Urban Vegetation, Wellbeing and Pro-environmental Behaviour: A Socio-ecological Experiment in Wellington City, New Zealand

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A thesis submitted in fulfilment of the requirements for the degree of Master of Science in Conservation Biology.

Victoria University of Wellington

2014

Abstract

The challenges ahead for sustainability and biodiversity conservation require a better understanding of the relationship human beings have with the natural environment. The evidence that nature has a positive influence on human wellbeing is extensive but there is uncertainty about the influence of urban vegetation in the immediate vicinity of residents' homes. Current research is also inconclusive as to the mechanisms that underlie the relationship between nature, human wellbeing and pro-environmental behaviour.

I investigated whether engagement with urban nature influenced the wellbeing and pro-environmental behaviour (PEB) of residents of Wellington City, New Zealand. Engagement with nature was specified by the amount of vegetation cover in urban neighbourhoods and participation in a community-planting scheme. Wellbeing was assessed by measures of mental and physical health and satisfaction with life.

Firstly, I aimed to describe the population of people who participated in the community planting scheme and identify the motivation, barriers and benefits associated with participation.

Secondly, I aimed to test hypotheses about the relationship between urban residents and the natural environment using Structural Equation Modelling (SEM):

1. Exposure to vegetation in residents' immediate neighbourhood and/or participation in the planting scheme has a positive influence on residents' wellbeing and PEB.
2. The effect of nature on wellbeing or PEB is mediated by a number of socio-psychological constructs, such as Connection with Nature, use of nature for Psychological Restoration, Neighbourhood Satisfaction, (both social and natural aspects of the neighbourhood) and Environmental Attitude. PEB also mediates the nature-wellbeing relationship.

Finally, I wanted to determine if adding socio-demographic variables and the amount of time residents spent outdoors could improve the models.

A stratified random sample of 20 neighbourhoods across Wellington City was selected. The neighbourhoods varied in their amount and type of vegetation cover. The amount of vegetation cover was determined by site visits and using maps, with a 5 x 5 m^2 grid, which showed vegetation cover and property boundaries. I quantified the mediator and wellbeing variables using existing measures, some of which were modified, and by developing some constructs based on the literature. The usefulness of these constructs was confirmed by an Exploratory Factor Analysis in SPSS.

I conducted a postal survey during October 2012 of 1200 households in the 20 neighbourhoods of Wellington City to test my hypotheses. Thirty-six percent of surveys were returned (N = 428) which resulted in 423 useable surveys.

Respondents who participated in the planting scheme were more likely to be married or in a partnership, highly educated and New Zealand Europeans. They also had a greater connection with nature, used nature more for psychological restoration and had stronger higher environmental attitudes and PEB those respondents who did not participle in the planting scheme. The most frequently reported barrier to participation was the lack of time and the most commonly reported benefits corresponded to the stated motivation, which was to improve the appearance of participants' immediate neighbourhood.

A priori mediation models were specified. Structural Equation Modelling followed by Information Theoretic model selection and inference using Akaike Information Criterion identified the leading influences and tested the hypotheses for wellbeing and PEB. All the *a priori* models fitted the data. Model selection resulted in two parsimonious models being identified, the *Wellbeing* model and the *Pro-environmental Behaviour* model.

The *Wellbeing* model explained 16%, 13% and 3% of the variance in mental health, life satisfaction and physical health, respectively. Both the amount of neighbourhood vegetation and participation in the planting scheme were associated with the wellbeing measures. Neighbourhood Satisfaction (both nature and social), the use of nature for Psychological Restoration and Pro-environmental Behaviour were significant mediators.

The *Pro-environmental Behaviour* model explained 38% of the variance in PEB. Participation in the planting scheme was associated with increases in PEB but the level of neighbourhood vegetation was not. Connection with Nature was the sole mediator of the relationship between participation in the planting scheme and PEB.

Socio-demographic characterisations and the amount of time people spent outdoors were not necessary to explain wellbeing or PEB beyond the effect of neighbourhood vegetation or participating in the planting scheme.

A final combined model, *Wellbeing +Pro-environmental Behaviour,* explained more of the variance in mental health (22%), satisfaction with life (16%) and PEB (45%) than the individual *Wellbeing* and *Pro-environmental Behaviour* models but did not explain physical health. Connection with Nature and Environmental Attitude were additional mediators and the amount of neighbourhood vegetation level influenced PEB. The strength of the effects of vegetation level and the planting scheme on the wellbeing measures were about the same as in the *Wellbeing* model. This was a less parsimonious model.

I have demonstrated that the resources invested into greening Wellington City added significantly to the quality of residents' lives, via their relationship with nature and increased wellbeing, and were associated with increases in PEB. I have identified mediators that synergistically facilitate the relationship between urban vegetation, a community planting scheme, PEB and human wellbeing and helped clarify the positive effect of vegetation in the immediate vicinity of residents' homes on residents' wellbeing. The effect of biologically depauperate neighbourhoods on residents' quality of life requires further investigation.

My findings suggest the promotion of time in nature and increases in the amount of urban planting, particularly trees, may be an effective public health intervention and also result in increased PEB. The demonstrated diversity of nature's benefits and value may provide motivation for greater investment in urban greening and broader conservation initiatives by government.

Acknowledgements

Firstly, I would like to thank my supervisor, Dr Wayne Linklater, for his enthusiasm, support and his academic contribution to this research project in an area that is relatively new to him. Thanks for learning with me and always encouraging me. I also thank Taciano Milfont who as my secondary supervisor was always supportive and interested in my work. I especially valued his expertise in the Structural Equation Modelling and the validation of my survey design.

This research was financially supported by the Holdsworth Charitable Trust via a Wellington Zoo Conservation Fellowship for which I am very grateful.

Thank you to Myfanwy Emeny of the Wellington City Council for her interest in this project and for providing access to the data from the planting scheme.

I greatly appreciate the help of Sam Whitburn with analysis of site vegetation and technical support, and especially for his endless encouragement when the going got tough.

I also thank my family Paul, Matt, Sam and Lucy for their support and encouragement to pursue my dreams and your patience when I have been less available than usual.

