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The Connection between Biodiversity and Well-Being: A New Zealand Case Study

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Abstract

The link between human well-being and biodiversity has not been well studied and was therefore the goal of this research project. Focus was placed on an increase in New Zealand native biodiversity, by an increase in the number of native trees and shrubs being planted on public lands. An increase in well-being occurred in response to an increase in native biodiversity for urban residents that have lived in their current home for less than six years. Responses were also affected by household income, whether a person was self employed and their level of education. We believe this information will be useful in targeting future community participants for voluntary biodiversity projects.

Keywords

native biodiversity
New Zealand
well-being
utility
community volunteers

JEL Classification

Q57; Q2; Q51

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Introduction

Biodiversity, the term used to describe all aspects of biological diversity such as ecosystem complexity, genetic variation, and species richness, is necessary to sustain ecosystem functions (Allaby, 1998). These ecosystem functions provide ecosystem services such as the maintenance of air quality, food production, and recreation (Millennium Ecosystem Assessment, 2005; Daily, 1997; Costanza et al., 1997). Biodiversity is also important to human well-being because it provides physiological, psychological and social benefits to people. As the Millennium Ecosystem Assessment (2005) suggests, "biodiversity is the foundation for human well-being."

The contribution of biodiversity to human well-being may differ depending on where a person lives. For a person living in a town/city or urban area, the presence of green spaces or trees may enhance quality of life by improving air quality and providing aesthetic views (Chiesura, 2004; Vesely, 2007). A resident in a rural area, such as a person engaged in agricultural production, may view biodiversity differently. One farmer may view biodiversity as a coping mechanism for agricultural risks including the mitigation of the impacts of climate change on agricultural production (Wood and Lennė, 2005; DEFRA, 2005). Another farmer may perceive biodiversity enhancement on farms as a negative issue, believing the foregone production benefit of using an additional acre of land for biodiversity may be greater than the additional benefit from biodiversity (Pascual and Perrings, 2007).

New Zealand (NZ) is internationally regarded as an important contributor to global biodiversity, since many of its plants and animals are found nowhere else in the world (MfE, 2007). Despite this status, NZ has experienced one of the highest biodiversity losses in the world (Hitchmough et al., 2007). Over the past millennium, 90% of NZ wetlands have disappeared and almost 75% of its forest resources have been cleared (Ewers et al., 2006; MfE, 2007; NZB, 2005). As a result, many native plants and animals have either become extinct (e.g., moa, huia, quail) or endangered (e.g., kiwi bird, kaka beak flower) (Conservation International, 2007). Sadly, this decline is not only linked to habitat destruction, but also to the introduction of invasive pest species, both of which are human related activities (Porteous, 2007; Green and Clarkson, 2005).

NZ initiatives have been created by national, local, and individual agencies to respond to this extensive biodiversity decline. The most prominent initiative was the creation of a 20-year multi-agency action plan called the NZ Biodiversity Strategy (NZBS). The NZBS, launched in 2000, was coordinated by the NZ Department of Conservation with a goal of the enhancement of indigenous biodiversity on public lands. National and regional policies have led to the creation of mechanisms that became instrumental in promoting vegetation enhancement through the planting of native trees, as well as the control of plant and animal pests. The implementation of these policies has enabled NZ to become recognized as a world leader in biodiversity conservation (Carter, 2007).

As mentioned previously, biodiversity provides numerous anthropocentric benefits, one being an increase in human well-being. Well-being, or utility, is the measure of satisfaction or happiness gained from a good or service such as biodiversity (Kahnemann et al., 1997; Kahnemann and Sugden, 2005). To calculate well-being, a self-reported happiness statistic such as an arbitrary life-satisfaction scale (e.g., 1 to 4 where 1 is unhappy and 4 is extremely happy or 0 to 10 where 0 is unhappy and 10 is extremely happy) is used to determine respondents happiness or well-being levels in their current and/or future life situations (van Praag and Baarsma, 2000; Ng, 1997; Frey and Stutzer, 2002; Cantril, 1965; Kaval and Loomis, 2007). This research method produces estimates of the respondent's level of subjective well-being, which is believed to represent his/her utility level.

