a proposal by government to put out preferred [recreational] fishing areas and they're going to close those as well ... Let's say this one next year, that one in ten year-time – what sort of fishery is my son going to have? He's going to have a very limited fishery. And it's all very well saying that Cray will overflow from this marine reserve here to the outsides, you've still got to be able to put your pots somewhere (INT14-CF-ATCM).

6. Prospects for integrated marine management

6.1. Hope and potential strategies to harmonise conflicts

From the perspectives of marine reserve advocates, there was quite a lack of balance in the current marine spatial allocation between biodiversity preservation, cultural protection, recreational, and commercial fishing. Recreational and commercial fishing interests have largely prevailed over other interests as the former has covered most of the marine areas. Māori cultural interests seem adequately represented in the marine management at least in these case studies. Though, more CPAs are needed for ensuring the continuity of customary fishing and cultural resilience within Māori communities (Jacobson et al., 2013;

Schweikert et al., 2012). Nevertheless, biodiversity might be at risk without marine reserves as biodiversity is not the main objective of CPAs and their efficacy is not proven. It is unlikely that the race for space can be settled without the guarantee of biodiversity preservation:

> We've supported the taiapure application, but on the grounds that the future of the harbour is protected by investment in a mixed portfolio of management tools in which the Marine Reserve tool provides the guaranteed security that there will actually be full regeneration of natural biodiversity in one part of the harbour (FG2).

> It's worthwhile to continue, struggle, and seek compromise because in the end we'll all be winners if we have a clean harbour and if the fish can come back. In our understanding of marine reserves in the North Island, the local people and the marae seem to be able to marry any conflict very well and they can have marine reserves because everybody can see what a good thing is (INT1-AMPS).

Cultural inconsistency was deemed a major barrier to implementing marine reserves, but it was believed that negotiation and compromise might be able to harmonise such inconsistency. Marine reserve advocates expressed their will to appropriate marine reserves to capture features of Māori culture:

> If we had to choose, I would want to do what was best and culturally appropriate for Māori and back off because that's important to me (INT1-AMPS).

Two possible ways to implement the concept of marine reserves while capturing some features of Māori culture were discussed by some interviewees. These included: the use of a Māori term instead of marine reserves or implementation of a self-imposed long-term no-take area in taiāpure:

> I think that's a real shame that this kind of cultural stuff comes up. I don't think it matters whether you call it a marine reserve or a permanent rāhui or whatever, it doesn't matter whose words are being used. It's not about honour of people, it's about biodiversity (FG4).

> There's been talk in the community about just putting some buoys here [in the taiāpure] and shaming people not fishing there, like a self-imposed marine reserve from the community (INT9-TO-AMPS).

These highlight some aspects of potential marine reserve policy that might help get around some of the cultural inappropriateness for Māori. Yet, this has not been properly investigated and translated into legislation.

6.2. Restoring stocks and ecosystems as a way forward

Despite many conflicting interests, all stakeholders would in general agree that they want to have abundant fish stocks and healthy ecosystems:

> Once some of the extreme things drop away a little bit, it always holds true that we all love this marine environment, we would all like to see fish there, and we would all like to see that we can always take fish from there (INT17).

Various stakeholders would be satisfied when their interests (especially in terms of material needs and aspirations) are met by rehabilitated fish stocks and ecosystems. Hence, the best way forward is perhaps to maximise the chance of success in such rehabilitation. In so doing, some current consumptive uses must be sacrificed.

CPAs and marine reserves need to be implemented together in order to maximise the chance of success. A model for integrated management agreed by marine reserve advocates during FG4 can be displayed in Figure 3. In essence, taiāpure (or mātaitai in areas of greater cultural significance to Māori) provide an active mechanism that may be flexibly managed to meet the material needs and aspirations of local communities (e.g. customary, recreational, and commercial uses) and serves as a buffer zone to the core conservation zone (no-take marine reserve). (The core zone can begin from the shore so it is not necessarily surrounded by the buffer zone.) In return, the marine reserve acts as a hedge against management failure and provides a breeding stock that feeds back to the buffer zone and a larger area (i.e. normal use zone).

The integrated management would lead to practical implementation of the concept of "Marine Protected Areas" (MPAs) or more broadly "Biosphere Reserves". This concept provides a concrete solution of the nested spatial allocations to reconcile the conservation of biodiversity with sustainable use of natural resources for the benefits of local people (Bridgewater, 2002; Kusova, Tesitel, Matejka, & Bartos, 2008). Such reconciliation has been proven to be a key feature of successful management (Andrade & Rhodes, 2012). Therefore, the integrated management would speed up the progress toward achieving the government's commitment in setting aside ten per cent of the marine environment in a network of MPAs. Marine reserves are the most qualified management tool for inclusion in this network. Taiāpure and mātaitai may also be qualified for inclusion in the network, depending on whether they meet the protection standard of the MPAs Policy (Department of Conservation & Ministry of Fisheries, 2005).

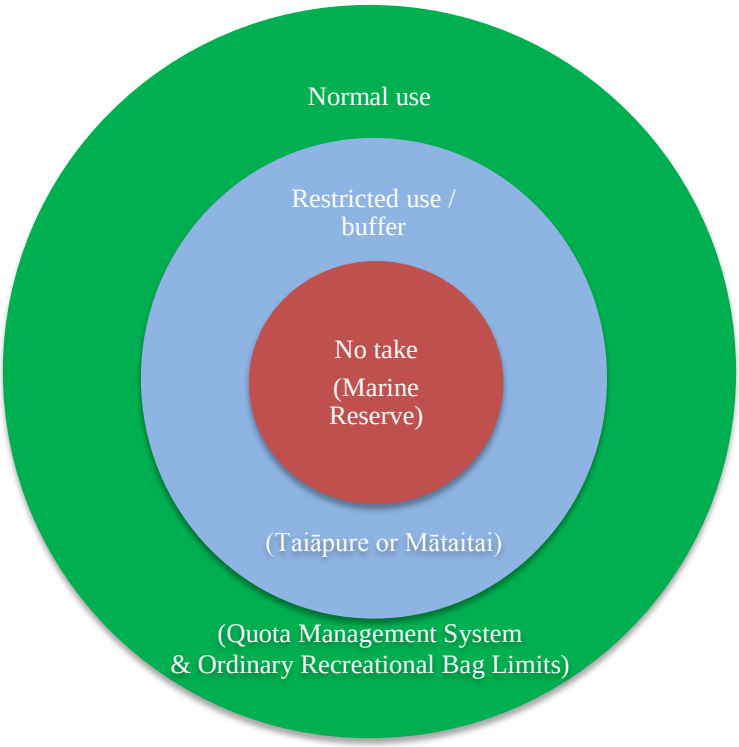


Figure 3: A model for integrated management

7. Discussion and conclusions

A management strategy that is acceptable to all stakeholders requires the balancing of different interests (Hein et al., 2006) and is a prerequisite for overcoming polarisation, building trust within communities, and bringing about the success of managing local environment (Ostrom, 2010, 1990). The debate about marine spatial allocation has in fact been induced by perceived unsustainable utilisation of marine resources and the demand for Māori cultural and biodiversity interests reasonably reflected in the marine management. Māori cultural interests can be met by implementation of CPAs, whereas biodiversity interests can be met by implementation of marine reserves. Implementing more CPAs and marine reserves can therefore be considered as an attempt to finding a balance between commercial and recreational fishing, Māori cultural, and biodiversity interests.

CPAs and marine reserves should be implemented together in an integrated management model as depicted in Figure 3 in order to maximise the chance of success in achieving ecological restoration for the benefits of all stakeholders over the long term. Both tools might also need to be implemented at the same time for near-shore fisheries in order to

avoid replacement of fishing efforts and depletion of stocks in areas left unprotected. Negotiation and compromise remain a critical step to harmonise some conflicting interests, especially the difference between the concept of marine reserves and Māori cultural practices. Where competition for limited space arises and if such harmonisation cannot be reached, a management strategy that gives a better chance of success in achieving sustainability (i.e. the integrated management) should be set at the highest possible priority. This priority setting holds even in situations where the implementation of marine reserves are claimed to infringe Māori *rangatiratanga* (chieftainship, right to exercise authority (Jackson, 2011, 2013)) "because degradation adversely affecting the continued use or enjoyment of resources whether in spiritual or physical terms is in itself an infringement of rangatiratanga and leads to the erosion of mana" (Kerr, 2006, p.65).

Balancing different interests does not equally mean enhancing the benefits/values of all individual stakeholders. It just means the values of each stakeholder group are recognised in the management, but some individuals (especially incumbent fishers) would have to bear the costs at least in the short term as a result of more and larger taiāpure, mātaitai, and/or marine reserves. Simply put, implementation of any of these management tools would benefit some people and cost others. The benefits (in terms of biodiversity and cultural practices) are largely intangible and postulated to extend to the larger public (Bennett & Blamey, 2001; Freeman, 2003; Kareiva et al., 2011) because they involve option and non-use values. That is, people are satisfied by simply knowing that biodiversity are preserved either for its own intrinsic value or for the future benefits. Similarly, people are also satisfied by simply knowing that Māori culture is maintained either for their future generations or simply for the existence of the culture. Therefore, the attempt to find the balance between commercial and recreational fishing, Māori cultural, and biodiversity interests would necessarily result in unequal redistribution of costs and benefits to different groups of stakeholders and individuals in the society. This has often been a major challenge for decision-making about choices of the marine spatial allocation.

A key input in political decision-making is a measure of social values associated with the intangible benefits of CPAs, marine reserves or MPAs in terms comparable with those associated with their tangible costs. As discussed in Chapter 2, choice experiments, in which representative samples of a population of interest participate, provide a way to

measure these social values. The question then is how to design such a choice experiment to reasonably capture aspects of the marine ecosystems that are valued by various stakeholders and the larger public. Findings in this chapter suggest that the choice experiment must drive at outcomes, not the putative mechanisms of getting there. Once deconstructed, the benefits of each mechanism are also valued by those who oppose it. For instance, fishers and Māori in general oppose marine reserves, but value biodiversity. Such deconstruction can be then repacked to determine individual and public preferences for the various mechanisms.

Further, the findings in this chapter help identify attributes and their levels (i.e. outcomes) for the proposed choice experiment. Any mechanism alternative to the current fisheries management would involve trade-offs between changes in four major socio-ecological attributes (i.e. attributes of society's interaction with marine ecosystems). They include: biodiversity, the practice of Māori cultural management, restrictions on recreational fishing and restrictions on commercial fishing. The findings also inform the development of an information sheet that aims to convey the meanings of these attributes and levels used in the choice experiment to survey respondents and the development of supplementary questions asked thereafter. We will now proceed to an application of the choice experiment to find out preferences for the various mechanisms under debate (Chapter 4).

Chapter 4 Public preferences for management of near-shore marine ecosystems: A choice experiment in New Zealand

Abstract: There is considerable interest in New Zealand in establishing "Customary Management Areas" (taiāpure and mātaitai) and Marine Reserves to support Māori cultural practices and restore declining biodiversity and fish stocks. Allocation of near-shore marine areas for these management systems potentially benefits the larger public, but it has often been vigorously opposed by recreational and commercial fishers. This paper reports estimates of the relative values held by the public toward four potentially conflicting uses of near-shore marine areas. These estimates come from a web-based choice survey completed by 1055 respondents recruited from throughout New Zealand. The response rate was especially high at 60%. We present results weighted to the characteristics of the population and test the results against a variety of well-known sources of survey bias. Scenario development suggests that some reallocation of near-shore marine areas to any of the management systems under discussion alternative to the status quo is likely to yield a welfare gain. A combination of marine reserves and taiāpure is most preferred. The exercise supports the use of discrete choice experiments to provide crucial information about difficult-to-quantify public values for aspects of management of near-shore marine areas, such as proposed taiāpure, mātaitai, or marine reserves.[xiv]

[xiv] Results in this chapter were accepted for publication in *Resources* (pending minor revision). These results and some of those in Chapter 3 were presented at the New Zealand Geographical Society Conference 2012: Connecting Landscapes, December 3-6, Napier.

1. Introduction

As reported in Chapter 3, there has been considerable public debate in New Zealand about how to balance recreational and commercial fishing interests with marine conservation and Māori customary fishing practices. Some people advocate creation of more and larger Customary Protection Areas (CPAs) such as taiāpure and mātaitai in near-shore marine areas as a way of encouraging the continuation of Māori culture and wellbeing (Jacobson & Moller, 2009). Others argue for more and larger marine reserves (where all fishing is permanently banned) to protect existing and restore declining marine biodiversity (Taiepa et al., 1997). In contrast, recreational and commercial fishing groups argue against additional restrictions on fishing. Recreational fishers want to make sure they can get a decent catch and have access to safe fishing grounds. Commercial fishers have production costs to pay for, and understandably they want to secure a profit and adequate livelihood. Not surprisingly, implementation of CPAs or marine reserves has been vigorously opposed by recreational and commercial fishers. Even if any of these management alternatives is proven to be needed to maintain fish stocks and restore biodiversity, there will be vigorous debate about their size and location. As a consequence, allocation of near-shore marine areas between all these interests has over the past decades become contested and acrimonious (Ackroyd & Beattie, 1998; Bess & Rallapudi, 2007).

Comparisons of the benefits and costs (not necessarily in dollar terms) of potential management scenarios can provide an objective metric for decision-making (Chapter 2). Failure to do such evaluation may encourage resource allocation to be biased against mechanisms such as taiāpure, mātaitai and marine reserves whose benefits are largely intangible (such as continuation of indigenous Māori cultural practices and protection of natural biodiversity). This bias against intangible benefits, especially relating to biodiversity, has been repeatedly emphasised in the literature (Biological Diversity Advisory Committee, 2005; Costanza et al., 1998; Loomis, Kent, Strange, Fausch, & Covich, 2000; TEEB, 2010). Such allocation may accordingly be controversial and increase the likelihood of a sub-optimal allocation.

This chapter reports the results from a survey-based choice experiment aimed at valuing the socio-ecological attributes (i.e. attributes of society's interaction with marine ecosystems) affected by management alternatives to near-shore fisheries in New Zealand.

A choice experiment is an emerging stated preference technique (Champ et al., 2003; Garrod & Willis, 1999) that provides a way to measure intangible values in terms comparable with measures of tangible values.

Values in this chapter are assessed on the basis of 'utility' (amounts of human 'satisfaction', 'happiness' or well-being (Brown, 1984; Freeman, 2003)) derived from changes from the status quo in the levels of one or more key socio-ecological attributes of the management systems under discussion. Utility values measured on a continuous scale are estimated from a series of discrete choices made by each individual participating in the choice survey. Each choice requires the respondent to trade-off more of one attribute for more of another, thereby revealing over the series of choices the respondent's relative strength of preference for each level of each attribute. The results from this study inform the above debate about the relative values New Zealanders as a whole place on the allocation of near-shore marine areas across commercial and recreational fishing, preservation of cultural practices and biodiversity. The results also thereby provide insight into public support for the specific management alternatives under debate.

The remainder of this chapter is organised as follows. Section 2 describes the choice survey and the sample of survey respondents. Section 3 reports relative values of socio-ecological attributes derived from choices made in the survey. Section 4 reports the population values of these socio-ecological attributes and treatments of bias to the choice experiment. Section 5 presents the application of these population values to evaluate various management scenarios/strategies, followed by discussion and conclusions in Section 6.

2. The choice experiment and the sample of survey respondents

Choice experiments (Adamowicz et al., 1998; Bennett & Blamey, 2001; Hanley et al., 2001; Louviere et al., 2000) are based on Lancaster's theory of consumer demand that the value of a good is derived from the constituent characteristics or 'attributes' of the good (Lancaster, 1966). For example, the value of a house depends on a number of attributes such as: floor area, number of bedrooms, age, distance to the market, environmental quality in the area, etc. Choice experiments were initially employed for a variety of purposes in transportation and marketing research and have been increasingly applied in

environmental economics over the last two decades. In particular, choice experiments have been used to estimate both use and non-use values derived from the benefits of biodiversity conservation as well as values associated with resource management scenarios that involve trade-offs between environmental and development interests (Adamowicz et al., 1998; Boxall et al., 1996; Mallawaarachchi, Blamey, Morrison, Johnson, & Bennett, 2001; Mansfield, Phaneuf, Johnson, Yang, & Beach, 2008; McVittie & Moran, 2010; Morrison, Bennett, & Blamey, 1998; Rolfe, Bennett, & Louviere, 2000; Wang, Bennett, Xie, Zhang, & Liang, 2007; Zander, Garnett, & Straton, 2010).

2.1. Attributes and levels used in the choice experiment

This choice experiment was designed to examine trade-offs New Zealanders are willing to make across various levels of four socio-ecological attributes: biodiversity, the practice of Māori cultural management, restrictions on recreational fishing and restrictions on commercial fishing (Table 3). Biodiversity was chosen as an attribute rather than particular ecosystem services or species/habitats in order to capture the full economic value of marine reserves. Ecosystem services yield only partial economic value of biodiversity conservation (McVittie & Moran, 2010). As reported in Chapter 3, the goal of marine reserves is to provide opportunity for regeneration of biodiversity as a whole. Māori cultural management was used as an attribute to capture the whole cultural value Māori attach to the coastal marine areas. Restrictions on recreational and commercial fishing represent the opportunity costs of biodiversity conservation and Māori cultural management. The use of opportunity costs as some of the attributes in a choice experiment could enhance the validity of the results (Bennett & Blamey, 2001). A tax attribute was also included in the choice model to allow estimation of monetary values of changes in the levels of the other attributes. The estimated monetary values of these outcomes are reported in Chapter 5.

The levels of each attribute were based primarily on concerns and interests of stakeholders and how they relate to the policy options under debate. There is cumulative evidence of declining marine biodiversity (Dick et al., 2012; McCarthy et al., 2013) and a major concern among conservationists, tourism operators, many of the general public and some fishers is that no change to the current restrictions on recreational and commercial fishing (i.e. the status quo) could push biodiversity to a ‘poor’ condition. Biodiversity could be

restored to a 'good' condition with more and larger marine reserves, which would require many more restrictions on recreational and commercial fishing. The effect of Māori cultural management will depend on its specifics (which could vary across locations), but it can be expected that biodiversity will be restored to a 'medium' condition with more and larger taiāpure or mātaitai. There is also major concern for the alienation of Māori cultural practices associated with coastal marine areas due to declining fisheries and the implementation of marine reserves (Chapter 3). However, cultural practices could continue either in partnership with the locals or exclusively by Māori with more and larger taiāpure and mātaitai, respectively. In the absence of these mechanisms, the cultural practices may be lost. To achieve better outcomes for biodiversity and Māori cultural practices, the levels of restrictions on recreational and commercial fishing need to be increased. This might result in 'more' or 'many more' restrictions on recreational fishing and more restrictions or a complete ban on commercial fishing in coastal marine areas where marine reserves and mātaitai are implemented. Section 5 discusses in detail outcomes that potentially occur under alternative management systems.

Table 3: Attributes and levels (worst to best) used in the choice experiment

Attributes	Levels
Condition of marine life (number and variety) in the coastal area*	• Poor (large drop in numbers and some species gone altogether) • Medium (some drop in numbers and some species might disappear) • Good (Original number and variety of fish and plants remain)
Māori cultural management in the coastal area	• No longer practiced anywhere • Practiced in partnership with locals in some locations • Practiced exclusively by Māori in some locations
Recreational fishing in the coastal area	• Many more restrictions (much lower bag limits and some locations closed) • More restrictions (lower bag limits and all locations open) • No change from existing bag limits and allocations open
Commercial fishing in the coastal area	• Not allowed anywhere • More restrictions (some locations closed and reduction in quota) • No change (allowed anywhere at the existing quota levels)
Your taxes (e.g. annual rate or monthly rent on your house)	• Increase by $120 per year (i.e. $10 per month) • Increase by $60 per year (i.e. $5 per month) • Do not change • Fall by $60 per year (i.e. $5 less per month)

Note: * Condition of marine life is used here to communicate the concept of biodiversity.

The tax attribute consisted of four levels. An increase of $120 or $60 in taxes indicates the survey respondent's willingness-to-pay (WTP) to improve (relative to the status quo) outcomes of the various attributes. This range of costs was selected based on the approximate amounts of money members of the public frequently donate to support conservation efforts[xv]. There is no cost to respondents for the status quo levels of the socio-ecological attributes. A drop of $60 in taxes indicates willingness-to-accept (WTA) or a gain to respondents who would be made worse off due to changes in the levels of some attributes. In theory and practice, either WTP or WTA can be used as a measure of value in any particular valuation study (Boardman et al., 2006; Champ et al., 2003; Freeman, 2003; Garrod & Willis, 1999). The use of both measures in this choice experiment is to establish a sense of neutrality to respondents. Non-neutrality is one of the factors that can lead to biased estimates of relative value in choice experiments (Bennett & Blamey, 2001).

Levels of each attribute (Table 3) were organised (and intrinsically ranked) from worst to best in terms of their relative values to the general public. If each attribute could be separated from (and had no impact on) other attributes and things, people would chronologically prefer: a good condition of biodiversity to medium and poor conditions; no compromise to Māori cultural management (i.e. "practiced exclusively by Māori") to some compromise (i.e. "practiced in partnership with the locals") and "no longer practiced"; no change to restrictions on fishing to greater restrictions; and a decrease in taxes to no change and an increase in taxes. In order for the algorithm at the heart of the 1000Minds software to work (discussed in the next section), the intrinsic rankings imposed need to be accepted by survey participants so that a trade-off is confronted each time a pairwise ranking question is asked. However, some people (including participants in this choice survey perhaps) might prefer the opposite rankings to the intrinsic/imposed rankings within each attribute. This represents a possible weakness of 1000Minds. The consequences of this weakness and ways to address it should be properly examined using real world research or experiments in order to improve the reliability and acceptability of the methodology.

2.2. Implementation of the choice experiment survey

[xv] Interviews with Marine Reserve Advocates, October 2011

This discrete choice experiment was implemented using 1000Minds internet-based software. The software applies a method of presenting choices to survey respondents, uniquely known as PAPRIKA for Potentially All Pairwise RanKings of all possible Alternatives (Hansen & Ombler, 2009). Each individual respondent makes a series of choices, such as the one shown in Figure 4. Each choice requires the respondent to trade-off a better level of one attribute for a better level of one other attribute. Comparing just two attributes at a time simplifies decision making, which likely increases the accuracy of each response. However, presenting attributes two (e.g. condition of marine life and commercial fishing) at a time does impose the assumption that how the respondent makes a choice (such as that depicted in Figure 4) does not depend strongly on the level of any third attribute (e.g. Māori cultural management or recreational fishing) not included in the choice. That is, the preference for any of the two combinations of the two attributes remains unchanged if the same level of a third attribute is included in both combinations.

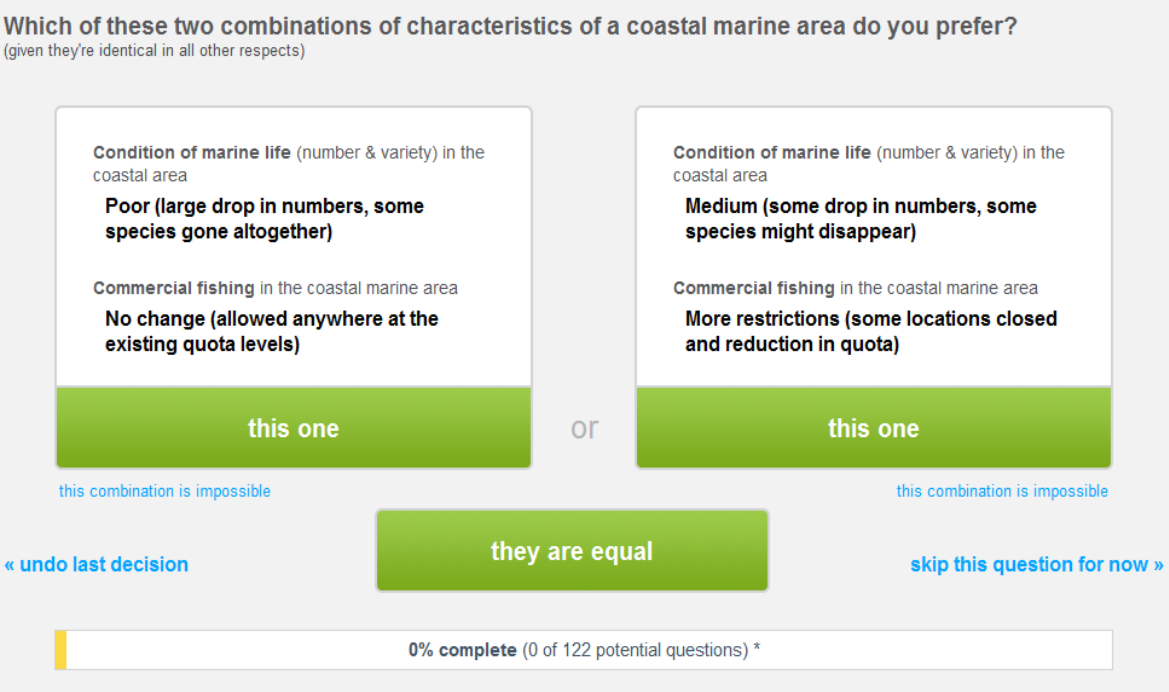


Figure 4: An example of choices asked in the choice experiment

The key feature of the 1000Minds algorithm is the efficiency with which it gathers information about each respondent's preferences for the attributes included in the choice experiment. The algorithm starts by identifying all "undominated pairs" of two attributes, such as the one in Figure 4, that impose a trade-off. It then chooses one such pair at random to present to the respondent. The respondent chooses which of the two pairs of

attributes he or she prefers. The software then identifies all other pairs whose ranking is implied by the respondent's choice via the logical property of 'transitivity'. For example, if the respondent prefers A to B, and B to C, then A must logically be preferred to C. The software next chooses a choice pair at random from those that have not yet been ranked either explicitly by the respondent or implicitly via transitivity. The process continues until all choice pairs have been ranked either explicitly or implicitly. As a consequence, each respondent made an average of 27 choices to rank a total of 122 possible combinations of two pairs of two attributes each. Each choice requires a trade-off between the two attributes presented.[xvi]

Before beginning the choice survey, respondents were asked to read an information sheet (Appendix B1) accessible via URL (Uniform Resource Locator) embedded in the email invitation. The information sheet provided a description of all potential attributes and how the survey would present them as choices. Reading the descriptions was important to develop some level of awareness about the kinds of choices the respondent would be making. Just like in a real market situation, consumers (i.e. respondents) need to know the characteristics of the available products (i.e. alternatives) to be able to evaluate the overall products and purchase a product (i.e. making a choice in this case).

After completing the choice survey, respondents were asked to answer a series of follow-up questions (Appendix B2). Most of these questions asked about the respondent's socio-economic characteristics and about their perceptions and beliefs relative to taiāpure, mātaitai and marine reserves. The remaining questions asked about aspects of the respondents' choices.

Prior to its launch, the choice survey was pre-tested in two stages. The first-stage pre-test involved ten friends and colleagues (including ecologists, geographers, sociologists, and economists). Most of them were researchers at the Centre for Sustainability (CSAFE) at the University of Otago. These people were asked to complete the survey individually and give feedback about whether: (i) the information sheet provided clear and understandable instructions and was an appropriate length, (ii) there was any irrelevant attribute included or any relevant attribute not included in the choice experiment, (iii) there was any bias in

[xvi] For a detailed description of the algorithm, see Hansen & Ombler (2009).

the description of the attributes, (iv) the payment vehicle (taxes/rents) and levels of payment seemed appropriate to respondents, and (v) the overall presentation of the survey seemed appropriate. The survey was modified according to the feedback and pre-tested again with members of the general public who were recruited at random at the PAKńSAVE supermarket (South Dunedin) and the Wall Street Shopping Mall (Central Dunedin). Twenty eight people participated. Most of them (at least 75 per cent) thought the survey was good enough for launch with regard to the five points above. Further modifications were made to simplify the choice survey in response to the few comments received during this last-stage pre-test.

2.3. The sample of survey respondents

We contracted with Smile City to conduct the choice survey on our behalf. Smile City is a leading online rewards program where any New Zealander over 14 years old may participate with no fees and earn rewards for online shopping, reading email, answering surveys, clicking on links and more[xvii]. Over the past years, Smile City has made considerable effort to recruit members through various channels, including traditional offline advertising on TV, radio and magazines. As at January 2011, Smile City had over 400,000 registered members, an active membership base of 190,000 members; more than 10,500 logins per day and an average of 400,000 visitors per month (Kao & Dam, 2011). As at May 2010, Smile City had successfully completed 1,400 online surveys, including research on medical and pharmaceutical studies, in-home product placement, new product development and testing, customer satisfaction, etc. (Glazer & Kao, 2010).

The choice survey was sent out by Smile City via email in September and October 2012 to a random sample of people in its sampling frame representative of the New Zealand population in terms of age, gender and residential region. The response was much stronger than expected. To prevent a large cost over-urn, the survey was closed before the stated closing date. At that stage, Māori were under-sampled. Given the special interest in Māori preferences relative to other ethnic groups, we asked Smile City to 'top up' the number of Māori respondents. This resulted in over-sampling of Māori relative to the NZ population.