Finally, this research could not have taken place without the contribution of the people who took the time to complete my survey. I appreciate your openness and generosity. I especially appreciated your encouraging comments acknowledging the importance of this study.

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Introduction

1.1 Biophilia, Urbanisation and Environmentalism

The Biophilia Hypothesis, outlined by Wilson (1984), suggests that humans have an innate tendency to affiliate with nature - other living things and the natural environment. Biophilia is regarded as a product of our biological evolution. The human species evolved for the best part of two million years in the savannahs of East Africa, 99% of this time as hunter-gatherer societies. Our brains are attuned to processing and evaluating information from the natural environment and this shaped our cognitive and emotional functions (Gullone, 2000; Kellert, 1997). It is thought that the complexity of learnings associated with this conferred an evolutionary advantage that extended beyond obtaining the physical necessities of life to aesthetic, intellectual and spiritual meaning and satisfaction (Kellert, 1997). A degradation of humanity's relationship with nature is considered by some to bring with it a diminished existence (e.g., Kellert and Wilson, 1993).

Humans began living in cities late in our evolutionary history. Agricultural societies began to develop around 10,000 ago but urbanisation has proceeded rapidly over the last century. In 1900 13% of the world's population lived in cities. The urban population had increased to 29% by 1950 and by 2050 it is predicted that 67% of the world's total population will live in urban areas. This may be as high as 92% in some developed countries, such as Japan, and 64 % in less developed countries (United Nations, 2012). New Zealand is one of the world's highly urbanised societies with around 86% percent of people already living in the minor-main urban areas (Statistics New Zealand, 2006a).

Man's influence on earth is widespread and human activity has influenced most of the world (Vitousek et al., 1997). Cities, in particular, are highly modified environments. Natural areas in cities are usually fragmented and homogenised with an associated loss of native flora and fauna and the introduction of cosmopolitan and commensal species that do well in urban

settings (McKinney, 2002; Miller and Hobbs, 2002; Miller, 2005). The biological uniformity and decline of biodiversity in cities results in what Pyle (2003) calls the 'Extinction of Experience'. Urban dwellers, exposed to diminished biodiversity and isolated from the rhythms of the natural world, have reduced expectations about the quality of nature and may assume the level of biodiversity they are exposed to is normal (Pyle, 2003). This leads to a disconnection from nature and, in turn, creates apathy towards further environmental degradation (Pyle, 2003). This disengagement with the natural environment begins in childhood and is thought to have major consequences for humans' relationship with nature, their wellbeing and their care of the natural world (e.g., Kahn and Kellert, 2002; Kellert, 1993; Louv, 2008). The biophilic tendency that draws people to connect with nature may, however, have remained adaptive for urban dwellers who try to meet the demands of daily life in an environment that may contribute chronic stressors (Van Den Berg et al., 2007; Kellert 1997). For example, some suggest that humans are drawn to, or prefer, natural settings that facilitate recovery from stress and mental fatigue (Kaplan and Kaplan, 1989). This adaptive response enables the organism, that is, people, to be better able to live in their urban habitat.

Human activities and urbanisation have contributed to major losses of biodiversity and this is of great concern to conservationists (e.g., Oskamp, 2000). New Zealand's endemic species have declined largely because of hunting, deforestation, urbanisation and introduced predators. The number of New Zealand's endemic vertebrate species has nearly halved since human arrival around 1250-1300 AD (Holdaway, 2013). However, effective management of the vegetation in cities, such as preserving the remnants of natural habitat or restoring modified habitats, can promote native species conservation (McKinney, 2002). Native urban streetscapes can potentially provide habitat for bird and invertebrate communities and support species movement through urban areas (White et al., 2005).

As the number of people living in cities increases, the fate of our native species both in cities and beyond urban areas may depend on the support of city dwellers whose only experience of nature is in the cities where they live (Dunn et al., 2006; Miller, 2005; Schultz, 2000). Therefore, we need to think carefully how we manage urban nature for the wellbeing of both the human and non-human population. Understanding the relationship between

humans and nature is a relatively new discipline in conservation science. There has been something of a paradigm shift in ecology and conservation towards viewing ecosystems as socio-ecological systems of which humans are an integral part and toward community participation in conservation initiatives (Berkes, 2004).

The means to effectively arrest or reverse the degradation of native biodiversity has so far lacked broad-based public support (Miller, 2005). Miller suggests this might be because conservationists have failed to convey the wonder and relevance of nature to the public alongside urban dweller's estrangement from nature. Raising awareness of humanity's dependence on nature for our survival and the value of nature to enhance our quality of life may engender public and governmental support for biodiversity conservation (Miller, 2005) and other environmentally responsible behaviours.

Nature can be an environment where human influence is minimal or nature can be living components of the environment, such as animals or trees, or inanimate features such as the rocks around coast line (Clayton and Opotow, 2003). When I use 'nature' or 'natural environment' in this thesis it is in its most inclusive sense. It incorporates the idea that experiences in nature are not confined to only wild areas but can occur in an urban setting as well. Urban nature includes the diversity of plant and animal life and landscape features found in and in close proximity to cities. The benefits of urban nature can potentially be experienced in a range of different green spaces including private gardens, urban parks, reserves and zoos.

1.2 Human Wellbeing in Cities

The World Health Organisation has a holistic definition of health. It defines health as a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity (World Health Organisation, 1946). Urban living is demanding. It requires the management of work, families, relationships, health and personal interests. In addition, the urban environment itself exposes people to many stressors, such as, air pollution, noise, traffic congestion, and over-crowding and is a source of constant demands on the urbanites cognitive faculties (Van Den Berg et al., 2007).