The well-being method has long been used in the field of psychology to assess how the happiness of individuals is affected by different stimuli or life situations (Dixon, 1997; Ng, 2003). More recently, economists have begun to use well-being studies and have found the results from these studies reliable and valid (Pavot and Diener, 1993; Fordyce, 1985; Di Tella et al., 2001; Easterlin, 2001; Frey and Stutzer. 2002; Kaval and Loomis, 2007; Dixon, 1997; Ng, 2003). However, very few studies have examined the economic link between human well-being and biodiversity (Rehdanz, 2007). In this study, we will attempt to fill this gap in the literature.

Using the well-being method, which will be described in the next section, this study examines whether biodiversity enhancement affects the well-being of NZ households by focusing on the planting of additional native trees and shrubs on public lands (e.g., public parks, native reserves).

Methods

To investigate the link between biodiversity enhancement and the well-being of NZ households, we conducted a phone-mail survey where we distributed our survey instrument by mail to willing participants that agreed to participate in the study during a phone conversation. The survey was tested and updated from information provided during two focus groups and several one-on-one pretesting sessions (Kaval and Yao, 2006; Yao and Kaval, 2006).

Using the NZ White Pages Telephone Directory, residents were randomly selected and called between November 2006 and December 2007. During this period, a total of 3,211 phone calls were placed, which resulted in phone conversations with 1,617 NZ residents. Eight hundred-three (803) qualified respondents agreed to participate in the survey. This constituted a phone invitation success rate of 50%. These qualified respondents were each sent a survey packet. Out of the 803 mail survey respondents, 709 returned their completed surveys. This constituted a mail survey response rate of 88.3%. We then included the survey

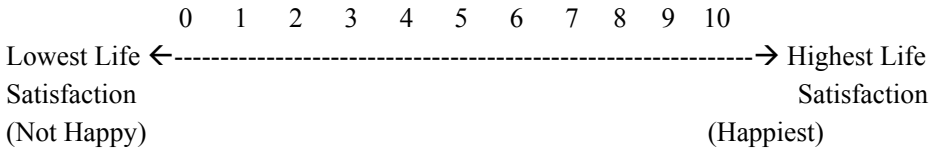
responses from 12 focus group respondents in our analysis, resulting in a total survey sample of 721 respondents.

The survey questionnaire was eight pages in length and included questions about native plants and birds in parks and reserves, as well as two well-being questions. The first well-being question asked the respondent to rate their current life satisfaction level for the existing biodiversity scenario. This question started with a descriptive statement to make each respondent think about their current life situation, which implicitly referred to their biodiversity scenario. The question ended by asking respondents to rate their life satisfaction level with 0 as not at all happy and 10 as the happiest life possible. The first question for eliciting the satisfaction rating of the respondent for the life situation at the time of the survey is as follows:

> Think about your life now and where you are living. You may be living near a city, living within walking distance from a school, being close to work, or living near a gully, to name a few.
>
> On a scale from zero to ten, where zero is very unhappy with your life and ten is the best possible life, how would you rate your current satisfaction with your life?
>
> Please circle the appropriate number.
>
> 0 1 2 3 4 5 6 7 8 9 10
> Lowest Life Satisfaction (Not Happy) ←----------→ Highest Life Satisfaction (Happiest)

The next well-being question asked respondents to rate their life satisfaction if there were more native plants and animals in the parks and reserves closest to their current location. The parks and reserves could either be national parks, regional parks, scenic reserves or district council parks. The park types were enumerated in the scoping questions asked prior to the well-being question. The second well-being question was:

> Would Your Life Change If There Were More Native Plants and Animals on The Parks and Reserves Closest to Your Current Location?
>
> Thinking about your answer to the first question on this page (current location of your property or residence). If there were more native bush on the parks and reserves closest to your property or residence and this attracted more native wildlife to the parks and reserves in your area such that you would now see native animals such as Tui's and Green Tree Geckos on a regular basis if you went to those parks, how would you rate your satisfaction with your life in this case?
> Please circle the appropriate number.



The two well-being questions represented before and after scenarios. The before biodiversity enhancement scenario was represented by their current or existing scenario, while the after biodiversity enhancement scenario was represented by the hypothetical increase in native plants and animals on the public parks and reserves in their area.

