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Valuing Biodiversity Enhancement in New Zealand

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Abstract

The value of biodiversity enhancement in New Zealand was estimated from a survey sample of 457 residents. We determined the willingness of respondents to financially support biodiversity programs on private and public lands, as well as determining which factors influence this willingness-to-pay. Our data indicates that an average respondent was willing-to-pay $42 (2007 NZD) annually in their rates (taxes) to support a government initiated private land biodiversity programme and $82 (2007 NZD) annually to support a biodiversity programme on public lands.

Keywords

biodiversity
contingent valuation
New Zealand
household residents
native species

JEL Codes

Q51, Q56, Q57

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1. Introduction

Over 15 years have passed since the Convention on Biological Diversity in Rio de Janeiro was signed. At this historic event, signatory countries bound themselves to promote biodiversity conservation and enhancement (SCBD 2005, Sands 2003). However, valuing the benefits of biodiversity enhancement is a complex process, as there are numerous aspects to consider, such as the number of species per unit area, species interactions, habitat diversity and variation between species (Pearce, 2001; Nunes et al., 2003; Christie et al., 2004; Montgomery et al., 1999). In addition, the market benefits from biodiversity improvement cannot be readily observed. This absence of market benefits has led to the development and refinement of several non-market valuation techniques (Pearce, 2001; Christie et al., 2006; Nunes and van den Bergh, 2001).

The economic literature indicates that the most widely used non-market valuation technique currently practiced for biodiversity valuation is the contingent valuation method (CVM) (Nunes et al., 2003; Nunes and van den Bergh, 2001; Mitchell and Carson, 1989; Hagen et al., 1992; Garrod and Willis, 1994; Hanley and Craig, 1991; Reaves et al., 1999). One of the primary tasks of CVM, a survey research method, is the creation of a hypothetical market used to elicit the willingness-to-pay (WTP) amount of an individual for an improvement of a specific feature.[1] For instance, if we are valuing the provision of added protection to an endangered species, a hypothetical market might have three components: (1) description of the species to be protected and the added protection measure; (2) the cost of this measure and method of payment (e.g. one lump sum payment, annually in taxes); and (3) the type of elicitation method – either a closed-ended or open-ended question[2] (Bateman et al., 2002; Haab and McConnell, 2002; Carson, 2000; Mitchell and Carson, 1989).

The majority of biodiversity valuation studies, to date, have used the CVM method (Sahu and Choudhury, 2005; Nunes et al., 2003). Between 1983 and 1994, at least 20 different CVM studies, which value the benefits of preserving more than 25 different endangered species, were reported in the form of journal articles, theses and discussion papers (Loomis and White, 1996). Compared to countries that have conducted many biodiversity valuation related studies like the United States, the United Kingdom, and Australia, the number of biodiversity valuation studies in New Zealand (NZ) remains scarce (Yao and Kaval, 2007; Carson and Hanemann, 2005, DECC, 2004; Pearce, 2002, Navrud and Pruckner, 1997).

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[1] For a decrease in a biodiversity benefit, a CVM in the form of a willingness-to-accept question can be asked.

[2] An open-ended question asks a respondent how much they are WTP. In this way, the respondent can choose any value they wish. A closed-ended question asks a respondent about one particular value such as $5 or $30.

Based on the inventory of non-market valuation studies in NZ conducted by Yao and Kaval (2007), currently, only seven studies have reported values for biodiversity (Table 1).[3] Three of these studies valued the benefits from the control of pests that have negative impacts on biodiversity (Table 1). Greer and Sheppard (1990) and Lock (1992) study the benefits from the control of the common brushtail possum (*Trichosurus vulpecula*), while Kerr and Cullen (1995) value the benefits from the control of the noxious weed, *Clematis vitalba*. Three studies focused on valuing forests, wetlands and trees in urban areas. Mortimer et al. (1996) values forest conservation on the Little Barrier Island, Kirkland (1988) focuses on biodiversity of the Whangamarino Wetland in the Waikato Region, and Vesely (2007) values the prevention of a 20% reduction of trees in 15 major NZ cities. The biodiversity valuation study by Patterson and Cole (1999) focuses on ecosystem services and valuation of various ecosystems. All of these studies have focused on the value of biodiversity conservation and not on biodiversity enhancement, as is the aim of our study. Consequently, we did not find any study that valued indigenous biodiversity enhancement in terms of habitat creation through the planting of native trees and shrubs on *private* and *public* land.