[xvii] www.smilecity.or.nz

We received overall 1055 complete responses at a response rate of approximately 60 per cent. Socio-economic characteristics of the sample differ somewhat from those of the population. For instance, female (gender), Māori (ethnicity), age 15-39 (age), complete high school and polytechnic/university degrees (education), and rural (dwelling) are overrepresented in the sample (Figure 5). Unemployed people are under-sampled. The overrepresentation of a subgroup (e.g. female) leads, of course, to underrepresentation of other subgroup/s (e.g. male) of the same group (gender), and vice versa.

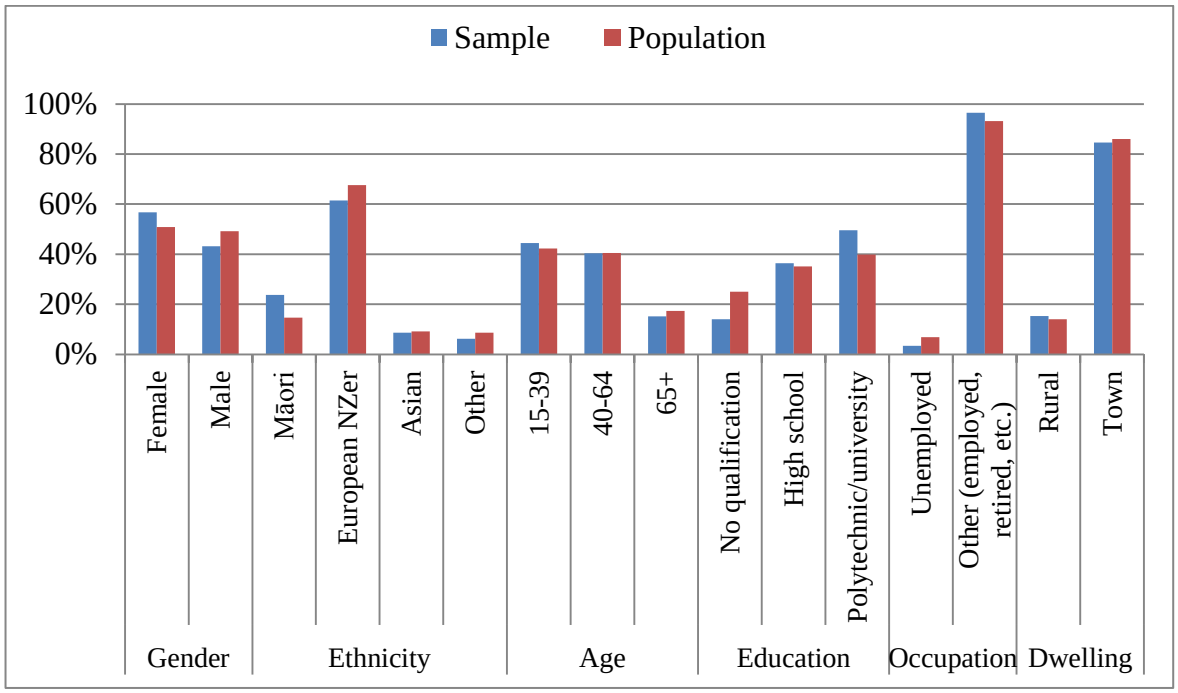


Figure 5: Key socio-economic characteristics of the sample corresponding to the population

Residents of Bay of Plenty, Canterbury, Hawkes Bay, Nelson, Northland, Otago, Southland, Taranaki, and Wellington Region are overrepresented (Figure 6). The over-representation of residents in these regions again leads to underrepresentation of those in other regions.

Household size and income of respondents in the sample also differ from those in the population. The mean (≈ $54,000) and median (≈ $50,000) of respondents' household income are well below those of the population (mean ≈ $82,000 and median ≈ $59,000). The mean of household size in the sample is, in contrast, higher than that of the New Zealand population (mean ≈ 2.7). Full details of how the socio-economic characteristics of

respondents in the sample and their perceptions and beliefs correspond with the known characteristics of the NZ population are presented in Appendix B3.

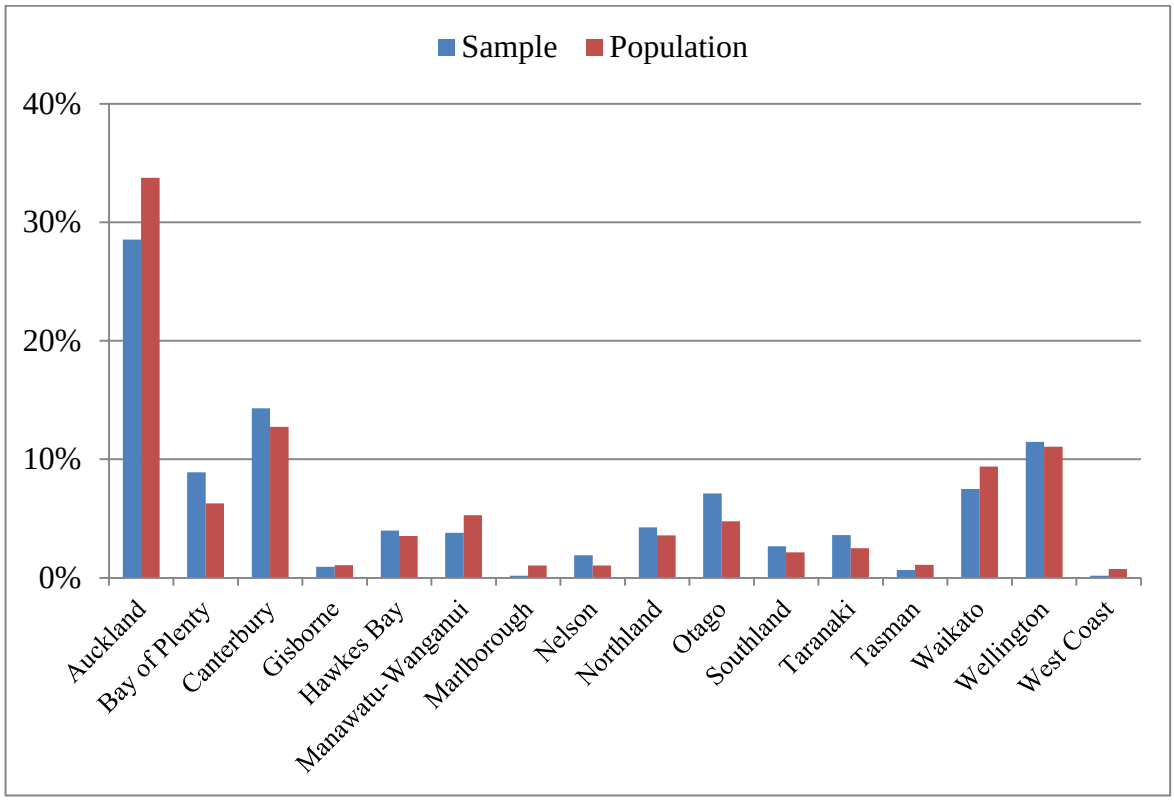


Figure 6: Residential regions of the sample corresponding to the population

The differences in the socio-economic characteristics of the sample from those of the population indicate misrepresentation of the population. This is a common problem in any study that recruits a sample of volunteers from a population (Keller, 2005). It is possible to get a sample that aligns well with the population in one or two key socio-economic characteristics, but it is difficult or practically impossible to get a sample that aligns perfectly with the population for all key socio-economic characteristics. In this case, misrepresentation was due to the top-up of Māori respondents in addition to the usual non-response error (Keller, 2005) as responses were only obtained from less than 100% of the selected sample. Some sampled persons chose not to participate in the survey, whereas some others abandoned it or were cut off on the way to completion.

It is acknowledged that people who have signed up for Smile City might differ from the general population in their preferences. Despite this, there is no obvious reason to think that Smile City registered members are in general more or less interested in this survey

than non-members or tend to be biased toward any particular attribute in this choice experiment. An alternative method of sampling would be to invite a sample of respondents drawn randomly from the electoral roll to participate. A recent application of a 1000Minds choice survey in New Zealand using this method achieved a response rate of only 10 per cent (Sullivan, 2012). Low response rates make the survey results susceptible to non-response bias and accordingly affect the validity of these results (Keller, 2005; Mitchell & Carson, 1989).

Different groups of people (e.g. males *vs.* females, young *vs.* old, and greater *vs.* lesser levels of education) have been shown to differ in their values for many public goods (see e.g. Birol, Karousakis, & Koundouri, 2006; Gillespie & Bennett, 2011; Mallawaarachchi et al., 2001; Wielgus, Gerber, Sala, & Bennett, 2009; Zander et al., 2010; Zander & Straton, 2010). If the value of a particular good varies according to certain observed characteristics, and the observed characteristics of the sample are not representative, then the sample mean value is a biased estimate of the population mean value (Mitchell & Carson, 1989). For example, Māori are overrepresented in the sample relative to their proportion in the population, and if Māori have a lower value for any socio-ecological attribute than other ethnic groups, then the mean value of that attribute in the sample would be biased downward. The procedure to correct for this bias is reported in Section 4.

3. Relative values of socio-ecological attributes

This section is organised as follows. Section 3.1 summarises the procedure for estimating relative weights of each level of each attribute in the choice model, followed by a report of the resulting relative weights in Section 3.2. Section 3.3 describes how the relative weights vary across different groups of respondents from regression modelling results, followed by discussion of potential bias in the choice survey results in Section 3.4.

3.1. Procedure for estimating relative weights

The choices made in the choice survey by each respondent provide just enough information to estimate the relative numerical weights he or she places on each level of each attribute. The 1000Minds programme implements a linear programming routine to estimate these relative weights, also known as 'part-worth utilities'. For a more in-depth description, see Hansen & Ombler (2009). The linear program is specified as:

$$\text{Min } a_1 + \ldots + a_i + \ldots + n_1 + \ldots + n_j$$

where the letters a through n correspond to attributes and the subscripts to levels.

Subject to:

$a_1, \ldots n_j \in I^+$	Positive integers
$a_{i+1} - a_i \geq 0$ for all a through n	Utility in each attribute is positive monotonic in levels
$a_i + b_j > = < b_j + a_i$	Each explicit or implicit ranking

Thus each choice (i.e., ranking) made by the respondent forms a constraint in the linear program.

This specification of the programme has several implications. Utility increases in the levels of each attribute (marginal utility is positive), but marginal utility itself may not be monotonic. Utility is strictly additive across attributes; there are no interactions among the attributes.

3.2. Sample average values of socio-ecological attributes

The results (summarised in Table 4/Column 'original model') show the estimated relative utility values of each level of each attribute averaged across all respondents. Prior to averaging, the utility values for each respondent were scaled for convenience. The worst levels of each attribute (i.e. poor biodiversity) are each scored zero. The utilities of the best level of each attribute are scaled so that their part-worth utilities sum to 100. The utilities of the medium levels of each attribute correspondingly fall between 0 and the value of the best level.

The utility values have no absolute interpretation. Instead, a change in the utility of a given attribute can only be understood relative to a change in the utility in another attribute (the relative utility values of a given level of an attribute can also be compared across people, as reported in the next section). For example, an improvement in biodiversity from Poor to Good condition increases average utility by somewhat more than twice as much as does reducing restrictions on recreational fishing from High to their current Low level ($30.8/14.1 \approx 2.18$). Note that each attribute displays diminishing marginal utility

(assuming that the differences in levels remain constant) on average, i.e., the utility increases somewhat less with each successive increase in level.

Table 4: Estimated 'part-worth' utilities

Attributes	Levels	Original model		Model without taxes		Δ Utility from the status quo	
		Mean	Std. dev.	Mean	Std. dev.	Mean	Std. dev.
Biodiversity (Bio)	Poor condition (Poor)	0	0	0	0	0	0
	Medium condition (Medium)	16.3	8.7	22.7	11.8	22.7	11.8
	Good condition (Good)	30.8	14.1	42.9	18.3	42.9	18.3
Māori cultural management (MCul)	No longer practiced (No)	0	0	0	0	0	0
	Practiced in partnership with locals (Partner)	9.3	8.6	12.8	11.4	12.8	11.4
	Practiced exclusively by Māori (Exclusive)	13.4	10.4	18.5	13.6	18.5	13.6
Recreational fishing (Rec)	Many more restrictions (High)	0	0	0	0	-20.1	-11.7
	More restrictions (Medium)	7.7	5.7	11.0	8.0	-9.1	-7.2
	Current restrictions (Low)	14.1	8.3	20.1	11.7	0	0
Commercial fishing (Com)	Not allowed (High)	0	0	0	0	-18.5	-12.2
	More restrictions (Medium)	8.2	6.9	11.5	9.2	-7.0	-7.0
	Current restrictions (Low)	13.1	9.0	18.5	12.2	0	0
Taxes	Increase $120 per annum (+$120)	0	0	-	-	-	-
	Increase $60 per annum (+$60)	11.6	6.8	-	-	-	-
	No change (+$0)	21.0	10.1	-	-	-	-
	Decrease $60 per annum (-$60)	28.5	11.5	-	-	-	-

Note: A negative sign indicates adverse impact of the associated level of the attribute on utility.

To focus on the preferences of the various socio-ecological attributes, the tax attribute can be excluded from the original model, and the values on the remaining attributes re-scaled so that the utilities on the best levels of socio-ecological attributes sum to 100. This is equivalent to running a choice experiment that involves only the socio-ecological attributes. The rescaling was based on Eq. 1 and gave the results as summarised in Table 4/Column 'model without taxes'. Note that the ratios of any two utilities (relative values) remain unchanged from those in the "original model".

$$\boldsymbol{U'_{Aa} = \frac{U_{Aa}}{100 - U_{Tax-\$60}} \times 100} \quad \text{(Eq. 1)}$$

Where:

U'_{Aa} : Utility affected by level *a* of socio-ecological attribute *A* in the model without taxes

$U_{Tax-\$60}$: Utility affected by the best level of the tax attribute (decrease \$60)

U_{Aa} : Utility affected by level *a* of socio-ecological attribute *A* in the model with taxes

An alternative rescaling (shown in Table 4/Column 'Δ Utility from the status quo') sets conditions in the status quo as the base equal to zero (Bio-Poor, MCul-No, Rec-Low, and Com-Low). In fact the current value of any level of a given attribute is not genuinely zero. Nevertheless, we designated a zero base to measure the relative importance of different outcomes if the status quo was to change. It is self-evident from their definitions (Table 3) that Rec-Low and Com-Low are the status quo levels of the restrictions on recreational and commercial fishing. That the status quo level of biodiversity is poor is justified in Section 2.1. Not Practiced is in fact not the status quo level of Māori cultural management due to the fact that taiāpure and mātaitai have been operated in some areas (Ministry of Primary Industries, 2013) and almost 26 per cent of the survey respondents were aware of the operation. For the purpose of the following analysis, Not Practiced is however assumed to be the status quo level. I will return to a discussion of this assumption in Section 3.3.

What do we conclude from Table 4? First we conclude that improving biodiversity from poor to good is the most valued change, on average valued about twice as highly as moving from 'worst to best' in any other attribute. On average, respondents are willing to trade greater restrictions on fishing for better biodiversity. Secondly, maintaining Māori cultural practices are roughly as important as maintaining the current light restrictions on fishing.

3.3. Determinants of the variation in the values of socio-ecological attributes

The large standard deviations around the means of the part-worth utilities associated with each of the socio-ecological attributes included in the choice survey indicate large variation in preferences/values across respondents. Multiple regression modelling using

statistics software GenStat® (Payne, 2012) was undertaken to identify some of the influences (except those of the status quo due to zero utility). The results are of interest in their own right: they indicate how preferences vary with observed individual and household characteristics. They also allow prediction of the mean utility values for the population, rather than for the sample, as population characteristics differ somewhat from those of the sample (e.g., Māori are over-sampled).

A linear regression specification is inappropriate because the dependent variables, i.e., the utility values, are essentially proportions. The relative utility of each attribute is scaled from 0 to 100, with most observations closer to zero than to 100. A sigmoid-shaped relationship would seem a sensible specification. Thus logistic regressions (Eq. 2) were estimated using a specific routine in GenStat (Payne, 2012, p.62). This is a generalised linear model (GLM) estimated using maximum likelihood assuming a binomial distribution. The regression residuals were more closely normally distributed than those from a linear specification.

$$Logit(P) = Log\left(\frac{P}{1-P}\right) \qquad \text{(Eq. 2)}$$

Where

$P = \frac{U}{100}$	Probability of event
U	Utility derived from a level of a socio-ecological attribute
$\frac{P}{1-P}$	Odds ratio

The utility values associated with each level of each attribute were fitted one at a time to the same model consisting of twenty three sets of explanatory variables (Table 5), essentially all of the information obtained from each respondent. The first nine sets consist of demographic characteristics of the respondent and household. The next three sets contain information about the extent and type of use to which the respondent puts near-shore marine areas. The next three indicate membership in organisations relevant to the question at hand: Māori, environmental or recreational fishing organisations. The next three sets consist of the respondent's knowledge of taiāpure and mātaitai and beliefs about their effectiveness in preserving Māori cultural practices. The next set consists of the respondent's beliefs about the effectiveness of marine reserves. The last four sets consist

of questions that may help control for the effects of various biases known to afflict choice surveys. These will be discussed in more detail shortly in Section 3.4.

Table 5: Explanatory variables used in the models

Explanatory Variable	Type	Description
Gender	Factor	Two groupings: Male and Female
Ethnicity	Factor	Four groupings: Asian, European New Zealanders (EUNZ), Māori, and Other ethnicity
Age	Factor	Three groupings: Age 15-39, Age 40-64, and Age 65+
Education	Factor	Three groupings: No qualification, High school, and Polytechnic/University
Occupation	Factor	Six groupings: Employed in agriculture, forestry and fisheries (Employed-AFF), employed in other sectors (Employed-Non-AFF), Home duty, Retired, Student, and Unemployed
Household income	Variate	Income of households in NZ$10,000
Household size	Variate	Number of persons per household
Residential region	Factor	Sixteen groupings: Auckland, Bay of Plenty, Canterbury, Gisborne, Hawkes Bay, Manawatu-Wanganui, Marlborough, Nelson, Northland, Otago, Southland, Taranaki, Tasman, Waikato, Wellington, and West Coast
Rural/town dwelling	Factor	Two groupings: Rural and Town
Fisher	Factor	Four groupings: Commercial, Customary, Recreational, and Non-fisher
Fishing user	Factor	Three groupings: - Have fished in the last twelve months (Current user) - Have never fished in the last twelve months but likely to fish in the future (Future user) - Have never fished in the last twelve months and unlikely to fish in the future (Non-user)
Non-fishing user/visitor	Factor	Three groupings: - Have visited in the last twelve months (Current visitor) - Have never visited in the last twelve months but likely to visit in the future (Future visitor) - Have never visited in the last twelve months and unlikely to visit in the future (Non-visitor)

Explanatory Variable	Type	Description
Māori organisation	Factor	Two groupings: member (Māori-Org) and non-member (Non-Māori-Org)
Environmental organisation	Factor	Two groupings: member (Environment-Org) and non-member (Non-Environment-Org)
Recreational fishing club	Facto	Two groupings: member (Rec-Fishing-Club) and non-member (Non-Rec-Fishing-Club)
Operation of taiāpure and mātaitai	Factor	Two groupings: aware of the operation (Aware) and unaware of the operation (Unaware)
Management approaches taken in taiāpure and mātaitai	Factor	Three groupings: Know nothing, Know some, and Know a lot
Belief about Māori culture associated with a coastal marine area	Factor	Three groupings: - Māori culture is unlikely to persist even if Māori manage the area in their own way (MC-1) - Māori culture would be maintained if Māori manage the area in partnership with the locals (MC-2) - Māori culture would be maintained if Māori manage the area in their own way (MC-3)
Belief about marine reserves	Factor	Four groupings: - Marine reserves do not restore most of the plants and fish to their former abundance and variety within the reserves and do not spill more fish and plants into the surrounding areas (MR-1) - Marine reserves do not restore most of the plants and fish to their former abundance and variety within the reserves but spill more fish and plants into the surrounding areas (MR-2) - Marine reserves restore most of the plants and fish to their former abundance and variety within the reserves but do not spill more fish and plants into the surrounding areas (MR-3) - Marine reserves restore most of the plants and fish to their former abundance and variety within the reserves and spill more fish and plants into the surrounding areas (MR-4)
Confidence in choices made	Factor	Three groupings: Confident, Sort of confident, and Not confident
Protest against a tax payment vehicle	Factor	Two groupings: Protest taxes and Non-protest taxes

Explanatory Variable	Type	Description
Social desirability bias	Factor	Two groupings: Social desirability and Non-social-desirability
Choice-making speed	Factor	Two groupings: Speedy and Non-speedy

For this modelling purpose, the negative utility values of greater restrictions on recreational and commercial fishing (Table 4/Column 'Δ Utility from the status quo') are converted to positive for convenience. Hence, it should be interpreted from the modelling results as utility values derived from avoiding such greater restrictions.

The modelling results (Appendix B4) indicate that the utility values of the various levels of the socio-ecological attributes vary with variation in socio-economic characteristics, respondents' beliefs and perceptions and with the indicators of inaccurate responses to the choice experiment. Interpreting these coefficients from a logistic regression is, however, unintuitive: each one unit change in a given explanatory variable results in the estimated change in the logit(P).

Easier to understand are the implications of the regression results for differences in the mean predicted utility values of each attribute for each of the various groups, as reported in Table 6. These values were obtained using fitted values from each regression model:

$$\hat{Y}_i = \hat{\alpha} + \hat{\beta}_1 X_1 + \hat{\beta}_2 X_2 + \cdots + \hat{\beta}_j X_j \qquad \text{(Eq. 3)}$$

where:

$\hat{Y}_i$ Fitted logit(P) for an *i* respondent

$\hat{\alpha}$ Constant term

$\hat{\beta}_1 \ldots \hat{\beta}_j$ Coefficients attached to explanatory variables of the regression model

$X_1 \ldots X_j$ Explanatory variables of the regression model

The mean fitted logit(P), $\overline{\hat{Y}}$, is given by Eq. 4. Substituting Eq. 3 in Eq. 4 yields Eq. 5, which can be rearranged to get Eq. 6. Each of the terms $\sum \frac{X_{1i}}{n} \ldots \sum \frac{X_{ji}}{n}$ is simply a proportion of a respective categorical variable (e.g. female, Māori) or the mean of a

continuous variable (e.g. household income and size) in the sample. Each of the mean values reported in Table 6 are obtained by substituting the relevant proportion and mean into Eq. 6 and converting the resulting logit(P) back to a utility value using Eq. 2.

$$\overline{\hat{Y}} = \frac{\sum \hat{Y}_i}{n} \qquad \text{(Eq. 4)}$$

where:

n Total number of respondents

$$\overline{\hat{Y}} = \frac{\sum_i \hat{\alpha} + \hat{\beta}_1 X_{1i} + \hat{\beta}_2 X_{2i} + \cdots + \hat{\beta}_j X_{ji}}{n} \qquad \text{(Eq. 5)}$$

$$\overline{\hat{Y}} = \hat{\alpha} + \hat{\beta}_1 \sum \frac{X_{1i}}{n} + \hat{\beta}_2 \sum \frac{X_{2i}}{n} + \cdots + \hat{\beta}_j \sum \frac{X_{ji}}{n} \qquad \text{(Eq. 6)}$$

Important to note is that information from 208 of the 1055 respondents is excluded from the regression analysis due to item non-response, i.e., some respondents chose not to provide all of the information requested in the follow-up questionnaire. Any observation with a missing item was omitted from the regression sample. Omitting these observations affects the mean fitted utility values, with those on the medium levels of the fishing attributes most affected. The mean values depend, of course, on the characteristics of the sample. Neither the original sample, nor the sample used in the regression is representative of the population. The next section reports estimates adjusted to represent the population.

The results (Table 6) are indicative of the influence of demographic and other respondent characteristics on mean utility values. The results show that females on average value biodiversity and maintenance of Māori cultural practices more highly than do males and correspondingly place less value on avoiding more restrictions on fishing. These results suggest that women would somewhat more strongly than males support improvements in biodiversity and continuation of Māori culture with the cost of greater restrictions on recreational and commercial fishing. Greater support for biodiversity amongst women is consistent with that from previous studies (e.g. Gillespie & Bennett, 2011; Wielgus et al., 2009).

Table 6: Mean fitted utility values of each level of each attribute by groups of respondents

N = 847 (208 excluded due to item non-response)	Bio-Good (Mean = 43.3)	Bio-Medium (Mean = 22.7)	MCul-Exclusive (Mean = 17.3)	MCul-Partner (Mean = 11.6)	Rec-High (Mean = 19.3)	Rec-Medium (Mean = 8.6)	Com-High (Mean = 17.7)	Com-Medium (Mean = 6.2)
Gender								
Male (43.8%)	42.4®	21.7®	16.4®	10.7®	20.8®	9.2®	18.1®	6.7®
Female (56.2%)	44.0	23.5**	18.0*	12.3**	18.2***	8.2**	17.5	5.9**
Ethnicity								
Māori (23.8%)	37.4®	19.5®	22.8®	15.5®	19.5®	8.6®	18.0®	6.7®
EUNZ (60.6%)	46.6***	24.5***	15.0***	10.2***	19.3	8.8	17.1	6.0
Asian (9.0%)	38.4	19.9	18.3**	11.5**	19.7	8.4	21.1*	7.4
Other (6.6%)	42.0*	22.3*	19.4	12.5*	18.2	7.9	18.3	5.2
Age								
15-39 (46.5%)	45.0®	24.0®	15.8®	10.8®	18.6®	8.4®	18.6®	7.0®
40-64 (38.1%)	42.5	21.5**	18.6**	12.3*	19.3	9.0	17.2	5.8**
65+ (15.4%)	40.3	21.8	18.8	12.4	21.8*	8.5	16.4	5.1**
Education								
No qualification (12.6%)	42.4®	22.4®	16.7®	11.5®	20.0®	8.4®	18.6®	6.8®
High school (36.9%)	41.5	22.0	17.0	11.1	20.9	9.7*	18.4	6.9
Polytechnic/university (50.5%)	44.9	23.3	17.6	11.9	18.1	8.0	17.0	5.6*
Occupation								
Unemployed (3.7%)	38.0®	20.3®	16.0®	10.8®	20.9®	8.8®	22.5®	7.0®
Home duties (6.0%)	46.3**	24.3	17.6	11.5	18.5	7.5	15.2***	4.9*
Student (22.3%)	43.3	22.1	17.1	11.3	18.2	7.7	18.9	6.0

N = 847 (208 excluded due to item non-response)	Bio-Good (Mean = 43.3)	Bio-Medium (Mean = 22.7)	MCul-Exclusive (Mean = 17.3)	MCul-Partner (Mean = 11.6)	Rec-High (Mean = 19.3)	Rec-Medium (Mean = 8.6)	Com-High (Mean = 17.7)	Com-Medium (Mean = 6.2)
Retired (12.6%)	43.6	23.6	16.9	11.6	19.4	9.8	18.4	6.7
Employed-AFF (1.2%)	35.9	21.5	13.5	11.0	27.4	12.1	19.3	9.0
Employed-Non-AFF (54.2%)	43.4	22.8	17.6	11.7	19.6	8.8	17.1**	6.2
Household income (mean = $56,000 p.a.)	43.3	22.7	17.3*	11.6	19.3	8.6**	17.7	6.2
Household size (3 persons)	43.3	22.7	17.3	11.6	19.3	8.6*	17.7	6.2
Residential region								
Auckland (27.6%)	43.9®	23.0®	16.9®	11.5®	20.0®	8.9®	17.3®	6.1®
Bay of Plenty (8.2%)	41.7	21.6	17.0	11.9	20.6	9.3	18.6	6.8
Canterbury 15.9%)	43.1	21.7	18.4	12.2	18.4	8.7	17.8	5.9
Gisborne (1.1%)	38.0	24.9	15.3	13.0	16.9	7.6	28.1**	6.7
Hawkes Bay (3.8%)	46.2	26.2	13.1	8.6	19.7	7.6	18.1	5.8
Manawatu-Wanganui (3.9%)	44.8	22.6	15.6	9.8	19.7	9.1	18.1	6.9
Marlborough (0.2%)	74.2**	37.4*	4.1	1.8	16.8	8.1	4.5	2.0
Nelson (1.9%)	52.1*	28.2*	17.1	13.2	17.0	7.2	11.5*	4.3
Northland (4.8%)	44.3	22.6	17.3	12.1	20.3	8.8	15.7	6.6
Otago (7.3%)	41.2	21.8	18.9	11.3	18.9	8.3	18.7	6.0
Southland (2.4%)	38.9	19.8	22.0*	16.4**	19.4	7.7	17.7	6.7
Taranaki (3.3%)	34.8***	19.5	20.7	12.9	21.7	8.6	20.0	7.4
Tasman (0.5%)	44.6	19.6	17.5	10.5	17.4	8.4	19.0	5.4
Waikato (7.0%)	42.5	23.2	16.6	10.7	20.7	8.6	17.6	7.4
Wellington (11.9%)	45.1	23.9	16.8	11.3	17.4**	8.3	18.6	5.7