There are grave concerns around the increasing levels of lifestyle related physical illness like obesity (Ward Thompson, 2011) and the dramatic increase in mental illness. Obesity has been associated with the increase risk of Type II Diabetes, cardio-vascular disease and various cancers. According to the World Health Organisation, 35% of the world's adult population were overweight and 11 % obese in 2008 (as measured by the Body Mass Index, BMI). This is on the rise in low and middle income communities, especially in urban areas (World Health Organisation, 2014). In New Zealand, the rate of obesity is higher than the international average and has risen between 1997 and 2013 from 17 to 30% of the population over 15 years of age. Our childhood obesity rate is at record levels, around 11% (Ministry of Health, 2013). In addition, mental health disorders currently make up 10% of the global burden of disease and this is expected to rise to 15%. Depression alone will be one of the world's largest health problems (Murray and Lopez, 1996). In New Zealand, 20% of the population experience a mental disorder each year, most commonly anxiety and mood disorders (Brunton, 2013). Successful and cost effective, population-wide strategies for promoting health are desperately needed (Maller et al., 2006).

Nature in the residential environment has been shown to have a significant, independent effect on health outcomes. Therefore, widespread access to nature may be a potential factor in enhancing the health of urban dwellers. The Ottawa Charter for Health Promotion (World Health Organisation, 1986), of which the New Zealand government is a signatory, identified the importance of environments that support good health in the everyday settings where people live, work and play. Local and National Government has a duty to make decisions that support the wellbeing of all New Zealanders.

1.3 Nature's Influence on Human Wellbeing

There is compelling evidence from a range of empirical and qualitative studies that exposure to nature benefits human wellbeing. Various forms of nature have been used as the independent variables in studies: wilderness areas and urban parks, along with views, shared areas, streetscapes and private gardens in urban neighbourhoods. There has also been a variety of health outcomes measured: physical, psychological and social wellbeing.

International Studies

Wilderness experiences have been shown to offer considerable lasting benefits to participants. A 10-year study of an outdoor challenge programme found that two weeks exposure to survival tasks resulted in deeply satisfying experiences. The participants reported increased satisfaction with the natural environment and increased self-confidence with a developing sense of tranquillity and inclination towards contemplation or reflection, which endured at the 5-month follow-up (Kaplan and Kaplan, 1989; Kaplan and Talbot, 1983). Wilderness experiences have also been shown to provide opportunities for the restoration of depleted psychological faculties (Hartig et al., 1991; Kaplan and Kaplan, 1989).

Nature near to where people live is also thought to influence wellbeing. A review of 90 studies from the journal *Landscape and Urban Planning* by Matsuoka and Kaplan (2008) and a meta-analysis of 25 studies by Bowler et al. (2010) concluded there was strong evidence that nature in the urban landscape is important for human wellbeing.

International epidemiological studies in the Netherlands, Denmark and the United Kingdom also found that nearby urban green space positively influenced various aspects of human wellbeing. Higher levels of perceived general and mental health, lower stress levels, lower likelihood of obesity and fewer health complaints were among the health measure's associated with greener environments (Ellaway et al., 2005; Grahn and Stigsdotter, 2003; Korpela et al., 2014; Maas et al., 2009, 2006; Mitchell and Popham, 2007; Nielsen and Hansen, 2007; Stigsdotter et al., 2010; Sugiyama et al., 2008; van den Berg et al., 2010; Vries et al., 2003).

Studies of smaller urban populations also contribute to the dialogue. Early research into the association between urban green space and human wellbeing found views of nature from windows correlated with improved recovery from mental fatigue (Tennessen & Cimprich, 1995; Kaplan 2001) and recovery from gall bladder surgery (Ulrich, 1984). Greener residential areas enhanced residents' cognitive functioning and effectiveness in managing demanding life situations (Kuo, 2001). Walking in natural settings was found to be more

restorative and resulted in lower levels of anger or aggression than a walk through an urban environment or relaxing indoors (Hartig et al., 1991).

More recent studies continue to provide evidence that greater amounts of green space are associated with better mental health, lower levels of stress and fewer physical symptoms of illness. In the Netherlands, Dillen et al., (2012) linked the quality and quantity of green space to general and mental health and the number of symptoms of illness. Greater amounts of green space correlated with lower diurnal cortisol levels, indicating lower levels of stress, in residents in a deprived area of Dundee, Scotland (Ward Thompson et al., 2012). Van Herzele and de Vries (2012) in Ghent, Belgium, found a positive correlation between neighbourhood green space and self-reported happiness but there was no effect on general health or the prevalence of physical symptoms of illness. The longevity of senior citizens in Tokyo, Japan, improved with closer walking distance to green spaces and the presence of tree-lined streets (Takano et al., 2002). In another area of Japan forest bathing has been associated with increased immune functioning (Li, 2009).

The level of biodiversity has had mixed associations with wellbeing. Higher levels of the plant species richness, and to a lesser extent birds, have been associated with higher levels of psychological health in Sheffield, England (Fuller et al., 2007). However, Luck et al. (2011) in south-eastern Australia found that, even though the amount of vegetation cover in the urban landscape was weakly related to personal wellbeing, socio-demographics explained the greatest amount of variance in wellbeing. Dallimer et al. (2012) in Sheffield, England, also found no association with biodiversity of birds, butterflies or plants and psychological wellbeing of visitors to riparian zones.

The physical environment has also been shown to have an important role in fostering a sense of community (e.g., Kim and Kaplan, 2004). In a series of studies Kuo, Sullivan and their colleagues reported a positive relationship between the amount of green space, particularly trees, and social relationships (Coley et al., 1997; Kuo and Sullivan, 2001; Kuo et al., 1998; Sullivan et al., 2004).

Participation in environmentally responsible behaviour is generally associated with caring for the environment but it has also has been associated with greater levels of personal happiness. For example, Brown and Kasser (2005) found a positive relationship between subjective wellbeing and ecologically responsible behaviour. This effect on psychological wellbeing is consistent with other research into the benefits of participating in ecological restoration schemes or community gardening initiatives.

Studies into the benefits of gardening and environmental restoration groups demonstrated their importance for physical and mental health and social relationships. Miles et al. (1998) studied the psychological benefits of volunteering in a Chicago-based, prairie ecological restoration project. Those who were regularly involved had higher levels of life satisfaction and life functioning than those involved less often. The psychological benefits that rated most highly were being involved in a meaningful activity and fascination with nature. In California, Pillemer et al.'s (2010) 20-year epidemiological study found that mid-life volunteering in environmental projects correlated with subsequent increased physical activity, better self-reported health and fewer depressive symptoms. In a study of community gardens in Port Melbourne, Australia, participants reported benefits to their health, wellbeing and increased sense of worth (Kingsley et al., 2009).