Six of the seven NZ biodiversity studies used the CVM technique. These CVM studies have evolved over the years from using simple non-parametric applications to relatively modern parametric approaches. The first study, conducted by Kirkland (1988), used an open-ended CVM elicitation format. In this study, respondents were asked directly to state how much they would be willing-to-pay for a specific improvement in the preservation of the Whangamarino wetland. The average WTP from this study was $22/household/year (2008 NZD). Some researchers may consider this to be a low value, while others may not. Regardless, low average WTP values can be attributed to a high proportion of respondents[4] who reported WTP values equal to $0. Open-ended CVM questions would likely get many zero bids, as well as protest responses, and this lowers the average WTP (Bateman et al., 2002; Carson, 2000; Mitchell and Carson, 1989).

To address the issue of zero bids and protests, CVM researchers developed closed-ended CVM questions to facilitate the ease of answering CVM questions. Many studies have shown evidence that closed-ended questions result in lower protest rates and higher respondent participation (e.g., Bateman et al., 2002; Carson, 2000; Duffield and Patterson, 1991; Sellar et al., 1986). In 1993, the use of closed-ended questions was recommended for CVM surveys by a panel of experts organized by the National Oceanic and Atmospheric Administration (NOAA), who examined the validity of estimates from CVM studies (Arrow et al., 1993).

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[3] Yao and Kaval (2007) only found a total of 92 completed economic valuation studies in all of NZ. These studies were published between 1974 and 2007.

[4] In the Kirkland (1988) study, 67% of respondents reported a WTP value equal to zero.

Prior to the NOAA panel's recommendation to use closed-ended CVM questions, some NZ biodiversity valuation studies had already used closed-ended CVM questions (Table 1). Two NZ CVM studies conducted before 1993 employed closed-ended questions. In addition, data generated from closed-ended CVM questions were often analyzed using the logistic regression model (Bateman et al., 2002; Capps and Cramer, 1985). However, there are two major functional forms available to estimate logistic regressions: the linear and the exponential forms. The linear form uses the actual WTP bid amount as the independent variable in the logistic regression, while the exponential form uses the natural log of the bid as the independent variable.

Table 1. New Zealand biodiversity valuation studies (2008 NZD)

Study No.	Author(s)	Publica-tion Year	Valuation Method	Item Valued	Mean Values Reported	Model and Functional Form
1	Kirkland	1988	Contingent valuation	Whangamarino Wetland Preservation	$22/household/ year (Open)	Total sample average WTP
2	Greer and Sheppar d	1990	Contingent valuation	Research on the control of *Clematis vitalba*	$73/ person/ year (Closed)	Logistic – linear
3	Lock	1992	Contingent valuation	Possum Control Programme	$261/ household/ Year (Closed) and $67/household/ year (Open)	Logistic – linear
4	Kerr and Cullen	1995	Contingent valuation	Possum Protection of the Forest at the Paparoa National Park	$392/ person/ year (Closed)	Logistic - linear
5	Mortime r, Sharp and Craig	1996	Contingent valuation	Conservation Benefits of Little Barrier Island	$53/ household/ Year (Closed) and $44/household/ year (Open)	Logistic – linear
6	Patterso n and Cole	1999	Benefit transfer	NZ Land Biodiversity	$8,629/person/ year	--
7	Vesely	2007	Contingent valuation	Avoidance of a 20% reduction in local urban tree estate	$210/ household/ year (Closed)	Logistic – linear and exponential

* Note: Values have been adjusted for inflation for comparison purposes using the 2008 Reserve Bank of New Zealand's CPI inflation calculator, accessed: http://www.rbnz.govt.nz/inflationcalculator/calculate.do

Note: (Open) stands for an open-ended question and (Closed) represents a closed-ended question.

Haab and McConnell (2002) suggest that a linear model accurately predicts the probability of no responses at the highest bid. However, this format puts a greater weight on the no responses at the lowest bids. Therefore, if there were many no responses at the lowest bids, the mean WTP can become negative. This violates the assumption that WTP is a non-negative random variable in the valuation of *public* goods. The exponential functional form is also not without drawbacks. While the linear function puts greater weight on the lower left tail of the cumulative distribution function (CDF), the exponential function assigns a large proportion of weight in the upper right tail. Thus, if there were too many yes votes at the highest bids, the mean WTP could become very high, with a possibility of exceeding income. This would not be an ideal result since income is supposed to serve as the upper bound of WTP value (Haab and McConnell, 2002; Creel, 1998).

