UNIVERSITY OF WAIKATO

Hamilton
New Zealand

Evaluating the Welfare Effects of Biodiversity on Private Lands: A Choice Modelling Application

Richard Yao and Pamela Kaval
University of Waikato

Department of Economics

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Corresponding Author

Pamela Kaval
Department of Economics
University of Waikato,
Private Bag 3105,
Hamilton, New Zealand

Fax: +64 (7) 838 4331
Phone : +64 (7) 838 4045
Email: pam98k@yahoo.com; pkaval@mngt.waikato.ac.nz

Abstract

Biodiversity loss is a global problem, especially in reference to private lands. In response, we investigated whether private land biodiversity may be attained by developing incentives which include funding landholders through the provision of native trees to enhance biodiversity on their own properties. Using choice modelling, we tested this hypothesis. A typical respondent was found to be better off, in terms of welfare, if there would be a biodiversity enhancing scheme in their locality. We also found that respondents in the upper northern regions of New Zealand were relatively more receptive in supporting biodiversity enhancement programmes on their properties, compared to those residing in the southern regions of the country.

Keywords

Native biodiversity
New Zealand
Choice Modelling
Community volunteers

JEL Classification

Q57; Q2; Q25

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Introduction

Biodiversity loss is a global environmental problem, especially in reference to private lands (Pascual and Perrings, 2007; Theobald and Hobbs, 2002; Daily, 2000; Stoneham et al., 2000; Dale et al., 2000; Noss et al., 1997). In the case of New Zealand (NZ) and Australia, the most severely depleted ecosystems are on private agriculturally productive areas, as well as cleared land and land conversion areas (Dickson et al., 2005; Saunders and Norton, 2001; Norton, 2000; Buckley, 2002; Watkinson et la., 2000). This scenario represents the importance of biodiversity conservation and biodiversity management on private lands. Bennett (2003) suggests that private land biodiversity conservation may be attained by developing incentives such as funding landholders to protect or enhance biodiversity on their own properties. To examine the usefulness of funding private land biodiversity, it is important to ascertain if there is an incentive for private landholders to participate in biodiversity enhancement programmes on private lands.

To examine the value of biodiversity enhancement on private lands, economic valuation techniques can be used. The Convention on Biological Diversity (1998) recognised that the "economic valuation of biodiversity and biological resources is an important tool for well-targeted and calibrated economic incentive measures". These valuation techniques are classified into two major categories: *market* and *non-market* valuation techniques. Since many benefits from biodiversity (e.g., better air quality, higher water quality, habitat provision) are not currently exchanged in existing markets, most biodiversity valuation studies use non-market valuation techniques (Bennett, 2003).

One non-market biodiversity valuation technique is the choice modelling (CM) method. CM is the most recently developed of the stated preference techniques (Rolfe and Windle, 2005; Dickson et al., 2005). CM aids in the estimation of biodiversity use and non-use values (Nunes and van den Bergh, 2001; Pearce, 2001). CM is typically conducted with a survey where a respondent is asked to state his/her preference between a set of environmental features or attributes at a given cost to the respondent, and another set of environmental features or attributes at a different cost (Whitten and Bennett, 2005).

Since CM examines the tradeoffs between alternatives with different sets of actions, CM is found to be an appropriate decision support tool (Rolfe and Windle, 2005). This is because policy decisions often involve the evaluation of several alternatives, with each alternative having a specific set of possible actions (Whitten and Bennett, 2005). Therefore, different alternatives would likely have different impacts on the environmental service in question. For instance, a set of actions for the operation of a more environmentally friendly winegrowing business can include an increase in the *number of planted native plants* surrounding the growing area, reduction in the *amount of chemicals used for growing the crops*, and *cost of the environmental improvement to an individual*. An example of a set of actions for an *alternative* might consist of a 25% *increase in the number of natives*, 20% reduction in the *amount of chemicals used* and a cost to the individual equal to $50/year. A second *alternative* might consist of a 50% *increase in the number of natives*, 10% reduction in the *amount of chemicals used* and a cost to the individual equal to $75/year. The third *alternative* can be a *no action* alternative (or status quo alternative) which would have no change in the *number of planted natives* (existing number of native trees = 200 trees), no reduction in the *amount of chemicals used* and $0/year cost to an individual. A respondent can choose his most preferred alternative among the three alternatives presented (Hensher et al., 2005).