To determine how biodiversity affected the well-being of the respondents, we constructed the well-being function:

$$w = l[u(y, g, t)] + e \qquad (1)$$

where w represents the individual's self-reported level of life satisfaction (0 to 10), l represents a continuous non-differentiable function which relates the real well-being of an individual to their self-reported well-being level, u is the individual's true utility level, y is the income level (e.g., $25,001 to $50,000 per year), t is a vector of the socio-demographic characteristics of households, and t represents a vector of the attitudes of respondents for the planting of native trees on public land. This analytic approach is in line with the experienced-utility concept proposed by Kahneman et al. (1997).

In this case, the latent variable represents true utility, while the error term takes into account the subjectivity of the responses. Since we were dealing with the changes in well-being of the respondents, the dependent variable of the ordered probit model was the difference between the life satisfaction rating if there were more natives on public lands and the rating given by the respondents for their current life situation. This method is similar to Cantril's ladder of life question and that of van Praag and Baarsma (Kaval and Loomis, 2007; Cantril, 1965; van Praag, 1988; van Praag and Baarsma, 2000). The independent variables were placed into three categories: income level, socio-demographic characteristics and attitudes towards biodiversity enhancement. The dependent variable in Equation 1 has an ordinal ranking. We therefore employ the probit model, as the appropriate model for our econometric analysis.

Data Collection

Our respondents represented all areas of NZ. Out of 721 respondents, 715 gave complete responses and were used in the analysis. A large proportion of respondents (69%) were residents in urban areas, while 31% reported living in rural areas. These proportions were very close to the 2005 Statistics New Zealand data, which stated that the NZ urban and rural populations were 67% and 33%, respectively.

Our respondents were further sub-grouped by the length of time they had resided at their current property. New timers were those respondents who resided at their current property for at most six years, while old timers were those who resided there for over six years. Six years was used as the dividing point, since it represented the median. The overall sample of 715 respondents consisted of 364 (50%) new timers and 351 (50%) old timers. In terms of education, 57% of the respondents stated that secondary schooling was their highest educational attainment. In addition, 34% had a tertiary education, while only 8% had entered graduate school. Comparing the educational attainment between the urban and rural groupings, we found the proportions to be virtually the same.

Overall, 29% of respondents had a household income between $25,000 and $50,000, the largest percentage of respondents fell into this category. Only 7%, the smallest percentage by category, had a household income between $100,001 and $125,000. The rural and urban sub-samples had very similar income distributions. In terms of age groups, 53% of the rural and urban sub-samples were younger than 55 years of age and 47% were older. This scenario revealed that rural and urban respondents shared very similar distributions in terms of location of residence, income and age. This is true, despite the large differences in features between urban and rural areas. In general, urban areas have better access to grocery stores, health services and logistics. Rural areas, on the other hand, were likely to have a relatively smaller population and more limited access to public services (Pink, 2006).

In this regard, our data also indicated marked differences between urban and rural respondents in terms of property size, employment type, volunteerism and park recreational activities. As can be expected, rural properties were significantly larger than urban properties. The average rural property (45 hectares) was over 10 times larger than an average urban property (4 hectares). The rural sub-sample had a significantly higher self-employment proportion (45%), compared to the urban sample (23%). This could possibly be attributed to the fact that urban areas have far more corporate or government employers, compared to rural areas, which can be dominated by self-employed farmers (Pink, 2006). A significantly greater proportion of rural respondents (83%) would be willing-to-volunteer to plant native trees in NZ, compared to 68% for the urban respondents. In terms of park recreation, a larger proportion of urban respondents (29%) participated in watching birds on public lands. This is significantly higher (95% confidence level) than the proportion of rural respondents (20%).

In terms of the length of time they have resided at their current property, rural respondents were found to have stayed at their property slightly longer (12 years) than the urban respondents (10 years). However, there was no statistical difference found between these two groups. In addition, no statistical difference was observed in terms of the proportions of property ownership, participation in jogging at public parks, and the proportion of those who found that a mixture of native and non-native plants was important to be located on neighbouring properties.