N = 847 (208 excluded due to item non-response)	Bio-Good (Mean = 43.3)	Bio-Medium (Mean = 22.7)	MCul-Exclusive (Mean = 17.3)	MCul-Partner (Mean = 11.6)	Rec-High (Mean = 19.3)	Rec-Medium (Mean = 8.6)	Com-High (Mean = 17.7)	Com-Medium (Mean = 6.2)
West Coast (0.2%)	37.7	16.3	35.3**	31.8***	10.6	8.0	6.4	3.2
Rural/town dwelling								
Town (84.3%)	42.9®	22.5®	17.4®	11.6®	19.4®	8.8®	17.9®	6.3®
Rural (15.7)	45.6	24.0	16.4	11.5	18.8	7.7*	16.8	5.9
Fisher								
Non-fishers (63.6%)	43.8®	22.8®	17.9®	12.2®	18.6®	8.5®	17.2®	6.1®
Recreational fishers (34.3%)	42.6	22.7	15.9	10.4*	20.8*	9.1	18.7	6.4
Commercial fishers (0.6%)	33.0	18.7	21.7	17.4	16.5	6.3	23.9	10.0*
Customary fishers (1.5%)	41.0	18.9	19.4	11.8	18.2	5.4*	18.0	5.9
Fishing user								
Non-user (52.3%)	45.4®	23.8®	15.4®	10.2®	18.6®	8.2®	18.6®	6.3®
Future user (25.3%)	41.8**	22.0	18.5***	12.9***	20.1	9.2	17.1	6.3
Current user (22.4%)	40.2**	21.1*	20.6***	13.7***	20.2	9.0	16.4	5.9
Non-fishing user/visitor								
Non-visitor (33.4%)	40.0®	21.0®	19.1®	12.6®	20.4®	8.9®	18.2®	6.4®
Future visitor (29.8%)	43.7**	23.4**	16.4**	10.7**	19.9	9.4	17.9	6.3
Current visitor (36.8%)	46.1***	23.8***	16.4**	11.3	18.0**	7.8*	17.2	6.0
Māori Organisation								
Non-Māori-Org (94.5%)	43.5®	22.9®	17.2®	11.5®	19.3®	8.6®	17.7®	6.2®
Māori-Org (5.5%)	39.8	18.9*	19.0	11.8	19.1	9.2	17.9	6.0
Environmental Organisation								
Non-Environment-Org (94.7%)	43.2®	22.7®	17.1®	11.4®	19.5®	8.7®	18.0®	6.3®

N = 847 (208 excluded due to item non-response)	Bio-Good (Mean = 43.3)	Bio-Medium (Mean = 22.7)	MCul-Exclusive (Mean = 17.3)	MCul-Partner (Mean = 11.6)	Rec-High (Mean = 19.3)	Rec-Medium (Mean = 8.6)	Com-High (Mean = 17.7)	Com-Medium (Mean = 6.2)
Environment-Org (5.3%)	45.8	22.6	20.9**	14.1*	17.0	7.3	13.8**	4.2**
Recreational fishing club								
Non-Rec-Fishing-Club (98%)	43.3®	22.7®	17.3®	11.6®	19.3®	8.7®	17.7®	6.2®
Rec-Fishing-Club (2%)	42.4	23.9	17.1	11.2	19.2	7.0	19.5	6.2
Operation of taiapure and mataitai								
Unaware (74.9%)	43.7®	22.9®	16.9®	11.0®	19.3®	8.5®	17.8®	6.0®
Aware (25.1%)	42.1	22.1	18.3	13.4**	19.3	8.9	17.5	6.8
Management approaches taken in taiāpure and mātaitai								
Know nothing (84.4%)	43.2®	22.7®	17.1®	11.6®	19.5®	8.7®	17.8®	6.4®
Know some (14.1%)	44.6	22.9	17.7	11.0	18.2	7.9	17.2	5.1**
Know a lot (1.5%)	37.9	20.7	21.8	13.7	18.5	10.1	17.0	4.5
Belief about Māori culture								
MC-1 (26.9%)	45.3®	23.9®	12.7®	7.0®	20.7®	9.7®	19.0®	7.2®
MC-2 (62.9%)	42.8*	22.3*	18.9***	13.9***	18.7**	8.3***	17.6	5.8***
MC-3 (10.2%)	41.0*	22.0	21.5***	13.4***	19.5	7.9**	15.6**	6.5
Belief about marine reserves								
MR-1 (7.8%)	30.4®	16.0®	23.4®	14.5®	23.1®	12.1®	20.0®	8.1®
MR-2 (6.7%)	38.7***	21.7***	16.5***	10.8*	21.8	8.8***	20.4	6.7
MR-3 (22.1%)	42.5***	22.2***	18.1***	12.6	19.9**	9.3***	17.5	6.7*
MR-4 (63.4%)	45.8***	23.9***	16.4***	11.0**	18.4***	8.0***	17.3*	5.8***
Confidence in choices made								
Confident (28.2%)	45.9®	23.8®	15.9®	10.7®	19.4®	8.7®	16.5®	6.2®

N = 847 (208 excluded due to item non-response)	Bio-Good (Mean = 43.3)	Bio-Medium (Mean = 22.7)	MCul-Exclusive (Mean = 17.3)	MCul-Partner (Mean = 11.6)	Rec-High (Mean = 19.3)	Rec-Medium (Mean = 8.6)	Com-High (Mean = 17.7)	Com-Medium (Mean = 6.2)
Sort of confident (62.3%)	42.9**	22.5	17.5	11.7	19.2	8.5	18.2*	6.1
Not confident (9.5%)	38.8***	20.8*	20.1***	13.3**	20.2	9.0	18.1	7.1
Protest against a tax payment vehicle								
Non-protest taxes (88.9%)	43.8®	23.0®	17.3®	11.5®	19.1®	8.4®	17.5®	6.1®
Protest taxes (11.1%)	39.6**	20.1**	17.3	12.4	21.4*	10.1**	19.3	7.3*
Social desirability bias								
Non-social-desirability (78.2%)	42.7®	22.3®	16.7®	11.1®	19.9®	8.7®	18.4®	6.4®
Social-desirability (21.8%)	45.4*	24.1*	19.3***	13.5***	17.3***	8.3	15.5***	5.5*
Choice-making speed								
Non-speedy (92.8%)	44.4®	23.4®	17.1®	11.6®	19.0®	8.4®	17.4®	5.9®
Speedy (7.2%)	30.0***	14.6***	19.4	11.0	24.1***	11.4***	22.8***	10.5***

*** significant at 1%, ** significant at 5%, and * significant at 10%, vis-à-vis an ® reference level

Variation in values also correlate significantly with ethnicity as suggested by (Phipps et al., 2013; Phipps et al., 2011). New Zealanders of European origin (i.e., EUNZ or "Pākehā" for some people) value biodiversity more highly, on average, than do Māori (the reference category) and other ethnicities. Unsurprisingly, Māori value continuation of Māori cultural practices more highly than all other ethnicities and hence would more strongly support continuation of their cultural practices. Asians value avoiding greater restrictions on commercial fishing more highly than others and therefore would be less likely to support a complete ban on commercial fishing in near-shore fisheries.

Age, education, occupation, income and household size all exhibit significant correlation with the variation in the values of some attributes. For example, younger respondents tend to be relatively more concerned about biodiversity and less concerned about Māori cultural practices. Those with home duties value biodiversity relatively highly and correspondingly are less concerned about avoiding more restrictions on commercial fishing less than others.

The results indicate some regional variation in preferences. Respondents from Marlborough express a very high and of Nelson a high value of biodiversity. West Coast residents value continuation of Māori cultural practices much more highly, on average, than those in other regions. Gisborne residents, in contrast, value avoiding greater restrictions on commercial fishing.

Values also differ across groups of fishers. Recreational fishers, not surprisingly, reveal relatively low values for Māori cultural management and high values on avoiding more restrictions on recreational fishing. Customary fishers, correspondingly, are relatively less concerned about greater restrictions on recreational fishing. This seems sensible as restrictions on recreational fishers are often imposed in taiāpure. More restrictions on recreational fishing imply more fish for customary fishers.

Times and types of resource uses also correlate as expected with values. Current and future fishers value biodiversity less than do non-fishers. Current and future visitors to near-shore marine areas value biodiversity more than do non-visitors.

Members of various organisations/associations vary somewhat in values. For example, members of Māori organisations value biodiversity somewhat less than do non-members. Members of environmental organisations, perhaps surprisingly, tend to value Māori cultural practices more highly than non-members. In contrast, they place relatively little value on avoiding greater restrictions on commercial fishing. This suggests that, on average, these members consider Māori cultural management as perhaps better for the environment than commercial fishing. Surprisingly, the values expressed by the members of recreational fishing clubs do not differ from those of non-members, especially for greater restrictions on recreational fishing.

Those respondents who report awareness of the operation of taiāpure and mātaitai tend to place higher value on maintaining Māori cultural practices, especially in partnership with the locals. On the one hand, this seems inconsistent with the scoping effect (Bennett & Blamey, 2001; Carson, 1997; Mitchell & Carson, 1989) that those who are aware that taiāpure and mātaitai are in operation should place less value on changes from 'Not Practiced' to 'Practiced in Partnership' or 'Practiced Exclusively' because they know that Māori culture is being practiced in at least a limited way. Perhaps those who are aware of taiāpure and mātaitai on balance perceive them positively and that the small number in operation is insufficient to maintain Māori culture.

Beliefs play a major role in explaining differences in the values of most outcomes. For example, those who believe that Māori culture will be maintained with exclusive management (MC-3) or management in partnership (MC-2) unsurprisingly express more value of Māori management than those who are sceptical of the persistence of Māori culture even with Māori management (MC-1). Not surprisingly, those who believe in the effectiveness of marine reserves to restore biodiversity and fish stocks express higher values for biodiversity.

3.4. Potential bias in the choice survey results

A key concern in this kind of survey is the accuracy with which respondents state their relative preferences for attributes through their choices. This is an example of error in data acquisition (Keller, 2005). Inaccurate responses in this study might arise from two sources.

The first one is associated with responder biases.[xviii] Seven potential responder biases were addressed in this study as summarised in Table 7. Measures taken to address these biases were mainly based on those suggested or employed in the literature (e.g. Bennett & Blamey, 2001; Hanley et al., 2001; Mitchell & Carson, 1989; Spash, 2006; Spash et al., 2009). Strategic, hypothetical, and information biases were addressed in the survey design. Biases associated with task understanding, protest payment vehicle and social desirability were addressed using inputs from follow-up questions. Those respondents (9.5%) who answered "No, I found many of the choices difficult" to the question "Do you feel confident about choices you made?" are treated as potentially subject to task understanding bias. Those (11.4%) who answered "I would prefer to pay in other ways (e.g. user fees or donation) rather than taxation" to the question "Why are you not willing to pay more tax?" are treated as potentially subject to protest payment vehicle bias. As a practical matter the protest payment vehicle seems most likely to affect values associated with taxes, and not non-monetary values reported in this chapter. However, it is worth examining whether the effect still exists as the non-monetary values come from a choice model involving a tax attribute. Those (21.6%) who answered "I consider it a moral obligation to protect marine life or cultures of indigenous people" to the question "Why are you willing to pay more tax?" are treated as potentially subject to social desirability bias.

Table 7: Potential biases and addressing measures

Type of bias	Description	Measures taken to address biases
Strategic	Respondents manipulate their responses to influence a decision in their favour. Making a potential financial effect on them compulsory might minimise this manipulation behaviour (Bennett & Blamey, 2001).	- Taxation was used to make the potential financial effect on respondents compulsory. - The amenities of interest (marine reserves, taiapure, and mataitai reserves) were hidden within the pool of available potential outcomes used in the choice experiment.
Hypothetical	If respondents view the process as entirely hypothetical then they may not take the survey or their choices seriously (Carson, 2000).	The following messages (as printed in the information sheet) were attempted to form such expectations: - "We encourage you to identify and think about a

[xviii] Although the elicitation method employed in this study is different from that commonly employed in choice experiments in environmental economics, similar biases can be expected.

Type of bias	Description	Measures taken to address biases
	Establishing some expectation that respondents' views will be used in some fashion can eliminate this hypothetical bias (Bennett & Blamey, 2001).	particular coastal marine area that you are most interested in or know well when you choose between the various outcomes from managing fishing in different ways. We will ask you to identify that area." - "Any increase [in your taxes] would go to a fund to pay for improving fishing or environmental outcomes in the coastal area, and any decrease would be removed from national and local government funding dedicated to managing the environment and fishing in the area."
Information	To the extent that respondents perceive the information in the survey as biased in favour of something, they may treat the survey casually and provide ill-considered answers (Bennett & Blamey, 2001).	Attributes included in the choice experiment were balanced between economic (commercial fishing), environmental (biodiversity), social (recreational fishing), and cultural (Māori) issues. Taxes (the monetary attribute) were also allowed to both increase and decrease. Description of each outcome was kept as neutral as possible. The choice experiment was also pretested to evaluate neutrality.
Task understanding	To the extent that respondents do not fully understand the choices offered or the choice tasks made, their responses may not represent their true preferences (Hanley, Spash, & Walker, 1995).	Each participant responded to the following question: "Do you feel confident in choices you made?" □ Yes □ Sort of, I found some of the choices difficult □ No, I found many of the choices difficult"
Protest against a payment vehicle	Respondents may have a tendency to choose doing nothing (e.g. without payment) because of an objection to the way in which their cost is to be imposed (Bennett & Blamey, 2001).	Each participant responded to the following question: "Why are you not willing to pay more tax?" □ I don't care much about coastal marine management □ There are other issues that are a better use of my money □ My tax is already too high. □ Someone else should pay □ I would prefer to pay in other ways (e.g. user fees or donation) rather than taxation □ Other reason: ……
Yea-saying or social	Respondents may have a tendency to present themselves in a	Each participant responded to the following question: "Why are you willing to pay more tax? "

Type of bias	Description	Measures taken to address biases
desirability	favourable position with respect to social norms or to make themselves look good. To the extent that respondents perceive that an amenity is socially desirable, they may overstate the importance of that amenity when formulating their responses (Bennett & Blamey, 2001).	□ I think better coastal management is important □ I consider it a moral satisfaction to protect marine life or cultures of indigenous people □ I consider it a moral obligation to protect marine life or cultures of indigenous people □ Other reason: ……..…

The second source of inaccurate responses is associated with Smile City's reward system. The reward system benefits the project by encouraging participation in the survey. But some respondents might have completed the survey purely for the reward; they might not fully consider the survey questions (especially relative to choice-making). The distribution of speeds in making choices (Figure 7) indicates that the number of respondents drops dramatically at speeds of less than six seconds/choice. Six seconds seems unbelievably fast to make a considered choice. The more time respondents took to make a choice, the more consideration they likely gave to each choice (the 47 respondents taking more than 50 seconds/choice presumably discontinued the survey for a while). So, the speedy choosers are treated as having provided lightly considered responses. This treatment can also be considered as a way to treat hypothetical bias because viewing the survey as a practically meaningless exercise might encourage lightly considered and speedier choices.

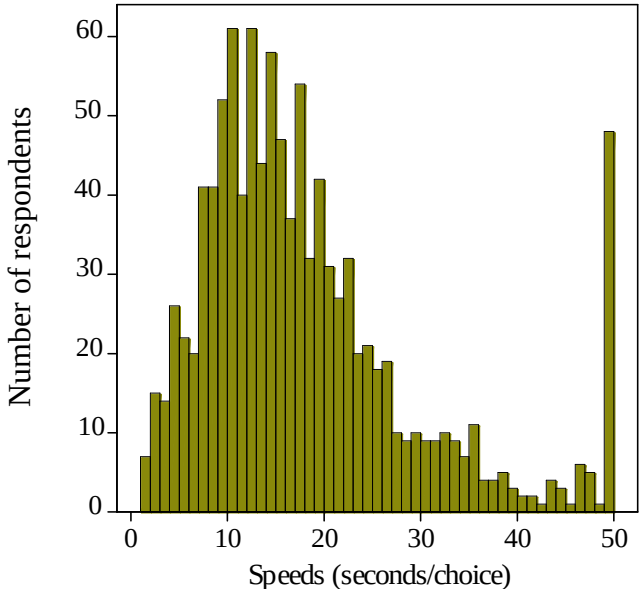


Figure 7: Distribution of choice-making speeds

Returning to the results in Table 6, controlling for the indicators of inaccurate responses to the choice experiment led to systematic differences in values of many socio-ecological attributes. Values of biodiversity drop with levels of confidence in choices made or if respondents protested taxes. These findings are consistent with the assumption that respondents who are uncertain about the choices asked or in protest against a payment vehicle tend to favour the status quo (Bennett & Blamey, 2001). Further, those potentially subject to social desirability bias held higher value for biodiversity and Māori cultural practices. This is again consistent with the assumption that respondents who perceive the amenity in questions (i.e. biodiversity and Māori culture) as socially desirable tend to state a higher value for that amenity (Bennett & Blamey, 2001). Alternatively, speedy choice-makers tend to have lower values for biodiversity and higher values for avoiding greater restrictions on recreational and commercial fishing. This indicates that those who chose quickly tend to have more frequently chosen the status quo outcomes.

These results indicate that the estimates of utility values are distorted by various types of bias to the choice experiment. On an *ad hoc* basis, biased responses can be excluded from analysis. However, "[t]his procedure suffers from the obvious drawback that it opens the researcher to criticism that he has engaged in selective deletion to achieve desired results. A more defensible approach is to mitigate the effect of outliers [biased responses] through the use of robust statistic estimators" (Mitchell & Carson, 1989, p.226). The treatments of bias using this latter approach are reported in the next section.

4. Population utility values and treatments of bias in the choice experiment

As noted earlier, the sample is not representative of the population. The estimated coefficients from the regression analysis can, however, be combined with population characteristics in Eq. 6 to predict $\overline{\hat{Y}}$ or the population mean logit(P), which can be then converted using Eq. 2 to population mean utility values (as reported in Table 8). Note that these population mean values differ somewhat from those of the sample (reported in Table 4 and repeated in Table 8). In particular, the mean relative value improvement in biodiversity is higher and that of maintaining Māori cultural practices is lower than in the sample. This largely reflects the relatively high proportion of Māori respondents in the sample. In general, the differences in values reflect the effects of the divergence of the sample from the population in terms of socio-economic characteristics.

Table 8: Estimated population mean utility values

Socio-ecological attributes	Bio-Good	Bio-Medium	MCul-Exclusive	MCul-Partner	Rec-High	Rec-Medium	Com-High	Com-Medium
Population mean utility values	44.3	23.3	15.7	10.7	19.6	8.4	18.1	6.4
Sample mean utility values	42.9	22.7	18.5	12.8	20.1	9.1	18.5	7.0

Recall: for the modelling purpose and convenience, all utility values are converted to positive in Section 3.3.

To investigate the potential effects of bias in the choice experiment, four treatments were considered (the mean population values reported in Table 8 do not account for potential bias). As described in the previous section, the regression analysis included variables potentially indicative of sources of bias as summarised in the left-hand column of Table 9: "not confident", "non-protest", "social-desirability", and "speedy", respectively. In each of the first four treatments, one coefficient associated with bias is given zero population weight. In Treatment 5 all four of the variables associated with bias are un-weighted. The weights of the variables associated with unbiased indicators are correspondingly adjusted. This exercise is equivalent to rerunning the choice experiment with a sample of respondents whose characteristics align with those of the population and whose responses do not suffer from one or all of the biases described in the previous section.

The corresponding predicted population mean utility values are reported in Table 10. The unadjusted predicted population means from Table 8 are repeated for convenience in the first row of results. The differences in the adjusted estimates in general appear fairly minor. Treatment 5, which adjusts for the effects of all indicators at once, not surprisingly produces the estimates that differ most from the unadjusted values. These combined adjustments further boost the mean relative value of improvements to biodiversity and decrease the mean relative value of maintaining Māori cultural practices. In general, improving biodiversity from a poor condition (or preventing its decline to a poor condition) remains the most highly valued outcome, whereas maintaining relatively light restrictions on recreational and commercial fishing appears of considerably less value.

Table 9: Proportions of each group of people in various treatments of bias

Indicators of bias	Treatment 1	Treatment 2	Treatment 3	Treatment 4	Treatment 5
Confidence in choices made					
Confident	31.2	28.2	28.2	28.2	31.2
Sort of confident	68.8	62.3	62.3	62.3	68.8
Not confident	0	9.5	9.5	9.5	0
Protest taxes					
Protest	88.9	100	88.9	88.9	100
Non-protest	11.1	0	11.1	11.1	0
Social desirability bias					
Non-social-desirability	78.2	78.2	100	78.2	100
Social-desirability	21.8	21.8	0	21.8	0
Choice-making speed					
Non-speedy	92.8	92.8	92.8	100	100
Speedy	7.2	7.2	7.2	0	0

Table 10: Estimated population mean utility values by various treatments of bias

Socio-ecological attributes	Bio-Good	Bio-Medium	MCul-Exclusive	MCul-Partner	Rec-High	Rec-Medium	Com-High	Com-Medium
Population (no bias treatments)	44.3	23.3	15.7	10.7	19.6	8.4	18.1	6.4
Treatment 1	44.7	23.5	15.5	10.5	19.5	8.3	18.0	6.3
Treatment 2	44.7	23.6	15.7	10.6	19.3	8.2	17.9	6.3
Treatment 3	43.7	22.9	15.2	10.2	20.2	8.5	18.7	6.7
Treatment 4	45.4	24.0	15.6	10.7	19.2	8.2	17.7	6.2
Treatment 5	45.7	24.2	14.8	10.0	19.5	8.1	18.1	6.2

5. Evaluation of alternative management systems

The mean values of changes in the various levels of each attribute reported in the previous section can be used to evaluate proposed policy alternatives. Table 11 lists seven such alternative policy ‘scenarios’, organised under three more general ‘strategies’.

Table 11: Policy scenarios and potential outcomes of major socio-ecological attributes

Strategy	Scenario	Potential outcomes			
		Bio	MCul	Rec	Com
1 (Māori culture first)	1 (Mātaitai)	Poor	Exclusive	Medium	Medium
	2 (Taiāpure)	Poor	Partner	Medium	Low
	3 (Mātaitai)	Medium	Exclusive	Medium	Medium
	4 (Taiāpure)	Medium	Partner	Medium	Low
2 (Biodiversity first)	5 (Marine reserves)	Good	No	High – Medium	Medium
3 (Biodiversity and Māori culture)	6 (Marine reserves and mātaitai)	Good	Exclusive	High	High
	7 (Marine reserves and taiāpure)	Good	Partner	High	Medium

Scenarios 1-4 constitute a strategy that aims primarily to maintain Māori cultural practices associated with marine coastal areas. This can be achieved by implementation of either of the two national approaches available, mātaitai and taiāpure. Given the public debate and uncertainty about their effects on biodiversity (Chapter 3), both approaches in scenarios 1 and 2 are assumed to be ineffective for restoring biodiversity. In contrast, in scenarios 3 and 4, it is assumed that both approaches work to restore biodiversity to a medium condition. More restrictions on recreational fishing are imposed under both mechanisms. Commercial fishing is not allowed in mātaitai (Ministry of Fisheries, 2010b) so more restrictions may eventually result under a mātaitai scenario. However, it is difficult to regulate commercial fishing in taiāpure; under the Quota Management System, commercial fishers are allowed to catch their quota anywhere in a Quota Management Area (Batstone & Sharp, 1999; Lock & Leslie, 2007; Straker et al., 2001), of which taiāpure may be a part. Taiāpure cannot exclude commercial fishing (Ministry of Fisheries, 2010c). Therefore, it is assumed that there is no change to restrictions on commercial fishing under a taiāpure scenario.

Scenario 5 constitutes a strategy that aims primarily to restore biodiversity to a good condition. As reported in Chapter 3, marine reserves are the only tool trusted to achieve that outcome. All fishing is permanently banned in areas designated as marine reserves. This ban may cause replacement of fishing effort and depletion of fish stocks in areas that remain fishable. It is assumed some regulation can be put in place to prevent such

replacement; that is, fishing effort previously carried out in areas designated as marine reserves is assumed eliminated (e.g. through buy-back of commercial quota and reductions in daily recreational bag limits in nearby fishable areas). As a result, commercial fishers face more restrictions under scenario 5, and recreational fishers face a higher level of restrictions halfway between many more and more restrictions (note the definitions in Table 3).

Scenarios 6 and 7 constitute a strategy that aims to both restore biodiversity to a good condition and maintain Māori cultural practices. To achieve both outcomes, some parts of marine coastal areas are allocated to marine reserves and the remaining parts to mātaitai (scenario 6) or to taiāpure (scenario 7). Both scenarios are likely to require many more restrictions on recreational fishing. A complete ban on commercial fishing in marine coastal areas may eventually result under scenario 6, whereas only more restrictions on commercial fishing may result under scenario 7 due to the difficulty in regulating commercial fishing under taiāpure.

Table 12: Net mean relative change in social value due to management alternatives

Scenario	Net changes in social values per household						
	Whole sample	Population (no bias treatments)	Population Treatment 1	Population Treatment 2	Population Treatment 3	Population Treatment 4	Population Treatment 5
1	2.4	0.9	0.8	1.2	0.1	1.2	0.6
2	3.7	2.3	2.2	2.4	1.7	2.5	1.9
3	25.1	24.2	24.3	24.9	23.0	25.3	24.8
4	26.4	25.6	25.7	26.0	24.6	26.5	26.1
5	24.9	26.6	27.2	27.3	25.3	28.2	28.2
6	22.9	22.4	22.7	23.3	20.0	24.0	23.0
7	28.6	28.9	29.4	29.7	27.0	30.7	30.1

Table 12 reports the net changes in mean relative values for each scenario from the assumed status quo. The mean changes are reported for the sample and for the population with and without adjustments for the various forms of bias. With the population mean values (either without or with treatments of bias), the rankings are: scenario 7 > 4 > 5 > 3 > 6 > 2 > 1. Scenarios 1 and 2 offer negligible benefit over the status quo. All of the other

scenarios offer substantial improvement. Better biodiversity clearly has a dominant effect, though the heavy restrictions on both recreational and commercial fishing hurt the popularity of scenario 6. Using sample rather than population means, scenario 5 (marine reserves) ranks lower than scenario 3 (mātaitai), most likely due to over-representation of Māori in the sample.

6. Discussion and conclusions

The results from this general choice experiment provide a rather strong indication that the general public share a concern for the maintenance of biodiversity. They indicate a clear willingness to trade light restrictions on recreational and commercial fishing to preserve biodiversity. More and larger marine reserves, potentially in combination with carefully managed taiāpure and mātaitai can be established to restore declining biodiversity and protecting Māori cultural practices with net social benefit. However, this does not mean that marine reserves and/or taiāpure or mātaitai can defensibly and legitimately be established in every harbour, bay and estuary. Marine reserves, taiāpure and mātaitai are proposed according to real needs, and decisions are made on a case-by-case basis. Where it is difficult to decide whether to approve or reject a proposal or where a decision is expected to cause controversy, the choice experiment approach presented in this chapter could potentially be adapted to gauge individual and public preferences that can be used as inputs for decision-making.

A number of papers in the literature have cast doubt on the accuracy of the results of stated-preference surveys (such as this choice experiment) due partly to the difficulty in obtaining representative samples and partly due to concerns about the accuracy of the responses by those who choose to participate. The first issue in this choice experiment was addressed by obtaining a large sample with a high response rate. The effects of the divergence of the sample from the population in terms of measured characteristics were then accounted for using the results of standard regression analysis. The representativeness of these results is arguably relatively good, and the results therefore defensible.

Nonetheless, bias from the hypothetical nature of the decisions may still be seen as problematic. A number of steps were taken to minimise this risk. An attempt following

(Bennett & Blamey, 2001) was made to establish some expectation in respondents (in the information sheet) that their views would be used in some fashion in shaping policy. This may, of course, not be sufficient. A number of other efforts were made to assess the potential impacts of biased choices on survey results (see Section 3.4). In general, these impacts appear small in this study, and none affects the overall evaluation of several management scenarios currently under discussion (see Table 12).

A number of other methods might be used to assess or limit bias from the hypothetical nature of the survey. For example, a follow-up question coupled with the information sheet might be effective, e.g., a question like "how likely do you think the results will shape the direction of future policy?" has been recently asked after choice questions (e.g. Petrolia & Interis, 2013), and those who answer "unlikely" have been treated as more likely to give a biased response. In this study, the speeds with which respondents made choices was used as an indicator of respondents who answered survey questions with inadequate care. It is, however, possible that some of those who answered more slowly nevertheless paid equally little consideration to their answers. Providing some redundancy in choices presented to respondents (an option not yet available in 1000Minds) might help identify lazy respondents[xix]. In short, there is no way to perfectly determine whether respondents do not treat the survey as hypothetical and therefore make choices according to their true preferences. Multiple approaches (including those taken in this study and some additional ones just discussed) can minimise error in results caused by such hypothetical bias.