Many recent biodiversity valuation studies have elected to use the CM technique (Kerr and Sharp, 2007; Schou et al., 2006; Christie et al., 2006; Othman et al., 2004). This may be attributed to the fact that CM surveys elicit less biased responses than other available stated preference techniques (Hanley et al., 2001). Estimates from CM studies also offer advantages for use in benefit transfer[1] studies, compared to other non-market valuation techniques (Bennett, 2006). One advantage of incorporating CM data into a benefit transfer study is that it can be used to value marginal changes in environmental attributes (Morrison and Bergland, 2006). Another advantage is that CM allows the transfer of a valuation function that permits adjustment for differences in site characteristics (Rolfe, 2006). These features offer more flexibility and a more useful basis for benefit transfer studies.

However, despite the advantages of the CM technique, the number of biodiversity valuation studies that have applied CM remains limited. In the case of NZ, only one CM biodiversity valuation study, to date, was reported (Kerr and Sharp, 2007). Kerr and Sharp (2007) used CM to estimate the values associated with the protection of indigenous species from the invasive wildling pines on NZ's South Island. Other NZ biodiversity valuation studies have primarily used the contingent valuation method (CVM) (Yao and Kaval, 2008; Yao and Kaval, 2007). This dominance in the use of CVM in biodiversity valuation is evident, not only in NZ, but around the world (Yao and Kaval, 2007; Christie et al., 2006; Brander, et al., 2006; Woodward and Wui, 2001; Brouwer et al., 1999).

Current biodiversity valuation studies have focused on the biodiversity of parks, wetlands and public forests (e.g., Yao and Kaval, 2007; Woodward and Wui, 2001; Brouwer et al., 1999). Most of these biodiversity valuation study sites were located on government owned land or partly-private-partly-government owned areas. We did not find any biodiversity valuation studies that focused specifically on private land. In this regard, this study addresses this gap in the literature by using the CM valuation technique to answer the question of "*Is biodiversity enhancement on private land important to NZ residents*?" In this study, biodiversity enhancement refers to the planting of additional trees and shrubs that can provide a better developed habitat for native animals on private lands. In 2000, approximately 70% of NZ land was privately owned or occupied. Since so much land is privately held, private residents play an integral role in influencing the issue of biodiversity loss in NZ (Kneebone, 2000).

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[1] Benefit transfer is a non-market valuation technique that uses estimates from previous non-market valuation studies such as the contingent valuation method, travel cost method and hedonic pricing method. These valuation estimates are rescaled to suit the conditions of the transfer study site.

Analytic Models

In a CM survey, a respondent is presented with different sets of alternatives called *choice sets*. Each *choice set* may have between two to six different alternatives. Typically, each choice set contains a baseline alternative (also called the status quo alternative). The inclusion of the status quo alternative in each choice set is recommended to derive welfare-consistent estimates (Bateman et al., 2002, p. 251). Every alternative is composed of several characteristics or attributes (e.g., number of trees, cost). The alternative that has the best set of attributes, as perceived by the respondent, provides the largest positive change in utility to an individual. In a choice set, this "best" alternative is the most influential to the respondent's well-being and is therefore selected as the ideal alternative by the respondent. From an analytical point of view, an individual's utility difference has two components: the observed and the unobserved. The observed component of utility is the one that can be observed and modelled by the analyst and is treated as deterministic. The unobserved component is the one not included in the model and is therefore treated as stochastic. We express the utility (*U*) contribution of alternative *j* as:

$$U_j = V_j + \varepsilon_j \quad (1)$$

Where V_j is the observed utility change, which can be translated into monetary amounts, while ε_j is the change in utility unobservable to a researcher. These two components are generally assumed to be additive and independent of each other. Since V_j is observable, we use it as an approximation of the true change in utility of an individual. We express the influence of a good's attributes to a person's observed utility in a simple linear form as:

$$V_j = \beta_{0j} + \beta_{1j} f(X_{1j}) + \beta_{2j} f(X_{2j}) + \beta_{3j} f(X_{3j}) + ... + \beta_{Kj} f(X_{Kj}) \quad (2)$$

Where β_{0j} represents the alternative specific constant (ASC), or the parameter estimate associated with the measured and observed attributes, β_{1j} is the parameter estimate associated with attribute X_1 and alternative *j*. The explanatory variables, which in this case represent the attributes of the good in question, are represented as $f(...)$. This implies that the explanatory variables can be entered into the equation in different forms (e.g., linear, quadratic, log, square root, exponential). An attribute (e.g., price) can interact with another explanatory variable (e.g., attitude) and be entered into the right hand side of the equation (e.g., $\beta_{4j} X_{1j} X_{3j}$) (Hensher et al., 2005; Louviere et al., 2000). In this choice modelling exercise, we use the Multinomial Logit (MNL) and the Random Parameter Logit (RPL) models.