Figure 1 presents a summary of the satisfaction ratings of the rural and urban sub-samples, subdivided by new timers and old timers. Overall, new timers had virtually the same average life satisfaction rating for the current life situation (8.00) as the situation of if there were more native trees in public parks and reserves (8.06). However, dividing the new timer sub-sample into new timer rural and new timer urban, we found the new timer urban to have a significantly higher life satisfaction rating if there were more natives (from 7.87 to 8.04), while the new timer rural had a significantly lower satisfaction rating (from 8.34 to 8.09). We also found that old timers overall would likely have a lower expected life satisfaction rating if there were more natives. This also holds true for both rural old timers and urban old timers.

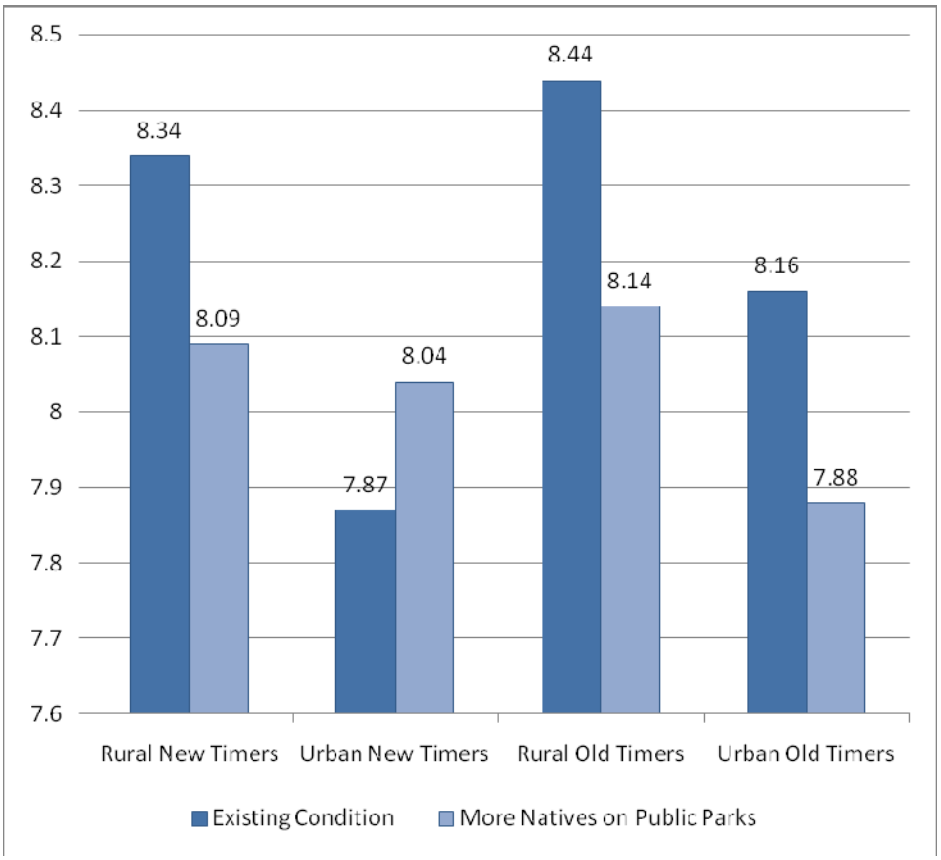


Figure 1. Life satisfaction rating representing the current life satisfaction level and the estimated life satisfaction level if there were more native plants and animals on public parks

The sample was divided by rural and urban residents, as well as new timers (resided at property 6 or less years) and old timers (resided at property over 6 years). Life satisfaction rating ranged from 0 to 10 where 0 is extremely unhappy and 10 is extremely happy.

Results

To determine the factors influencing the well-being of rural and urban residents, an ordered probit regression analysis was conducted with the change in the well-being rating as the dependent variable. This variable represented the difference between the rating for the new scenario with more native trees on public parks and their current life satisfaction rating. The independent variables consisted mainly of socio-demographic variables and activity variables that we hypothesized to have an influence on the change in the well-being of respondents. Socio-demographic variables included age group, household income, an indicator for being self-employed, an indicator for whether they owned their property, education level, property size in hectares, and number of years they resided at their current property. Activity included two indicator variables, one for participating in bird watching at public parks and one for jogging at public parks. We also included two behavioural variables: an indicator for their preference to have a mixture of native and non-native plants on their neighbour's property and an indicator for their willingness to volunteer to plant native trees in NZ.