Many researchers focus on the cognitive, affective and behavioural determinants of PEB, but there are also psychological consequences including an associated increase in mental health and satisfaction with life. Some authors suggest that participating in behaviour that benefits the environment can be associated with personal cost and deprivation, which implies a certain loss of personal happiness (e.g., Brown and Kasser, 2005; Lindenberg and Steg, 2007). This may not be so and requires further investigation.

New Zealand Studies

Some researchers have investigated the effect of nature on people's health in New Zealand. Population studies have yielded conflicting results about the relationship between nature and human wellbeing. Nationwide studies found that neighbourhood access to open spaces was not associated with Body Mass Index, sedentary behaviour or heart disease (Witten et

al.'s , 2008). Nor was there any association between the risk of mortality from cardio-vascular disease or lung cancer and useable or total green space (Richardson et al., 2010). However, greater amounts of green space in Auckland City did correlate with lower levels of anxiety and mood disorders (Nutsford et al., 2013).

Other New Zealand studies provide only qualitative data from semi–structured interviews, but common themes arise. In Wellington City, New Zealand, short park visits have had comprehensive benefits for visitors that include gaining a deeper appreciation for nature along with greater physical, mental, emotional and spiritual wellbeing (Prospero, 2008). Earle's (2011) research into 35 community gardens in Auckland and Wellington Cities reported improvements in nutrition, increased physical activity and enhanced mental and spiritual health. Cleghorn et al. (2010) compared benefits of participation in community gardening and environmental restoration projects. All participants experienced a sense of achievement. In addition the different types of projects had benefits uniquely their own. Community gardeners reported relief from stress and those involved in restoration projects felt it gave their lives more meaning and purpose. The benefits experienced from participating in community gardens and larger scale restoration projects included enhanced mental health and life satisfaction.

Limitations and Contradictions in Evidence

The evidence that nature has a positive influence on human wellbeing is convincing and seems particularly convincing for the psychological benefits of nature. There are still many unanswered questions. First, one feature of the studies introduced above was their focus on largish areas of public green space near people's homes. The European studies used the National Land Cover Classification database and a 25 x 25 m grid, which was unable to detect small areas of green space. Even Maas et al. (2009), Dillen et al. (2012) and Van Herzele and de Vries (2012), who detected significant associations closer to home, only considered areas of green space over one hectare in their studies. The New Zealand studies showed a similar tendency to exclude private gardens and small green areas of vegetation. Nutsford et al. (2013) measured 'useable' green space over 500 m^2, including parks and sports fields, and Richardson et al. (2010) included areas greater than 200 m^2. These studies

exclude an important quantity of easily accessible green space that people are exposed to on a daily basis, such as their own gardens and/or the trees and vegetation (like road reserves) they experience as they go about their daily routine in their immediate neighbourhoods.

Domestic gardens often comprise the largest land use in cities and provide an immediate way for urban residents to connect with nature (Freeman et al., 2012; van Heezik et al., 2013). In their Dunedin, New Zealand, study, Freeman et al. (2012) reported gardens provided important benefits for participants' physical and mental health, their social connections and helped develop a sense of environmental stewardship. Early research into the association between urban green space and human wellbeing found views of nature from windows correlated with improved recovery from mental fatigue (Tennessen & Cimprich, 1995; Kaplan 2001) and recovery from surgery (Ulrich, 1984). The natural areas in people's immediate neighbourhoods and viewed from their homes should not be discounted; they may be the main sustained contact that urban residents have with nature.

Second, the epidemiological studies measured the prevalence of the outcomes for a population but not for individual people. They did not measure individual differences in exposure to nature, but assumed they were uniform. Differences amongst individuals are important in the aetiology of disease and may also be important in the way nature affects a person's wellbeing. Some studies indicate that the amount of use of green space varies considerably between individuals and it is the amount of use, not merely the presence of green space, that is associated with better health outcomes (e.g., Grahn and Stigsdotter, 2003).

A third aspect of these international and New Zealand studies is the evidence for the association between green space and wellbeing in residents' immediate neighbourhood is contradictory. Some studies found associations within 1-3 km of a person's home but no association with green space only 1 km from home (Vries et al., 2003; van den Berg et al., 2010). Maas et al.'s (2009) and Stigsdotter et al.'s (2010) findings contradicted this. They found green space within 1 km of home had a stronger influence on residents' wellbeing than that within the 1-3 km boundary. Ward Thompson et al. 's (2012) findings were also for

green space within 300 m of people's homes. The association between green space and mood disorders found by Nutsford et al. (2013), in Auckland, only held for green space in the wider neighbourhood environment (within 3 km) and not for green space in a person's immediate living environment (within 300 m). This could have been because of the low number of green areas included within their 300 m boundary. In addition to these inconsistencies the green space was often 1- 3 km from a person's home. This could be a prohibitive distance for some people. The use of nearby green space has been shown to decline with increased distance from people's homes, especially for those with limited mobility (e.g., the elderly or children) or for lower socio-economic means (Grahn and Stigsdotter, 2003). For example, the number and duration of visits per week decreased with green space that was over 300 m from people's homes and even more so if the distance was over 1 km (Grahn and Stigsdotter, 2003).

Finally, in some studies, the amount and/or quality of green space was not quantified. Sugiyama et al. (2008) used 'perceived' neighbourhood greenness and Takano et al. (2002) also relied on survey participants' assessment of the environmental qualities. Other researchers have found participants' perceptions of green space or biodiversity rarely equate to objective measures (Dallimer et al., 2012; Hur et al., 2010). Further, Fuller et al. (2007) found the accuracy of people's perceptions was dependent on the taxonomic group. The richness of plant species was more accurately assessed than that for birds or butterflies. Using perceived measures of green space along with self-reports for wellbeing can result in same-source bias and any significant relationships between variables could also be attributed to other factors such as people's disposition (Weden et al., 2008). This problem could be avoided by making an objective assessment of the green space that is independent of the measure of wellbeing.