In the case of NZ biodiversity valuation, all five parametric studies listed in Table 1 used the linear logistic model. Greer and Sheppard (1990), Lock (1992), Mortimer et al. (1996), and Kerr and Cullen (1995), solely used the linear logistic model, while Vesely (2007) used both the linear and exponential logistic models. Vesely reported all the estimates of mean and median WTP values from both linear and exponential functional forms.

Ultimately, this study aims to fill a gap in NZ biodiversity valuation research. As a result of functional form discrepancies, we find the importance of the need to identify which functional form would most appropriately fit the dataset. It is also important to know whether the mean or the median WTP values would best be suited for the goals of NZ biodiversity valuation. In addition, we present our results to the end-users (e.g., government policy decision makers) to estimate realistic WTP values of the benefits derived from biodiversity enhancement focusing on the planting of native trees and shrubs.

2. Methods

As mentioned previously, CVM is the most widely used approach for biodiversity valuation in NZ and around the world (Yao and Kaval, 2007; Sahu and Choudhury, 2005; Nunes and van den Bergh, 2001). Although WTP estimates from CVM studies were questioned in the past due to inherent "biases" (e.g., Diamond and Hausman, 1994; Hausman, 1993), over the years, many economists have confirmed that carefully constructed CVM studies produce valid and reliable estimates (Venkatachalam, 2004; Carson et al., 2001; Welsh and Poe, 1998; Kriström, 1997; Welsh, 1986; Brookshire et al., 1982). This study adopts the CVM approach to valuation by applying the recommended CVM survey techniques, which include the use of closed-ended CVM questions, questionnaire pre-testing in focus groups, consultation with experts in the field, and creating personalized, easy to accomplish survey questionnaires (Bateman et al., 2002; Dillman, 2000; Arrow et al., 1993; Mitchell and Carson, 1989).

CVM is a method that directly estimates the value an individual would be WTP for a particular change in the provision of a good in question, contingent upon a hypothetical market. In this study, we examine if there is an incentive for people to support a government programme that encourages the planting of native trees and shrubs to enhance biodiversity. The hypothetical market consists of a NZ regional council planting programme that would provide plants for *private* and *public* land biodiversity projects.

Our CVM question was in the form of a closed-ended question, also known as the *take it or leave it* approach, *referendum format*, or *dichotomous choice yes-no CVM*. Dichotomous choice questions were initially introduced for survey work by Bishop and Heberlin (1979) and continue to be an important tool in biodiversity valuation (e.g., Vesely, 2007). The dichotomous choice format is proven to reduce strategic bias, wherein a respondent might have the tendency to overstate or understate the bid amount if he/she acts strategically. The use of carefully constructed dichotomous choice WTP questions address strategic bias and reduce the number of protest responses (Berrens et al., 1997; Arrow et al., 1993; Hoehn and Randal, 1987).

The dichotomous choice CVM scenario provides each respondent with a specific WTP amount (e.g., \$10) to support the implementation of the proposed council-led biodiversity enhancement programme on *private*ly owned and *public*ly owned (government) land. Given the biodiversity valuation scenario, a respondent can accept or reject a bid offer by answering "Yes" or "No" in the questionnaire. The probability of getting a 'Yes' or 'No' answer can be illustrated as:

$$Prob_i\,(no) = \pi^n = F(B;\theta) \tag{1}$$

$$Prob_i\,(yes) = \pi^y = 1 - F(B;\theta) \tag{2}$$

where $F\,(B;\,\theta)$ is a cumulative density function with parameter vector θ. The vector of bids, B, can be estimated by using the logistic regression model. We use two functional forms of the logistic model: the logistic cumulative density function

$$Prob_i(\text{yes}) = \frac{1}{1+e^{-[\alpha+\beta(B)]}} \tag{3}$$

and the log-logistic cumulative density function

$$Prob_i(yes) = \frac{1}{1+e^{-[\alpha+\beta(\ln B)]}} \tag{4}$$

where:

$\theta \equiv (\alpha, \beta)$

α = the intercept

β = the estimated coefficient of the bid amount

Therefore, F (B; θ) represents the cumulative density function of a respondent's true maximum WTP. This indicates that a respondent will vote "yes" to a bid amount if and only if the bid amount is equal to or below their maximum WTP, and will vote "no" if the bid amount exceeds this maximum (Hanemann, 1984; 1989).

