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Article

Preferences for Management of Near-Shore Marine Ecosystems: A Choice Experiment in New Zealand

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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.

Keywords: ecosystem service valuation; choice experiment; marine spatial allocation; fisheries; public good

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1. Introduction

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 [1–3]. Some people advocate creation of more and larger Customary Protection Areas (such as taiāpure or mātaitai) in near-shore marine areas as a way of encouraging the continuation of Māori culture and wellbeing [4]. Others argue for more and larger Marine Reserves (where all fishing is permanently banned) to protect existing and restore declining marine biodiversity [5]. 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 Customary Protection Areas 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 [6,7].

Comparisons of the benefits and costs (not necessarily in dollar terms) of potential management scenarios can provide an objective metric for decision-making [8]. 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 emphasized in the literature [9–12]. Such allocation may accordingly be controversial and increase the likelihood of a sub-optimal allocation.

This paper 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 a developing stated preference technique (see e.g., [13,14]) that provides a way to measure intangible values in terms comparable with measures of tangible values.

Values in this paper are assessed on the basis of 'utility' (amounts of human 'satisfaction', 'happiness' or 'well-being' [15,16]) 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 paper is organized 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 (see e.g., [17–20]) 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 [21]. 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 (see e.g., [22–30]).

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 (Table 1). 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 [27], whereas the goal of marine reserves in this context is to provide opportunity for regeneration of biodiversity as a whole [3]. 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 [19]. 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 changes are reported in a separate paper [31].

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 (e.g., [32,33]) 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 [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 1. 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.

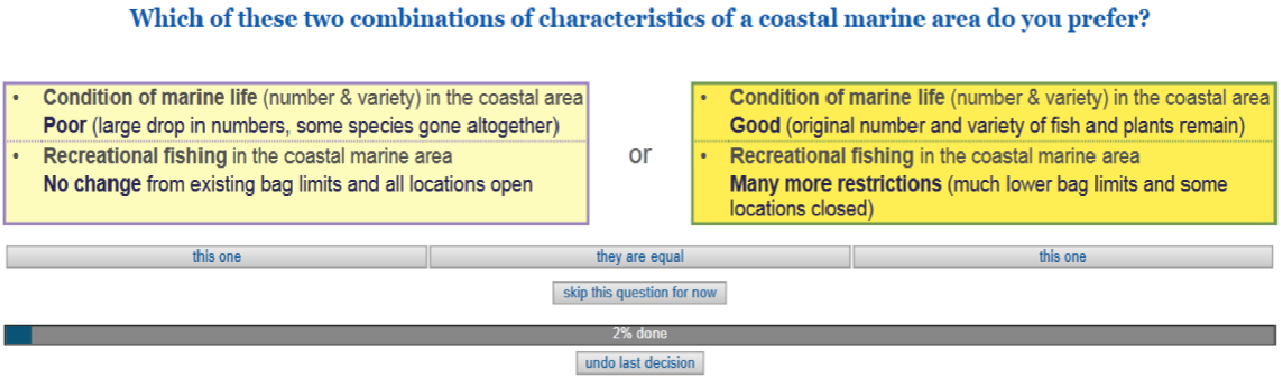
The tax attribute consisted of four levels. An increase of \$120 or \$60 in taxes indicates the survey respondent's willingness-to-pay (WTP) to improve (relative to the status quo) outcomes of the various attributes. This range of costs was selected based on the approximate amounts of money members of the public frequently donate to support conservation efforts [34]. 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 [13–15,35]. 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 [19].

2.2. Implementation of the Choice Experiment Survey

This discrete choice experiment was implemented using 1000minds internet-based software. The software applies a unique method of presenting choices to survey respondents [36]. Each individual respondent makes a series of choices, such as the one shown in Figure 1. 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 at a time does impose the assumption that how the respondent makes a choice (such as that depicted in Figure 1) does not depend strongly on the level of any third attribute not included in the choice.

Figure 1. 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 that in Figure 1, 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 each of the total of 122 possible combinations of two pairs of two attributes. Each choice requires a trade-off between the two attributes presented (For a detailed description of the algorithm, see [36]).

Before beginning the choice survey, respondents were asked to read an information sheet 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.

After completing the choice survey, respondents were asked to answer a series of follow-up questions. 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 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 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 percent) 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 in 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, *etc*. [37]. 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 [38]. As at May 2010, Smile City had successfully completed 1400 online surveys, including research on medical and pharmaceutical studies, in-home product placement, new product development and testing, customer satisfaction, *etc*. [39].