Another potential methodological issue that may be addressed in future research is associated with the logic of transitivity property. The present application of 1000Minds assumes transitivity to reduce the number of choices; that is, 1000Minds eliminates all choice combinations logically implied by each choice made explicitly by respondents. This logical property offers a great advantage because responder burden is substantially reduced. Lower burden to respondents improves the reliability of the results (Hansen & Ombler, 2009). The risk, however, is that considerable weight may fall on a poorly considered choice: an inaccurate choice eliminates all other choices implied by it, which affects the resulting estimates of relative utility. A way to test for these effects would be to

[xix] This has already been added to the list of future features of *1000minds* according to Paul Hansen, the founder of the software.

ask respondents to explicitly make a few choices that are eliminated by transitivity[xx]. Another way is to ask a sample of respondents to retake the survey some weeks after completing it for the first time and compare results. This was done in Sullivan (2012) with little change in results overall.

Despite their limitations, choice experiments can be a useful tool for making controversial and unquantified impact assessment of policy proposals more legitimate. If a proposed taiāpure, mātaitai, or marine reserve causes impacts on existing fishers/users considered undue by the general public, a choice survey will help reveal that reality. The determination of what constitutes an undue impact currently lies at the discretion of the Minister of Fisheries (for taiāpure and mātaitai) and the Minister of Conservation (for marine reserves) (Bess & Rallapudi, 2007). In the absence of input from a representative or nearly representative sample of the population, their assessment of impacts can remain controversial. For example, the rejection of a proposed Akaroa Marine Reserve was unacceptable and protested by its proponents to the New Zealand High Court. This marine reserve has recently been approved after the Government reconsidered its decision according to the High Court's advice (Department of Conservation, 2013). The results from a carefully implemented choice experiment can lead to a more defensible and legitimate decision. As demonstrated in this chapter, both negative and positive impacts can be weighed against each other according to individual preferences. If everyone or a representative sample of a population participates in a choice experiment, the results will reveal the societal preferences and choices.

[xx] This again has been added to the list of future features of 1000minds according to Paul Hansen.

Chapter 5 Public willingness to pay for near-shore marine biodiversity and ecosystem services in New Zealand

Abstract: Willingness to pay (WTP) for retaining social-ecological systems was estimated from an online choice experiment survey using PAPRIKA (**P**otentially **A**ll **P**airwise **R**an**K**ings of all possible **A**lternatives) implemented by *1000Minds* internet-based decision software. A completed set of 'part-worth utilities' for each of 1055 respondents recruited from throughout New Zealand were obtained from the choice survey and used to calculate the relationship between utility and tax changes to estimate individual-level WTP for changes in four socio-ecological attributes: biodiversity, Māori culture, recreational and commercial fishing. Regression analysis shows that the WTP estimates vary according to socio-economic characteristics, perceptions, beliefs, and indicators of inaccurate responses to the survey. Annual population-weighted WTP is estimated at roughly NZ$224/ household (NZ$370 million for the nation) or NZ$128/household (NZ$212 for the nation) for improving biodiversity from poor to good or to medium condition, respectively. Mean population-weighted WTP to maintain Māori culture associated with the coastal marine areas or current light restrictions on commercial or recreational fishing is almost half as large. These WTP estimates were used to calculate net changes in economic benefits affected by various management scenarios currently under discussion. An annual net economic benefit (equivalent to roughly NZ$165 million or NZ$66 million at a minimum) can be generated for the nation by policy (most reliably, joint implementation of Marine Reserves and Customary Protection Areas) that either restores biodiversity or both biodiversity and Māori culture.[xxi]

[xxi] Results in this chapter and some of those in Chapter 3 were presented at the Challenges of Natural Resource Economics & Policy (CNREP) 2013: 4th National Forum on Socioeconomic Research in Coastal Systems, March 24-26, New Orleans.

1. Introduction

Over the last few decades there has been growing interest in using stated preference techniques to estimate the dollar values of non-market environmental goods (e.g. biodiversity, ecosystem services). These dollar values can then be used in cost-benefit analyses (CBA) of policy that affects the environment. There are two types of stated preference techniques: "contingent valuation methods" and "choice experiments" (Adamowicz et al., 1998; Bennett & Blamey, 2001; Louviere et al., 2000). These stated preference techniques are particularly required in circumstances where changes in resource allocation are proposed because preferences revealed in the past may be of little interest (Bennett & Blamey, 2001; Louviere et al., 2000; Mitchell & Carson, 1989).

Both contingent valuation methods and choice experiments are based on welfare economic theory and primarily involve asking survey respondents to state their willingness to pay (WTP), known as "compensating surplus", or willingness to accept (WTA) compensation, known as "equivalent surplus", given a hypothetical change in the situation relative to a *status quo* (Champ et al., 2003; Freeman, 2003; Garrod & Willis, 1999). The maximum amount an individual is willing to pay for a better situation (e.g. improved environmental quality) measures the associated dollar-equivalent increase in wellbeing from the improvement. This is because the individual would be indifferent between spending the amount of money for the improved environment and keeping the money to spend on other things. Alternatively, the minimum amount an individual is willing to accept compensation for a deteriorated situation (e.g. water quality dropping from a standard level set out in legislation) measures the associated decrease in wellbeing from the deterioration. This is because the individual would be indifferent between enjoying the standard level of environmental quality and getting the extra money for spending on other things. Choice experiments have recently gained popularity over contingent valuation methods as the former can value multiple attributes at a time and generate more valid estimates (Adamowicz et al., 1998; Bennett & Blamey, 2001; Boxall et al., 1996).

This chapter reports the results from a survey-based choice experiment aimed at valuing socio-ecological attributes affected by alternative systems of managing near-shore fisheries in New Zealand. This choice experiment allows estimation of the values of the socio-ecological attributes in both non-monetary (utility) and dollar values. The focus of this

chapter is on dollar values; the utility values are reported in Chapter 4. WTP is used as the measure of the dollar values instead of WTA. It seems unethical in this case that people are willing to accept some amount of money for depletion of biodiversity and estrangement of other people from their cultural practices.

By focusing on relative utility values, this choice experiment is a form of multi-criteria analysis (MCA). MCA is increasingly used in circumstances where trade-offs between several potential criteria (or attributes) of management alternatives are being investigated in order to determine the relative importance of these attributes and thereby identify a most favourable management alternative (Kiker et al., 2005; Linkov et al., 2006). By focusing on dollar values, the choice experiment contributes to CBA (Dobes & Bennett, 2009). CBA requires values of all attributes at varying levels estimated in dollars, which are a convenient metric and common to market goods. Any CBA (if incomprehensive) may be reconstructed whenever information about dollar values of attributes not included in the choice model become available, whereas such reconstruction is impossible with MCA. The choice experiment needs to be done again in order to determine the values of new attributes (at different levels) relative to those of the existing ones. Therefore, CBA may offer a more flexible decision-support tool and economically make more sense for lay people.

The remainder of this chapter is organised as follows. The next section describes the procedure for estimating sample WTP for changes in socio-ecological attributes. Section 3 describes the procedure for estimating population WTP and various treatments of potential bias in the results from the choice experiment. Section 4 performs a cost-benefit analysis using the population WTP estimates, followed by sensitivity analysis. Discussion and conclusions appear in Section 5.

2. Procedure for estimating sample WTP for socio-ecological attributes

This section starts with a brief description of the choice experiment and the resulting sample utility values (reproduced from Chapter 4). Section 2.2 discusses the effect on utility of changes in income. Finally, Section 2.3 reports the estimates of WTP for changes in socio-ecological attributes.

2.1. The choice experiment and sample average utility values of attributes

Implemented by 1000Minds decision software (Hansen & Ombler, 2009), the choice experiment consists of a series of discrete choices. Each choice puts each respondent in a situation where he or she must trade-off a better level of one attribute for a better level of another attribute. A subset of choices involves trade-offs between a better level of one socio-ecological attribute and a better level of the tax attribute, such as the one shown in Figure 8.

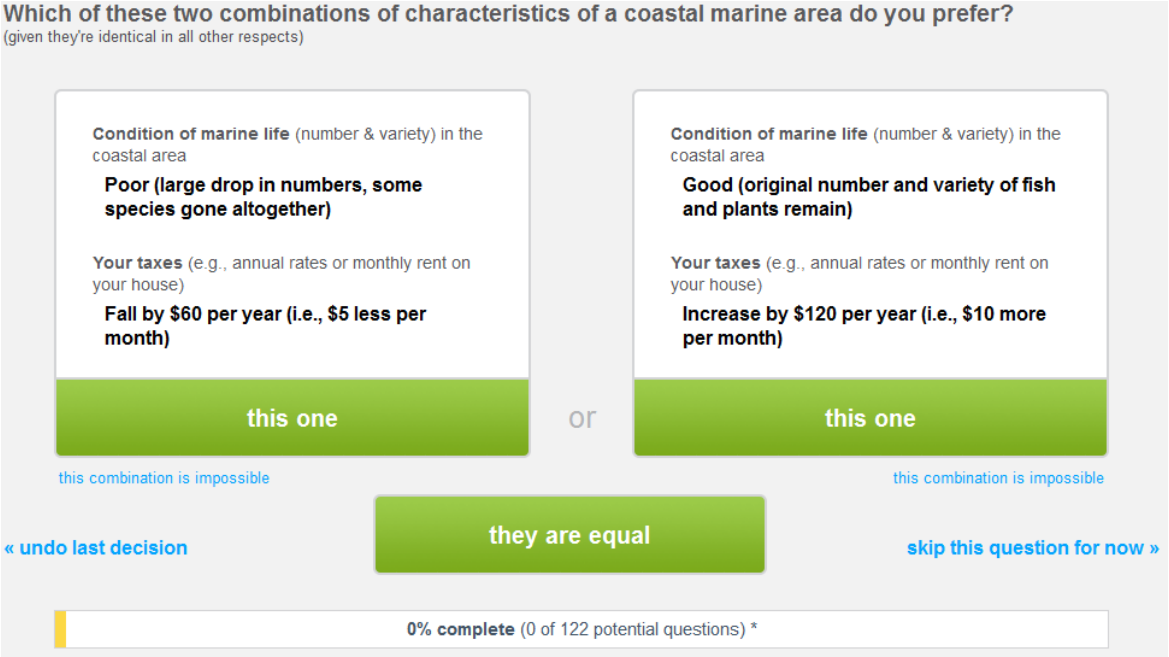


Figure 8: An example of choices involving tax

The results (as summarised in Table 13/Column 3) reproduce from Chapter 4 the estimated relative utility values of each level of each attribute, including the tax attribute, averaged across all 1055 respondents. These relative utility values are estimated using a linear programming routine from data associated with choices each respondent made on the survey. Prior to averaging, the utility values for each respondent are scaled for convenience. The worst levels of each attribute (i.e. Bio-Poor, MCul-No, Rec-High, Com-High, and Tax+$120) are each scored zero. The utility values of the best level of each attribute are scaled so that their part-worth utilities sum to 100. The utilities of the medium levels of each attribute correspondingly fall between zero and the value of the best level. An alternative rescaling (shown in Table 13/Column 4) sets conditions in the status quo as the base equal to zero (i.e. Bio-Poor, MCul-No, Rec-Low, Com-Low, and Tax+$0).

In fact the current value of any level of a given attribute is not genuinely zero. Nevertheless, we designated a zero base to measure the relative importance of different outcomes if the status quo was to change

Table 13: Mean utility of each level of each attribute

Attributes	Levels (from low to high)	Raw average utility scores	Δ in utility from status quo
Biodiversity (Bio)	Poor condition (Poor)	0	0
	Medium condition (Medium)	16.3	16.3
	Good condition (Good)	30.8	30.8
Māori cultural management (MCul)	No longer practiced (No)	0	0
	Practiced in partnership with locals (Partner)	9.3	9.3
	Practiced exclusively by Māori (Exclusive)	13.4	13.4
Recreational fishing (Rec)	Many more restrictions (High)	0	-14.1
	More restrictions (Medium)	7.7	-6.4
	Current restrictions (Low)	14.1	0
Commercial fishing (Com)	Not allowed (High)	0	-13.1
	More restrictions (Medium)	8.2	-4.9
	Current restrictions (Low)	13.1	0
Tax	Increase $120 per annum (+$120)	0	-21.0
	Increase $60 per annum (+$60)	11.6	-9.4
	No change (+$0)	21.0	0
	Decrease $60 per annum (-$60)	28.6	7.6

2.2. Effect on utility of changes in income

Including varying levels of annual tax payments as an attribute in the choice model (Table 13/Column 2/last four rows) allows estimation of WTP for any change in the level of any other attribute in the model. The average utilities on the four levels of tax included in the model as reported in the right-hand column of Table 13 indicate diminishing marginal utility, as one would expect. A decrease in taxes of $60/year results on average in an increase in utility of 7.6 units of scaled utility. An increase in tax of $60 decreases utility by a larger 9.4 units, and a further increase in tax of $60 decreases utility by a yet larger 11.6 units, on average. Utility falls at a modestly decreasing rate with each successive decrease in after-tax income, which seems plausible.

One can compare these changes in utility to those associated with changes in any of the other attributes. For example, improving biodiversity 'from poor to good' increases utility on average by 30.8 units. This exceeds the drop in utility associated with an increase in tax of $120/year, so WTP to restore a damaged marine environment exceeds $120/year on average in this sample.

The averages, however, mask considerable heterogeneity across respondents in the relative values of changes in taxes and in other attributes (Chapter 4). Indeed, there is considerable heterogeneity across respondents just in the functional relationship of utility with changes in tax. The estimated utilities associated with decreasing levels of tax for most respondents display diminishing marginal utility. Perhaps not surprisingly, the estimates from a large minority of respondents indicated utility linear in taxes over relatively small range in tax. Finally, the estimates from a relatively small minority of respondents indicate surprisingly large increases in utility from a drop in taxes.

To illustrate this heterogeneity, respondents were sorted into clusters based on the pattern of estimated utility values associated with each level of tax. Prior to clustering, the raw utility values associated with taxes for each respondent were rescaled to allow comparison across respondents. The worst level of the tax attribute (Tax+$120) is scored zero, and the best level of that attribute is scored 100. The utilities of the medium levels (Tax+$60 and Tax+$0) correspondingly fall between 0 and 100. Such rescaling is equivalent to running a choice experiment that involves only the tax attribute. The rescaling was based on Eq. 7 and gave the results (as summarised in Table 14/Column 2). A further rescaling (as shown in Table 14/Column 3) sets the conditions in the status quo as the base equal to zero (Tax+$0).

$$U'_{\mathrm{Tax}_n} = \frac{U_{\mathrm{Tax}_n}}{U_{\mathrm{Tax}-\$60}} \times 100 \qquad \text{(Eq. 7)}$$

where:

U'_{Tax_n} : Rescaled utility of the tax attribute at an n^{th} level

U_{Tax_n} : Raw utility of the tax attribute at an n^{th} level

$U_{\mathrm{Tax}-\$60}$: Raw utility of Tax-$60

Table 14: Rescaled utility values affected by changes in taxes

Levels of the tax attribute (from low to high)	Average utility scores	Δ Utility from status quo
Tax+$120	0	-73.4
Tax+$60	40.6	-32.9
Tax+$0	73.4	0
Tax-$60	100	26.6

The non-hierarchical cluster analysis routine in GenStat® (Harding & Payne, 2012) was used to cluster respondents with similar patterns of scaled utility with changes in income. See, for example, Hartigan (1975) for a discussion of clustering algorithms. Non-hierarchical cluster analysis sorts units of observation (i.e. respondents) into a predetermined number of groups, *n*. In this case, the process starts by assigning respondents randomly to *n* groups of roughly equal size. The mean values of each group are calculated and each respondent is re-assigned to the group with mean values 'closest' to their own value. 'Close' is defined as Euclidian distance, or 'between-group sum of squares'[xxii]. This process iterates until an equilibrium sorting is established.

The mean utility values in each cluster are reported in Table 15. I plot the utility values of each respondent in each cluster against the corresponding levels of change in after-tax income to give a feel for the variation in functional relationships (Figures 9 and 10). The intercept of each functional relationship was set at zero because changes in utility at the status quo are genuinely zero.

The effects of income changes on utilities for each respondent in Clusters 1-3 fit well with a second order polynomial function (Figure 9). Let us focus only on the left hand-side of the y axis as the primary purpose was to estimate WTP (i.e. income loss due to an increase in tax). Despite different patterns of how fast utility drops with income loss, the utility functions for all respondents in Clusters 1-3 (52.9% of the sample) comply well with the basic assumption in economics of increasing marginal pain (or, conversely, diminishing marginal returns)[xxiii]. The respondents in Cluster 1 are those least willing to pay, i.e., least willing to give up marketed goods not included in the choice model.

[xxii] 'Between-group sum of squares' minimises the trace of the pooled with-class dispersion matrix; this is equivalent to maximizing the total between-group sum of squares or Euclidean distance between groups.
[xxiii] A first dollar the respondents receive makes them more satisfied than a second dollar they receive. Alternatively, a first dollar the respondents lose makes them less dissatisfied than a second dollar they do.

Table 15: Mean utilities affected by changes in taxes for five clusters

Tax	Cluster 1 (n = 193 or 18.3%)	Cluster 2 (n = 222 or 21%)	Cluster 3 (n = 143 or 13.6%)	Cluster 4 (n = 362 or 34.3%)	Cluster 5 (n = 135 or 12.8%)
$120	-24.5 (-86.8)	-27.3 (-86.8)	-19.4 (-71.7)	-19.2 (-67.7)	-12.1 (-44.7)
$60	-6.5 (-22.3)	-14.1 (-45.4)	-5.4 (-20.1)	-10.5 (-37.4)	-7.2 (-26.6)
$0	0	0	0	0	0
-$60	3.6 (13.2)	3.9 (13.2)	7.7 (28.3)	9.1 (32.3)	14.9 (55.3)

Note: Numbers in parentheses are mean utility values rescaled to allow comparison across respondents (as overall summarised in Table 14/Column 3) and used for this cluster analysis; whereas numbers not in parentheses are mean utility values (as overall summarised in Table 13/Column 4).

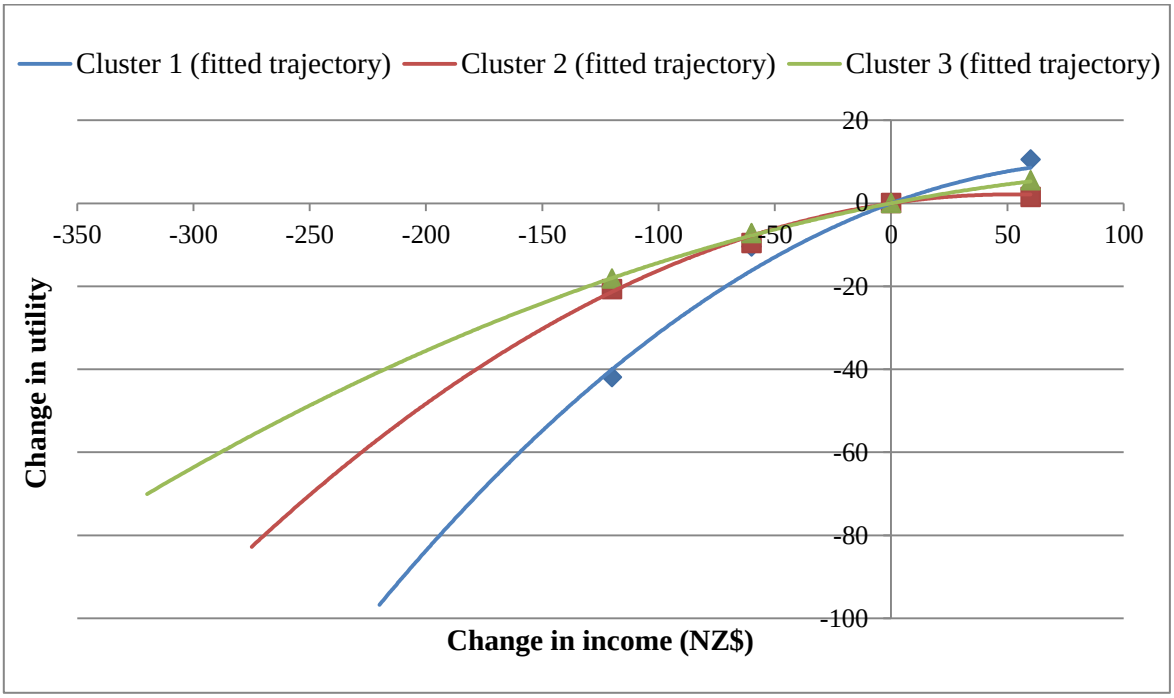


Figure 9: Effect of income change on utility
(Examples of exact responses in clusters 1-3)

Next, consider the plots for Clusters 4 and 5 in Figure 10. For Cluster 4, utility appears linear over the range of tax payments represented in the model, as shown by the solid purple line. It seems likely, however, that utility would eventually begin to decrease at an increasing rate, as indicated by the dotted purple line. Given the levels of tax included in the model, however, we lack the information to estimate this non-linear model.

A line fits the data from Cluster 5 somewhat less well. Utility appears to fall linearly as income falls (tax increases) from $0 to -$60 to -$120. As with Cluster 4, we would expect the marginal decrease in utility eventually to increase as the tax levels increase beyond the range included in the choice model, such as that illustrated by the dashed blue-green line. Looking in the other direction, an increase in income (a tax decrease) of $60 appears to generate a surprisingly large increase in utility. There appears to be an unexpected change in the functional relationship at zero.

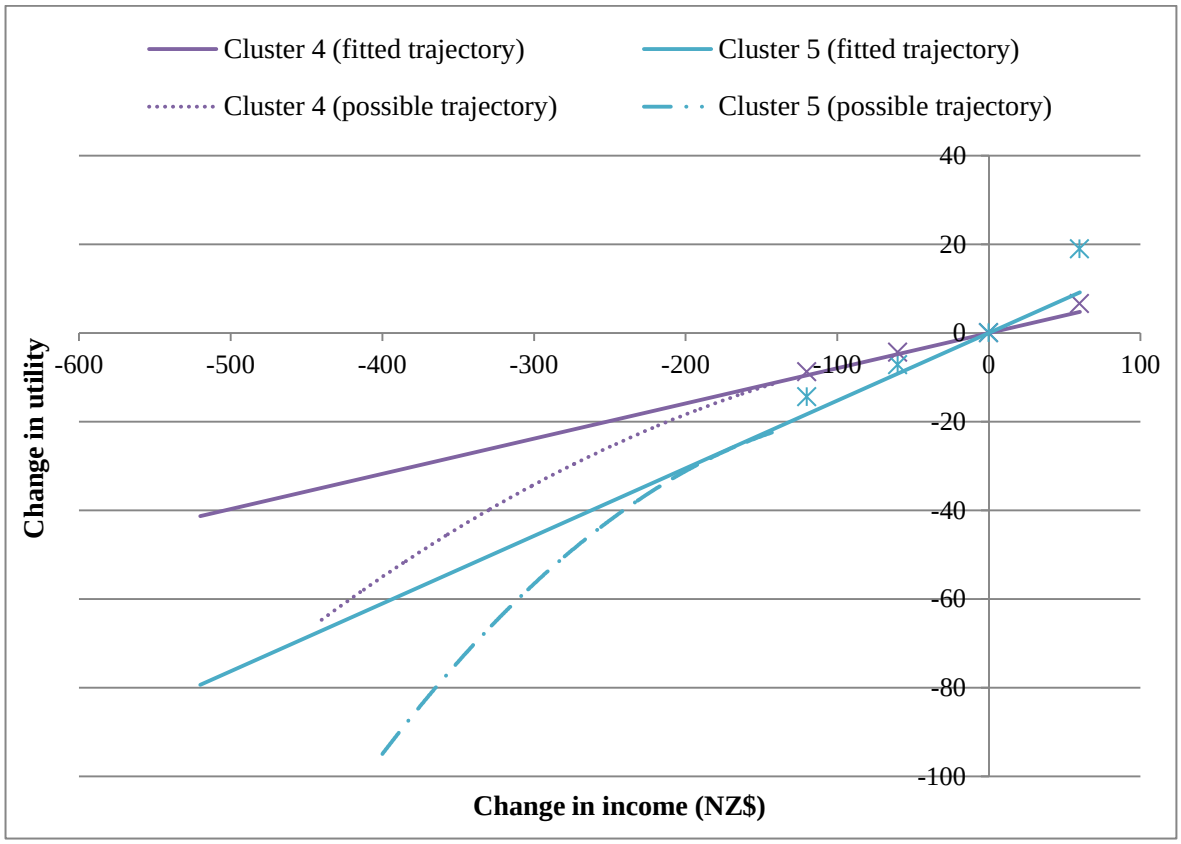


Figure 10: Effect of income change on utility

(Examples of responses in clusters 4 & 5)

As the default, I decided to begin by calculating WTP using linear or non-linear relationships as estimated from the information available. Models displaying these relationships (utility functions) fit reasonably well. R^2 (goodness of fit) for only 46 models (less than 5 per cent of all models) falls below 0.8 (Figure 11). However, these estimates may result in over-estimates of WTP, at least in the cases of respondents in Clusters 4 and 5. The results of sensitivity analysis that treats these concerns are reported in Section 4.2.

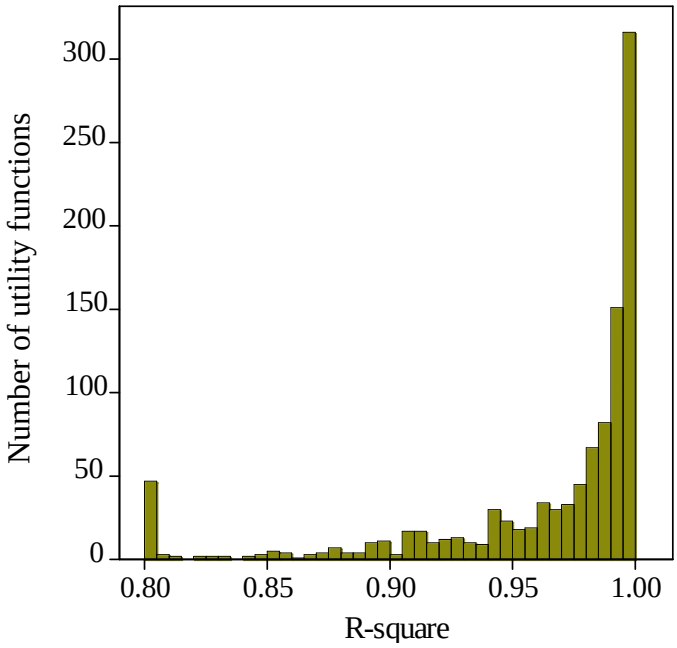


Figure 11: Distribution of R^2 for utility functions of all respondents

2.3. Estimates of WTP for socio-ecological attributes

The first column of numbers in Table 16 reports estimated WTP for each level of each socio-ecological attribute averaged across all respondents. The first step was to estimate each individual respondent's utility as a function of increased tax (decreased after-tax income) using Eq. 8 for respondents in Clusters 1-3 and using Eq. 9 for those in Clusters 4-5. Recall that changes in utility at the status quo are genuinely zero, so the intercept of each utility function was set at zero. WTP for an improvement in any of the socio-ecological attributes was then estimated as the decrease in after-tax income that just offsets the gain in utility from the improvement in the attribute. That is, consistent with welfare theory, we slide down the estimated utility function in income until tax rises just enough to leave the respondent indifferent between the status quo and the combination of a better level of the attribute and higher taxes.

$$\hat{Y}_i = \hat{\beta}_{1i} X_i + \hat{\beta}_{2i} X_i^2 \qquad \text{(Eq. 8)}$$

$$\hat{Y}_i = \hat{\beta}_{1i} X_i \qquad \text{(Eq. 9)}$$

where:

$\hat{Y}_i$ Fitted utility for an *i* respondent

X_i WTP (i.e. income loss due to an increase in taxes) for an *i* respondent

$\hat{\beta}_{1i}$ Coefficient attached to X_i

$\hat{\beta}_{2i}$ Coefficient attached to X_i^2 ($\hat{\beta}_{2i}$is equal zero in a linear function)

Table 16: Sample mean estimates of WTP (NZ$/household)

Socio-ecological attributes	Levels	Mean (N = 1055)	Std. dev.	% of respondents WTP > $180
Biodiversity	Poor	0	0	0
	Medium	119.2	86.3	21.7
	Good	210.8	150.6	50.8
Maori cultural practices	No	0	0	0
	Partner	75.7	93.2	11.1
	Exclusive	105.3	117.3	16.3
Recreational fishing	Low	0	0	0
	Medium	50.6	53.7	3.9
	High	104.9	94.7	14.3
Commercial fishing	Low	0	0	0
	Medium	39.9	51.9	2.9
	High	98.6	101.2	13.5

Note: For recreational and commercial fishing, it should be interpreted as WTP for avoiding restrictions.

Just like the utility values reported in Chapter 4, WTP for socio-ecological attributes indicates the relative importance of these attributes, but this time in dollar terms. From Table 16, we can conclude that improving biodiversity 'from poor to good condition' is on average the most important to respondents relative to other socio-ecological attributes included in the choice model. This means that the social value from improving biodiversity 'from poor to good' more than offsets the analogous value of imposing much higher restrictions on either commercial or recreational fishing. Maintaining Māori cultural practices is roughly as important as maintaining the current low restrictions on fishing.

The rather large standard deviations in WTP reported in the second column of numbers in Table 16 indicate considerable heterogeneity across respondents. Estimated WTP for an improvement in an attribute 'from worst to best' for many respondents exceeds the $180 range in tax payments included in the survey. In particular, 50.8% of respondents are

estimated to be willing to pay more than $180 per household per annum for improvement in biodiversity from poor to good condition.