We have placed the above choice set into a log-likelihood function as follows:

$$lnL(\theta) = \sum_{i=1}^{N} \left\{ v_i^y \ln \pi^y(B) + v_i^n \ln \pi^n(B) \right\} \quad (5)$$

where: v_i^y = 1 if the i^{th} respondent voted 'yes', and 0 if 'no'

v_i^n = 1 if the i^{th} respondent voted 'no', and 0 if 'yes'.

To determine the factors that influence the probability of the WTP of individual respondents, we run more detailed logistic regressions to control for demographic characteristics (e.g., age, property size, type of ownership) and attitudes (e.g., willingness to volunteer to plant native trees). We built the more detailed models upon the original base models in Equations 3 and 4 by adding the demographic and attitude variables that we hypothesized would have an influence on respondent's WTP. The more detailed models were run as linear and exponential functional forms of the logistic regression approach, with selected respondents' characteristics as covariates.

3. Survey Design and Data

To collect the necessary data, a two-staged phone-mail survey was conducted between December 2006 and January 2008. The first stage included the placement of phone calls to randomly selected NZ households listed in the White Pages telephone directory. If a person that was contacted agreed to participate in the survey, this person was sent a survey packet. Overall, 3211 phone calls were placed which resulted in contacting 1617 household residents. Out of 1617 contacts, 803 residents agreed to participate in the survey. This constituted a first stage response rate of 50%. We then mailed survey questionnaires to these 803 residents and 709 completed and returned their surveys. This represented a mail survey response rate of 88.3%. To the 709 completed surveys, we added the responses of the 20 focus group participants, resulting in a total of 729 observations. To properly test our hypothesis, it was necessary to filter out incomplete WTP observations. After the filtering process, we found that we were able to use 467 observations for this particular analysis.

In our hypothesis, we believed that many respondent characteristics would be related to how much people would be willing-to-pay for biodiversity planting projects. The variables we believed were of importance are listed in detail in Table 2. In relation to property ownership, 84% of the respondents owned the property where they live, 12% were renting, while 4% neither owned nor rented their properties. Thirty percent of the respondents were self-employed, while the rest were either working for salary, retired or unemployed. The larger bulk (61%) of the respondents was aged between 35 to 64 years old. Twenty-seven percent of respondents lived close to land reserves or were situated near a gully. Over half (59%) of the respondents stated that they would be willing to volunteer to plant native trees in their neighbourhood, such as public parks.

Table 2. Characteristics of respondents (n = 467)

Variable Name	Variable Levels	Percentage
Property Ownership	Owned	84%
	Rented	12%
	Neither owned, nor rented	4%
Self-employed (1 if 'yes', 0 if 'no')	Self-employed	30%
	Not self-employed	70%
Age of respondent (mean = 51 years old)	Under 25	6%
	25 to 34	10%
	35 to 44	21%
	45 to 54	19%
	55 to 64	21%
	65 to 74	16%
	75 and above	7%
Property location	Bordering a gully or reserve	27%
	Not bordering a gully or reserve	73%
Would volunteer to plant natives in their neighbourhood (e.g., *public* park)	Would volunteer	59%
	Would not volunteer	41%

4. Results and Discussion

There were two dichotomous choice WTP questions in our survey. The first CVM question asked respondents if they would be willing to support a council initiated native tree planting programme on *private land*. The second CVM question asked respondents if they would be willing to financially support a native tree planting programme on *public land*. They were told their funding would only support the purchase or propagating of native plants in a council nursery as well as *public* plant distribution and would not go towards incidentals such as administrative fees. In this sample of respondents, we have nine bid amounts ranging between \$1 and \$500. Each respondent was given the same bid amount to financially support *private* and *public* land planting. For instance, when we ask a respondent if he/she would be willing-to-pay \$50 to support *private* land planting, we also asked if he/she would be willing-to-pay \$50 to support *public* land planting.