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.

We received overall 1055 complete responses at a response rate of approximately 60 percent. Socio-economic characteristics of the sample differ somewhat from those of the population [40]. 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 2). 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.

Residents of Bay of Plenty, Canterbury, Hawkes Bay, Nelson, Northland, Otago, Southland, Taranaki, and Wellington are overrepresented (Figure 3). The overrepresentation 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 NZ population (mean ≈ 2.7).

Figure 2. Key socio-economic characteristics of the sample corresponding to the population.

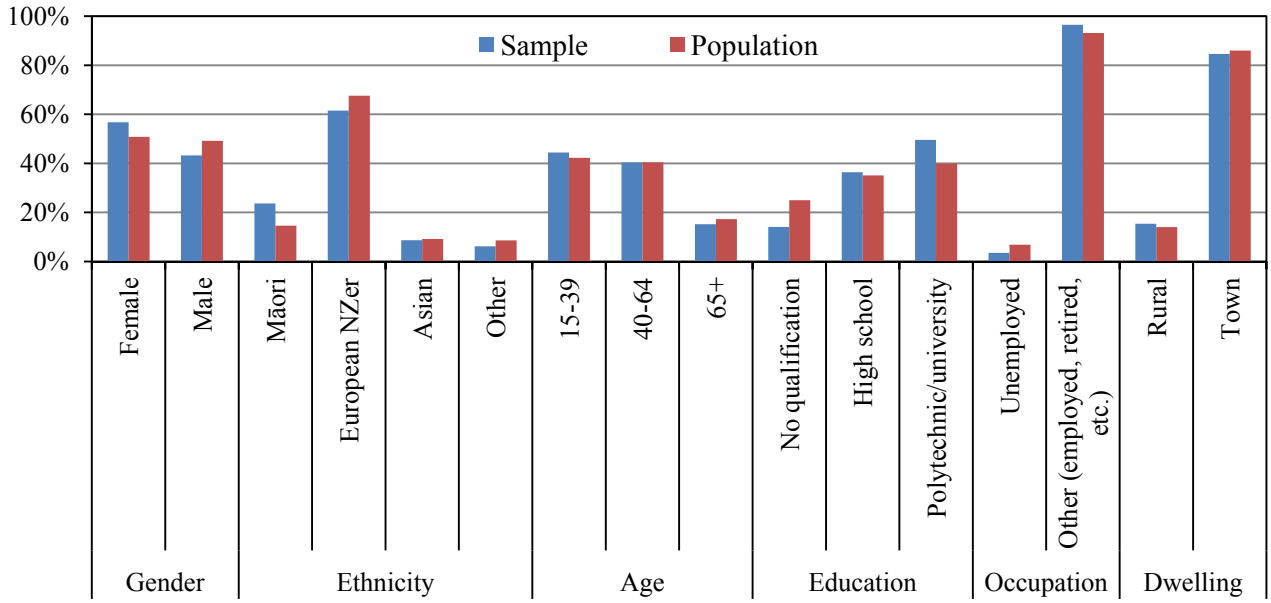
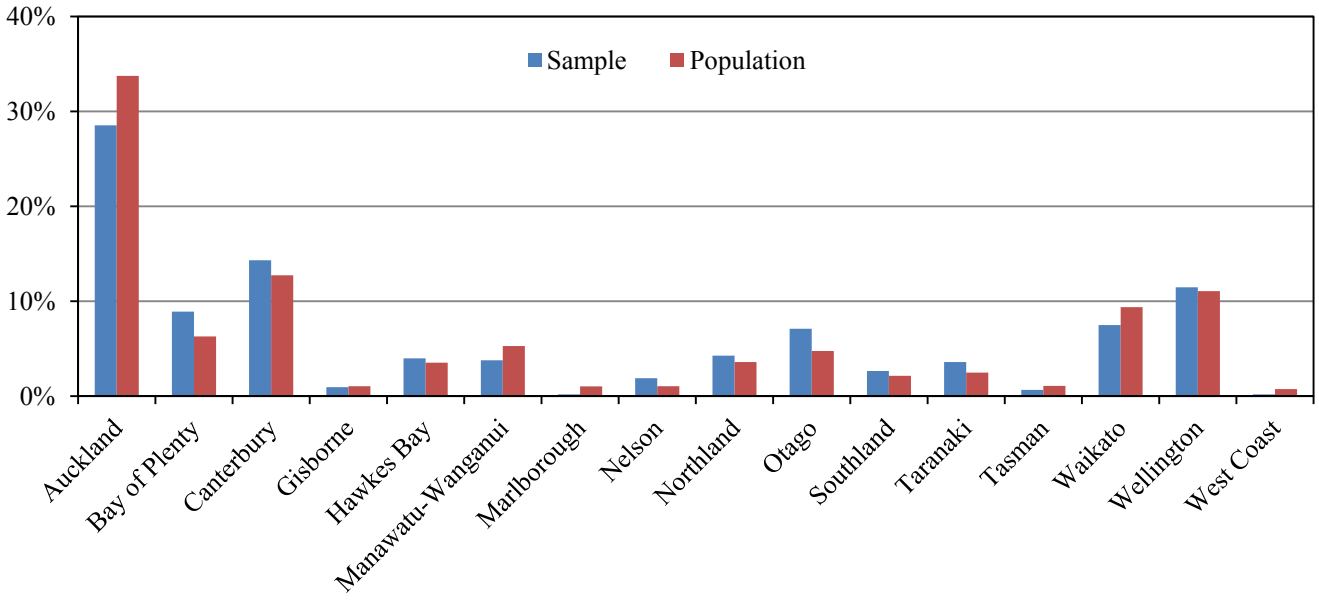