On the one hand, that these respondents are willing to pay more than $180 is plausible given the relatively large number of choices involving tax payments in the choice model. The four levels of tax meant that respondents faced more choices involving tax than of any other attribute in the choice model. And some choices (such as the one shown in Figure 8) explicitly asked for $180. On the other hand, as discussed in the previous subsection, estimates of WTP well outside the range in tax increases included in the model might for some respondents be overestimated. For these respondents we can say that they are perhaps likely willing to pay more than $180, but we have much less confidence about how much more. This issue is directly addressed in Section 4.2 (sensitivity analysis).

3. Population-weighted estimates of WTP for socio-ecological attributes

If estimates of WTP for a change in a particular socio-ecological attribute vary across groups of respondents, then the sample mean WTP is a biased estimate of the population mean WTP given that population characteristics differ somewhat from those of the sample (e.g. Māori are over-represented). Multiple regression modelling using statistics software GenStat® (Payne, 2012) was undertaken to identify some of the influences on the variation in these estimates. The results are not only of interest in their own right, but they also allow in particular prediction of the mean WTP of the population, rather than of the sample.

The next section reports the results of the regression analysis. Its estimated coefficients are then combined with known characteristics of the population to predict population-weighted estimates of WTP in Section 3.2. The population-weighted estimates of WTP are further adjusted according to various sources of bias in the choice experiment in Section 3.3.

3.1. Determinants of variation in WTP estimates

The WTP estimates associated with each level of each socio-ecological attribute were fitted one at a time to the same log-linear model of twenty three sets of explanatory variables as in the previous chapter. These explanatory variables (Chapter 4/Table 5)

comprise essentially all of the information obtained from each respondent. Log-linear modelling was used instead of ordinary linear regression as the regression residuals of the former models were more closely normally distributed than those of the latter models. The regression results are reported in Table 17. Note that with log-linear modelling, the estimated coefficient can be interpreted as the proportionate (i.e., $\exp(\beta) - 1$) change in the response variable from a one unit change in an explanatory variable.

The results (Table 17) indicate that WTP for each level of each socio-ecological attribute varies, as expected, with variation in socio-economic characteristics, perceptions, beliefs and with the indicators of inaccurate responses to the choice experiment. For instance, females tend to be more willing to pay than males for improving biodiversity from poor to medium condition. Asians tend to be less willing to pay than Māori for improvements to biodiversity. Māori tend to be more willing to pay than Asians and Pākehā (EUNZ in the table) for preserving Māori cultural practices. Commercial fishers tend to be more willing to pay than others for improving biodiversity and Māori cultural practices and also more willing to pay for avoiding greater restrictions on recreational and commercial fishing. Current and future visitors to near-shore marine areas tend to be more willing to pay for better biodiversity than non-visitors. Members of Māori organisations tend to be less willing to pay than non-members for improving biodiversity, whereas members of environmental organisations are willing to pay more than non-members for preserving Māori cultural practices.

Those who report awareness of the operation of taiāpure and mātaitai tend to be more willing to pay for maintaining Māori cultural practices in partnership with the locals. Those who know a lot about management approaches taken in taiāpure and mātaitai tend to be willing to pay more for improving biodiversity as well as Māori cultural practices.

Beliefs play a major role in explaining differences in WTP estimates. For example, those who believe that Māori culture will be maintained with exclusive management (MC-3) or management in partnership (MC-2) are willing to pay more for Māori cultural management than those who are sceptical of the persistence of Māori culture (MC-1). Unsurprisingly, those who believe in the effectiveness of marine reserves to restore biodiversity and fish stocks are willing to pay more for biodiversity.

Table 17: Determinants of variation in WTP for each level of each socio-ecological attribute

Explanatory variable N = 847 (208 excluded due to item non-responses)	Bio-Good (Mean = 217.2, Residual deviance = 84.8)		Bio-Medium (Mean = 123.1, Residual deviance = 51.5)		MCul-Exclusive (Mean = 105, Residual deviance = 67.7)		MCul-Partner (Mean = 76.1, Residual deviance = 51.8)		Rec-High (Mean = 105.6, Residual deviance = 58)		Rec-Medium (Mean = 51, Residual deviance = 37.5)		Com-High (Mean = 98.3, Residual deviance = 69.4)		Com-Medium (Mean = 38.7, Residual deviance = 35)	
	Coeff.	s.e.	Coeff.	s.e.	Coeff.	s.e.	Coeff.	s.e.	Coeff.	s.e.	Coeff.	s.e.	Coeff.	s.e.	Coeff.	s.e.
Constant	4.78***	0.20	4.26***	0.21	4.62***	0.23	4.17***	0.25	5.01***	0.20	4.31***	0.23	5.13***	0.23	4.71***	0.25
Female	0.07	0.05	0.09*	0.05	0.07	0.06	0.10	0.07	-0.07	0.06	-0.05	0.06	-0.01	0.06	-0.09	0.07
EUNZ	0.00	0.06	0.00	0.06	-0.50***	0.07	-0.55***	0.08	-0.21***	0.07	-0.24***	0.08	-0.15*	0.08	-0.26***	0.09
Asian	-0.26**	0.10	-0.30***	0.11	-0.52***	0.12	-0.52***	0.14	-0.52***	0.12	-0.63***	0.14	-0.21	0.13	-0.43***	0.15
Other ethnicity	-0.05	0.10	-0.04	0.10	-0.15	0.12	-0.16	0.13	-0.24**	0.12	-0.30**	0.14	-0.09	0.14	-0.49***	0.17
Age40-64	-0.17***	0.06	-0.21***	0.06	-0.12	0.08	-0.16*	0.08	-0.09	0.07	-0.05	0.08	-0.18**	0.08	-0.29***	0.09
Age65+	-0.09	0.11	-0.04	0.11	0.12	0.15	0.07	0.16	0.15	0.13	0.06	0.15	-0.13	0.15	-0.24	0.17
High school	0.06	0.08	0.06	0.08	0.09	0.10	-0.01	0.10	0.09	0.08	0.24**	0.10	0.01	0.10	0.07	0.10
Polytechnic/University	0.13*	0.08	0.11	0.08	0.11	0.10	0.03	0.10	-0.09	0.09	-0.02	0.10	-0.08	0.10	-0.20*	0.11
Home duty	0.16	0.16	0.16	0.17	-0.02	0.19	-0.05	0.20	-0.33*	0.17	-0.40**	0.20	-0.36*	0.19	-0.25	0.21
Student	0.18	0.14	0.17	0.15	-0.04	0.16	-0.07	0.18	-0.15	0.14	-0.21	0.16	-0.20	0.15	-0.09	0.17
Retired	0.03	0.17	-0.01	0.18	-0.22	0.21	-0.22	0.23	-0.29	0.18	-0.15	0.21	-0.38*	0.20	-0.23	0.22
Employed-AFF	-0.13	0.29	-0.05	0.29	-0.44	0.37	-0.31	0.39	-0.30	0.27	-0.42	0.34	-0.90***	0.35	-0.53	0.35
Employed-Non-AFF	0.24*	0.14	0.22	0.14	0.12	0.15	0.09	0.16	-0.09	0.14	-0.04	0.15	-0.26*	0.14	-0.06	0.16
Household income	0.00	0.01	0.00	0.01	-0.02**	0.01	-0.01	0.01	0.01	0.01	-0.01	0.01	0.01	0.01	0.01	0.01
Household size	0.02	0.02	0.01	0.02	0.02	0.02	0.01	0.02	0.05**	0.02	0.08***	0.02	0.00	0.02	-0.03	0.03
Bay of Plenty	-0.17*	0.09	-0.19**	0.10	0.00	0.12	0.05	0.13	0.02	0.10	-0.01	0.12	0.10	0.12	0.15	0.13
Canterbury	-0.08	0.07	-0.13*	0.07	-0.03	0.09	0.00	0.10	-0.18**	0.09	-0.12	0.10	-0.09	0.10	-0.20*	0.11
Gisborne	-0.27	0.25	-0.14	0.25	-0.20	0.28	-0.01	0.28	-0.12	0.26	-0.11	0.30	0.13	0.28	-0.16	0.35

Explanatory variable N = 847 (208 excluded due to item non-responses)	Bio-Good (Mean = 217.2, Residual deviance = 84.8)		Bio-Medium (Mean = 123.1, Residual deviance = 51.5)		MCul-Exclusive (Mean = 105, Residual deviance = 67.7)		MCul-Partner (Mean = 76.1, Residual deviance = 51.8)		Rec-High (Mean = 105.6, Residual deviance = 58)		Rec-Medium (Mean = 51, Residual deviance = 37.5)		Com-High (Mean = 98.3, Residual deviance = 69.4)		Com-Medium (Mean = 38.7, Residual deviance = 35)	
	Coeff.	s.e.	Coeff.	s.e.	Coeff.	s.e.	Coeff.	s.e.	Coeff.	s.e.	Coeff.	s.e.	Coeff.	s.e.	Coeff.	s.e.
Hawkes Bay	-0.12	0.12	-0.04	0.12	-0.38*	0.20	-0.32	0.21	-0.04	0.14	-0.15	0.17	-0.05	0.17	-0.16	0.20
Manawatu-Wanganui	-0.17	0.13	-0.19	0.14	-0.34*	0.18	-0.34*	0.20	-0.20	0.15	-0.21	0.17	-0.16	0.17	-0.09	0.18
Marlborough	0.54	0.34	0.41	0.38	-1.43	1.24	-1.88	1.62	-0.11	0.61	-0.03	0.74	-1.52	1.23	-1.35	1.37
Nelson	0.06	0.16	0.04	0.17	0.16	0.18	0.32*	0.18	-0.13	0.20	-0.22	0.23	-0.08	0.22	-0.07	0.24
Northland	-0.01	0.11	-0.03	0.11	0.01	0.13	0.06	0.14	-0.10	0.13	-0.13	0.16	-0.23	0.17	-0.04	0.18
Otago	-0.05	0.09	-0.08	0.10	0.00	0.12	-0.11	0.14	-0.04	0.11	-0.14	0.13	0.11	0.12	0.00	0.15
Southland	-0.04	0.15	-0.03	0.16	0.19	0.19	0.37*	0.19	-0.11	0.20	-0.20	0.23	-0.14	0.22	-0.17	0.25
Taranaki	-0.14	0.13	-0.09	0.14	0.11	0.16	0.06	0.18	0.13	0.14	-0.01	0.17	0.16	0.16	0.12	0.18
Tasman	0.12	0.29	0.03	0.30	0.32	0.43	0.36	0.46	0.10	0.39	0.24	0.42	0.49	0.39	0.15	0.51
Waikato	0.03	0.09	0.07	0.09	-0.05	0.12	-0.11	0.14	-0.01	0.11	0.00	0.12	0.06	0.12	0.15	0.13
Wellington	-0.03	0.08	-0.05	0.08	-0.09	0.10	-0.08	0.11	-0.11	0.09	-0.05	0.11	0.02	0.10	-0.21*	0.13
West Coast	-0.40	0.51	-0.49	0.53	-0.07	0.44	0.27	0.42	-0.59	0.69	-0.23	0.62	-0.96	1.05	-0.76	1.06
Rural	0.00	0.07	-0.02	0.07	-0.15*	0.09	-0.12	0.10	-0.06	0.08	-0.20**	0.10	-0.04	0.09	0.06	0.10
Recreational fisher	0.01	0.07	0.03	0.07	0.05	0.08	0.05	0.09	0.17**	0.08	0.06	0.09	0.10	0.09	0.01	0.10
Commercial fisher	0.40	0.32	0.64**	0.30	1.32***	0.26	1.43***	0.28	0.87***	0.25	0.79***	0.30	1.59***	0.24	1.59***	0.25
Customary fisher	-0.29	0.22	-0.43*	0.25	-0.15	0.21	-0.22	0.24	-0.10	0.24	-0.48	0.32	-0.17	0.27	-0.14	0.30
Future user	-0.09	0.06	-0.09	0.06	0.11	0.08	0.16*	0.08	-0.02	0.07	0.02	0.09	-0.06	0.08	-0.03	0.09
Current user	0.02	0.09	-0.02	0.09	0.12	0.11	0.10	0.12	0.15	0.10	0.18	0.12	-0.08	0.11	-0.07	0.13
Future visitor	0.15**	0.06	0.17***	0.06	-0.02	0.08	-0.03	0.09	0.12*	0.07	0.18**	0.08	0.06	0.08	0.06	0.09
Current visitor	0.18***	0.06	0.19***	0.06	-0.09	0.08	-0.03	0.09	0.00	0.07	-0.02	0.09	0.04	0.08	-0.06	0.09

Explanatory variable N = 847 (208 excluded due to item non-responses)	Bio-Good (Mean = 217.2, Residual deviance = 84.8)		Bio-Medium (Mean = 123.1, Residual deviance = 51.5)		MCul-Exclusive (Mean = 105, Residual deviance = 67.7)		MCul-Partner (Mean = 76.1, Residual deviance = 51.8)		Rec-High (Mean = 105.6, Residual deviance = 58)		Rec-Medium (Mean = 51, Residual deviance = 37.5)		Com-High (Mean = 98.3, Residual deviance = 69.4)		Com-Medium (Mean = 38.7, Residual deviance = 35)	
	Coeff.	s.e.	Coeff.	s.e.	Coeff.	s.e.	Coeff.	s.e.	Coeff.	s.e.	Coeff.	s.e.	Coeff.	s.e.	Coeff.	s.e.
Māori-Org	-0.24**	0.11	-0.36***	0.12	-0.09	0.12	-0.17	0.13	-0.40***	0.14	-0.42***	0.16	-0.26	0.16	-0.38*	0.20
Environment-Org	0.14	0.09	0.09	0.10	0.33***	0.11	0.28**	0.12	0.09	0.12	0.13	0.14	-0.10	0.14	-0.09	0.17
Rec-Fishing-Club	-0.15	0.17	0.01	0.18	0.02	0.20	0.03	0.23	-0.05	0.18	-0.09	0.23	0.06	0.21	0.12	0.22
Aware	0.02	0.06	0.01	0.07	0.13	0.08	0.25***	0.09	0.01	0.08	0.02	0.09	0.07	0.09	0.16*	0.10
Know some	0.14*	0.08	0.10	0.08	0.12	0.10	0.05	0.11	0.07	0.09	0.03	0.11	0.05	0.11	-0.13	0.12
Know a lot	0.34*	0.17	0.37**	0.19	0.62***	0.18	0.69***	0.19	0.50**	0.20	0.59***	0.23	0.41*	0.25	0.02	0.32
MC-2	-0.04	0.05	-0.03	0.06	0.53***	0.09	0.81***	0.10	-0.06	0.06	-0.12	0.07	-0.08	0.07	-0.17**	0.08
MC-3	0.03	0.09	0.07	0.09	0.68***	0.11	0.85***	0.13	-0.05	0.10	-0.09	0.11	-0.11	0.11	-0.02	0.12
MR-2	0.35***	0.13	0.49***	0.14	-0.62***	0.15	-0.67***	0.17	0.08	0.13	-0.14	0.15	-0.14	0.15	-0.30*	0.16
MR-3	0.35***	0.11	0.37***	0.12	-0.38***	0.11	-0.39***	0.12	-0.16	0.11	-0.21*	0.12	-0.15	0.12	-0.29**	0.13
MR-4	0.38***	0.11	0.41***	0.11	-0.42***	0.10	-0.44***	0.11	-0.24**	0.10	-0.34***	0.11	-0.14	0.11	-0.40***	0.12
Sort of confident	-0.11**	0.05	-0.10*	0.05	0.01	0.07	0.01	0.07	-0.06	0.06	-0.03	0.07	0.04	0.07	-0.06	0.08
Not confident	-0.17*	0.09	-0.15	0.09	0.19*	0.10	0.11	0.12	0.04	0.10	0.00	0.11	0.10	0.11	0.14	0.12
Protest taxes	-0.32***	0.08	-0.33***	0.09	-0.26**	0.11	-0.18	0.11	-0.16*	0.09	-0.13	0.11	-0.09	0.10	0.00	0.11
Social-desirability	0.13**	0.05	0.12**	0.06	0.29***	0.06	0.33***	0.07	0.04	0.07	0.06	0.08	-0.06	0.08	-0.09	0.09
Speedy	-0.37***	0.11	-0.49***	0.12	0.18	0.12	0.01	0.14	0.24**	0.10	0.28**	0.12	0.35***	0.11	0.50***	0.11

Distribution : Poisson
Link function : Log
Reference level : Male, Māori, Age15-39, No qualification, Unemployed, Auckland, Town, Non-fisher, Non-user, Non-visitor, Non-Māori-Org, Non-Environment-Org, Non-Rec-Fishing-Club, Unaware, Know nothing, MC-1, MR-1, Confident, Non-protest taxes, Non-social-desirability, Non-speedy
Significant level : *** significant at 1%, ** significant at 5%, and * significant at 10%

Controlling for the indicators of inaccurate responses to the choice experiment leads to systematic differences in WTP for changes in many socio-ecological attributes. WTP for biodiversity drops with levels of confidence in choices made or if respondents protest taxes. Those potentially subject to social desirability bias tend to be willing to pay more for biodiversity and Māori cultural practices. Alternatively, speedy choice-makers tend to be willing to pay less for biodiversity, but more for avoiding greater restrictions on recreational and commercial fishing.

Note that there is some inconsistency in the determinants of variation in the values of socio-ecological attributes based on WTP (reported herein) relative to those based on relative utility (as reported in Chapter 4). To explain, recall that the dependent variable in each of the regressions reported in Chapter 4 is the ratio of the utility gain from improvement in one socio-ecological attribute to that from the maximum improvement in all of the socio-ecological attributes (the tax attribute was excluded). Each dependent variable is essentially a proportion of the maximum potential total from change in all of the socio-ecological attributes included in the model, i.e., not including the tax attribute.

The dependent variables in the regression reported in Table 17 are also essentially ratios: the rate of change in utility from a change in the relevant socio-ecological attribute (as in Chapter 4) to the rate of change in utility from a change in after-tax income. To put it another way, the dependent variable measures how strongly individuals feel about gains in one of the socio-ecological attributes relative to losses in the ability to purchase goods not included in the choice model. These dependent variables clearly differ from those in the regressions reported in Chapter 4; the numerators in the ratios are the same, but the denominators differ. It seems unsurprising that things change when we bring in preferences for sacrifice of goods not included in the model.

3.2. Population-weighted estimates of WTP

The sample-average WTP values reported in Table 16 probably differ from those that would have been obtained from a population representative sample. We lack the information necessary to estimate the results from a truly random and representative sample of the population. But we can use the demographic information from the

population and the results of the regressions reported in Table 17 to correct for bias related to the divergence of the sample from the population in terms of observed characteristics.

Let us start by obtaining the predicted values for each respondent for each regression:

$$\hat{Y}_i = \hat{\alpha} + \hat{\beta}_1 X_1 + \hat{\beta}_2 X_2 + \cdots + \hat{\beta}_j X_j \quad \text{(Eq. 10)}$$

where:

- $\hat{Y}_i$ $\widehat{logWTP}$ of an *i* respondent estimated from the regression results
- $\hat{\alpha}$ Constant term
- $\hat{\beta}_1 \ldots \hat{\beta}_j$ Coefficients attached to explanatory variables of the regression model
- $X_1 \ldots X_j$ Explanatory variables of the regression model

The predicted value is that of the log of WTP, so taking the anti-log should result in the predicted value of WTP. It turns out, however, that simply taking the anti-log underestimates WTP (by $\exp(\sigma^2/2)$, where σ^2 is the variance of the regression error). Wooldridge (2003, p.208) suggests a simple procedure for obtaining an unbiased estimate of $\widehat{WTP}$:

$$\widehat{WTP} = \hat{\alpha}_0 \exp(\widehat{logWTP}) \quad \text{(Eq. 11)}$$

where

$\hat{\alpha}_0$ is the coefficient from a regression of WTP on $\exp(\widehat{logWTP})$ without an intercept.

$$\overline{\widehat{WTP}} = \hat{\alpha}_0 \exp(\widehat{log}\overline{WTP}) \quad \text{(Eq. 12)}$$

Table 18 reports the estimate of $\hat{\alpha}_0$ for each regression model.

Table 18: Constant estimator for each regression model

Constant estimator	Regression models							
	Bio-Good	Bio-Medium	MCul-Exclusive	MCul-Partner	Rec-High	Rec-Medium	Com-High	Com-Medium
$\hat{\alpha}_0$	1.05	1.05	1.17	1.22	1.05	1.06	1.05	1.11

How can we use these estimates to correct for population mean WTP? In general,

$$\overline{\hat{Y}} = \frac{\sum \hat{Y}_i}{n} \quad \text{(Eq. 13)}$$

Where:

n Total number of respondents

$$\overline{\hat{Y}} = \frac{\sum_i \hat{\alpha} + \hat{\beta}_1 X_{1i} + \hat{\beta}_2 X_{2i} + \cdots + \hat{\beta}_j X_{ji}}{n} \quad \text{(Eq. 14)}$$

$$\overline{\hat{Y}} = \hat{\alpha} + \hat{\beta}_1 \sum \frac{X_{1i}}{n} + \hat{\beta}_2 \sum \frac{X_{2i}}{n} + \cdots + \hat{\beta}_j \sum \frac{X_{ji}}{n} \quad \text{(Eq. 15)}$$

Each of the terms $\sum \frac{X_{1i}}{n} \ldots \sum \frac{X_{ni}}{n}$ is simply a proportion of a respective categorical variable (e.g. female, Māori) or the mean of a continuous variable (e.g. household size and income) in the sample. Thus, Eq. 15 can be used to predict the mean of a dependent variable for any population if the proportions of its segments represented by the categorical variables and the means of segments represented by continuous variables are known.

The estimated coefficients from the regression analysis (Table 17) can be combined with population characteristics in Eq. 15 to predict $\overline{\hat{Y}}$ (i.e. $\widehat{log}\overline{WTP}$). Each $\widehat{log}\overline{WTP}$ can be then combined with each respective $\hat{\alpha}_0$ (Table 18) in Eq. 12 to obtain population mean WTP for each level of each of the socio-ecological attributes (Table 19). Note that the population means differ from those of the sample reported in Table 16. The differences reflect the effects of the divergence of the sample from the population in terms of socio-economic characteristics.

Table 19: Population mean estimates of WTP

Socio-ecological attributes	Bio-Good	Bio-Medium	MCul-Exclusive	MCul-Partner	Rec-High	Rec-Medium	Com-High	Com-Medium
WTP estimates (NZ$/household)	215.0	122.0	95.2	69.5	107.2	49.2	98.7	39.7

3.3. Treatments of potential bias in the choice experiment

Several potential sources of bias in the results of the choice experiment were discussed in Chapter 4/Section 3.4). The population mean WTP estimates reported in Table 19 do not account for these potential forms of bias. The potential extent of these biases is explored in manner similar to that employed in Chapter 4: the regression analysis includes variables potentially indicative of sources of bias as summarised in the left-hand column of Table 20 (reproduced for convenience from Chapter 4). In each of the first four treatments, one coefficient associated with bias is given zero population weight in Eq. 15. In Treatment 5 all four of the variables associated with bias are un-weighted. The weights of the variables associated with unbiased indicators are correspondingly adjusted. This procedure produces results equivalent to rerunning this choice experiment to obtain a sample of respondents whose characteristics align with those of the population and whose responses are unbiased (to the extent indicated by these measures) and reflect their true preferences.

Table 20: Proportions of each group of people in various treatments of bias

Indicators of bias	Treatment 1	Treatment 2	Treatment 3	Treatment 4	Treatment 5
Confidence in choices made					
Confident	31.2	28.2	28.2	28.2	31.2
Sort of confident	68.8	62.3	62.3	62.3	68.8
Not confident	0	9.5	9.5	9.5	0
Protest taxes					
Protest	88.9	100	88.9	88.9	100
Non-protest	11.1	0	11.1	11.1	0
Social desirability bias					
Non-social-desirability	78.2	78.2	100	78.2	100
Social-desirability	21.8	21.8	0	21.8	0
Choice-making speed					
Non-speedy	92.8	92.8	92.8	100	100
Speedy	7.2	7.2	7.2	0	0

Results are reported in Table 21. The first row reproduces the population-weighted estimates from Table 19. Most notable is that estimates of mean WTP vary relatively little across these treatments; bias from these sources appears reasonably minor. The differences that exist reflect the effects of different sources of bias in the choice experiment on WTP estimates. Despite the differences, improving biodiversity from ‘Poor to Good’ or from

'Poor to Medium' remains the two most highly valued changes. Avoiding some decreases in commercial or recreational fishing remains the two least valued changes.

Table 21: Population mean estimates of WTP (NZ$/household) by various treatments of bias

Socio-ecological attributes	Bio-Good	Bio-Medium	MCul-Exclusive	MCul-Partner	Rec-High	Rec-Medium	Com-High	Com-Medium
Population WTP (No treatment of bias)	215.0	122.0	95.2	69.5	107.2	49.2	98.7	39.7
Treatment 1	216.9	122.9	93.5	68.9	106.4	49.1	98.0	39.0
Treatment 2	222.9	126.5	97.9	71.0	109.1	50.0	99.7	39.7
Treatment 3	209.0	118.8	89.4	64.7	106.3	48.6	100.1	40.5
Treatment 4	220.8	126.4	94.0	69.5	105.4	48.3	96.2	38.3
Treatment 5	224.2	128.6	89.3	65.4	105.5	48.2	97.9	38.4

4. Cost-benefit analysis

The section starts with evaluation of alternative management systems using the population-weighted estimates of WTP (with and without treatments of bias), followed by sensitivity analysis in Section 4.2.

4.1. Evaluation of alternative management systems

Seven scenarios under three strategies of practical local relevance were described in Chapter 4 (Section 5) and are reproduced in Table 22. The levels of each socio-ecological attribute that define each scenario appear in the third through sixth rows. The first two scenarios focus on maintaining/improving Māori cultural practices assuming continued harm to biodiversity. The next two scenarios assume that Māori cultural practices result in biodiversity improvements to medium quality. The fifth scenario focuses on improving biodiversity through the use of marine reserves, which place heavy restrictions on fishing activity. The last two scenarios place a high priority on restoring biodiversity while supporting Māori cultural practices.

Table 22: Annual net economic benefits (NZ$/household) by various scenarios/strategies

Strategy		1 (Māori culture first)				3 (Biodiversity first)	4 (Biodiversity & Māori culture)	
Scenario		1 (Mātaitai)	2 (Taiāpure)	3 (Mātaitai)	4 (Taiāpure)	5 (Marine reserves)	6 (Marine reserves & Mātaitai)	7 (Marine reserves & Taiāpure)
Potential outcomes	Biodiversity	Poor	Poor	Medium	Medium	Good	Good	Good
	Māori cultural management	Exclusive	Partner	Exclusive	Partner	None	Exclusive	Partner
	Recreational fishing	Medium	Medium	Medium	Medium	High – Medium	High	High
	Commercial fishing	Medium	Low	Medium	Low	Medium	High	Medium
Population (without treatment of bias)		6.2	20.3	128.2	142.2	117.4	104.3	137.7
Treatment 1		5.4	19.7	128.3	142.6	120.6	106.0	140.3
Treatment 2		8.3	21.0	134.8	147.5	124.0	112.0	145.0
Treatment 3		0.4	16.1	119.1	134.9	110.8	92.0	126.9
Treatment 4		7.4	21.2	133.8	147.6	125.4	113.1	146.6
Treatment 5		2.7	17.2	131.3	145.8	128.5	110.1	145.7

Annual net per-household economic benefits can be calculated simply by adding up estimated mean WTP of each of the levels of socio-ecological attributes that define each scenario. The results (Table 22) show that policy that improves biodiversity (Scenario 5) or both biodiversity and Māori culture (Scenario 3, 4, 6 or 7) yield substantial net benefit, on average. A mechanism that trades light restrictions on fishing and improvement in biodiversity for preservation of Māori cultural practices (Scenario 1 or 2) has modest net benefit. Better biodiversity clearly has a dominant effect, though the high restrictions on both recreational and commercial fishing hurt the popularity of Scenario 6. These results are very highly correlated with those drawn from the assessment of non-monetary values (reported in Chapter 4). This accordingly provides a rather strong economic justification for allocating larger quantities of near-shore marine areas to marine reserves and/or taiāpure/mātaitai.

4.2. Sensitivity analysis

As discussed earlier, a real concern with the WTP estimates is that many of the estimates fall outside the range in the levels of tax (i.e., after-tax income) included in the survey. The aim of this sensitivity analysis is to investigate the effects on net benefits of the discussed scenarios assuming minimal estimates of WTP.

The logic of the approach taken in this sensitivity analysis is illustrated by Figure 12. Suppose that the solid line shows the estimated functional relationship of utility with income for a particular respondent. In this case, a tax increase of about $200 would be required to off-set a change in a socio-ecological attribute that generates a part-worth utility of 20. This estimated WTP is well outside the highest level of tax increase, $120. As a consequence, there is uncertainty about the trajectory of this utility function (and any other) beyond a change in income of –$120. The actual utility function may follow Trajectory B, C, or even D in a worst case, assuming that the law of diminishing marginal returns (or, conversely, increasing marginal utility of pain) applies. To keep things simple, I assume as a worst case scenario that WTP for any respondent with an estimate of greater than $180 is in fact $180. Recall from Section 2.3 that WTP of $180 is plausible.