In following the literature recommendations for CVM questions, prior to the WTP questions, a valuation scenario was provided. The valuation scenario involved the presentation of the photos of three NZ native animals, the tui bird (*Prosthemadera novaeseelandiae*), the giant kokopu fish (*Galaxias argenteus*) and the green tree gecko

(*Naultinus elegans*). We then mentioned that NZ native plants like flax (*Phormium tenax*) and pohutukawa (*Metrosideros excelsa*) provide food for the tui and green tree gecko, while the giant kokopu fish lives in streams shaded by overhanging native vegetation.

Applying Equations 3 and 4, we ran logistic regressions on the CVM data set with the binary yes-no variable as the dependent variable and the bid amount as the explanatory variable. We employed both linear and exponential functional forms. Table 3 presents the estimated coefficients and model parameters of the linear and exponential functional forms for both *private* and *public* lands. The coefficient for the bid amount was negative and significant at the 99.9% confidence level for all models; this implies that respondents were more apt to pay for a programme at lower bid amounts than higher bid amounts. If we compare the goodness of fit between the exponential and linear models, we find the pseudo R-squares of the exponential models higher than linear models for both *private* and *public* lands. The log-likelihood values from the exponential were also higher (–267.86 for *private*, –279.08 for *public*) than the linear (–288.19 for *private*, –296.39 for *public*). The AIC and BIC values were lower for the exponential models. This scenario implies that the exponential form was the preferred functional form in terms of having a better model fit and making better use of the data.

Table 3. Logistic regression estimates (dependent variable: WTP: 1 if 'yes', 0 if 'no')

	Linear		Exponential	
	Private Land	*Public* Land	*Private* Land	*Public* Land
Constant	**0.600**	**0.798**	**2.739**	**2.668**
	(0.000)	(0.000)	(0.000)	(0.000)
Bid amount	**-0.007**	**-0.005**	**-0.735**	**-0.606**
	(0.000)	(0.000)	(0.000)	(0.000)
Pseudo R-squared	0.1090	0.0697	0.1719	0.1240
Log-likelihood	-288.19	-296.39	-267.86	-279.08
LR-chi squared	70.53	44.38	111.19	79.02
AIC	580.38	596.79	539.73	562.15
BIC	588.68	605.08	548.02	570.44
Number of observations	467	467	467	467

Note: Values enclosed in parentheses represent p-values.

To confirm that the exponential was the appropriate functional form, grid search Box-Cox tests were completed for both *private* and *public* land settings. The Box-Cox transformation parameter (λ) was assigned to different values ranging between -3.0 to 3.0. The λ parameter was used to transform the vector of bid amounts using the Box-Cox formula:

$$B^{\lambda} = \frac{B^{\lambda} - 1}{\lambda} \tag{6}$$

From Equation 6, we have two strategic values for λ: when λ = 1, we simply go back to the logistic linear form; when λ = 0, we get the exponential form (Haab and McConnell, 2002

p. 36-40). A logistic regression was run for each set of transformed bid amounts, with *Prob* (yes_j) as the binary dependent variable and the transformed bids as the independent variable. We ran 29 logistic regressions using different values of λ (e.g., 0.2, 1.0, 0.0, 2.0). Log-likelihood values were plotted on the y-axis while λ values were on the x-axis. At λ=1, we achieve the linear form with a log-likelihood value of -294.38. At λ=0, we achieve the exponential form and find the highest point of the log-likelihood curve to be -267.86. This indicates that the exponential form maximizes the value of the log-likelihood function for the *private* land setting. A similar Box-Cox grid search exercise was completed using the binary responses for *public* land as the dependent variable and the transformed bids as the independent variable. These results reveal that at λ=0, we achieve the highest point in the log-likelihood curve. This indicates that the exponential is the form that maximizes the log-likelihood function for *public* land responses.

Using the logistic regression estimates in Table 3, we applied the method proposed by Hanemann (1989) to calculate mean and median WTP values. Since we consider that the planting of more trees is a *public* good which has *private* benefits, we assume WTP to be a non-negative random variable. Table 4 represents the calculated mean and median WTP values and their corresponding confidence intervals. The mean WTP on *public* land using the linear bid was \$256/person/year (2007 NZD) in additional annual rates (taxes)[5] while the mean WTP for *private* land was \$147. This reveals that the WTP value for *public* land was 67% higher than the WTP on *private* land. We are 90% confident that the mean WTP for *private* land was between the confidence interval of \$123 and \$186, while the mean WTP for *public* land was between \$210 and \$333. These confidence intervals for the mean WTP were computed using the method proposed by Park et al. (1991).