Thus, future studies should investigate the effect of small areas of green space, including private gardens, in the immediate vicinity of people's home, to clarify some of the discrepancies in current research. They should attempt to quantify vegetation on a finer scale. It would also be useful to investigate variations in individuals' experiences in nature and determine how these affect individual wellbeing or health outcomes.

1.4 Potential Mechanisms

The evidence that nature positively affects human wellbeing is convincing even in the light of the many different study designs and variables. However, the research is not conclusive as to the mechanisms or processes that underlie the relationship (e.g., Korpela et al., 2014; Maas et al., 2008; Sugiyama et al., 2008; Van Herzele and de Vries, 2012). Identifying and understanding these mechanisms is important to help understand what drives the relationships and identify where interventions are possible.

The literature suggests nature may influence human wellbeing through an increased connection with nature, by providing opportunities for psychological restoration, improving neighbourhood satisfaction (both social and environmental aspects) and encouraging physical activity (e.g., Nutsford et al., 2013; Van Herzele and de Vries, 2012). Three of the proposed mediators, connection with nature, psychological restoration and neighbourhood satisfaction, are all aspects of a person's relationship with nature. Environmentally responsible behaviour has also been positively associated with increases in wellbeing. In addition, there are probably synergistic effects from a variety of mediators that require comprehensive analysis. For example, neighbourhood satisfaction was significantly associated with physical activity (walking) in several studies (Owen et al., 2004).

Connection with Nature

The concept of a connection between humans and nature is central to Biophilic theory. Childhood experiences in nature are important in children's physical and mental development and also help to shape their connection with the natural world (Kahn and Kellert, 2002). Experiences in nature are also associated with increased sense of connection with nature as adults (e.g., Mayer et al., 2009; Schultz, 2014). The notion of being connected to nature from a psychological perspective has cognitive, affective and behavioural components (Schultz et al., 2001). Understanding or conceptualising this relationship has been a focus of several researchers with slightly different perspectives who have each tried to capture individual differences in a person's relationship with nature. Connection with Nature has been investigated through the role of the natural environment in a person's identity (Clayton and Opotow, 2003; Clayton, 2009), in people's emotional attachment to

nature (Mayer and Frantz, 2004), in the extent to which a person sees themselves as part of nature (Schultz, 2002), as a combination of affective, cognitive and experiential aspects (Nisbet et al., 2009) and as an attitude (Brügger et al., 2011).

These conceptual differences have resulted in the development of a number of different measures seeking to quantify a person's connection to the natural world. Brügger et al. (2011) demonstrated that there is considerable overlap between Clayton's (2003) Environmental Identity Scale, Mayer and Frantz's (2004) Connectedness to Nature Scale and Schultz's (2002) model of Inclusion of Self with Nature. These measures all require a person to reflect on and articulate an abstract representation of their relationship with nature, which can be quite difficult. In addition (apart from the Schultz measure) these measures show some convergence with Dunlap et al.'s (2000) New Ecological Paradigm (NEP) scale which seeks to measure environmental concern or an environmental world view rather than a person's general connection with nature. Brügger et al.'s (2011) own Disposition to Connect with Nature scale applies Campbell's Paradigm (Kaiser et al., 2010). This scale indirectly gauges a person's connection with nature by asking about past activities and responses to statements that would indicate a bond with nature or reflect a regard for nature. Brügger et al.'s (2011) scale converges with the other scales mentioned, has less overlap with the NEP and only requires minimal self-reflection which suggests it may be superior to Clayton's (2003) and Mayer and Frantz's (2004) measures of connection with nature.

Research testing these various measures has been limited, but generally reports a significant relationship between a person's connection with nature and their wellbeing. A greater connection with nature has been associated with higher levels of life satisfaction (Mayer and Frantz, 2004; Zelenski and Nisbet, 2012), greater positive affect and the ability to reflect on life's issues (Mayer et al., 2009; Zelenski and Nisbet, 2012) and was identified as a mediator of the relationship between exposure to nature and ability to reflect on one's life (Mayer et al., 2009). Nisbet et al. (2011) detected correlations with some measures of wellbeing (e.g., positive affect, vitality, autonomy and purpose in life) but not with Diener et al.'s (1985) Satisfaction with Life scale. Brügger et al.'s (2011) scale was developed to investigate the relationship between a person's connection with nature and their

environmental attitude and behaviour, so has not been tested in relation to human wellbeing. Most of these studies have been validating the particular scales and have had small sample sizes with limited demographic breadth. For example, university students have been a convenient sample population with sample sizes around or less than 100 for Mayer and Frantz (2004) and Mayer et al. (2009).

Other research into the relationship to urban nature and a person's connection to nature is limited. Luck et al. (2011), in south-eastern Australia, found residents' connection to nature was related to the variation in species richness and abundance of birds and density of plants but demographic characteristics, such as age and level of activity, explained the greatest proportion of variance in connection to nature. Qualitative gardening studies report increased feelings of connection with nature among the benefits reported by participants (Freeman et al., 2012; Earle, 2011; Kingsley et al., 2009).

Experiences in nature appear to be important in forming human connections with nature which in turn is associated with higher levels of wellbeing in some studies. Further investigation is required to determine if a persons' connection with nature does mediate the relationship between nature and wellbeing.

Use of Nature for Psychological Restoration

Natural environments may have a role in human survival by promoting recovery from states associated with a decline in cognitive functioning or performance that would interfere with human survival behaviours (Gullone, 2000; Kaplan and Kaplan, 1989). Two main lines of research seek to explain how contact with the natural environment benefits the human psyche in urban settings. First, through the cognitive restoration of fatigued attention (Kaplan and Kaplan, 1989) or alternatively through aesthetic and affective responses which enables emotional regulation (Ulrich, 1983).