Table 1 presents the ordered probit model coefficient estimates for the three samples. Regression summary statistics indicate that the rural sample had a better model fit compared to the urban sample, as exhibited by the higher log-likelihood value and higher pseudo r^2 value. However, the urban sample appeared to have a better overall model significance, as demonstrated by the higher likelihood ratio chi square value (Urban = 71.83, Rural = 38.36). It may be worth noting that the urban sample (493 respondents) had more observations than the rural sample (222 respondents). However, this is directly representative of the NZ population, as the actual proportion of urban to rural residents is directly correlated with our proportions (Statistics NZ, 2008).

Results of the ordered probit regressions revealed that the factors affecting the well-being of urban and rural respondents were different. Only the volunteer to plant variable had positively significant coefficient estimates for both groups. This indicates that the attitude of being willing-to-volunteer to plant native trees in NZ positively contributes to a greater well-being if they could eventually have more native plants in nearby public parks and reserves. For urban respondents, the two variables that contributed to an increase in well-being levels were educational attainment and participation in bird watching in public parks. This implies that more natives on public parks significantly benefits urban respondents with a higher education and those involved in bird watching in parks. Results also show that rural respondents, who were engaged in jogging at public parks and those who preferred to see a mixture of native and non-native plants on neighbouring properties, would likely experience

a significant increase in well-being if there were more natives on public parks. The above scenario reveals that respondents' preferences, as well as the type of activities participated in at public parks, influences the positive change in well-being.

Table 1. Well-Being Regression Models – Rural, Urban, Pooled
Dependent variable is change in well-being

	Urban	Rural	Pooled
Willingness to volunteer to plant native trees in NZ (1 if yes)	**0.534**	**0.688**	**0.533**
	(0.000)	(0.010)	(0.000)
Age group	-0.069	**-0.163**	**-0.078**
	(0.129)	(0.024)	(0.037)
Household income	**-0.084**	-0.031	**-0.063**
	(0.040)	(0.619)	(0.062)
Self-employed (1 if self-employed)	**-0.290**	-0.009	**-0.236**
	(0.032)	(0.964)	(0.030)
Own property (1 if own property)	**-0.500**	-0.117	**-0.352**
	(0.011)	(0.676)	(0.026)
Education	**0.292**	0.101	**0.227**
	(0.001)	(0.465)	(0.002)
Log of property size in hectares	0.037	**-0.138**	**-0.055**
	(0.425)	(0.001)	(0.012)
Log of number of years living at the property	**-0.112**	0.111	-0.065
	(0.016)	(0.204)	(0.113)
Bird watching in public parks? (1 if yes)	**0.401**	0.132	**0.308**
	(0.004)	(0.522)	(0.007)
Jogging in public parks? (1 if yes)	-0.249	**0.537**	-0.062
	(0.148)	(0.077)	(0.675)
Prefer to have a mixture of native and non-native plants on neighbour's property? (1 if yes)	0.099	**0.390**	**0.173**
	(0.395)	(0.035)	(0.074)
Log likelihood	-528.86	-200.51	-752.87
Pseudo R^2	0.064	0.087	0.055
LR Chi^2	71.83	38.36	87.84
No. of observations	361	175	536

Note: Figures in parentheses represent p-values and figures in boldface font represent coefficient estimates significant at the 90% confidence level or greater.

For the urban sample, we found four variables that appear to contribute to perceived well-being levels. Urban respondents with relatively lower household incomes and those who were not self-employed would likely be more satisfied with more natives on public parks. Urban respondents who did not own the property they resided at would also experience an increase in well-being with more natives on public lands. We also found that urban respondents who resided at their property for a shorter period of time perceived that they would be better off if there were more natives on public parks. This is consistent with the results shown in Figure 1, where urban new timers had a significantly higher life satisfaction rating with more natives.

The significantly negative coefficient for the number of years living at the property indicated that urban new timers would be significantly better off with more natives on public parks. To examine this conjecture, separate ordered probit regression models were used to examine the factors influencing the change in well-being of the urban new timers and urban old timers. Table 2 presents the ordered probit estimates for the two sub-samples.