On the other hand, using the mean WTP might lead to high WTP estimates, since the mean has the tendency to be pulled up by yes votes at the higher bid amounts. The median WTP represents the amount that the 'middle respondent,' or the 50th percentile respondent, would be willing-to-pay and is therefore not influenced by extreme values at the upper tail of the WTP distribution. In this regard, we also calculated median WTP values as well as their corresponding confidence intervals, from the linear form. As was expected, median WTP values were relatively lower than mean WTP values (Table 4). The median WTP for *private* land (\$85) was 42% lower than the mean WTP (\$147); for *public* land, it was 32% lower. Median WTP confidence intervals were estimated using the simulation method proposed by Krinsky and Robb (1986, 1990). At the 90% confidence level, the lower bound of the median WTP for *private* land was \$123, while the upper bound was \$186. The median WTP for *public* land was \$174, with lower and upper bounds of \$131 and \$234, respectively.

[5] All WTP values from this point are in 2007 NZD and represent the WTP of a person to pay the specified amount in their annual rates (taxes) each year, unless otherwise noted.

Table 4. Mean WTP from linear bids with upper and lower bounds of mean (median) WTP (WTP values represent 2007 NZD/person/year in annual rates (taxes)

Land Type	Median (Mean) WTP	90% Confidence Interval of Median (Mean) WTP	
		Lower Bound	Upper Bound
Linear WTP			
Private	$ 85.26 ($147.46)	$ 57.18 ($123.48)	$ 115.84 ($185.51)
Public	$ 173.81 ($254.74)	$ 130.97 ($209.76)	$ 234.17 ($333.02)
Exponential WTP			
Private	$ 41.53 (*)	$30.88 (*)	$54.88 (*)
Public	$ 81.67 (*)	$58.86 (*)	$118.76 (*)

*Mean WTP is undefined using the exponential functional form.

From the exponential form, our calculated mean WTP values for both *private* and *public* lands were undefined. The mean WTP was undefined because of the low coefficient estimates for the bid amount (Haab and McConnell, 2002, p. 94 - 96). The calculated median WTP values for the exponential form were $42 for *private* land and $82 for *public* land planting programme, constituting the lowest WTP values in Table 4. Median WTP for *public* planting was 97% higher for the *private* land planting programme.

Running a logistic regression model with additional covariates would reveal a more detailed calculation for WTP. We hypothesized that the factors that would influence the WTP include their willingness to volunteer to plant natives on public lands, if they lived near a gully or nature reserve, if they were self-employed, owned property, and how old they were. Similar to the logistic regressions without covariates, we get a better model fit from using the exponential functional form. This was indicated by higher log-likelihood values and higher pseudo R-squared values. The log-likelihood values for *private* and *public* land models with the log of bids were higher at –240 and –249 than those with linear bids of –260 and –268, respectively (Tables 5 and 6). The pseudo R squared values, as well as the AIC and BIC values, indicate that the exponential function form provides a better model of goodness of fit. For these fuller logistic regression models, the Box-Cox tests also indicate that at $\lambda=0$, we get the highest points in the log-likelihood curves for both *private* and *public* settings. These results confirm that the exponential was the better functional form for both settings.

Table 5 represents the logistic regression results for *private* land with the binary yes-no as the dependent variable. We also reported the estimated median WTP values beside the estimated coefficient for each covariate. The indicator variable for bordering a gully or reserve was positive and significant, implying that an average respondent with property next to a gully or reserve would have a higher probability of supporting a *private* land planting programme. This respondent would likely be WTP more annually ($68 for the linear model and $2 for the exponential model) to support government initiated programmes for *private* land planting programme than someone with a property that does not border a gully or *public* land reserve. Respondents living close to a gully or reserve might be aware of the environmental benefits of planting natives on these areas, which include creation of biodiversity corridors for native animals, soil erosion control and establishment of an attractive landscape (FEAT, 2003; Watson and Basher, 2006). These respondents might also be aware that land reserves, especially those forest reserves managed by the NZ Department of Conservation, provide a scenic view, as they would likely have a wide variety of native trees and therefore a high level of indigenous biodiversity (DOC, 2007).