Rachel and Stephen Kaplan's Attention Restoration Theory (e.g., Kaplan and Kaplan, 1989) focuses on the cognitive benefits of exposure to nature. These benefits centre on what they call attention restoration. There are four different levels of restoration:

Clearing the head,
Recovery of mental fatigue associated with over-used directed attention,
Processing cognitive residue from the day,
Reflecting on one's life, and thinking over things such as unresolved challenges or goals.

The recovery from mental fatigue is central to the Kaplan's argument. Urban living requires high levels of focused or directed attention that requires mental effort to sustain. Directed attention can become fatigued from over use. In addition, the urban environment itself exposes people to many stressors. For example, air pollution, traffic noise and congestion and over-crowding (Van Den Berg et al., 2007). The consequences of fatigued directed attention include decreased ability to concentrate, decreased effective functioning and problem solving, increased irritability and a greater proneness to making mistakes or having accidents.

Natural environments are particularly well equipped to aid recovery from mental fatigue. Natural environments are complex and can provide a safe context to engage the mind in effortless attention through an interest or curiosity in objects, such as plants, or processes, such as exploration. This effortless attention relieves the demands on directed attention and gives it the opportunity to recover, enabling a return to optimum functioning. Natural environments are also conducive to the other the aspects of restoration clearing the head, processing cognitive residue and reflection.

The evidence in support of the Kaplan's Attention Restoration Theory began with the study of the restorative effect of wilderness experiences, as discussed earlier. Then the focus moved to urban nature. Views of nature from windows of people's homes correlated with improved recovery from mental fatigue (Kaplan 2001). In more structured experiments, Tennessen & Cimprich (1995) found views of nature from undergraduate dormitories were associated with better results in tests to measure cognitive function than views of buildings. Hartig et al. (2001) demonstrated walks in natural settings were associated with greater perceived restoration than walks in an urban setting or passive relaxation. Berman et al. (2008) also found improved directed attention (cognitive functioning) after walks in nature.

The presence of green space and trees around high-rise apartment buildings in Chicago enhanced residents attentional functioning (ability to concentrate) and effectiveness in managing the demands associated with poverty by reducing metal fatigue (Kuo, 2001). Thus, the evidence for nature's role in restoration of mental fatigue is consistent.

The second line of research is advocated by Ulrich (Ulrich, 1984, 1983; Ulrich et al., 1991) and is concerned with the influence of the natural environment on people's affective and physiological responses. Affect has an important role as in facilitating people's adaptive behaviours. For example, fear is felt in response to imminent danger, which moves people to act to protect themselves. Ulrich proposed that exposure to situations that are emotionally taxing or threatening produces stress and anxiety. Spending time in nature is thought to reduce this stress and anxiety by regulating the physiological arousal associated with the fight/flight stress response. These changes can be observed in physiological responses of the body. Studies have measured these physiological responses and found a reduction in arousal associated with exposure to nature. For example, decreases in salivary cortisol (Ward Thompson et al., 2012), blood pressure (Hartig et al., 2003; Ulrich et al., 1991), heart rate, skin conductivity and muscle tension (Ulrich et al., 1991) have been associated with exposure to nature.

The two lines of research, physiological stress reduction and psychological or cognitive restoration, are probably interrelated. Stephen Kaplan (1995) has put forward an integrative model that suggests these two responses are distinct but fit together in the larger context of relationship between humans and nature.

Neighbourhood Satisfaction

A neighbourhood of people living in close proximity is the most basic social unit of urban society. A neighbourhood serves several functions: relaxation, making connections with other people, fostering a sense of belonging and attachment and reflecting one's own values (Kearney, 2006). Neighbourhood conditions can affect the quality of life of its residents. Neighbourhood characteristics such as quality of the environment and the perceptions of residents are important factors in the psycho-social benefits attributed to

being at home (Kearns et al., 2000) and have been found to influence both mental and physical well-being (e.g., Ellaway et al., 2005; Mitchell et al., 2000; Wilson et al., 2004). Mitchell et al. (2000) also reported that the residential environment had a significant influence on health outcomes. The effects on health were associated with both the spatial and social characteristics of the neighbourhoods they studied. Fried (1984) reported that satisfaction with the immediate neighbourhood environment was the second most powerful explanatory variable of life satisfaction, after marital satisfaction, in urban populations across America and was an important influence at all socio-economic levels. Measuring neighbourhood satisfaction is an attempt to quantify or evaluate residents' experiences of their neighbourhoods' natural and social features.

Neighbourhood satisfaction is complex and multi-dimensional. The personal, social and psychological factors associated with neighbourhood satisfaction have been well studied but the contribution of the natural environment has been somewhat overlooked (Hur et al., 2010). Physical and social characteristics of neighbourhoods both contribute to neighbourhood satisfaction. Hur and Morrow-Jones (2008) showed that housing density and satisfaction with the general neighbourhood appearance were the strongest predictors of neighbourhood satisfaction. Social factors especially factors which cause stress, such as tension with neighbours, racial discrimination and crime, are also important. The factors that were important to residents differed between neighbourhoods. Safety and social problems were more important than physical factors in neighbourhoods that reported the lowest levels of neighbourhood satisfaction (Hur and Morrow-Jones, 2008).

The positive influence of neighbourhood vegetation on neighbourhood satisfaction has been found by a number of researchers. Natural features in views from homes were positively correlated with general neighbourhood satisfaction and satisfaction with nature in Ann Arbour, Michigan (Kaplan, 2001) and in Seattle, Washington (Kearney, 2006). In Franklin County, Ohio, Hur et al. (2010) reported that neighbourhood satisfaction was directly associated with the measured presence of trees and open space and was also indirectly associated with residents' perceptions of these environmental factors. Van Herzele and de Vries (2012) in Ghent, Belgium, also found people living in greener neighbourhoods had higher levels of neighbourhood satisfaction. However, Kearney (2006) in Seattle,

Washington, found no association with the presence of natural areas or people's proximity to them as such but neighbourhood satisfaction was associated with the frequency of visits to nearby natural areas.