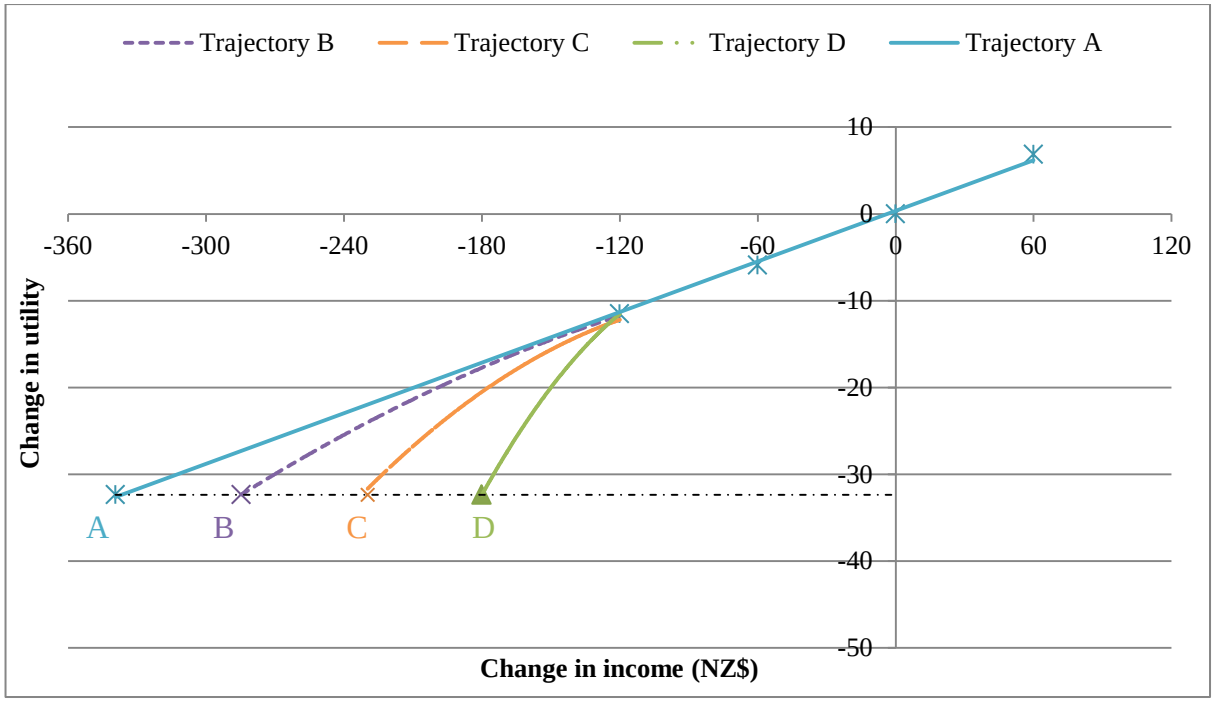


Figure 12: Possible trajectories of a utility function

As a practical matter, this assumption reduces the influence on estimated mean WTP of those respondents whose utility functions are relatively flat in income, i.e., those who reacted the least to changes in tax in the choice survey. It also affects, on average, WTP for biodiversity relatively strongly, since on average the part-worth utility on biodiversity is relatively high, and therefore requires a relatively high increase in tax to off-set.

The resulting 'trimmed' sample mean estimates (i.e. minimal estimates) of WTP for each level of each socio-ecological attribute averaged across all respondents are summarised in Table 23. Not surprisingly, the mean WTP is now considerably lower than that with the 'un-trimmed' estimates (Table 16). And WTP for improvement in biodiversity is now smaller relative to that for improvement in the other socio-ecological attributes.

Table 23: Sample mean estimates of WTP (NZ$/household) under a minimal assumption

Socio-ecological attributes	Bio-Good	Bio-Medium	MCul-Exclusive	MCul-Partner	Rec-High	Rec-Medium	Com-High	Com-Medium
Whole sample WTP	140.3	106.7	84.1	65.3	89.2	48.1	83.5	37.9
Standard deviation	50.5	59.5	61.1	60.0	52.0	43.4	56.1	41.8

To adjust the mean estimates of WTP to the characteristics of the population, the minimal estimates of WTP for each respondent were regressed on the twenty three sets of explanatory variables as before. The modelling results appear in Appendix C. Table 24 reproduces Table 21 except using results from the minimal estimates of WTP. Again, population weighting tends to increase WTP for biodiversity and decrease WTP for support of Māori cultural practices, due to the over-sampling of Māori in the survey. However, Table 24 overall indicate relatively little variation in WTP estimates down the rows. The main differences from Table 21 are that the mean WTP estimates are generally lower, with a relatively larger drop in mean WTP for biodiversity.

Table 24: Population mean WTP estimates (NZ$/household) by various treatments of bias under a minimal assumption

Socio-ecological attributes	Bio-Good	Bio-Medium	MCul-Exclusive	MCul-Partner	Rec-High	Rec-Medium	Com-High	Com-Medium
Population WTP (No treatment of bias)	141.4	110.0	76.9	60.9	88.9	46.5	82.0	37.1
Treatment 1	141.8	110.5	75.8	60.2	88.4	46.3	81.8	36.5
Treatment 2	143.7	113.3	78.5	61.7	89.9	46.9	82.5	37.0
Treatment 3	138.7	106.4	73.6	57.4	89.3	46.1	82.7	37.7
Treatment 4	143.0	112.8	75.8	60.6	87.2	45.4	80.4	35.7
Treatment 5	142.9	113.0	72.9	57.3	88.2	45.2	81.3	35.6

Finally, we can use these more conservative WTP estimates to calculate net economic benefits from implementation of the seven management scenarios discussed earlier in the context of Table 22. As earlier, annual net economic benefits can be calculated simply by adding up the more conservative estimates of mean WTP for each of the levels of socio-ecological attributes that define each scenario. The results appear in the same format in Table 25. The largest net gains again come from policies that maintain a medium level of biodiversity, encourage Māori cultural practices in partnership with others in the community and thereby only modestly restrict recreational fishing. Protecting biodiversity not surprisingly has net benefits that are substantial but relatively small compared to those in Table 22. Exclusive Māori control of near-shore marine management that results in poor biodiversity now results in negative net benefit.

Table 25: Annual net economic benefits (NZ$/household) by various scenarios/strategies under a minimal assumption

Strategy		1 (Māori culture first)				3 (Biodiversity first)	4 (Biodiversity & Māori culture)	
Scenario		1 (Mātaitai)	2 (Taiāpure)	3 (Mātaitai)	4 (Taiāpure)	5 (Marine reserves)	6 (Marine reserves & Mātaitai)	7 (Marine reserves & Taiāpure)
Potential outcomes	Biodiversity	Poor	Poor	Medium	Medium	Good	Good	Good
	Māori cultural management	Exclusive	Partner	Exclusive	Partner	None	Exclusive	Partner
	Recreational fishing	Medium	Medium	Medium	Medium	High-Medium	High	High
	Commercial fishing	Medium	Low	Medium	Low	Medium	High	Medium
Population (without treatment of bias)		-6.7	14.4	103.3	124.4	61.9	47.4	76.3
Treatment 1		-7.0	13.9	103.5	124.4	63.1	47.3	77.0
Treatment 2		-5.4	14.8	107.8	128.1	63.7	49.8	78.5
Treatment 3		-10.2	11.4	96.2	117.8	57.8	40.2	69.2
Treatment 4		-5.3	15.2	107.5	128.0	65.5	51.2	80.7
Treatment 5		-8.0	12.1	105.0	125.0	64.3	46.3	76.3

5. Discussion and conclusions

5.1. Reflections on methodological issues

In order for people to reveal meaningful preference information they must explicitly confront trade-offs (Adamowicz et al., 1998; Bennett & Blamey, 2001; Louviere et al., 2000). In this study, a large sample of New Zealanders participated in a choice experiment in which choices involved trade-offs in the levels of four policy-relevant attributes of near-shore marine areas. A fifth attribute, tax level, was also included to allow estimation of WTP for changes in each of the socio-ecological attributes.

Implementation of any choice model itself requires trade-offs. In the extreme, the researcher would like each respondent essentially to rank every combination of all levels of all five attributes or choose one from several of these combinations at a time. However, comparing even two combinations of five attributes is cognitively challenging. And the number of potential five-attribute combinations is very large. In this study, respondents compared a series of just two combinations of two attributes at a time. Each choice is cognitively as easy as such choices can be. Nevertheless, the number of potential choices is still relatively high (122 in this case). The number of choices is reduced to a manageable level by taking advantage of the logic of transitivity property; the software eliminates all choice combinations logically implied by each choice made explicitly by the respondent. The respondent continues choosing until all possible combinations of two attributes have been answered explicitly or implicitly via transitivity. In this case, the average number of (relatively easy) choices was 27.

Worth pointing out are the main advantages and disadvantages of this (PAPRIKA) method. The advantages are that each choice is relatively easy, there aren't 'too many' choices, and the choices provide a very rich set of information, sufficient to estimate a full set of part-worth utilities for each respondent. This allows exploration of the correlates of preferences and the estimation of population-representative means (insofar as characteristics of the population and sample are observed).

The method also has its potential disadvantages. The method enforces a relatively simple utility function that is strictly additive in attributes. In particular there are no interactions among attributes. Though interactions among attributes of consumer goods may be important, interactions across the attributes in this choice model seem less so. In addition, as a practical matter, increasing the number of attributes considered in each choice to allow interactions increases responder burden. As discussed by Bennett & Blamey (2001), respondents may react by resorting to "simplified decision strategies" that effectively limit the accuracy of estimates of interaction effects. Another potential disadvantage is that an error in making a choice may produce relatively large errors in the estimated utilities because a wrong choice eliminates all the choices implied by it. Sullivan (2012) investigates this possibility by asking a sub-sample of respondents to repeat the choice survey after two weeks. The results are largely consistent with those from the initial survey.

A number of methodological issues facing other stated preference techniques (e.g. hypothetical, strategic, information, task understanding, protest against taxes, and social desirability biases) were addressed in this choice experiment. As discussed in Chapter 4, an attempt, following (Bennett & Blamey, 2001), was made to establish some expectation in respondents (in the information sheet) that their views would be used in some fashion in shaping policy. In addition, a number of other efforts were made to assess the potential impacts of biased choices on survey results. In general, these impacts appear small (as shown in Tables 21 and 24), and none affected the overall evaluation of the various management scenarios currently under discussion (as shown in Tables 22 and 25).

Nevertheless, there remain some areas where future applications of the choice experiment should be considered. As discussed in Chapter 4, hypothetical bias can be addressed more effectively with two additional measures to those employed in this study. A follow-up question can be used to identify those who are likely to have been involved in hypothetical bias. Some redundancy in choices presented to respondents can also help identify inconsistent responses and accordingly those who are not taking the survey seriously. It is worth noting that there is no way to perfectly determine whether respondents do not treat the survey as merely hypothetical and therefore make choices according to their true preferences. Multiple

approaches (including those taken in this study and some additional ones just discussed) can minimise hypothetical bias.

An issue that arose is that some estimates of WTP fell well outside the range of tax increases included in the choice model. One option would have been to include one or more additional levels of tax payments, which has the disadvantage of lengthening the choice survey, potentially reducing the reliability of the results (Hansen & Ombler, 2009). The numbers of attributes and their levels can be kept as they are by increasing the spacing between levels, e.g., to $100 from the current $60. Another option would be to drop Tax-$60 (an indication of WTA) and add a tax level that is valued greater than $120 (say Tax+$240). As discussed in Chapter 4, Tax-$60 was included in this choice experiment to establish a sense of neutrality to respondents. Non-neutrality is one of the factors that can lead to biased WTP estimates (Bennett & Blamey, 2001). Therefore, there is a trade-off between estimation bias induced by likely increasing non-neutrality (due to the drop of Tax-$60) and that induced by likely increasing burden to respondents.

Like many other valuation studies, this study employs WTP as a measure of values. WTA has been alternatively used in some studies. Nevertheless, I have never seen a study that employed both measures. I suspect that both measures can be employed in choice experiments that involve valuing both benefits and opportunity costs of a policy. For example, the choice model presented herein may be redesigned to allow estimation of both WTP and WTA by adding some more levels of the tax attribute on the decrease side (say, Tax-$120, Tax-$180). In so doing, attention should be paid to balancing the increase in information acquired with the number of choice questions with the burden to respondents, as discussed above. It seems plausible that WTP is ethically appropriate for valuing biodiversity and Māori culture, whereas WTA is more appropriate for valuing opportunity costs induced by greater restrictions on recreational and commercial fishing. WTA can be expected to be larger than WTP due to the law of diminishing marginal returns or, conversely, increasing marginal pain (see Figure 9). However, this might not be always the case (see Louviere, 2001, p.32). In theory, the differences between WTA and WTP estimates can be negligible with small changes in income (Boardman et al., 2006). It would be interesting then to see

how value estimates using both measures are different in real case studies. This is accordingly an area on which future application of choice experiments may focus.

5.2. Policy implications

Despite their limitations, choice experiments provide a way to value intangible environmental goods and services in monetary terms that can be used in cost-benefit analysis of policy that affects the supply of these goods and services. Failure to do such valuation may encourage resource allocation to be biased against mechanisms that provide these intangible benefits. This bias, especially relative to biodiversity, has been repeatedly emphasised in the literature (e.g. Biological Diversity Advisory Committee, 2005; Costanza et al., 1998; Loomis et al., 2000; TEEB, 2010).

The results reported in this chapter indicate the current allocation of near-shore marine areas in New Zealand may be sub-optimal. Cost-benefit analysis using the results from this choice experiment shows that an annual net economic benefit of roughly NZ$100 per household (NZ$165 million for the nation overall),[xxiv] or at least NZ$40 per household (NZ$66 million for the nation) using the more conservative estimates of WTP, can be generated by allocating some near-shore fisheries to implement a policy that improves either biodiversity or both biodiversity and Māori cultural practices. As reported in Chapter 3, these outcomes can be reliably achieved by joint implementation of Marine Reserves and Taiāpure (or Mātaitai in areas of greater cultural significance to Māori) in the form of Biosphere Reserves or Marine Protected Areas. The positive net economic benefit suggests the joint implementation satisfies the 'Potential Pareto Improvement' (PPI) criterion or passes a potential improvement test (Boardman et al., 2006; Hanley & Spash, 1993; Perkins, 1994; Scarborough & Bennett, 2012). Therefore, there is sufficient money that could in concept be transferred from the beneficiaries of this alternative management system to the losers (i.e. recreational and commercial fishers) so that after the transaction each household gains an amount equal to the net economic benefit.

[xxiv] The total number of households in New Zealand is roughly 1.65 million (total population ≈ 4.47 million and mean household size ≈ 2.7, according to http://www.stats.govt.nz/).

The PPI criterion does not require the compensation be paid, but it may be needed in this case for equity issues. The most obvious way is to buy back commercial quota that would be affected by the alternative management systems. However, it is difficult, if not impossible, to identify and accordingly compensate for affected recreational fishers. One possible way to deal with recreational fishers is to buy extra commercial quota such that reductions in recreational daily bag limits are not required and the expected benefits of the alternative management systems (in terms of biodiversity and Māori culture) are maintained. The substitution between reductions in commercial quota and recreational daily bag limits might be done without any effect on the net economic benefits of the alternative management system given that the opportunity costs of greater restrictions on recreational fishing are somewhat greater than the opportunity costs of greater restrictions on commercial fishing.

Scepticism about the results in this chapter is appropriate. For instance, this cost-benefit analysis might be considered partial. If so, it may be reconstructed whenever dollar values of other costs and benefits (if any and plausible) become available; reconstruction of other management scenarios defined by different levels of socio-ecological attributes are also possible. Based on a comprehensive balance sheet of costs and benefits of a marine protected area (Dalton, 2004; The Allen Consulting Group, 2009), this cost-benefit analysis might need to include costs associated with additional planning, compliance enforcement, and monitoring. Nevertheless, these costs (albeit currently unknown) can be small relative to the net economic benefit reported above. Costs associated with displacement of commercial and recreational fishing and benefits associated with potential increases in fishing benefits are already counted.

One might also be sceptical about the estimation of opportunity costs associated with greater restrictions on commercial fishing. In this study, restrictions on commercial fishing are considered as the concern of the general public rather than the concern of commercial fishers themselves. The opportunity costs estimated are accordingly not just the loss of profit associated with reductions in commercial quota, but also the loss of benefits the general public is expected to experience as a result of a decrease in the economic activity induced by commercial fishing. Under a quota management system, the loss of profit from greater restrictions is simply equal to quota prices times the amount of the reduced quota (Tietenberg,

2004). Given this, the opportunity costs estimated in this study are most likely to be conservative. An alternative way to see why such estimation is conservative is to look at the opportunity that the commercial quota can be bought back. Without accounting for the opportunity costs associated with greater restrictions on commercial fishing (roughly NZ$98 per household), the annual net economic benefit reported above would increase to NZ$198 per household (NZ$326.7 million for the nation overall). This amount is most likely to be more than sufficient to buy back commercial quota that would be reduced due to the effect of the relevant policy and perhaps some extra commercial quota to substitute for not reducing recreational bag limits.

Chapter 6 Implications for policy and issues for future research

1. Where have we got to?

This research started with an overarching goal to identify opportunities to improve social well-being associated with the long-term allocation of near-shore marine resources. The main findings are summarised in Figure 13. The literature review in Chapter 2 identified a direction for marine policy for achieving sustainability of the complex, coupled social-ecological marine systems as well as obstacles to moving policy in this direction. These findings not only motivated detailed exploration of the associated issues in real case studies, but also informed the design and analysis of the studies, as reported in Chapter 3 (A). These results are critical for the design of the choice experiment, the results of which are reported in Chapter 4 (B and C) and Chapter 5 (D).

In this chapter, all results from the preceding chapters are drawn together. The next section discusses implications for the spatial allocation of near-shore marine areas in New Zealand. Policy implications are discussed in some length in each respective chapter. Rather than repeating the many policy implications, this chapter relates these implications to the implementation of New Zealand Marine Protected Areas (MPAs) Policy (Department of Conservation & Ministry of Fisheries, 2005). An economic model for achieving efficiency in marine spatial allocation is proposed in Section 3. The significance of environmental valuation studies and epistemological challenges are discussed in Section 4, followed by pros and cons of non-monetary and monetary valuation in Section 5. A final comment appears in Section 6.

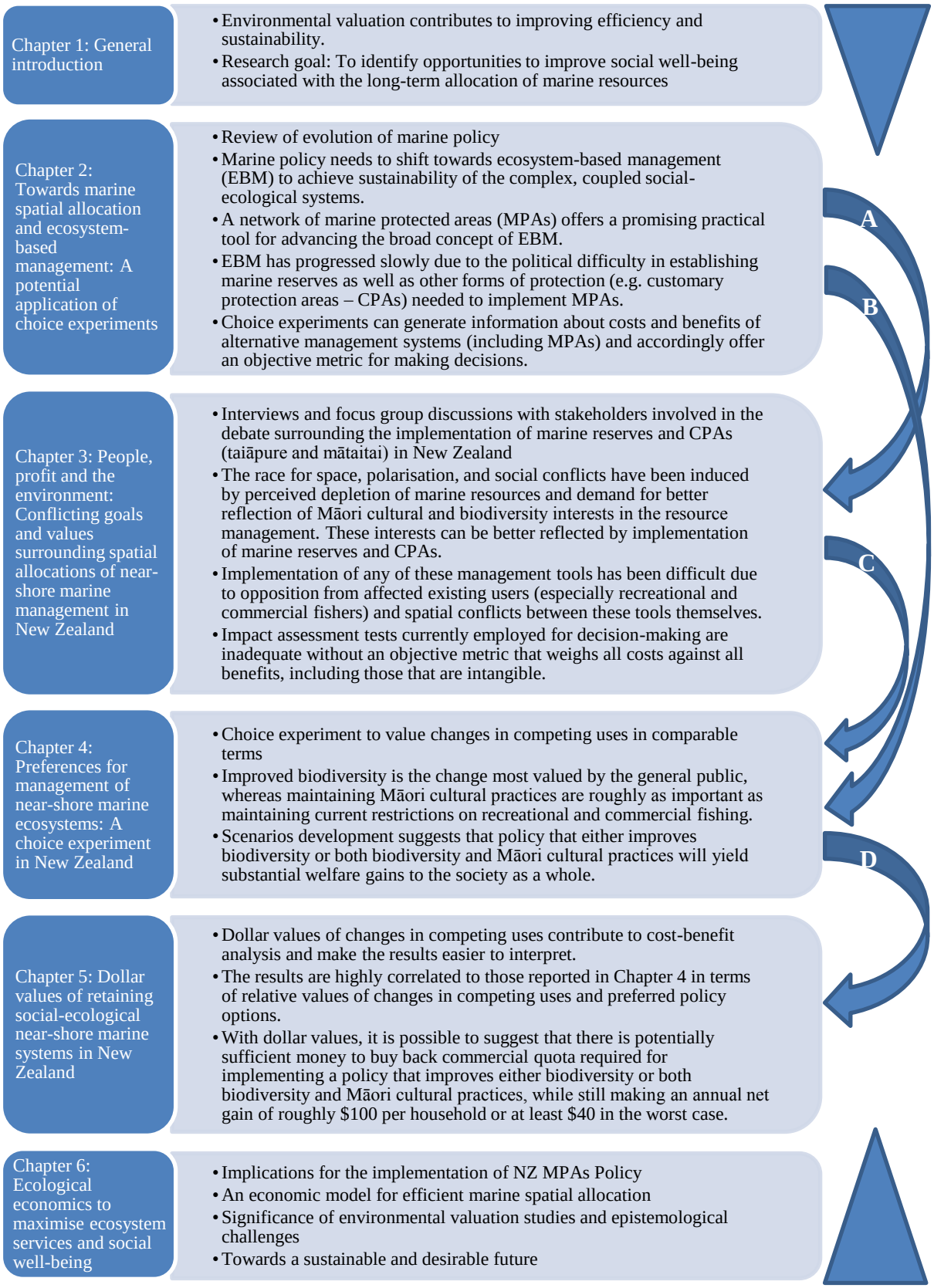


Figure 13: Summary of thesis results

2. Implications for the implementation of New Zealand Marine Protected Areas Policy

According to the Marine Protected Areas (MPAs) Policy formally released in 2005 (Department of Conservation & Ministry of Fisheries, 2005), the government is committed to setting aside ten per cent of the marine environment in a network of MPAs that is comprehensive and representative of New Zealand's marine habitats and ecosystems. The policy implementation has been delayed due to the difficulty inherent in providing marine protection in near-shore areas (Bess & Rallapudi, 2007; Helson et al., 2010). Among many eligible tools, marine reserves are most suited for inclusion in the MPAs network; taiāpure and mātaitai may also be included in that network if the Māori communities who manage them wish to do so and if these Māori mechanisms meet the policy's protection standard (Department of Conservation & Ministry of Fisheries, 2005).

The results from this general study provide a rather strong indication that the MPAs Policy should move forward. The policy implementation can be justified on ecological, social-cultural and economic grounds. The current management regimes, which focus on commercial and recreational fishing, have resulted in declining fish stocks and more general harm to biodiversity and ecosystem health (Dick et al., 2012; McCarthy et al., 2013). The race for space among various interest groups, polarisation, and social conflicts as in the case study (Akaroa Harbour) can be expected to occur as resources become depleted. Biodiversity is coveted by many people for its own sake and for human benefits over the long term. Depletion of fish stocks also puts Māori cultural practices at risk. People respond to resource depletion in varying ways based on their socio-economic affiliations, and their perceptions and beliefs to protect their own and societal values.

It seems unlikely that the race for space, polarisation, and social conflicts can be settled down without practical representation in policy of the values of the various groups affected by marine management. Therefore, a desirable strategy to prevent these issues from occurring (and reconcile them if already in place) is to prevent fish stocks and biodiversity from declining further and restore those that are depleted, while at the same time taking into account Māori cultural and biodiversity interests. As reported in Chapter 3, this can potentially be achieved through joint implementation of marine reserves and taiāpure (or

mātaitai in areas of greater cultural significance to Māori) in a biosphere reserve model. Given the promise of this model in achieving sustainability, the joint implementation is perhaps the most likely to meet the protection standard of the MPAs Policy. Furthermore, scenarios development based on results from the choice experiment (reported in Chapter 4 and 5) indicates that the joint implementation could yield a substantial net gain in social welfare. Therefore, a network of MPAs should be established to benefit the larger public and generate a level of welfare greater than what can be provided by the current management regimes.

Where should we start? As discussed in Chapter 2, perhaps the most effective way is to start in areas with the greatest problems, those heavily used and high conflict areas such as harbours, bays, and estuaries. Success in these areas could build support for change at larger regional and national scales. In essence, marine reserves and CPAs candidates may be identified in harbours, bays, and estuaries by making good use of local and traditional ecological knowledge and science. Efforts may then be made to join both tools (in each area where their candidates are identified) in the model of biosphere reserves (Chapter 3/Figure 3) to form MPA candidates.

Preservationists (especially the Department of Conservation) should negotiate and collaborate with Māori communities so that MPA candidates support features of Māori cultural practices at the best possible way. If consensus cannot be reached, the formulation of the MPA candidates should be set at the highest possible priority according to both environmental and cultural precautionary principles (Curtin & Prellezo, 2010; Phipps et al., 2011). This priority setting holds even in situations where the implementation of the MPA candidates are claimed to infringe on Māori *rangatiratanga* (chieftainship, right to exercise authority (Jackson, 2013)) because degradation that adversely affects the continued use or enjoyment of resources, whether in spiritual or in physical terms, is in itself an infringement of rangatiratanga (Kerr, 2006).

The MPA candidates may be then selected to ensure comprehensiveness and representativeness of marine habitats and ecosystems at the regional and national scales. As discussed in Chapter 2, this is quite challenging given our limited knowledge of complex

marine systems. Adaptive management appears as perhaps the best available strategy to overcome this challenge (Curtin & Prellezo, 2010). MPAs may be selected and formed into a network based on the available knowledge. Sizes, scopes and perhaps locations may be then modified as new knowledge becomes available.

Ideally, the MPAs network should be proposed and implemented as a package in order to achieve the MPAs Policy as efficiently as possible. Such a proposal might reduce opposition due to concerns of an indefinite increasing number (one at a time) and size of protection areas (Chapter 3). However, marine reserves and some forms of CPAs (taiāpure and mātaitai) may only be applied separately according to the existing legislation. Further investigation into how to make the application of that package meets the legal requirement is accordingly needed.

Opposition from affected existing users may remain a barrier to the implementation of the MPAs network, however. Dialogue among stakeholders can generate first answers that help orient the proposed MPAs network. However, if consensus cannot be reached and if the implementation of the proposed MPAs network is expected to cause controversy, the choice experiment approach presented in this thesis could potentially be adapted to gauge individual and public preferences that can be used as inputs, or to make justifications, for decision-making. With a concrete proposal for the MPAs network, socio-ecological attributes and levels used in the choice experiment could be made to resemble more closely the actual aspects of these proposed MPAs.

A tax attribute may be included, if necessary, in the choice experiment to value changes in socio-ecological attributes in dollars. Dollar values contribute to real cost-benefit analyses and are often easier for lay people and decision-makers to grasp. As reported in Chapter 5, if the net dollar benefit is positive, it is possible to suggest that there is potentially sufficient money to transfer from the beneficiaries (i.e. the general public) to the losers (i.e. commercial and recreational fishers). Compensation to the affected users (especially commercial fishers) may be needed in this case in order to treat concerns about equity. The most obvious way that compensation can be paid in that case is to buy back commercial fishing quota. Hence, dollar values provide an indication of how much the general public might be prepared to pay for the

benefits they expect from the implementation of MPAs. How to design an appropriate payment scheme is another issue and may be further investigated in future research.

3. An economic model for efficient allocation of near-shore marine areas

In an economic way of thinking, we should allocate marine space to allow the combinations of uses that maximize 'total net social benefit' (Macleod et al., 2009). The correct measure of economic costs and benefits required to calculate the net benefit in welfare economics is changes in the present value of social well-being (Kubiszewski et al., 2013; Musikanski & de Graaf, 2013). For simplicity, let us focus on an allocation model that involves only two alternative uses of marine space: MPAs (marine reserves and restricted use zones) and fishing in normal use zones (Chapter 3/Figure 3); though this model may be used to guide spatial allocation between any two alternative uses.

Analysing the trade-offs in allocating marine areas to fishing versus MPA is interesting for several reasons. The benefit from allocating space to fishing is tangible. For instance, commercial fishers benefit in dollars from sale of their fish and, of course, pay their costs in dollars to suppliers of labour and equipment. Some of the benefits from allocating space to an MPA are also tangible: money spent by tourists to explore the biodiversity of the MPA. Other benefits are less tangible and therefore more difficult to measure. First, an MPA to some extent protects the viability of fishing resources, which is of value to fishers in the future (i.e. option use value). Second, biodiversity has 'non-use (bequest, altruistic and existence) values' to New Zealanders, many of whom may never visit an MPA.