Table 5. Linear and Exponential Logistic Regression Estimates for Biodiversity Projects on *Private* Lands (WTP values represent 2007 NZD/person/year in annual rates (taxes)

	Linear	Median WTP Value	Exponential	Median WTP Value
Bid	**– 0.008**	--	**– 0.830**	--
	(0.000)		(0.000)	
Indicator for bordering a gully/reserve (1 if 'yes', 0 if 'no')	**0.565**	**$ 68.16**	**0.558**	**$ 1.96**
	(0.022)		(0.029)	
Indicator for volunteering to plant (1 if 'yes', 0 if 'no')	**0.813**	**$ 98.09**	**0.974**	**$ 3.23**
	(0.000)		(0.000)	
Self-employed (1 if 'yes', 0 if 'no')	**0.678**	**$ 81.78**	**0.676**	**$ 2.26**
	(0.004)		(0.006)	
Age group (1 to 7 groups)*	**– 0.150**	**– $ 18.13**	**– 0.161**	**$ 0.82**
	(0.032)		(0.031)	
Indicator for property ownership (1-own property, 0-otherwise)	– 0.547	– $ 65.98	-0.575	$ 0.50
	(0.073)		(0.072)	
Constant	**0.934**	**$ 112.70**	**3.308**	**$ 53.72**
	(0.016)		(0.000)	
Log-likelihood value	-259.79		-240.18	
Pseudo R-squared	0.1786		0.2406	
Likelihood ratio chi square test value	112.99		152.21	
AIC (Akaike Information Criterion)	533.58		494.36	
BIC (Bayesian Information Criterion)	562.45		523.23	
No. of observations	457		457	

Note: Figures in parentheses are p-values. Figures in boldface font are statistically significant at the 90% confidence level or greater. *Age groups include: 1 – less than 25 years old; 2 – 25-34; 3 – 35-44; 4 – 45-54; 5 – 55-64; 6 – 65-74; 7 – 75 years and above.

Regression estimates from the linear model indicate that self-employed respondents would be WTP $82 more for *private* planting than those earning wages or that are retired. For the exponential model, self-employed people only had a WTP of $2 more than wage earners and retired persons. On the other hand, those who would be willing to volunteer to plant natives in their neighbourhood, such as in the public parks, would pay more ($98 for linear and $3 for exponential) in their annual rates than those that would not. Of the three positive contributors to the overall median WTP value on *private* land, it appears that the volunteerism attitude towards *private* tree planting contributes the most.

In both linear and exponential forms, the coefficients for age group were both negative and significant. The negative coefficient for age indicates that younger respondents were more WTP than older ones. For example, in the linear model, a person in the 45 to 54 age group would be WTP $18 more ($1 for the exponential model) than a person that was in the 55 to 64 age group. Our data also indicated that older respondents, especially those who were retired, had a lower income, which may be the reason for this difference. The coefficients for property ownership in both functional forms were negative and significant at the 90% level (Table 5).

Table 6 presents the logistic regression estimates for a *public* land planting programme. Similar to the results on *private* land, the coefficients for property owners was negative and significant. This shows that a property owner, on average, has a lower median WTP (-$143 for the linear model and $0.32 for the exponential) for *public* land planting programmes than those who were not property owners. However, this WTP can be offset if the property owners were willing to volunteer to plant and/or were self-employed ($165 for the linear and $4 for the exponential for volunteering to plant and $155 for the linear and $3 for the exponential for being self-employed).

In contrast to the regression results for *private* land planting programmes, age does not seem to influence the probability of financially supporting *public* land planting programme. Being close to a land reserve or situated next to a gully also does not seem to influence a respondent's WTP decision on *public* land.

5. Conclusions

This study contributes to the NZ biodiversity valuation literature in two ways. First, we contribute to the literature by valuing a different biodiversity aspect, biodiversity enhancement through the planting of additional native trees. Second, we examine two functional forms for estimating WTP values, the linear and exponential functional forms. Regression results and tests on the functional form indicate that, for this particular case study, the exponential model was superior to the linear form. In addition, when presented with both mean and median values, the median WTP estimates from the exponential logistic regression models without covariates were found to be the most realistic of our results by some of the end users of this research (e.g., regional council staff members). For the logistic regression where we included the socio-demographic covariates, the positive median WTP values from covariates in the linear form were higher than those of the exponential model. However, although the logistic models in the exponential form gave lower median WTP values, they were all non-negative which support our assumption of non-negative WTP.