Figure 3. Residential regions of the sample corresponding to the population.



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 [41]. In this case, misrepresentation was due to the top-up of Māori respondents in addition to the usual non-response error [41] 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 percent [42]. Low response rates make the survey results susceptible to non-response bias and accordingly affect the validity of these results [41,43].

Different groups of people (e.g., males *vs.* females, young *vs.* old) have been shown to differ in their values for many public goods (see e.g., [24, 28, 44–47]). 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 [43]. 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 organized as follows. Section 3.1 summarizes 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 modeling 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 program implements a linear programming routine to estimate these relative weights, also known as part-worth utilities (For a more in-depth description, see [36]).

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.

The specification of the program 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 (Table 2/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 (e.g., 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 of 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 ≈ 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.

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 Equation (1) and gave the results as summarized in Table 2/Column 'model without taxes'. Note that the ratios of any two utilities (relative values) remain unchanged from those in the 'original model'.

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

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 2/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 1) 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 [48] and almost 26 percent 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. We will return to a discussion of this assumption in Section 3.3.

What do we conclude from Table 2? 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.

Table 2. 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.

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 modeling using statistics software GenStat® [49] 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.

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 [Equation (2)] were estimated using a specific routine in GenStat [49] (p.62). This is a generalized 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.

$$Logit(P) = Log\left(\frac{P}{1 - P}\right) \quad (2)$$

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 3), 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 organizations relevant to the question at hand: Māori, environmental or recreational fishing organizations. 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 3. 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)

Table 3. *Cont.*

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

For this modeling purpose, the negative utility values of greater restrictions on recreational and commercial fishing (Table 2/Column 'Δ Utility from the status quo') are converted to positive for convenience. Hence, it should be interpreted from the modeling results as utility values derived from avoiding such greater restrictions.

The modeling results (Appendix 1) indicate that the utility values of the various levels of the socio-ecological attributes vary, as expected, 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 4. These values were obtained using fitted values from each regression model:

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

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 Equation (4). Substituting Equation (3) in Equation (4) yields Equation (5), which can be rearrange to get Equation (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 4 are obtained by substituting the relevant proportion into Equation (6) and converting the resulting logit(P) back to a utility value using Equation (2).

$$\overline{\hat{Y}} = \frac{\sum \hat{Y}_i}{n} \quad (4)$$

where n: Total number of respondents.

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

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

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 4) 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., [46,47]).

Variation in values also correlate significantly with ethnicity (as suggested by [50,51]). 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 organizations/associations vary somewhat in values. For example, members of Māori organizations value biodiversity somewhat less than do non-members. Members of environmental organizations, 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 [19,43,52] 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.

Table 4. 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
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

Table 4. *Cont.*

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)
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
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

Table 4. *Cont.*

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)
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 Organization								
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 Organization								
Non-Environment-Org (94.7%)	43.2®	22.7®	17.1®	11.4®	19.5®	8.7®	18.0®	6.3®
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

Table 4. *Cont.*

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)
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®
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***

Notes: *** significant at 1%; ** significant at 5%; and * significant at 10%; vis-à-vis an ® reference level.

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 skeptical 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 [41]. Inaccurate responses in this study might arise from two sources.