In Figure 14, let MB_MPA and MB_Fishing represent the net marginal social benefits of using a given quantity of marine space for MPAs and fishing, respectively. Let us assume that each net benefit is proportional to the size of the allocated area (i.e. the smaller the size, the lower the net present benefit). MB_MPA and MB_Fishing are portrayed as a function of the size of area within the available limited marine space (Q_1Q_2). The quantity of space allocated to MPAs is read from left to right while the quantity allocated to fishing is read from right to left. Thus, increasing the size of area for MPAs would result in a smaller area for fishing.

Both MB_MPA and MB_Fishing curves slope downward due to the diminishing returns from the use of a scarce resource.

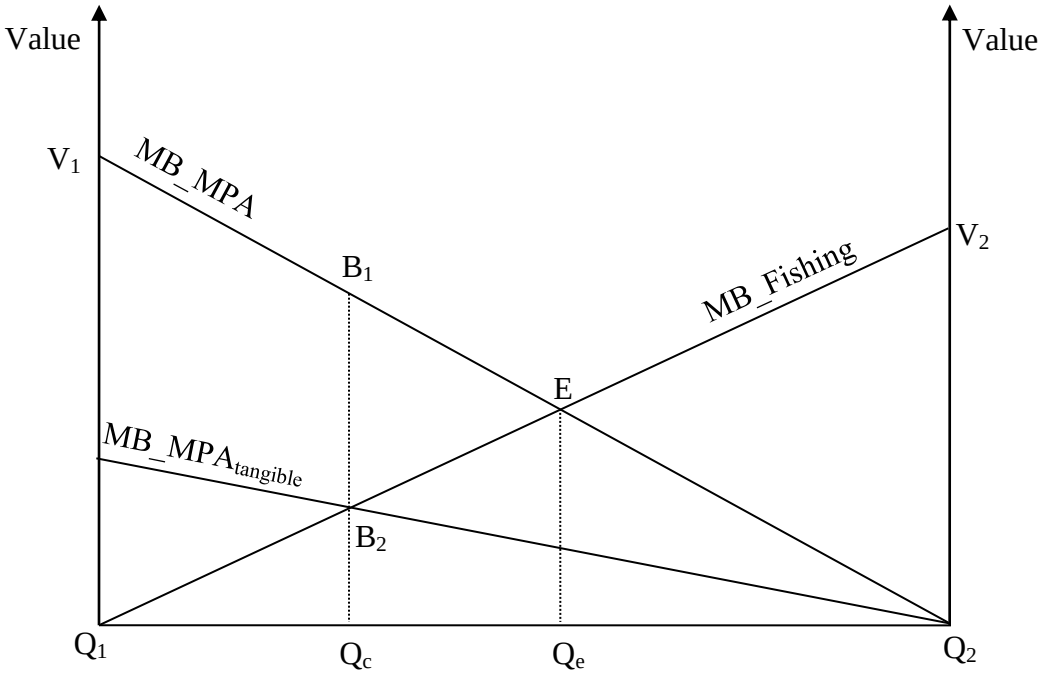


Figure 14: Efficient spatial allocation

An economically efficient allocation is achieved at Q_e where the marginal net benefits from both alternative uses are equal. It is practically difficult, if not impossible, to identify Q_e with precision. In any case, with the allocation at Q_e, MPAs cover an area equal to Q_1Q_e, whereas fishing covers an area equal to Q_2Q_e. This allocation generates the highest total net present benefit, which is graphically equal to the sum of $Q_eEV_1Q_1$ (the net present benefit from MPAs) and $Q_eEV_2Q_2$ (the net present benefit from fishing).

Any allocation of the marine area for the two alternative uses that differs from Q_e would be inefficient. For instance, as suggested by the findings in this study, the marginal social benefit of MPAs is greater than the marginal social benefit of fishing areas at the current marine spatial allocation in New Zealand. This current allocation can be graphically observed somewhere between Q_1 and Q_e. Let Q_c be the current allocation. This allocation could be efficient only if $MB_MPA_{tangible}$ was the marginal social benefit of MPAs. $MB_MPA_{tangible}$

might be so only if MPAs did not generate intangible benefits. However, due to the substantial intangible benefits of MPAs, the current allocation is thereby economically inefficient.

To maximise the net benefit from marine spatial allocation, we should shift the current allocation to Q_e where both marginal net present social values are equal (E). That is, we should progressively allocate more marine areas for MPAs until Q_e. Nevertheless, the allocation for MPAs more than Q_e would again produce an inefficient outcome because the marginal net present social value of MPAs is lower than that of fishing areas. This result can be observed in any allocation between Q_e and Q_2.

With the current allocation at Q_c, the total net present social benefit is graphically equal to the sum of $Q_cB_1V_1Q_1$ (a net present social benefit from MPAs) and $Q_cB_2V_2Q_2$ (a net present social benefit from fishing). If it is possible to allocate more fishing areas for MPAs until Q_e, a net gain in social value graphically equal to EB_1B_2 will be generated. Notice that the opportunity cost of fishing that is graphically equal to $Q_cQ_eEB_2$ would be lost, but it is well captured by an increase in the benefit of MPAs. So, this opportunity cost does not represent a loss to the economy; it is just a benefit transfer from fishing to MPAs within the economy.

To further improve efficiency in the allocation of marine resources, allocation models for improving efficiency in resource allocation in each zone (or in a further lower level of a nested hierarchy of marine areas) may be further investigated. For instance, efforts may be made to allocate quota in fishable areas (e.g. restricted use or normal use zones) between different types of fishing (e.g. commercial, recreational, and perhaps customary) to allow the combinations of uses that maximize the 'total net present benefit'. This highlights an area on which future research may be focused.

4. Significance of environmental valuation studies and epistemological challenges

Environmental valuation (not necessarily in monetary terms) lies at the core of every effort to improve efficiency in the allocation of all natural resources. Various benefits associated with biodiversity preservation (including indirect use, option and non-use values) and traditional

cultural practices associated with use of the resources are largely intangible. Intangible categories of the benefits people have received (i.e. ecosystem services) or expect to receive from natural environment (i.e. option use and non-use values) are difficult to value and are often side-lined when making decisions that involve inevitable trade-offs between these intangible benefits and the tangible ones (TEEB, 2010). However, the well-being of individuals in the society is, as reported in Chapters 4 and 5, affected by changes in the intangible benefits in a similar way as it is affected by changes in the tangible ones as well as changes in the ability (i.e. changes in after-tax income) to purchase other market goods. Public policy may fail to achieve efficiency in resource allocation and miss opportunities to increase welfare in the context of limited natural resources without properly accounting for these intangible benefits. Conversely, having quantitative values (especially in monetary terms) for the intangible benefits in terms comparable with the tangible ones could potentially provide justification for choosing a conservation option over a more resource-exploitation alternative.

Revealed and stated preference techniques are the only two available tools that can be used to value intangible benefits as they are not traded in markets. Revealed preference techniques (e.g. travel cost and hedonic pricing methods) have been extensively applied and have established their theoretical and practical credentials. However, their applications are not only limited to the provision of information regarding the values that have been experienced, but also constrained by a limited number of cases where non-market values exhibit a quantifiable relationship with a market good (Bennett & Blamey, 2001). This means that valuation of the intangible benefits in many circumstances (especially where a change to resource allocation is proposed) depends on stated preference techniques.

Whilst choice experiments can be more promising than the alternative stated preference technique (i.e. contingent valuation methods), the fact remains that the former still depends on preferences people state in the survey. Many methodological challenges can potentially distort the validity of results from a choice experiment study. The fundamental one is associated with the difficulty inherent in conveying through a questionnaire to survey respondents what a policy-maker or a researcher wants them to take into account in a way that

is both theoretically and technically sound and also understandable and plausible (Bennett & Blamey, 2001). Another challenge involves the complexity and cognitive burden of choice questions to respondents. Recall that there are various approaches to conducting a choice experiment, each with its own strengths and weaknesses (see e.g. (Hanley et al., 2001) for a review of the various approaches). The approach (PAPRIKA – 'Potentially All Pairwise RanKings of all possible Alternatives') employed in this study is relatively simpler and natural. Still, approximately 9.5% of the respondents were not confident in choices made, implying complexity or cognitive difficulty of the choice questions. Other challenges include how to effectively address various sources of potential bias in a choice experiment and how to make the results obtained from a survey drawn a sample of observations from a population generalizable.

Because we still have much to learn about the limitations and possibilities of a choice experiment approach (especially PAPRIKA), its future applications should routinely include methodological experiments as part of their study design. In addition to the many problematic methodological issues and research gaps reported in the preceding chapters and those discussed above, two types of future research priorities are suggested. First, replication of the approach taken in this study to investigate opportunity to improve efficiency in long-term allocation of natural resources in a freshwater and terrestrial context is desirable. Second, comparative studies between PAPRIKA and other choice experiment approaches should be considered with a view to improving the reliability of results from a choice experiment for guiding public policy in general rather than to be defensive about any particular approach.

5. Non-monetary and monetary valuation: pros and cons

Choice experiments can be designed, as demonstrated in this thesis, to allow valuing changes in relevant attributes in both non-monetary and monetary terms. The former metric (Chapter 4) contributes to multi-criteria analysis (MCA), whereas the latter metric (Chapter 5) contributes to cost-benefit analysis (CBA), of policy that affects the environment and the distribution of its benefits. CBA is argued to be better than MCA for guiding public policy (Dobes & Bennett, 2009). Nevertheless, each metric has its own pros and cons.

At least two major advantages of non-monetary values can be realised. First, non-monetary values might be ethically more appropriate than monetary ones. Some people object strongly to any attempt to monetise intrinsic value (Justus et al., 2009; Maguire & Justus, 2008), but there was no such objection from those who have made efforts to protect intrinsic value of biodiversity in this study (Chapter 3). Second, estimation of non-monetary values is by construction less affected by income levels and therefore might be the more sensible to measure of changes in the well-being of individuals in the society and welfare. (Monetary values estimated in this study are only modestly correlated with income levels, however.) Whilst non-monetary values (i.e. utility) convey clear meaning to conjoint practitioners, that meaning is often difficult for others, especially lay people, to grasp (Orme, 2001). This difficulty can be considered as a drawback of a non-monetary metric. Further, there is no absolute interpretation of utility values. As reported in Chapter 4, the utility value of a level of an attribute can only be understood relative to that of another included in the choice model. This limits the reconstruction of MCA whenever other attributes are claimed to be relevant. The choice experiment needs to be done again in order to determine the values of new attributes (at different levels of interest) relative to those of the existing ones.

Monetary values offer some advantages over non-monetary ones. For instance, a dollar value is a convenient metric and common to market goods. Dollar values of changes in attributes in a choice model can be compared with the values of changes in attributes not included in the model as well as other market and public goods (e.g. pollution, education, health care) whenever the information about the dollar values of these latter attributes and goods become available. Monetary values provide CBA a more flexible decision-support tool than MCA. Any CBA (if incomprehensive) may be reconstructed by accounting for other costs and benefits (i.e. changes in other attributes not included in the model) if relevant and plausible. As discussed in Section 2 above and in Chapter 5, monetary values provide a rather strong indication of how it is easier to justify a policy economically that generates a net welfare gain. With monetary values, it is possible to suggest that there is potentially sufficient money that can be transferred from the beneficiaries to the losers so that after the transaction there is at least one person better-off. Further, monetary values could potentially provide an indication

of how the government should allocate the limited national budget across sectors (e.g. marine *vs.* terrestrial biodiversity conservation *vs.* pollution control) to maximise a net welfare gain.

Both non-monetary and monetary metrics should accordingly complement each other to maximise their usefulness in guiding public policy. However, attention should be paid to minimising potentially misleading estimates in converting differences between attribute levels to a monetary scale (Orme, 2001). A lesson learned from Chapter 5 suggests that a monetary attribute included in a choice experiment should vary in a wide range of levels in order to minimise uncertainty in estimation. Sensitivity analysis should be often conducted if some uncertainty in the estimation remains.

6. Towards a sustainable and desirable future

"If we hope to achieve a sustainable and desirable future, we need to rapidly shift our policy focus away from maximising production and consumption (GDP) and towards improving genuine human well-being" (Kubiszewski et al., 2013, p.67). One way to measure changes in well-being is to observe preferences of individuals in the society. A more sustainable policy option is likely to be chosen if the goal is to generate greater social well-being, i.e., to improve efficiency in resource allocation over the long term. However, that efficiency is achieved, if any, does not necessarily mean sustainability is ensured. "Biologically, sustainability means avoiding extinction and living to survive and reproduce ... [so] determinations of sustainability can only be made after the fact" (Costanza & Patten, 1995, p.193 & 194). Despite this, the fact remains that the world ecosystems have been broadly degraded and we need to protect them from further degrading and restore the degraded ones in order to meet the growing demands for food and other basic needs for human well-being (Millennium Ecosystem Assessment, 2005a). Therefore, we should take every chance to implement a more sustainable policy option, while ensuring desirable social goals. To this end, biological/ecological, sociological, and economic studies need to complement each other to produce results that can be used for guiding choices about resource allocation.

We should aim for sustaining coupled, social-ecological systems. In a world of degrading ecosystems, preservation perhaps offers the best way to improve sustainability. However,

failure to meet the needs of local communities, especially in terms of maintaining their cultural practices leads to social undesirability and potentially compromise the success of preservation. The economic systems that rely on ecosystems and on which we rely should allocate our depletable natural resources in a way that reasonably provides for the long-term interests of local communities (especially indigenous people) to lock in social-ecological resilience. Resource allocation between preservation, social/cultural fulfilment and development needs is therefore at the cutting edge of modern economics that guide our economic systems.

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Appendices

Appendix A: Profile of interviews/interviewees

Interview (Place)	Number of interviewees	F	Māori (M)	Recreational fisher (RF)	Commercial fisher and fish farmer (CF)	Tour operator (TO)	Akaroa Taiāpure Committee/ Marae (ATCM)	Koukourarata Mātaitai Committee/ Marae (KMCM)	Akaroa Marine Protection Society (AMPS)	Tag
1 (Akaroa	2	1							2	INT1-AMPS
2 (Akaroa)	1			1			1			INT2-RF-ATCM
3 (Akaroa)	2	1							2	INT3-AMPS
4 (Akaroa)	1		1				1			INT4-M-ATCM
5 (Akaroa)	1				1		1			INT5-CF-ATCM
6 (Akaroa)	2				2					INT6-CF
7 (Akaroa)	2	1				2			2	INT7-TO-AMPS
8 (Akaroa)	1		1				1			INT8-M-ATCM

Interview (Place)	Number of interviewees	F	Māori (M)	Recreational fisher (RF)	Commercial fisher and fish farmer (CF)	Tour operator (TO)	Akaroa Taiāpure Committee/ Marae (ATCM)	Koukourarata Mātaitai Committee/ Marae (KMCM)	Akaroa Marine Protection Society (AMPS)	Tag
9 (Akaroa)	1					1			1	INT9-TO-AMPS
10 (Akaroa)	1		1				1			INT10-M-ATCM
11 (Akaroa)	1	1							1	INT11-AMPS
12 (Akaroa)	1			1			1			INT12-RF-ATCM
13&14 (Akaroa)	1				1		1			INT13&14-CF-ATCM
15 (Akaroa)	3	2	3							INT15-M
16 (Akaroa)	2	2	2							INT16-M
17 (Akaroa)	1	1								INT17
18 (Akaroa)	1			1		1				INT18-RF-TO

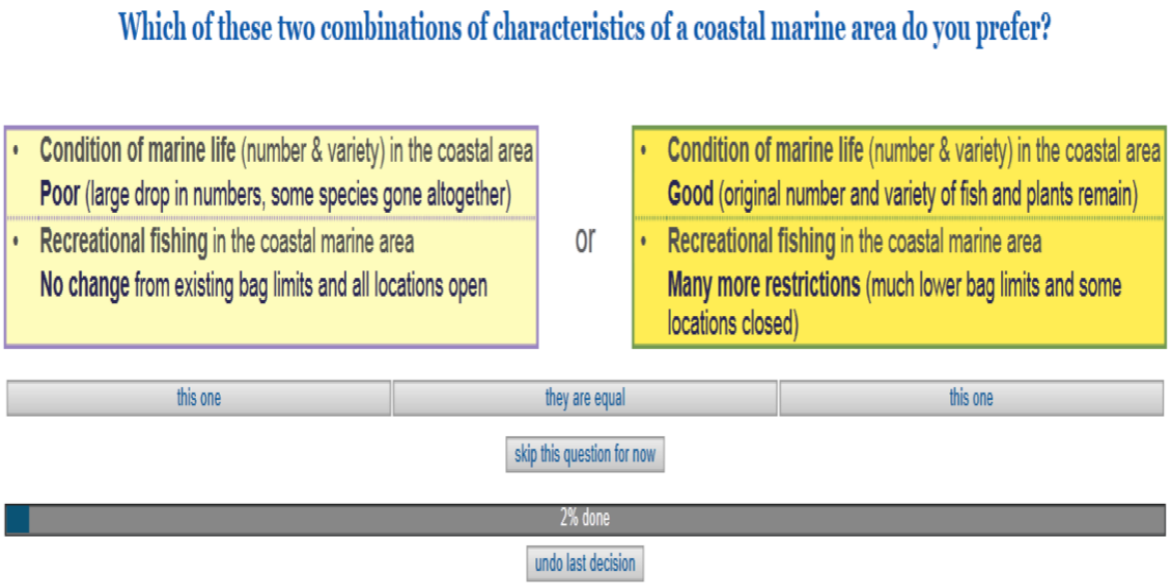
Interview (Place)	Number of interviewees	F	Māori (M)	Recreational fisher (RF)	Commercial fisher and fish farmer (CF)	Tour operator (TO)	Akaroa Taiāpure Committee/ Marae (ATCM)	Koukourarata Mātaitai Committee/ Marae (KMCM)	Akaroa Marine Protection Society (AMPS)	Tag
19 (Akaroa)	1	1	1					1		INT19-M-KMCM
20 (Akaroa)	1		1		1					INT20-M-CF
21 (Akaroa)	1				1		1			INT21-CF-ATCM
22 (Akaroa)	1		1		1					INT22-M-CF
23 (Akaroa)	1								1	INT23-AMPS
24 (Akaroa)	1	1							1	INT24-AMPS
25 (Koukourarata)	2	2	2					1		INT25-M-KMCM
26 (Koukourarata)	1		1					1		INT26-M-KMCM
27 (Koukourarata)	1		1					1		INT27-M-KMCM

Interview (Place)	Number of interviewees	F	Māori (M)	Recreational fisher (RF)	Commercial fisher and fish farmer (CF)	Tour operator (TO)	Akaroa Taiāpure Committee/ Marae (ATCM)	Koukourarata Mātaitai Committee/ Marae (KMCM)	Akaroa Marine Protection Society (AMPS)	Tag
28 (Koukourarata)	1	1	1							INT28-M
29 (Koukourarata)	1			1				1		INT29-RF-KMCM
30 (Koukourarata)	2	1	1							INT30-M
31 (Koukourarata)	1		1					1		INT31-M-KMCM
32 (Koukourarata)	1		1							INT32-M
33 (Koukourarata)	1	1	1							INT33-M
34 (Koukourarata)	2	1		2						INT34-RF
35 (Koukourarata)	1	1	1					1		INT35-M-KMCM
36 (Koukourarata)	2		2					2		INT36-M-KMCM

Interview (Place)	Number of interviewees	F	Māori (M)	Recreational fisher (RF)	Commercial fisher and fish farmer (CF)	Tour operator (TO)	Akaroa Taiāpure Committee/ Marae (ATCM)	Koukourarata Mātaitai Committee/ Marae (KMCM)	Akaroa Marine Protection Society (AMPS)	Tag
37 (Koukourarata)	2	1			2					INT37-CF
38 (Koukourarata)	1				1					INT38-CF
39 (Koukourarata)	1			1						INT39-KMCM
40 (Koukourarata)	1		1							INT40-M

Appendix B1: Information sheet

The survey requires you to choose one outcome of coastal marine management policy over another. Below is an example.



Here are your options:

- Click "this one" under the box with combination of outcomes you prefer.
- Click "they are equal" if you like both boxes about the same.
- Click "skip this question for now" if you can't decide (you may not have to make this particular choice again).
- Click "undo last decision" if you want to reconsider the choice you've just made.

You will have to make about 30 choices. Most people gradually speed up as they get familiar with the way it works, and most take about 15 minutes to get to the end. The bar at the bottom shows your progress.

We encourage you to **identify and think about a particular coastal marine area** that you are most interested in or know well when you choose between the various outcomes from managing fishing in different ways. We will ask you to identify that area. Consider each choice on its own; don't worry about choices you've made before. You may start to think the

choices are similar and that you have already answered, but actually each one is different and we would like you to concentrate on the detail in each one as you go.

Below is the list of outcomes that you'll be asked about:

Condition of marine life (i.e., the number and variety of fish and plants) compared to before human impacts on marine ecosystems: A coastal marine area with more abundance and variety of fish and plants provides a better life-supporting system and is more attractive to local recreationists and tourists. Please choose between:

- Outcome 1: **Poor condition**: there are few fish and plants remaining in the coastal area overall and some have gone altogether.
- Outcome 2: **Medium condition**: there is some reduction in fish and plants overall and some species might disappear in future.
- Outcome 3: **Good condition**: the original number and variety of fish and plants remain and are secure for the future.

Restrictions on recreational fishing: recreational fishers are ordinarily restricted in a variety of ways, including bag limits and open seasons. Please choose between:

- Outcome 1: **Many more recreational fishing restrictions**: much lower bag limits and some locations within the coastal area closed to recreational fishing
- Outcome 2: **More recreational fishing restrictions**: lower bag limits but all locations within the coastal area open for recreational fishing
- Outcome 3: **No change in current recreational fishing restrictions**: Existing bag limits remain and all locations within the coastal area remain open for recreational fishing

Restrictions on commercial fishing: commercial fishers are ordinarily restricted to a limited total catch (i.e., quota) and can only use certain gear to reduce damage to non-target

species. There is ordinarily no restriction on location of their fishing within a quota management area. Please choose between:

- Outcome 1: **No commercial fishing allowed** in the coastal area.
- Outcome 2: **More restrictions of commercial fishing:** Commercial fishing allowed only within some locations in the coastal area and with some reduction in quota.
- Outcome 3: **No change in current commercial fishing:** No change, allowed anywhere within the coastal area at the existing quota levels.

Māori cultural management: refers to practices Māori have developed and carried out over many generations as part of their relationships with the area and to gather food for cultural events, family sustenance and spiritual beliefs. It allows special fishing regulations for Māori and could restrict recreational and commercial fishing in particular (usually small) areas. Please choose between:

- Outcome 1: **Māori cultural management no longer practiced anywhere**
- Outcome 2: **Māori cultural management practiced in partnership with locals in some locations** within the coastal area.
- Outcome 3: **Māori cultural management practiced exclusively by Māori in some locations** within the coastal area.

We will at the same time ask you whether you think **your taxes** (e.g. annual income taxes or rates) should be changed to achieve your desired outcome in the coastal area. It might result in an increase, no change, or a decrease in your tax payment. Any increase would go to a fund to pay for improving fishing or environmental outcomes in the coastal area, and any decrease would be removed from national and local government funding dedicated to managing the environment and fishing in the area. As you make your choices, don't forget that if you are willing to pay more for a given outcome, there will remain less money for you to spend on other future public improvements of all sorts in your community (e.g. schools, hospitals, roads).

Appendix B2: Follow-up questions

1. Please name the coastal marine area you considered when answering the choice questions: ……..
2. I would like my answers applied:
   □ specifically to my coastal marine area (specified in question 1).
   □ generally to coastal marine areas in New Zealand.
3. Do you feel confident in the choices you made?
   □ Yes
   □ Sort of, I found some of the choices difficult.
   □ No, I found many of the choices difficult.
4. When working through the choice questions involving "your taxes", did you indicate that you're willing to pay more tax?
   □ Yes □ No
5. Why are you not willing to pay more tax?
   Please mark only the most important reason. (tick 1 box only and then skip to question 7)
   □ I don't care much about coastal marine management.
   □ There are other issues that are a better use of my money.
   □ My tax is already too high.
   □ Someone else should pay.
   □ I would prefer to pay in other ways (e.g. user fees or donation) rather than taxation.
   □ Other reason (please specify) …….
6. Why are you willing to pay more tax?
   Please mark only the most important reason (tick 1 box only).
   □ I think better coastal management is important.
   □ I consider it a moral satisfaction to protect marine life or cultures of indigenous people.
   □ I consider it a moral obligation to protect marine life or cultures of indigenous people.
   □ I consider it a moral obligation to protect marine life or cultures of indigenous people.
   □ Other reason (please specify) …….

7. Age: _____ years old

8. Gender: □female □ male

9. Ethnicity: □Māori □European New Zealander □ Other:……

10. Education:

□No qualification □Complete high school

□Polytechnic degree/certificate □University degree

11. Household income per annum before taxes:

□ Less than $20,000 □ $20,000 – $40,000

□ $40,001 – $60,000 □ $60,001 – $80,000

□ $80,001 – $100,000 □ $100,001 – $150,000

□ More than $150,000

12. Number of people in your household: _____

13. Have you fished in any coastal marine area over the last 12 months?

□ Yes

□ No, but I am likely to fish in the future (skip to question 15)

□ No, and I am unlikely to fish in the future (skip to question 15)

14. What type of fishing have you been most involved with? (tick 1 box only)

□ Recreational fishing

□ Commercial fishing

□ Fishing under a customary permit

15. Have you visited any coastal marine area over the last 12 months, without fishing? (tick 1 box only)

□ Yes

□ No, but I am likely to visit some coastal marine area in the future.

□ No, and I am unlikely to visit any coastal marine area in the future.

16. Are you at present a member of or active in any of the following organisations/ associations? (tick as many boxes as apply)

□ An environmental organisation such as WWF or Forest and Bird

□ A recreational fishing club

□ A Māori organisation (e.g. Rūnanga, Marae Committee, Health provider, Cultural group)

□ None of the above

17. Which of the following statements closely describes your belief about “no-take areas” like marine reserves? (tick 1 box only)

□ A no-take area protects plants and some sedentary fish within the area.

□ A no-take area protects plants and fish sufficiently to restore the area to its natural condition.

□ A no-take area protects plants and fish sufficiently to restore the area to its natural condition and increase fish in surrounding areas that are open to fishing.

18. Which of the following statements closely describes your beliefs about how Māori cultural use and management practices related to coastal marine areas can be maintained? (tick 1 box only)

□ Māori cultural practices would be maintained if Māori manage the areas in partnership with the local community.

□ Māori cultural practices would be maintained only if Māori manage the areas in their own way.

□ Māori cultural practices are unlikely to persist even if Māori manage the areas in their own way.

19. Did you know that taiāpure and mātaitai reserves (marine management regimes) operate in some of New Zealand’s coastal marine areas?

□ Yes □ No

20. How much do you know about the specific management approaches taken in a taiapure or a mataitai?

□ A lot □ Some

□ Nothing □ I don’t know what a mataitai is.

□ I don’t know what a taiapure is

That's end of the survey. Thank you very much for your participation. If you have any criticism or suggestion, please put it down below.