Table 6. Linear and Exponential Logistic Regression Estimates for Biodiversity Projects on *Public* Lands (WTP values represent 2007 NZD/person/year in annual rates (taxes)

	Linear	WTP Value	Exponenti al	WTP Value
Bid	**– 0.005**	--	**– 0.704**	--
	(0.000)		(0.000)	
Indicator for bordering a gully/reserve (1 if 'yes', 0 if 'no')	0.400	$ 74.44	0.405	$ 1.78
	(0.101)		(0.108)	
Indicator for volunteering to plant (1 if 'yes', 0 if 'no')	**0.886**	**$ 164.67**	**0.998**	**$ 4.13**
	(0.000)		(0.000)	
Self-employed (1 if 'yes', 0 if 'no')	**0.833**	**$ 154.79**	**0.830**	**$ 3.25**
	(0.000)		(0.001)	
Age group (1 to 7 groups)*	– 0.083	– $ 15.49	– 0.091	$ 0.88
	(0.226)		(0.208)	
Indicator for property ownership (1-own property, 0-otherwise)	**– 0.765**	**– $ 142.30**	**– 0.793**	**$ 0.32**
	(0.016)		(0.015)	
Constant	**1.019**	**$ 189.41**	**3.192**	**$ 93.05**
	(0.008)		(0.000)	
Log-likelihood value	–267.56		–248.85	
Pseudo R-squared	0.1428		0.2027	
Likelihood ratio chi square test value	89.14		126.55	
AIC (Akaike Information Criterion)	549.12		511.71	
BIC (Bayesian Information Criterion)	577.99		540.58	
No. of observations	457		457	

Note: Figures in parentheses are p-values. Figures in boldface font are statistically significant at the 90% confidence level or greater. *Age groups include: 1 – less than 25 years old; 2 – 25-34; 3 – 35-44; 4 – 45-54; 5 – 55-64; 6 – 65-74; 7 – 75 years and above.

Results also showed that biodiversity enhancement, through the additional planting of native trees, is valuable for both *private* and *public* lands. A typical respondent was willing to contribute at least $42 in additional annual rates (taxes) to support a hypothetical NZ government's programme to enhance biodiversity on both *private* and *public* lands. Factors that were found to positively influence the probability of financially supporting *private* land planting programme were: being self-employed, being situated close to a gully or reserve, being willing to volunteer to plant natives on neighbouring properties, and being a younger property owner. For *public* land planting programmes, the factors which positively influence the WTP probability were being self-employed, being willing to volunteer to plant trees in their neighbourhood's public parks, and being an aspiring property owner.

We presented our results to the end users of this research who were staff members of the regional councils of the Waikato, Bay of Plenty, and Wellington regions of NZ in April 2008. During the presentation, they seemed to find the estimated median WTP amounts from the logistic exponential form ($42 for *private*, $82 for *public*) as the most realistic and useful estimates. These values were actually the lowest among the sets of WTP estimates from this exercise. They mentioned that they would consider these estimated values for increasing their rates (taxes) for biodiversity enhancement. NZ property owners currently pay local taxes related to biodiversity conservation and enhancement. In 2007, property owners in the Waikato region paid *biosecurity rates* ranging between $19 for a small residence to $272 for a farm with an area of at least 83 hectares (Environment Waikato, 2007). Biosecurity rates collected are currently used to fund the council's activities for pest control for biodiversity conservation (e.g., possum (*Trichosurus vulpecula*) control and alligator weed (*Alternanthera philoxeroides*) control) (Environment Waikato, 2008a; Environment Waikato, 2008b; Environment Waikato, 2002).

This study focused on valuing additional native trees and shrubs throughout NZ to increase native biodiversity. We believe that this was a good baseline survey to give us a general picture of how NZ residents value additional trees on *private* and *public* lands. However, there are many different types of public lands in NZ, including national parks, native reserves, regional parks, city parks and forest parks. Having this the case, we recommend that future non-market valuation studies should estimate and compare biodiversity values between different types of *public* lands. Results from these studies will guide policy makers to determine which types of land they should prioritize for government initiated biodiversity programmes. As many local governmental units are faced with budgetary constraints, focusing on priority sites might provide the greatest biodiversity impact.

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