There are fewer studies in Australia and New Zealand that investigate the influence of the nature on residents' wellbeing. In south-eastern Australia, Luck et al. (2011) found natural features in the urban landscape (species richness and abundance for birds and percentage vegetation cover) were related to neighbourhood wellbeing (satisfaction) but the socio-demographic variables explained the greatest proportion of neighbourhood wellbeing. In New Zealand, neighbourhood satisfaction was investigated as part of an epidemiological study into environment and health. Satisfaction with access to parks and recreational areas was one of 15 items in Hill et al.'s (2012) measure of neighbourhood problems. Although they did find that perceptions of neighbourhood environmental problems were linked to wellbeing outcomes, the effect of green space alone was not determined.

Two cross-sectional studies investigated neighbourhood satisfaction as a potential mediator of the positive effect of environmental characteristics, such as greenery, on residents' wellbeing. In Adelaide, Australia, Leslie and Cerin (2008) identified neighbourhood satisfaction as a mediator of the positive association between neighbourhood characteristics and mental health. The perceived environmental characteristics included aesthetics and greenery. The second study, by Van Herzele and de Vries (2012) in Ghent, Belgium, also found neighbourhood satisfaction mediated the relationship between perceived neighbourhood greenness and happiness (overall wellbeing), but greenness had no effect on general health or the number of physical symptoms of illness. Neither study was an experimental design, their results are descriptive and do not show causation. In addition Van Herzele and de Vries (2012) used single-item measures for wellbeing and neighbourhood satisfaction. This can result in lower reliability than composite scores to measure latent constructs (Kline, 2005). The use of composite measures may have found additional associations with the other health measures and mediators they investigated. Natural features of the environment has also been shown to have an important role in fostering a sense of community (e.g., Kim and Kaplan, 2004). In a series of studies Kuo, Sullivan and their colleagues reported a positive relationship between the amount of green

space, particularly trees, and social ties in high rise apartments of a public housing development in Chicago (Coley et al., 1997; Kuo and Sullivan, 2001; Kuo et al., 1998; Kweon et al., 1998; Sullivan et al., 2004). The presence of nature near high-rise apartments was related to better relations among neighbours, less violence, increased use of outdoor spaces and increased overall satisfaction with one's home. In older adults, the use of shared outdoor green areas was associated with increases in the strength of their social ties and sense of community. Maas et al. (2009) reported similar findings in an epidemiological study in the Netherlands where people living with greater amounts of green space felt less lonely and better supported even though they did not have more contact with neighbours.

The availability of natural settings in areas where people live increases the opportunities to interact and develop mutually supportive friendships. Trees help create vital neighbourhood spaces, shade, privacy and eduction that may invite increased social interactions. The presence of trees also assists in developing a sense of ownership for the area surrounding homes and the development of greater sense of safety (Coley et al., 1997; Sullivan et al., 2004). Although some aspects of neighbourhood satisfaction have been well researched, the position of it as a potential mediator of the effect of neighbourhood vegetation and wellbeing is not conclusive.

Outdoor Activities

The presence of nature may also facilitate increased participation in outdoor activities and through this improvement to human wellbeing. Physical inactivity is a major preventive health risk, which can be avoided by only moderate levels of activity. Health promotions to increase physical activity are geared at encouraging activity close to where people live and emphasize walking (Bird, 2004; Ministry of Health, 2002). Considering the context in which health promoting behaviour takes place complements studies on individual determinants of physical activity (Giles-Corti and Donovan, 2002). Walking in safe, natural green space has the added benefit of engaging with nature which, as Bird (2004) found, is an important motivator in sustaining activity levels.

Two reviews examined environmental influences on physical activity (Humpel et al., 2002; Owen et al., 2004). They found physical activity was most likely to occur where there was easy access to attractive public spaces with enjoyable scenery, safe footpaths, a minimum of traffic and a friendly neighbourhood. The environmental variables examined were not generally measured by the researchers but relied on respondents' perceptions (e.g., Sugiyama et al., 2008; Takano et al., 2002), which may not reliably correspond with quantitative assessments as discussed earlier.

Residential environments with larger amounts of green space have been associated with higher levels of physical activity. Higher levels of greenery were associated with being more physically active and not overweight in Ellaway et al.'s (2005) study of residents from eight European countries. Living in close proximity to walkable green space or tree lined streets had a positive effect on the 5-year survival rates of older residents in Tokyo, Japan (Takano et al., 2002). However, Takano et al. (2002) did not investigate how often or for how long residents used these walkable areas. Increased greenness was also associated with greater levels of walking in Adelaide, Australia, and in turn explained the benefits to physical health and partially explained the gains in mental health associated with greener areas (Sugiyama et al., 2008).

Visitors to parks commonly engage in physical activity. Proximity to public parks and open areas was associated with increased amounts of walking in Perth, Australia, but not with overall physical activity. Facilities closer to home were used more often and the most frequently used were streets (45.6%), public open spaces (28.8%) and beaches (22.7%). These facilities enhanced the achievement of recommended doses of exercise but were of secondary importance to individual motivation and a supportive community (Giles-Corti and Donovan, 2002). In Wellington, New Zealand physical activity was a self-reported benefit of visitors to Belmont Regional Park (Prospero, 2008). However, Chiesura (2004), found the main reasons people visit parks were to rest, relax and be close to nature.

Not all researchers have found an association with greener environments and increases in physical activity. Maas et al. (2008), in the Netherlands, found the amount of green space in residential areas had no relationship with the amount of time residents spent engaging in

physical activities. There was no relationship between access to green space and physical activity in a national study in New Zealand (Witten et al., 2008). Nor was there an association between neighbourhood environmental variables and neighbourhood activity levels in south-eastern Australia (Luck et al., 2011).

The discrepancies in evidence could partly be because of the wide variety measures used for green space. For example, Maas et al. (2008), Luck et al. (2011), Giles-Corti and Donovan (2002) and Witten et al. (2008) all used quantitative measures of green space whereas Takano et al. (2002) and Sugiyama et al. (2008) used perceived measures of environmental greenness. Perceived greenness is often an inaccurate indicator of actual greenness. In addition, variation exists in the way green space was quantitatively assessed. Luck et al. (2011) measured all green space within their study area, as did Maas et al. (2008) but the latter but excluded private gardens and small areas of greenery or trees on streets or verges. A different approach was used by Giles-Corti and Donovan (2002) and Witten et al. (2008) who both measured distance to near-by green space via the road networks. The differences in green space measures alone allow only broad conclusions to be drawn. Although it is reasonable to conclude there is an association between the amount of green space nearby and physical activity which in turn may leads to improve physical and/or mental health, the effect of green space on health via other mediators may be more important, for example, in recovery from mental fatigue.