Multinomial Logit Model

For our analysis, the observed change in utility *V* represents the estimated total observed benefit from the different combinations of attributes. Equation 2 reveals that the estimate for *V* depends upon the functional form of the explanatory variables, the level of attributes and the magnitude of coefficient estimates. The most commonly used model for this estimation is the multinomial logit (MNL) model with a linear functional form. The error terms of the MNL model are assumed to be independent and identically Gumbel distributed. The MNL model is a closed-form model which can be estimated using the maximum likelihood approach. The MNL can be expressed as:

$$P_i(j) = \frac{\exp(X_i \beta_j)}{\sum_{k=1}^{J} \exp(X_i \beta_k)} \tag{3}$$

The term P_i (j) represents the probability that individual i chooses the j^{th} alternative from J number of alternatives. P_i (j) is a function of the individual characteristics (X_i) and k unknown parameters (β_k). In the MNL model, one of the several parameter vectors is normalized to zero since we only estimate utility differences (Hensher et al., 2005; Haab and McConnell, 2002). To make the notation simpler, the intercept term has been suppressed.

Coefficient estimates from the MNL model can be used to calculate the estimates of the change in welfare associated with a change in the level of an attribute (Hensher et al., 2005). This welfare measure can come in the form of an implicit price or the part worth of an attribute. The formula to calculate the part worth (PW) of an attribute is

$$PW = \frac{\beta_A}{\beta_M} \tag{4}$$

Where β_A represents the coefficient estimates for an attribute and β_M is the negative of the coefficient of the monetary variable. A part worth value is usually expressed in monetary terms (e.g., $25 for every 5% increase in the number of endangered species protected).

Random Parameter Logit Model

In our MNL model, we assumed that the error term was independent and identically Gumbel distributed. However, the independent and identically distributed (IID) property can be limiting, since all information in the random components of the error term may not be identical in quantity. To relax the IID assumption, we instead used the random parameter logit (RPL) model. The RPL is also called the “mixed multinomial logit” or “mixed logit” model. The RPL model is a generalized version of the multinomial logit model that takes into account the correlations in the unobserved components of utility (Hensher et al., 2005). It accounts for heterogeneity in the preferences of respondents. In an RPL model, individual parameters for taste are allowed to have their own statistical distributions, since parameters are allowed to be specific for each respondent (Revelt and Train, 1998). More specifically, the RPL model uses a maximum simulated likelihood approach that allows explanatory variables to vary over respondents, allowing each random parameter to have a particular distribution (e.g., normal, triangular, uniform) (Hensher et al., 2005).

The Choice Modelling Survey Design and Data

Survey Design

In this CM exercise, we created a hypothetical tree planting programme for the local government council. With the help of focus group meetings and suggestions from several experts, we identified four different attributes, or characteristics, of a tree planting programme on private land. These attributes and their corresponding levels are as follows:

1. Type of trees to plant
   - Levels: (1) non-native species only, (2) mixture of natives and non-natives, (3) native species only.

2. Type of council incentives to private landholders:
   - Levels: (1) get trees offered by the council for free; and (2) buy their own trees and have the specified amount reimbursed from councils upon the presentation of a purchase receipt.

3. Provision of free expert advice from councils about tree planting. This attribute remained the same for all alternatives, since local government councils in NZ continue to provide this service with or without the implementation of the hypothetical tree planting programme.

4. Values of trees and advice to the landholder. The values assigned included $45, $95, $120 and $145. The $45 refers to the value of an hour of tree planting advice provided by local government councils. The status quo alternative present in each choice set has the value of $45. This alternative did not offer any tree provisions, only advice. Alternatives that have values higher that $45 represent the changed alternatives, since they include both the value of the advice and the value of the trees provided by, or rebated from, councils. The changed alternatives were assigned different values, because different native and non-native trees can have different prices. The most expensive alternative is valued at $145. This value represents a biodiversity enhancing scheme where $100 of trees and $45 of tree planting advice can be obtained by the landowner. Therefore, the *value of trees and advice* attribute corresponds to the overall value of trees and advice that would be hypothetically provided by local government councils to residents.