……

……

Appendix B3: Summary of respondents' socio-economic characteristics, perceptions and beliefs

Socio-economic characteristics, respondents' perceptions and beliefs about taiāpure, mātaitai, and marine reserves	Sample (N = 1055)		NZ Population[a]
	Number	Percentage	Percentage/ Number
Gender			
Female	599	56.8%	50.8%
Male	456	43.2%	49.2%
Ethnicity (16 missing responses)			
Asian	90	8.7%	9.2%
European New Zealander	639	61.5%	67.6%
Māori	246	23.7%	14.6%
Other	64	6.2%	8.6%
Age[b]			
15-39	469	44.4%	42.3%
40-64	426	40.4%	40.4%
65+	160	15.2%	17.3%
Education (16 missing responses)			
No qualification	146	14.0%	25.0%
Complete high school	378	36.4%	35.1%
Polytechnic or university degree	515	49.6%	39.9%
Occupation (75 missing responses)[c]			
Employed in agriculture, forestry and fisheries	12	1.2%	(1.4%)
Employed in other sectors	553	56.4%	(62.4%)
Home duties	58	5.9%	(4.5%)
Retired	123	12.6%	(9.5%)
Student	200	20.4%	(15.4%)
Unemployed	34	3.5%	6.8%
Household income (9 missing responses)			
Mean	$53,886		$81,620
Median	$50,000		$59,000
Household size (2 missing responses)			
Mean	3.0		2.7

Socio-economic characteristics, respondents' perceptions and beliefs about taiāpure, mātaitai, and marine reserves	Sample (N = 1055)		NZ Population[a]
	Number	Percentage	Percentage/ Number
Residential regions			
Auckland	301	28.5%	33.7%
Bay of Plenty	94	8.9%	6.3%
Canterbury	151	14.3%	12.7%
Gisborne	10	0.9%	1.1%
Hawkes Bay	42	4.0%	3.5%
Manawatu-Wanganui	40	3.8%	5.3%
Marlborough	2	0.2%	1.0%
Nelson	20	1.9%	1.0%
Northland	45	4.3%	3.6%
Otago	75	7.1%	4.8%
Southland	28	2.7%	2.2%
Taranaki	38	3.6%	2.5%
Tasman	7	0.7%	1.1%
Waikato	79	7.5%	9.4%
Wellington	121	11.5%	11.1%
West Coast	2	0.2%	0.7%
Dwellers			
Rural	162	15.4%	14%
Town	893	84.6%	86%
Fishers (45 missing responses)			
Commercial fishers	6	0.6%	
Recreational fishers	366	36.2%	
Customary fishers	19	1.9%	
Fishing users (47 missing responses)			
Fished over the last 12 months	236	23.4%	
Not fished over the last 12 months, but likely to fish in the future	247	24.5%	
Not fished over the last 12 months and unlikely to fish in the future	525	52.1%	
Visitors (51 missing responses)			
Visited over the last 12 months	349	34.8%	

Socio-economic characteristics, respondents' perceptions and beliefs about taiāpure, mātaitai, and marine reserves	Sample (N = 1055)		NZ Population[a]
	Number	Percentage	Percentage/ Number
Not visited over the last 12 months, but likely to visit in the future	304	30.3%	
Not visited over the last 12 months and unlikely to fish in the future	351	35.0%	
Interest groups (49 missing responses)			
Member of a Māori organisation	57	5.7%	
Member of an environmental organisation	50	5.0%	
Member of a recreational fishing club	24	2.4%	
Aware of the operation of taiāpure and mātaitai (62 missing responses)	254	25.6%	
Management approaches taken in taiāpure and mātaitai (52 missing responses)			
Know nothing	840	83.7%	
Know some	144	14.4%	
Know a lot	19	1.9%	
Belief about Māori culture associated with a coastal marine area (61 missing responses)			
Māori culture is unlikely to persist even if Māori manage the area in their own way	266	26.8%	
Māori culture would be maintained if Māori manage the area in partnership with locals	622	62.6%	
Māori culture would be maintained if Māori manage the area in their own way	106	10.7%	
Belief about marine reserves (58 missing responses)			
Marine reserves do not restore most of the plants and fish to their abundance and variety within the reserves and do not spill fish and plants to surrounding areas	83	8.3%	
Marine reserves do not restore most of the plants and fish to their abundance and variety within the reserves but spill fish and plants to surrounding areas	68	6.8%	

Socio-economic characteristics, respondents' perceptions and beliefs about taiāpure, mātaitai, and marine reserves	Sample (N = 1055)		NZ Population[a]
	Number	Percentage	Percentage/ Number
Marine reserves restore most of the plants and fish to their abundance and variety within the reserves but do not spill fish and plants to surrounding areas	229	23.0%	
Marine reserves restore most of the plants and fish to their abundance and variety within the reserves and spill fish and plants to surrounding areas	617	61.9%	

Note:

[a] Information from Statistics New Zealand (www.stats.govt.nz) is used as a source of the population parameters.

[b] Figures in brackets under column "NZ (Percentage/Number)" are adjusted figures after excluding people ageing under 15 years old (20.1%) as these people were not included in the survey.

[c] The categories of occupation for the sample are different from those for the population. Unemployment is the only category common to both the sample and the population. The percentage of a given category of occupation for the population corresponding to the sample is calculated by adjusting the percentage of that category in the sample to the difference between the percentage of unemployment in the sample and that in the population. The calculated percentages are printed in brackets under column "NZ (Percentage/Number)".

Appendix B4: Determinants of variation in values of each level of each socio-ecological attribute

Explanatory variable (N = 847, 208 excluded due to item non-response)	BD-GC (Residual deviance = 11.3)		BD-MC (Residual deviance = 7.21)		MCM-PE (Residual deviance = 9.68)		MCM-PP (Residual deviance = 9.04)		RF-MMR (Residual deviance = 6.93)		RF-MR (Residual deviance = 4.89)		CF-NA (Residual deviance = 9.2)		CF-MR (Residual deviance = 5.04)	
	Coeff.	s.e.	Coeff.	s.e.	Coeff.	s.e.	Coeff.	s.e.	Coeff.	s.e.	Coeff.	s.e.	Coeff.	s.e.	Coeff.	s.e.
Constant	-1.08***	0.20	-1.80***	0.20	-1.68***	0.23	-2.40***	0.27	-0.93***	0.19	-1.81***	0.21	-0.82***	0.22	-1.70***	0.24
Female	0.07	0.05	0.11**	0.05	0.11*	0.06	0.16**	0.07	-0.16***	0.05	-0.14**	0.06	-0.04	0.06	-0.14**	0.07
EUNZ	0.38***	0.07	0.29***	0.06	-0.51***	0.08	-0.48***	0.08	-0.01	0.07	0.03	0.08	-0.06	0.08	-0.12	0.09
Asian	0.04	0.11	0.03	0.10	-0.27**	0.12	-0.35**	0.14	0.01	0.10	-0.02	0.12	0.20*	0.12	0.11	0.13
Other ethnicity	0.19*	0.11	0.17*	0.10	-0.20	0.13	-0.25*	0.14	-0.09	0.11	-0.09	0.13	0.02	0.13	-0.26	0.16
Age40-64	-0.10	0.07	-0.14**	0.06	0.20**	0.08	0.15*	0.09	0.04	0.06	0.07	0.07	-0.09	0.08	-0.20**	0.09
Age65+	-0.19	0.12	-0.13	0.11	0.21	0.15	0.16	0.17	0.20*	0.11	0.02	0.13	-0.15	0.14	-0.33**	0.16
High school	-0.04	0.08	-0.03	0.08	0.02	0.09	-0.04	0.11	0.05	0.08	0.16*	0.09	-0.02	0.09	0.02	0.10
Polytechnic/University	0.10	0.08	0.05	0.08	0.06	0.10	0.04	0.11	-0.12	0.08	-0.05	0.09	-0.11	0.09	-0.20*	0.10
Home duty	0.34**	0.17	0.23	0.16	0.12	0.19	0.07	0.21	-0.15	0.16	-0.18	0.18	-0.48***	0.18	-0.38*	0.21
Student	0.22	0.15	0.11	0.14	0.08	0.17	0.05	0.19	-0.17	0.13	-0.16	0.15	-0.22	0.15	-0.16	0.17
Retired	0.23	0.18	0.19	0.16	0.07	0.21	0.07	0.24	-0.09	0.16	0.12	0.18	-0.25	0.19	-0.04	0.21
Employed-AFF	-0.09	0.28	0.07	0.26	-0.19	0.34	0.01	0.37	0.36	0.23	0.35	0.27	-0.19	0.29	0.28	0.30
Employed-Non-AFF	0.22	0.14	0.15	0.13	0.11	0.16	0.09	0.18	-0.08	0.13	0.00	0.14	-0.34**	0.14	-0.12	0.16
Household income	0.01	0.01	0.01	0.01	-0.02*	0.01	-0.01	0.01	-0.01	0.01	-0.02**	0.01	0.01	0.01	0.01	0.01
Household size	-0.02	0.02	-0.02	0.02	0.03	0.02	0.01	0.02	0.02	0.02	0.04*	0.02	-0.03	0.02	-0.03	0.03
Bay of Plenty	-0.09	0.10	-0.08	0.09	0.01	0.12	0.04	0.13	0.04	0.09	0.04	0.11	0.09	0.11	0.12	0.13
Canterbury	-0.03	0.08	-0.07	0.07	0.10	0.09	0.07	0.10	-0.10	0.08	-0.02	0.09	0.03	0.09	-0.04	0.10
Gisborne	-0.24	0.26	0.10	0.23	-0.12	0.28	0.14	0.29	-0.21	0.24	-0.18	0.28	0.62**	0.25	0.10	0.31
Hawkes Bay	0.10	0.13	0.17	0.12	-0.30	0.18	-0.33	0.21	-0.02	0.13	-0.17	0.16	0.05	0.16	-0.05	0.18
Manawatu-Wanganui	0.04	0.13	-0.02	0.13	-0.10	0.16	-0.18	0.19	-0.01	0.12	0.03	0.14	0.05	0.15	0.12	0.16
Marlborough	1.30**	0.58	0.69*	0.41	-1.57	1.15	-1.96	1.55	-0.21	0.54	-0.10	0.66	-1.49	1.03	-1.15	1.18

Explanatory variable (N = 847, 208 excluded due to item non-response)	BD-GC (Residual deviance = 11.3)		BD-MC (Residual deviance = 7.21)		MCM-PE (Residual deviance = 9.68)		MCM-PP (Residual deviance = 9.04)		RF-MMR (Residual deviance = 6.93)		RF-MR (Residual deviance = 4.89)		CF-NA (Residual deviance = 9.2)		CF-MR (Residual deviance = 5.04)	
	Coeff.	s.e.	Coeff.	s.e.	Coeff.	s.e.	Coeff.	s.e.	Coeff.	s.e.	Coeff.	s.e.	Coeff.	s.e.	Coeff.	s.e.
Nelson	0.33*	0.18	0.27*	0.16	0.01	0.21	0.16	0.22	-0.19	0.18	-0.23	0.22	-0.48*	0.25	-0.36	0.28
Northland	0.02	0.13	-0.03	0.12	0.03	0.14	0.06	0.16	0.02	0.12	-0.02	0.15	-0.12	0.16	0.08	0.18
Otago	-0.11	0.10	-0.07	0.09	0.13	0.12	-0.02	0.14	-0.07	0.10	-0.08	0.12	0.10	0.12	-0.03	0.14
Southland	-0.21	0.17	-0.19	0.16	0.33*	0.19	0.41**	0.20	-0.03	0.17	-0.16	0.20	0.03	0.19	0.10	0.22
Taranaki	-0.38***	0.14	-0.21	0.14	0.25	0.16	0.13	0.19	0.11	0.13	-0.04	0.16	0.17	0.16	0.20	0.18
Tasman	0.03	0.36	-0.20	0.33	0.04	0.46	-0.10	0.53	-0.17	0.36	-0.06	0.41	0.11	0.43	-0.14	0.54
Waikato	-0.06	0.11	0.01	0.10	-0.02	0.12	-0.08	0.14	0.04	0.10	-0.04	0.12	0.02	0.12	0.20	0.13
Wellington	0.05	0.08	0.05	0.08	-0.01	0.10	-0.02	0.11	-0.17**	0.08	-0.08	0.10	0.08	0.10	-0.08	0.11
West Coast	-0.26	0.51	-0.43	0.52	0.99**	0.47	1.28***	0.46	-0.74	0.63	-0.11	0.60	-1.12	1.03	-0.67	1.04
Rural	0.11	0.07	0.08	0.07	-0.08	0.09	0.00	0.10	-0.04	0.07	-0.15*	0.08	-0.08	0.09	-0.06	0.10
Recreational fisher	-0.05	0.08	-0.01	0.07	-0.14	0.09	-0.18*	0.10	0.14*	0.07	0.08	0.08	0.10	0.09	0.05	0.10
Commercial fisher	-0.46	0.40	-0.25	0.37	0.24	0.37	0.42	0.40	-0.15	0.31	-0.32	0.37	0.41	0.34	0.54*	0.32
Customary fisher	-0.12	0.23	-0.24	0.23	0.10	0.22	-0.04	0.26	-0.03	0.20	-0.48*	0.28	0.06	0.24	-0.03	0.26
Future user	-0.14**	0.07	-0.10	0.06	0.22***	0.08	0.27***	0.09	0.10	0.07	0.12	0.08	-0.11	0.08	0.00	0.09
Current user	-0.21**	0.10	-0.16*	0.09	0.36***	0.11	0.34***	0.13	0.11	0.09	0.10	0.11	-0.16	0.11	-0.06	0.13
Future visitor	0.15**	0.07	0.14**	0.06	-0.19**	0.08	-0.19**	0.09	-0.03	0.06	0.05	0.07	-0.02	0.08	-0.01	0.09
Current visitor	0.25***	0.07	0.16***	0.06	-0.18**	0.08	-0.12	0.09	-0.15**	0.06	-0.14*	0.08	-0.07	0.08	-0.07	0.09
Māori-Org	-0.15	0.13	-0.25*	0.13	0.13	0.13	0.03	0.14	-0.01	0.12	0.07	0.14	0.01	0.15	-0.03	0.18
Environment-Org	0.11	0.11	-0.01	0.10	0.25**	0.12	0.24*	0.13	-0.16	0.12	-0.18	0.14	-0.32**	0.14	-0.45**	0.18
Rec-Fishing-Club	-0.04	0.18	0.07	0.17	-0.01	0.21	-0.04	0.24	-0.01	0.17	-0.24	0.22	0.12	0.20	0.00	0.22
Aware	-0.06	0.07	-0.05	0.07	0.10	0.09	0.22**	0.09	0.00	0.07	0.04	0.08	-0.02	0.08	0.14	0.09
Know some	0.06	0.09	0.01	0.08	0.04	0.11	-0.06	0.12	-0.08	0.09	-0.11	0.10	-0.04	0.10	-0.24**	0.12
Know a lot	-0.22	0.23	-0.12	0.23	0.30	0.22	0.19	0.25	-0.07	0.22	0.17	0.25	-0.06	0.28	-0.37	0.33

Explanatory variable (N = 847, 208 excluded due to item non-response)	BD-GC (Residual deviance = 11.3)		BD-MC (Residual deviance = 7.21)		MCM-PE (Residual deviance = 9.68)		MCM-PP (Residual deviance = 9.04)		RF-MMR (Residual deviance = 6.93)		RF-MR (Residual deviance = 4.89)		CF-NA (Residual deviance = 9.2)		CF-MR (Residual deviance = 5.04)	
	Coeff.	s.e.	Coeff.	s.e.	Coeff.	s.e.	Coeff.	s.e.	Coeff.	s.e.	Coeff.	s.e.	Coeff.	s.e.	Coeff.	s.e.
MC-2	-0.10*	0.06	-0.09*	0.05	0.48***	0.08	0.76***	0.10	-0.12**	0.06	-0.18***	0.07	-0.10	0.07	-0.23***	0.08
MC-3	-0.17*	0.10	-0.11	0.09	0.63***	0.11	0.71***	0.13	-0.08	0.09	-0.23**	0.11	-0.24**	0.11	-0.10	0.12
MR-2	0.37***	0.14	0.38***	0.13	-0.43***	0.15	-0.34*	0.18	-0.08	0.12	-0.36***	0.13	0.03	0.14	-0.20	0.15
MR-3	0.53***	0.11	0.40***	0.11	-0.33***	0.12	-0.16	0.14	-0.19**	0.10	-0.30***	0.11	-0.16	0.11	-0.21*	0.12
MR-4	0.66***	0.10	0.50***	0.10	-0.45***	0.11	-0.32**	0.13	-0.29***	0.09	-0.45***	0.10	-0.18*	0.11	-0.36***	0.11
Sort of confident	-0.12**	0.06	-0.07	0.05	0.11	0.07	0.10	0.08	-0.01	0.05	-0.01	0.06	0.12*	0.07	-0.02	0.07
Not confident	-0.29***	0.10	-0.17*	0.09	0.29***	0.11	0.24**	0.12	0.05	0.09	0.05	0.10	0.11	0.10	0.15	0.11
Protest taxes	-0.17**	0.08	-0.17**	0.08	0.00	0.09	0.09	0.10	0.14*	0.07	0.20**	0.08	0.12	0.09	0.19*	0.10
Social-desirability	0.11*	0.06	0.10*	0.06	0.18***	0.07	0.23***	0.08	-0.17***	0.06	-0.06	0.07	-0.21***	0.07	-0.17*	0.09
Speedy	-0.62***	0.11	-0.58***	0.12	0.15	0.12	-0.06	0.15	0.31***	0.09	0.33***	0.11	0.34***	0.11	0.62***	0.11

Distribution: Binomial

Link function: Logit

Reference level: Male, Māori, Age15-39, No qualification, Unemployed, Auckland, Town, Non-fisher, Non-user, Non-visitor, Non-Māori-Org, Non-Environment-Org, Non-Rec-Fishing-Club, Unaware, Know nothing, MC-1, MR-1, Confident, Non-protest taxes, Non-social-desirability, Non-speedy

Significant level: *** significant at 1%, ** significant at 5%, and * significant at 10%

Appendix C: Determinants of variation in WTP estimates under a minimal assumption

Explanatory variable N = 847 (208 excluded due to item non-responses)	Bio-Good (Mean = 141.8, Residual deviance = 19.6)		Bio-Medium (Mean = 109.6, Residual deviance = 33.2)		MCul-Exclusive (Mean = 83.8, Residual deviance = 37.1)		MCul-Partner (Mean = 65.9, Residual deviance = 42.6)		Rec-High (Mean = 88.7, Residual deviance = 27.9)		Rec-Medium (Mean = 48.1, Residual deviance = 29.8)		Com-High (Mean = 82.2, Residual deviance = 36)		Com-Medium (Mean = 36.4, Residual deviance = 29.8)	
	Coeff.	s.e.	Coeff.	s.e.	Coeff.	s.e.	Coeff.	s.e.	Coeff.	s.e.	Coeff.	s.e.	Coeff.	s.e.	Coeff.	s.e.
Constant	4.66***	0.11	4.31***	0.17	4.22***	0.19	3.76***	0.24	4.74***	0.16	4.23***	0.21	4.74***	0.18	4.48***	0.24
Female	0.03	0.03	0.06	0.04	0.11**	0.05	0.15**	0.06	-0.05	0.04	-0.02	0.06	0.02	0.05	-0.08	0.07
EUNZ	0.05	0.04	0.05	0.05	-0.40***	0.06	-0.47***	0.07	-0.08	0.05	-0.19***	0.07	-0.16**	0.06	-0.27***	0.08
Asian	-0.16***	0.06	-0.23**	0.09	-0.34***	0.10	-0.41***	0.12	-0.25***	0.09	-0.50***	0.13	-0.14	0.10	-0.38***	0.14
Other ethnicity	-0.06	0.06	-0.03	0.09	-0.24**	0.10	-0.27**	0.12	-0.14	0.09	-0.26**	0.13	-0.17	0.11	-0.45***	0.16
Age40-64	-0.10***	0.04	-0.20***	0.05	0.01	0.06	0.01	0.08	-0.06	0.05	-0.04	0.08	-0.15**	0.06	-0.26***	0.09
Age65+	-0.10	0.06	-0.10	0.09	0.05	0.12	0.14	0.15	0.08	0.10	0.07	0.14	-0.04	0.12	-0.22	0.16
High school	0.02	0.04	0.02	0.07	0.08	0.08	-0.02	0.09	0.11*	0.07	0.19**	0.09	0.05	0.08	0.06	0.10
Polytechnic/University	0.06	0.04	0.09	0.07	0.10	0.08	0.04	0.09	-0.01	0.07	-0.03	0.09	-0.02	0.08	-0.17*	0.10
Home duty	0.11	0.09	0.10	0.14	-0.01	0.16	0.05	0.19	-0.16	0.13	-0.29	0.18	-0.30*	0.15	-0.20	0.21
Student	0.12	0.08	0.09	0.12	0.07	0.14	0.11	0.17	-0.10	0.11	-0.16	0.15	-0.08	0.13	0.00	0.17
Retired	0.05	0.10	-0.02	0.15	-0.05	0.17	-0.07	0.22	-0.19	0.14	-0.09	0.19	-0.28*	0.16	-0.10	0.22
Employed-AFF	-0.11	0.16	-0.05	0.24	-0.16	0.29	-0.06	0.35	0.01	0.20	-0.28	0.31	-0.39	0.26	-0.06	0.32
Employed-Non-AFF	0.11	0.08	0.12	0.12	0.11	0.13	0.13	0.16	-0.04	0.10	-0.02	0.14	-0.16	0.12	0.01	0.16
Household income	0.00	0.00	0.00	0.01	-0.01	0.01	-0.01	0.01	0.00	0.01	-0.01	0.01	0.01	0.01	0.01	0.01
Household size	-0.01	0.01	-0.02	0.02	0.01	0.02	0.00	0.02	0.01	0.02	0.06***	0.02	-0.01	0.02	-0.02	0.03
Bay of Plenty	-0.01	0.05	-0.07	0.08	-0.01	0.10	-0.02	0.12	-0.07	0.08	-0.06	0.11	0.03	0.09	0.08	0.12
Canterbury	-0.04	0.04	-0.04	0.06	0.05	0.07	0.05	0.09	-0.14**	0.06	-0.11	0.09	-0.09	0.08	-0.20*	0.11
Gisborne	0.01	0.13	0.00	0.20	0.05	0.21	0.15	0.24	-0.02	0.19	-0.09	0.27	0.28	0.21	-0.11	0.32
Hawkes Bay	0.03	0.07	0.09	0.10	-0.15	0.15	-0.21	0.19	0.01	0.11	-0.09	0.16	-0.03	0.13	-0.17	0.19
Manawatu-Wanganui	-0.05	0.07	-0.10	0.11	-0.13	0.14	-0.19	0.17	-0.14	0.11	-0.14	0.15	-0.07	0.13	-0.07	0.17

Explanatory variable N = 847 (208 excluded due to item non-responses)	Bio-Good (Mean = 141.8, Residual deviance = 19.6)		Bio-Medium (Mean = 109.6, Residual deviance = 33.2)		MCul-Exclusive (Mean = 83.8, Residual deviance = 37.1)		MCul-Partner (Mean = 65.9, Residual deviance = 42.6)		Rec-High (Mean = 88.7, Residual deviance = 27.9)		Rec-Medium (Mean = 48.1, Residual deviance = 29.8)		Com-High (Mean = 82.2, Residual deviance = 36)		Com-Medium (Mean = 36.4, Residual deviance = 29.8)	
	Coeff.	s.e.	Coeff.	s.e.	Coeff.	s.e.	Coeff.	s.e.	Coeff.	s.e.	Coeff.	s.e.	Coeff.	s.e.	Coeff.	s.e.
Marlborough	0.18	0.24	0.40	0.32	-1.22	0.92	-1.72	1.39	-0.04	0.43	-0.04	0.66	-1.38	0.89	-1.38	1.27
Nelson	0.09	0.09	0.16	0.14	0.04	0.17	0.15	0.19	-0.19	0.16	-0.28	0.22	-0.38*	0.21	-0.35	0.27
Northland	0.00	0.07	0.03	0.10	0.07	0.11	0.04	0.13	0.00	0.10	-0.06	0.14	-0.17	0.13	-0.03	0.17
Otago	-0.02	0.05	-0.02	0.08	0.08	0.10	0.01	0.12	-0.08	0.08	-0.08	0.12	-0.03	0.10	-0.12	0.14
Southland	-0.08	0.09	-0.08	0.14	0.19	0.15	0.24	0.18	-0.11	0.14	-0.16	0.21	-0.05	0.16	-0.15	0.23
Taranaki	-0.04	0.08	-0.04	0.11	0.15	0.13	0.10	0.16	0.12	0.11	0.00	0.16	0.02	0.14	0.04	0.18
Tasman	0.05	0.18	0.04	0.26	0.36	0.34	0.35	0.40	0.17	0.27	0.24	0.37	0.37	0.31	0.07	0.47
Waikato	-0.04	0.06	-0.01	0.08	-0.02	0.10	-0.10	0.13	0.01	0.08	0.05	0.11	0.04	0.10	0.19	0.12
Wellington	0.01	0.05	0.06	0.07	0.00	0.08	0.02	0.10	-0.15**	0.07	-0.05	0.10	0.03	0.08	-0.19	0.12
West Coast	-0.03	0.27	-0.32	0.43	0.31	0.35	0.40	0.39	-0.44	0.48	-0.13	0.55	-0.86	0.76	-0.72	0.98
Rural	0.02	0.04	0.04	0.06	-0.09	0.07	-0.08	0.09	-0.07	0.06	-0.19**	0.09	-0.02	0.07	0.03	0.09
Recreational fisher	-0.02	0.04	-0.02	0.06	-0.08	0.07	-0.10	0.09	0.09	0.06	0.04	0.08	0.04	0.07	0.01	0.10
Commercial fisher	0.16	0.19	0.34	0.27	0.09	0.30	0.29	0.37	0.31	0.23	0.58**	0.29	0.52**	0.26	0.88***	0.29
Customary fisher	-0.16	0.13	-0.31	0.21	-0.03	0.18	-0.12	0.22	-0.09	0.17	-0.50*	0.28	-0.03	0.20	-0.16	0.28
Future user	-0.04	0.04	-0.07	0.05	0.18***	0.06	0.20***	0.08	0.03	0.06	0.07	0.08	-0.02	0.06	-0.05	0.09
Current user	-0.03	0.05	-0.06	0.08	0.27***	0.09	0.26**	0.11	0.07	0.08	0.14	0.11	-0.03	0.09	-0.05	0.13
Future visitor	0.08**	0.04	0.13**	0.05	-0.06	0.07	-0.04	0.08	0.05	0.05	0.17**	0.08	0.07	0.06	0.08	0.09
Current visitor	0.11***	0.04	0.18***	0.05	-0.06	0.07	0.00	0.08	-0.01	0.06	-0.01	0.08	0.07	0.06	-0.01	0.09
Māori-Org	-0.06	0.07	-0.20*	0.11	0.03	0.10	-0.07	0.12	-0.10	0.10	-0.29**	0.14	-0.11	0.12	-0.34*	0.18
Environment-Org	0.07	0.06	0.07	0.08	0.20**	0.09	0.28***	0.11	-0.08	0.09	0.02	0.13	-0.11	0.11	-0.08	0.16
Rec-Fishing-Club	0.04	0.10	0.09	0.15	0.13	0.16	0.08	0.20	0.06	0.14	-0.03	0.20	0.14	0.16	0.13	0.21
Aware	-0.01	0.04	-0.01	0.06	0.07	0.07	0.17**	0.08	-0.01	0.06	-0.01	0.08	0.00	0.07	0.13	0.09
Know some	0.06	0.05	0.06	0.07	0.04	0.08	-0.01	0.10	0.04	0.07	0.06	0.10	0.03	0.09	-0.11	0.12

Explanatory variable N = 847 (208 excluded due to item non-responses)	Bio-Good (Mean = 141.8, Residual deviance = 19.6)		Bio-Medium (Mean = 109.6, Residual deviance = 33.2)		MCul-Exclusive (Mean = 83.8, Residual deviance = 37.1)		MCul-Partner (Mean = 65.9, Residual deviance = 42.6)		Rec-High (Mean = 88.7, Residual deviance = 27.9)		Rec-Medium (Mean = 48.1, Residual deviance = 29.8)		Com-High (Mean = 82.2, Residual deviance = 36)		Com-Medium (Mean = 36.4, Residual deviance = 29.8)	
	Coeff.	s.e.	Coeff.	s.e.	Coeff.	s.e.	Coeff.	s.e.	Coeff.	s.e.	Coeff.	s.e.	Coeff.	s.e.	Coeff.	s.e.
Know a lot	0.12	0.12	0.18	0.17	0.21	0.17	0.24	0.20	0.36**	0.16	0.62***	0.21	0.33*	0.20	0.04	0.29
MC-2	0.01	0.03	-0.01	0.05	0.41***	0.07	0.69***	0.09	-0.04	0.05	-0.11*	0.07	-0.01	0.06	-0.20***	0.08
MC-3	-0.02	0.05	0.06	0.08	0.42***	0.09	0.71***	0.12	-0.03	0.07	-0.09	0.10	-0.16*	0.09	-0.09	0.12
MR-2	0.15**	0.08	0.25**	0.12	-0.26**	0.12	-0.31**	0.16	-0.01	0.10	-0.16	0.14	-0.01	0.12	-0.24	0.15
MR-3	0.16**	0.06	0.24**	0.10	-0.25***	0.10	-0.21*	0.12	-0.12	0.08	-0.24**	0.11	-0.11	0.10	-0.22*	0.12
MR-4	0.21***	0.06	0.33***	0.09	-0.30***	0.09	-0.30***	0.11	-0.12	0.08	-0.32***	0.10	-0.12	0.09	-0.33***	0.11
Sort of confident	-0.02	0.03	-0.04	0.04	0.07	0.06	0.07	0.07	0.00	0.05	-0.01	0.06	0.11*	0.05	-0.02	0.07
Not confident	-0.04	0.05	-0.08	0.08	0.21**	0.09	0.18*	0.11	0.05	0.07	0.04	0.10	0.10	0.09	0.15	0.11
Protest taxes	-0.14***	0.05	-0.27***	0.07	-0.18**	0.08	-0.12	0.10	-0.10	0.07	-0.09	0.09	-0.05	0.08	0.02	0.11
Social-desirability	0.09***	0.03	0.15***	0.05	0.20***	0.06	0.27***	0.07	-0.02	0.05	0.04	0.07	-0.04	0.06	-0.07	0.08
Speedy	-0.16**	0.06	-0.35***	0.10	0.20**	0.10	0.06	0.13	0.26***	0.08	0.33***	0.10	0.29***	0.09	0.53***	0.11

Distribution : Poisson

Link function : Log

Reference level : Male, Māori, Age15-39, No qualification, Unemployed, Auckland, Town, Non-fisher, Non-user, Non-visitor, Non-Māori-Org, Non-Environment-Org, Non-Rec-Fishing-Club, Unaware, Know nothing, MC-1, MR-1, Confident, Non-protest taxes, Non-social-desirability, Non-speedy

Significant level : *** significant at 1%, ** significant at 5%, and * significant at 10%