Table 2. Well-Being Regression Models – Urban New and Old
Dependent variable is change in well-being

	New-Timer	Old-Timer
Willingness to volunteer to plant native trees in NZ (1 if yes)	0.302	**0.734**
	(0.141)	(0.000)
Age group	**-0.116**	-0.019
	(0.044)	(0.798)
Household income	-0.059	**-0.115**
	(0.285)	(0.077)
Self-employed (1 if self-employed)	-0.140	**-0.475**
	(0.475)	(0.011)
Own property (1 if own property)	**-0.640**	-0.121
	(0.005)	(0.776)
Education	0.108	**0.477**
	(0.412)	(0.000)
Log of property size in hectares	**0.127**	-0.017
	(0.091)	(0.779)
Bird watching in public parks? (1 if yes)	**0.746**	0.062
	(0.000)	(0.739)
Log likelihood	-251.352	-269.364
Pseudo R2	0.070	0.057
LR Chi2	37.74	32.57
No. of observations	187	178

Note: Figures in parentheses represent p-values and figures in boldface font represent coefficient estimates significant at the 90% confidence level or greater.

For the urban new timers, those with relatively larger properties and those who participated in bird watching at public parks would likely be better off with more natives. This implies that property characteristics and activities participated in at public parks contributed to a positive well-being on the part of urban new timers. The significantly negative coefficient for age group indicates that younger residents, which can be expected to be relatively more agile, would be better off with more natives on public parks. This may be because they can engage in strenuous activities like hiking or bush walking. For the urban old timers, those who would be willing-to-volunteer to plant native trees in NZ and those who had a relatively higher education would tend to be better off if there were more natives.

Discussion and Conclusions

In this study, we investigated the link between the well-being of New Zealand (NZ) residents and native biodiversity in their local area. This analysis provides a significant contribution to our understanding of the link between human well-being and biodiversity, an upcoming research area. To accomplish our goal, we used data from an eight-paged mail survey completed by 721 NZ residents. Well-being was analyzed to see if it would be affected by an increase in native trees and shrubs in the respondent's local area. The area of native trees and shrubs was used as an indicator of native biodiversity of both the flora and fauna.

The response to biodiversity differed between people that live in urban and rural areas. Respondents that lived at their current locations for less than six years (new timers) also differed to those that lived at their current location for longer. Urban resident new timers had a greater well-being if there was an increase in biodiversity in their local area. All other categories: rural new timers, rural old timers, and urban old timers, all experienced a decrease in well-being when there was an increase in biodiversity in the local area.

Several variables were found to affect the well-being of rural and urban residents. In general, the well-being for rural respondents was influenced by age, property size, whether they jogged in public parks and if they felt their neighbours should have native plants on their properties. Urban residents well-being was influenced by household income, whether they were self employed, property ownership, education, if they bird watched on public lands and period of residence. We further broke down the urban residents into urban new timers and urban old timers and found that different variables influenced each groups well-being, confirming the importance of how long a person had lived at their current property. The well-being of urban new timers was influenced by age, property ownership, property size and whether they bird watched in public parks. In comparison, urban old timer's well-being was influenced by household income, the state of being self-employed and education level.

Overall, we found significant differences in opinions of native biodiversity in relation to well-being between urban residents and rural residents, as well as between new timers and old timers. Therefore, we recommend that committees and organizations seeking volunteers for native biodiversity projects first try to recruit urban new timers, as they may obtain better turnouts.

We believe the topic of biodiversity and well-being deserves further investigation. We recommend careful wording of well-being questions, as we believe that the wording of our well-being questions affected our results. Our question wording was approved by various focus groups and one-on-one interviews, but we later learned that the inclusion of the term "green tree geckos" in our well-being statement as a positive aspect of an increase in biodiversity may not have been perceived as a positive aspect by respondents. We asked whether native lizards (e.g., geckos, skinks) were important features for the enjoyment of

their local parks and/or reserves and an important feature for their ideal property. On average, native lizards were more undesirable than desirable, even though they are an important aspect of many ecosystems. Therefore, we recommend future researchers take caution when using potentially disliked species as a positive aspect of biodiversity.

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