In the hypothetical market created, we emphasized that the cost of the incentive package will be shouldered by the local government council. However, respondents were likely to be aware that residents pay local council taxes called annual rates (taxes) to fund local council’s environmental programmes (Environment Waikato, 2008a; Environment Waikato, 2008b)

Data Collection

The data collection process occurred between December 2006 and January 2008. A two-stage phone-mail survey was employed. The first survey stage involved the placement of phone calls to 3211 randomly selected NZ households listed in the White Pages telephone directory. A total of 1617 residents were contacted and 803 agreed to participate in the mail survey. These 803 residents were each sent a survey packet. Seven hundred nine (709) residents mailed completed surveys to us using the addressed freepost envelopes that we provided in the survey packet. This constitutes a mail survey response rate of 88.3%. In addition to the 709 returned surveys, we included in our database the responses of the 20 focus group participants, resulting in a total of 729 observations.

Of the 729 completed surveys, 618 had one CM choice set option, while 111 had two choice set options, for a total of 840 possible CM responses. However, not all people answered the CM questions. Seventy-three (73) choice sets were left unanswered by respondents. Eleven of these unanswered choice sets had a note saying that current local government council taxes were too high. We classified these responses as protest answers. Excluding these protest answers, we arrived at a total of 767 valid responses out of 840. We compiled these 767 valid responses into an MS Excel spreadsheet and called the sample the *no-protest sample*. The other sample, where we included all the responses (including protest responses), is called the *with-protest sample*. We used these two samples in our regression analysis.

Data Structure and Summary

In our analysis, we ran two different regression models: Model 1, which included the choice attributes only, and Model 2, which included both choice attributes and the socio-demographic characteristics (SDCs) of respondents. In Model 2, we interacted the alternative specific constant, as well as the price variable, with the SDCs. These SDCs were hypothesized to influence respondents' choice behaviour. Table 1 presents a description of the attributes, the SDC variables and the indicator variables for survey regions. All of these variables were included in Model 2.

Table 1. Description of variables included in the regression

Variables	Description
Attributes	
ASC	Alternative specific constant (takes the value of 0 if status quo, 1 for the alternative)
Price	Price of the tree planting scheme to be shouldered by the local council (in 2007 NZ$)
Native	Type of trees/shrubs for planting (1 if purely native trees, 0 otherwise)
Mixture	Types of trees/shrubs for planting (1 if mixture of native and non-native trees, 0 otherwise)
Rebate	Indicator for preference of purchase rebates (1 if the respondent preferred to have a rebate, 0 otherwise)
Socio-demographics	
Years at Property	Number of years living at property
Educational attainment	Highest educational attainment (1-primary, 2-secondary, 3-tertiary, 4-postgraduate)
Volunteer	Willing to volunteer to plant native trees in their neighbourhood (1 if willing to volunteer, 0 otherwise)
Urban	Indicator for urban area (1 if property was in an urban area, 0 otherwise)
Wellington	Indicator for Wellington Region (1 if property was in Wellington, 0 otherwise)
Bay of Plenty	Indicator for Bay of Plenty Region (1 if property was in Bay of Plenty, 0 otherwise)
Waikato	Indicator for Waikato Region (1 if property was in Waikato, 0 otherwise)
North Island	Indicator for other North Island regions (other than Wellington, Bay of Plenty, and the Waikato) (1 if property was in other North Island region, 0 otherwise)
South Island	Indicator for the South Island regions (1 if property was in a South Island region, 0 otherwise)

Table 2 presents a summary of the SDC variables and regional indicator variables for the *with-protest sample* and the *no-protest sample*. The summary figures for the two samples are virtually the same. In this regard, we focus on discussing the summary statistics of the *no-protest sample*.

From the *no-protest sample,* we find that a typical respondent lived at their property for 10 years. More than half (57%) of the respondents had secondary schooling as their highest level of education, while 34% had tertiary and 7% attended up to the post-graduate level of schooling. The spirit of volunteerism in the sample seemed high, as reflected by the fact that 57% of the respondents would be willing to volunteer to plant native trees in their neighbourhood, such as public parks. Almost one-third (31%) of the respondents had properties located in rural areas. This statistic comes very close to the reported data from Statistics NZ (2006) which shows that 33% of NZ residents lived in rural areas in 2005. The Greater Wellington Region served as our priority survey area among the five survey regions. The highest proportion (33%) of respondents had their properties in this region. The other four survey regions had smaller proportions of respondents: Bay of Plenty region (17%), Waikato region (18%), other North Island regions not including the Bay of Plenty, Wellington or Waikato regions (17%) and South Island regions (16%).