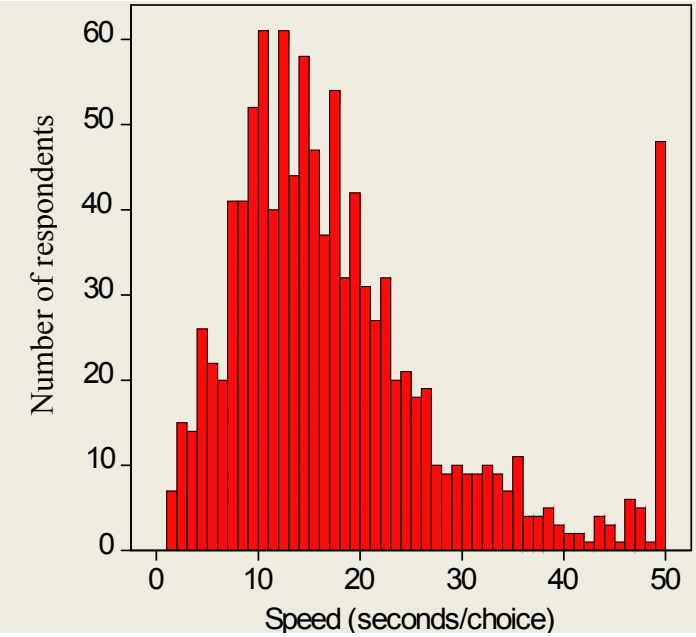
The first one is associated with responder biases. Seven potential responder biases were addressed in this study as summarized in Appendix 2. Measures taken to address these biases were mainly based on those suggested or employed in the literature (e.g., [18,19,43,53,54]). Strategic, hypothetical, and 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 who answered "Sort of, I found some of the choices difficult" and those 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 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 paper. 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 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.

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 4) 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.

Returning to the results in Table 4, 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 favor the status quo [19]. 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 [19]. 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.

Figure 4. Distribution of choice-making speeds.



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, "this 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" [43] (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 Equation (6) to predict the population mean logit(P), which can be then converted using Equation (2) to population mean utility values (as reported in Table 5). Note that these population mean values differ somewhat from those of the sample (reported in Table 3). In particular, the mean relative value of 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 5. 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

To investigate the potential effects of bias in the choice experiment, five treatments were considered (the mean population values reported in Table 5 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 6: '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.

Table 6. 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 7 reports the corresponding predicted population mean utility values. 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 (Table 5). 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 7. 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
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 8 lists seven such alternative policy 'scenarios', organised under three more general 'strategies'.

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 [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 [57] 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 [58–60], of which taiāpure may be a part. Taiāpure cannot exclude commercial fishing [61]. 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. Marine reserves are the only tool trusted to achieve that outcome [3]. The complete ban of fishing in marine reserves may cause replacement of fishing effort and depletion of fish stocks in areas that remain fishable [3]. 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 1).

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 8. 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

Table 9 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.

Table 9. 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

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 paper 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 paper 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 [19]) 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 9).

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., by [62]), 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. (This has already been added to the list of future features of 1000minds according to Paul Hansen, the founder of the software.) 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 [36]. 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 ask respondents to explicitly make a few choices that are eliminated by transitivity. (This again has been added to the list of future features of 1000minds according to Paul Hansen.) 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 [42] 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 Primary Industries (for taiāpure and mātaitai) and the Minister of Conservation (for marine reserves) [6]. 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 [63]. The results from a carefully implemented choice experiment can lead to a more defensible and legitimate decision. As demonstrated in this paper, 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.

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Conflicts of Interest

Authors declare no conflict of interest.

Appendices

Appendix 1. Determinants of variation in values of each level of each socio-ecological attribute.

Explanatory variables	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

Appendix 1. *Cont.*

Explanatory variables	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.**
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
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

Appendix 1. *Cont.*

Explanatory variables	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.**
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
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

Notes: 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 2. 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 favor. Making a potential financial effect on them compulsory might minimize this manipulation behavior [19].	- 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 [55]. Establishing some expectation that respondents' views will be used in some fashion can eliminate this hypothetical bias [19].	The following messages (as printed in the information sheet) were attempted to form such expectations: - "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."
Hypothetical		- "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 favor of something, they may treat the survey casually and provide ill-considered answers [19].	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 [56].	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 [19].	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 desirability	Respondents may have a tendency to present themselves in a favorable 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 [19].	Each participant responded to the following question: "Why are you willing to pay more tax? " - 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: ……

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