Table 2. Socio-demographic characteristics of respondents

Characteristic	All Responses	Excluding Protest Responses
Years living at property	10.46 (11.35)	10.02 (10.85)
Volunteer to plant natives in their neighbourhood (e.g., public parks)	465 (56%)	433 (57%)
Property in rural areas	255 (31%)	235 (31%)
Education	Primary = 17 (2%) Secondary = 476 (57%) Tertiary = 277 (33%) Postgraduate = 59 (7%)	Primary = 14 (2%) Secondary = 430 (57%) Tertiary = 258 (34%) Postgraduate = 58 (8%)
Region	Wellington = 275 (33%) Bay of Plenty = 142 (17%) Waikato = 150 (18%) North Island = 141 (17%) South Island = 132 (16%)	Wellington = 251 (33%) Bay of Plenty = 132 (17%) Waikato = 136 (18%) North Island = 127 (17%) South Island = 121 (16%)
No. of Responses	840	767

Note: Figures in parentheses are standard deviations or percentages of sample.

Results

In the CM survey, each respondent was presented with a choice set with four different alternatives. One of the four alternatives was the *status quo* which represented the current situation. In the *status quo*, a resident can avail of free expert advice from the local council. This tree planting advice was assigned a value of $45. No free trees were provided in this alternative. The status quo alternative was included in all three choice sets. Since the status quo was present in each choice set with four alternatives, if we assume that these alternatives have an equally likely probability of being chosen, each alternative would have a 25% chance of being selected. However, our results show that the status quo alternative only had a selection probability of 7%. This implies that a majority of the respondents preferred to have the non-status quo, or changed alternatives, where they will be able to get either tree purchase rebates or free trees from local councils.

Overall, the CM exercise had a total of six alternatives, which were shuffled across three choice sets. Using the average estimated probabilities from the MNL model, we identified the most preferred alternatives among the six. The alternatives with the highest average probabilities were *mixture of native and non-native trees you purchase* (27%) and *natives you purchase* (25%). The third and fourth most preferred alternatives were *native trees from* councils (19%) and *mixture of native and non-native trees from councils* (18%). This result indicates that, although many respondents preferred to receive free trees from local councils, a greater proportion of these respondents prefer to purchase trees themselves and get those purchase amounts reimbursed from councils. The average probability of selecting the *non-natives from councils* was only 5%, making this alternative the least preferred among the six.

The MNL regression was run for both the *with-protest sample* and the *no-protest sample*. We initially ran Model 1, the model with CM attributes only. For both samples, the estimated MNL coefficients had the expected signs, consistent with economic theory (Table 3). The coefficients for the price variable (the monetary value of trees and advice) are negative and significant at the 99.9% confidence level. This implies that as the price of the government incentive scheme rises, the less it becomes preferred by the respondents. This result is interesting. Even though the respondents were told in the questionnaire that the council will fund the tree planting project on a respondent's property, respondents may have also been aware that the funds to finance such projects would likely be derived from the annual rates they pay to the council. Having this notion, a typical respondent preferred to choose the cheapest (but most desired) option in a given choice set.

Table 3. Estimates for the attribute only Multinomial Logit Model

	Model 1 (*Attributes Only*)			
	With-Protest Sample		***No-Protest Sample***	
	Estimates	Part worth	Estimates	Part worth
ASC	**0.393**		-0.408	
	(0.008)		(0.149)	
Price	**-0.007**		**-0.018**	
	(0.000)		(0.000)	
Native	**1.923**	**$ 291.34**	**2.136**	**$ 119.59**
	(0.000)		(0.000)	
Mixture	**1.990**	**$ 301.46**	**2.000**	**$ 112.03**
	(0.000)		(0.000)	
Rebate	**0.267**	**$ 40.50**	**0.323**	**$ 18.07**
	(0.006)		(0.001)	
Pseudo R^2	0.0243		0.0747	
Adjusted R^2	0.0228		0.0726	
Log-likelihood	-1177.08		-996.68	
No. of observations	840		767	

Note: Figures in boldface font are significant at the 90% confidence level or greater.
Figures in parentheses are p-values.

Comparing the two samples, the regression summary statistics indicate that the *no-protest sample* had a higher log-likelihood value, as well as a higher pseudo-R^2. This implies that the *no-protest sample* provided a better model fit than the *with-protest sample*. If a typical respondent was given the choice between *purely natives*, *mixture of natives and non-natives* and *purely non-natives*, results from the *no-protest* sample show that this respondent would likely not choose *purely non-natives*. With *purely non-natives* serving as the reference dummy variable, the coefficients for *purely natives* and *mixture of natives and non-natives* are both positive and significant. In terms of magnitude, the coefficient for *purely native* is slightly higher than the coefficient for the *mixture of natives and non-natives*. Using the Wald test to check for the statistical difference between the two coefficients, we get a chi-square value of 1.08. This value is lower than the chi square critical value of 2.71 ($\chi_1^{0.10} = 2.71$). This indicates that we fail to reject the fact that the two coefficients are the same. This implies that *purely natives* and *mixture of natives and non-natives* are similarly more preferred than *purely non-natives*. The part-worth values for these parameters are virtually the same, with $120 for *purely native* and $112 for the *mixture*.

The significantly positive coefficient for *rebates* denotes that respondents preferred to buy and choose their own trees, rather than simply choose from the local council's available trees. Perhaps respondents feel that the rebate scheme gives them more flexibility to choose suitable trees from other tree nurseries for planting on their own properties, even though, the variety available could be the same. The part worth value for the *rebate* attribute is $18 in the *no-protest sample*.

Table 4 presents the regression estimates for Model 2. Model 2 represents the unrestricted MNL regression model where we included the attributes, SDCs, and the indicator variables for the location of the respondent's property. The unrestricted model enabled SDC variables to explain the choice behaviour of respondents. The positive and significant coefficient estimate for the interaction variable $ASC \times Years\ in\ Property$ indicates that respondents who resided longer at their property would likely get a higher utility from a governmental tree planting scheme. The positive coefficient for $Price \times Rural$ indicates that, although respondents in general would prefer the cheaper alternative, the group of urban respondents would prefer the relatively cheaper planting scheme, compared to the rural respondents.

The interaction variable $Price \times Volunteer$ is also significantly positive, which implies that those who would be willing to volunteer, would likely choose the tree planting scheme with a relatively higher price. However, the interaction variable $ASC \times Education$ is not significant in this MNL model. To check for variations in choice behaviour between regions, we included indicator variables for the survey regions. Each indicator was interacted with ASC to capture whether residents prefer the changed alternatives in the regions. We dropped the interaction variable $ASC \times South\ Island$ as it would be represented in the constant. Results show that $ASC \times Wellington$ is not statistically different than $ASC \times South\ Island$. The coefficients for $ASC \times Bay\ of\ Plenty$, $ASC \times Waikato$ and $ASC \times North\ Island$ are all significantly positive, which implies that, geographically, residents in the upper North Island regions would likely be more welcoming of a local council biodiversity initiative compared with South Island respondents.

Using a series of Wald tests, we were also able to compare the coefficient for $ASC \times Wellington$ with the coefficients for $ASC \times Bay\ of\ Plenty$, $ASC \times Waikato$ and $ASC \times North\ Island$. The three Wald tests gave chi-square statistics above the critical values for *ASC×Bay of Plenty* ($\chi_1^{0.1} = 7.96$), *ASC×Waikato* ($\chi_1^{0.1} = 9.46$) and *ASC×North Island* ($\chi_1^{0.1} = 6.04$). These results indicate that the respondents in the three upper North Island regions would likely be more receptive of a private land biodiversity programme compared to the respondents in the Greater Wellington region.

Table 4. Estimates for the multinomial logit model with Socio-Demographic Characteristics

	Model 2 (*With Socio-Demographics*)			
	With-Protest Sample		***No-Protest Sample***	
	Coefficient	***Part-worth***	***Coefficient***	***Part-worth***
ASC	-0.612		**-1.544**	
	(0.170)		(0.002)	
Price	**-0.019**		**-0.029**	
	(0.000)		(0.000)	
Native	**1.855**	**$ 98.73**	**2.056**	**$ 70.59**
	(0.000)		(0.000)	
Mixture	**1.999**	**$ 106.44**	**1.973**	**$ 67.77**
	(0.000)		(0.000)	
Rebate	**0.244**	**$ 13.01**	**0.314**	**$ 10.79**
	(0.013)		(0.002)	
ASC*Years in Property	**0.021**	**$ 1.12**	**0.025**	**$ 0.86**
	(0.023)		(0.010)	
Price*Education	**0.003**	**$ 0.14**	0.001	$ 0.04
	(0.037)		(0.512)	
Price*Volunteer	**0.009**	**$ 0.46**	**0.010**	**$ 0.34**
	(0.000)		(0.000)	
Price*Rural	**0.004**	**$ 0.19**	**0.006**	**$ 0.19**
	(0.068)		(0.056)	
ASC*Wellington	0.246	$ 13.10	0.233	$ 8.00
	(0.617)		(0.641)	
ASC*Bay of Plenty	**1.265**	**$ 67.35**	**1.221**	**$ 41.94**
	(0.010)		(0.014)	
ASC*Waikato	**1.308**	**$ 69.65**	**1.267**	**$ 43.50**
	(0.007)		(0.010)	
ASC*North Island	**1.138**	**$ 60.60**	**1.156**	**$ 39.69**
	(0.021)		(0.022)	
Pseudo R^2	0.0509		0.0971	
Adjusted R^2	0.0460		0.0906	
Log-likelihood	-1088.54		-871.39	
No. of observations	807		767	

Note: The indicator variable for the South Island region serves as the reference variable.
Figures in boldface font are significant at the 90% confidence level or greater.
Figures in parentheses are p-values.

We then check for differences between the coefficients of the three other North Island regional indicator variables using a Wald test. We obtained chi-square values of 0.02, 0.12, and 0.24, which indicate that the choice behaviour between the three other northern regions were not statistically different from one another. This scenario is consistent with their part worth values being virtually the same (Bay of Plenty = $42; Waikato = $44; and North Island = $40).

To examine if there were heterogeneity in respondents' preferences, we ran RPL models. The RPL models followed the procedure described in Hensher et al. (2005, p. 632-634). In this procedure, we initially identified which attributes (excluding price) and socio-demographic variables could be classified as random parameters. To accomplish this, a series of RPL regressions including all the attributes and SDC variables were conducted. We assigned different distributional forms to each explanatory variable to check which distribution (e.g., normal, triangular, uniform, log-linear) would provide the best regression model fit. From these regressions, variables found to have random parameters with significant standard deviation estimates (or demonstrated heterogeneity) were included in the final RPL models. We used the standard Halton sequence (SHS) with 200 random draws (Hensher et al., 2005).

For the RPL models, we used only the *no-protest sample,* since the MNL results point to this sample as having a better model fit. We estimated two RPL models, Model 1, which represents the restricted model (only has attributes as explanatory variables), and Model 2 was also called the unrestricted model, since it includes both attributes and SDC variables. Overall, estimates for both RPL Models 1 and 2 were found to be significant as indicated by the Chi-square values of 283.13 and 337.52, respectively. Chi-square values for RPL Models 1 and 2 far exceeded the critical Chi-square values of $\chi_6^{0.10} = 10.64$ and $\chi_{17}^{0.10} = 24.77$, respectively (Table 5). In addition, the pseudo-R^2's of RPL Models 1 and 2 of 0.1331 and 0.1634 are also higher than MNL Models 1 and 2 with 0.0747 and 0.0971, respectively. The above scenario implies that RPL models yield a better model fit than MNL models.

Despite the differences in the goodness of fit and model significance between the RPL and MNL models, almost all coefficient estimates and significance levels are very similar. The signs of the coefficients, as well as the magnitude of coefficient estimates, for the restricted MNL (no-protest sample) and the restricted RPL are virtually the same (Tables 3 and 5). In terms of the unrestricted models, the signs of the coefficients for both MNL and RPL are also the same. The only major difference between the two regression models is the estimate for the random parameter for the mean and standard deviation of the interaction variable $price \times education$, which was positive and significant. Under the MNL model, the coefficient estimate for this interaction variable is positive, but not significant. The significantly positive coefficient of 0.016 for $price \times education$ implies that residents with a higher educational attainment tend to be more willing to choose the planting scheme with a relatively higher price. This was not captured in the MNL, since it did not account for heterogeneity. The RPL model, which relaxed the IID assumption, allows the error components of different alternatives to be correlated, which accounts for heterogeneity.

Table 5. Random parameter logit results for sample with no protest responses

	Model 1 (*Attributes Only*)		**Model 2 (*With Socio-Demographics*)**	
	Parameter Estimate	***Standard Deviation***	***Parameter Estimate***	***Standard Deviation***
ASC	-0.437		**-5.319**	.
	(0.132)		(0.004)	
Price	**-0.019**		**-0.086**	
	(0.000)		(0.002)	
Native	**2.278**		**2.972**	
	(0.000)		(0.000)	
Mixture	**2.126**		**3.128**	
	(0.000)		(0.000)	
Rebate	**0.305**	**0.816**	**0.280**	**1.499**
	(0.006)	(0.076)	(0.052)	(0.042)
Price*Education			**0.016**	**0.018**
			(0.036)	(0.011)
Price*Rural			**0.016**	0.032
			(0.073)	(0.104)
ASC*Years in Property			**0.039**	
			(0.049)	
Price*Volunteer			**0.022**	
			(0.014)	
ASC*Wellington			0.952	
			(0.317)	
ASC*Bay of Plenty			**2.585**	
			(0.016)	
ASC*Waikato			**2.721**	
			(0.015)	
ASC*North Island			**3.000**	
			(0.015)	
Pseudo R^2	0.1331		0.1634	
Log-likelihood	-921.72		-864.03	
Chi-square value	283.13		337.52	
No. of observations	767		745	

Note: The indicator variable for the South Island region serves as the reference variable.
Figures in boldface font are significant at the 90% confidence level or greater.
Figures in parentheses are p-values.

Discussion and Conclusions

Although New Zealand was reported to have one of the world's highest levels of threatened species (Hitchmough et al., 2007), New Zealanders increasingly participate in contributing to biodiversity enhancement for future generations with the intentions of preserving economic well-being and cultural wealth (MfE, 2007). We therefore tried to determine if there is an incentive for a typical NZ resident to participate in government initiatives toward biodiversity enhancement on private land. In this study, we also attempted to ascertain if a typical resident finds biodiversity enhancement on private lands valuable. Our data suggests that government initiated biodiversity enhancement programmes using tree planting on private properties are valued by our sample of NZ residents. We found that our typical respondent would be better off in terms of welfare if there would be a biodiversity enhancing scheme on residential properties. This is exhibited by the part worth values of $120 for providing native trees to plant and $112 for providing a mixture of natives and non-natives to plant.

Our sample of residents would be willing to participate in the biodiversity scheme provided that this scheme would have the preferred attributes. From this choice modelling exercise, the two most preferred attributes were having *purely native trees* and having a *mixture of natives and non-native trees*. This represents a bimodal distribution of preference wherein there is a group who prefers to have purely native trees on their respective properties, while another group prefers a combination of natives and non-natives. The group who strictly prefers purely natives might have the notion that NZ native trees are very well adapted to the NZ environment and they do not have the tendency to become invasive or hard to control. Therefore, they consider native trees as the best strategy for enhancing indigenous biodiversity on private lands. The other group of respondents recognized that some non-natives can serve as good complements for natives. Perhaps they believe that some non-natives can have high aesthetic values (e.g., colourful leaves and flowers) and can also provide food and shelter for native animals (Salmon, 2003). On the other hand, purely non-natives were preferred by the least proportion of the respondents. This may be because some introduced plant species in NZ eventually became invasive (Weir, 2006; Pimentel, 2002; Froude, 2002; Environment Waikato, 2002; Fowler and Syrett, 2000).

Another feature of a biodiversity enhancing scheme valued by residents was having a *rebate for purchasing trees they will plant to enhance biodiversity on their properties*. This feature seems to provide residents with the freedom to choose, and/or flexibility to purchase, the type of trees they like. The part worth value of this *flexibility* was approximately $11. Respondents also preferred to have the least expensive alternative, where they would be able to plant trees on their property. Results show that the current situation (or status quo alternative), wherein local councils provide only free advice but no free trees to residents, appears to be insufficient. A typical resident seemed to have the need to be provided with both advice and subsidised trees to better encourage them to support biodiversity enhancement through the planting of trees. Ninety-seven (97) respondents who chose alternatives, which included additional trees on their property, shared their reasons why private properties should have trees. These reasons included: trees are good for the environment; trees attract birds and provide them shelter; trees attract native animals; trees provide aesthetic benefits; and their properties have space for additional trees.

This study examined how a set of identified characteristics or attributes of a hypothetical biodiversity enhancement programme influenced the preference behaviour of a sample of NZ residents. This study is hoped to serve as a starting point for future valuation studies of biodiversity enhancement on private lands. Future CM studies may further examine the preference behaviour of household residents given other characteristics of trees to be planted, such as maximum height, canopy size and the amount of food that can be provided to native birds. Through focus group meetings and experts' consultation, other relevant characteristics attributes can be identified. Other future studies might further investigate the preferences of rural and urban residents towards biodiversity on private land.

One limitation of this choice modelling exercise was that we developed our choice modelling scenario and bid design instrument based on experts' opinion, what councils desired to know, and focus group meetings with respondents, to make the information more applicable to the councils we were working with. Construction may have been easier if we used the experimental design method (e.g., full factorial, fractional factorial, d-optimal) because there are several software programmes that could aid in developing the experimental designs for choice modelling (e.g., SPSS, GAUSS, SAS, MATLAB) (Johnson et al., 2007, Hensher et al., 2005; Burgess and Street, 2003; Kanninen, 2002). This was an important decision. We decided on the method we used specifically for our end users' benefit.

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