Multiple Mediators

The mechanisms that underlie the relationship between nature and wellbeing just discussed can be referred to as mediators of the effect of nature on wellbeing. This means that nature has an effect on a second variable, for example, connection with nature or neighbourhood satisfaction, which in turn has an effect on human wellbeing. Two studies have investigated the possibility of multiple mediators. Korpela et al., (2014) recently tested the relative importance of physical activity, restorative experiences and the company of other people as mediators of effect of nature on wellbeing. Restorative experiences in nature mediated the effect of participation in nature-based recreation on emotional well-being. Van Herzele and de Vries's (2012) cross-sectional study investigated the relationship between the greenness

of the local neighbourhood and the health of its residents by looking at a variety of possible mediators including perceived stress, ability to concentrate, social cohesion and neighbourhood satisfaction. Neighbourhood satisfaction was the only variable that mediated the relationship between neighbourhood greenness and happiness (overall wellbeing). There was no association with general health or bodily function (symptoms of illness). This lack of association could be because of the method used to test the mediation. Both groups of researchers used Baron and Kenny's (1986) procedures for mediation regression analyses. Using this method the independent variable (X) needs to be directly associated with the dependent variable (Y) as the first step in mediation testing. If there is no significant relationship, no mediation can occur. This is disputed by Zhao et al. (2010) and MacKinnon (2008) who argue that mediation can still be valid without the initial significant direct effect between the independent and dependent variable if the effect in each step in the indirect relationship (that is, X-mediator-Y) is significant. Therefore, significant effects could still exist with the other dependent variables, especially in Van Herzele and de Vries's (2012) work. In addition, the measure they used for wellbeing was a single item which may be too few to detect an effect (Zhao et al., 2010).

1.5 Pro-environmental Behaviour

Pre-determinants of pro-environmental behaviour

Environmental problems are largely anthropogenic, caused by habitat destruction, invasive species, pollution, human over population and over-harvesting (Wilson, 2003). To reach a sustainable level of environmental impact (meeting the needs of the present without compromising the ability of the future generation to meet their own needs, Van Den Berg et al., 2007), human lifestyles and behaviours will require significant changes (Oskamp, 2000; Schultz, 2014a; World Health Organisation, 2005) .

People’s pro-environmental behaviour has been the focus of much research. Pro-environmental behaviour is that which consciously seeks to minimise the negative impact of one’s actions on the natural or built world (Kollmus and Agyeman, 2002) by, for example,

minimising resource and energy consumption, and the use and disposal of toxic substances and waste. Understanding what drives environmentally protective or destructive behaviour is key to effectively promoting environmentally responsible behaviour. Interestingly, it appears that participating in pro-environmental behaviour is also associated with gains to personal wellbeing (e.g., Brown and Kasser, 2005, and discussed in Section 1.3).

Pro-environmental behaviour (PEB) is complex and many researchers have tried to identify and quantify the variables that predict it in an effort to increase public engagement in PEB. According to the Theory of Planned Behaviour, the intention to perform a particular behaviour is the immediate antecedent to actual behaviour. Behavioural intention, in turn, is influenced by a person's attitudes, subjective norms and perceived behaviour control (Ajzen, 1991).

Environmentally responsible behaviour can also be motivated by a person's values which can be a mixture of self-interest and/or concern for other people, other species or the whole ecosystem (Gagnon Thompson and Barton, 1994). People with a predominantly eco-centric orientation towards nature value nature for its own sake and protect it for its intrinsic value. People with a more anthropocentric orientation may also take action to protect the environment but are motivated by nature's value in enhancing the quality of life for humans. The values underlying anthropocentrism are more human centred and utilitarian.

Complex models have been developed to measure the contribution of various psycho-social determinants of PEB based on altruistic or self-interested motivations. Bamberg and Möser (2007) proposed an integrative model where PEB is driven by a combination of both self-interest and pro-social motives and behavioural intention is the final and direct determinant of PEB. Environmental attitude is one of contributors to behavioural intention.
Attitudes are "a psychological tendency that is expressed by evaluating a particular entity with some degree of favor or disfavor" (Eagley and Chaiken, 1993, p. 1). Environmental attitude has been described as "a psychological tendency that is expressed by evaluating perceptions of or beliefs regarding the natural environment, including factors affecting its

quality, with some degree of favour or disfavour" (Milfont, 2007, p. 12). Attitudes are measurable and changeable.

Emotion and cognition both influence the development of environmental attitudes (Pooley and O'Connor, 2000). Attitudes that are formed through direct experience (e.g., with nature) tend to be more affectively based, than attitudes formed by indirect experience (e.g., through education) which tend to be more cognitive. In addition, attitudes formed through direct experiences are thought to have a greater impact on attitude formation than indirect experiences and may also be better predictors of behaviour (Millar and Millar, 1996).

Understanding the basis of attitude formation is important if one's aim is to change people's PEB. Environmental education programmes are often based solely on conveying information, in the hope it will change people's actions (Pooley and O'Connor, 2000). However, environmental education needs to take both the cognitive and affective basis of environmental attitude formation into account in order to effect behaviour change and perhaps encourage the strengthening of attitudes formed by direct experiences in nature.

Environmental attitude has been the focus of much research and has been associated with PEB, although the size of the effect is usually small (Kollmus and Agyeman, 2002). Kaiser et al. (1999), however, found environmental attitude (measured as environmental knowledge, values and behavioural intention) was a strong predictor of intended and actual PEB. They suggested that the associations were strong because they used a composite measure of attitude and a general measure for both attitude and PEB. They also took into account behaviour constraints that were beyond people's control.

The most widely used measure of environmental attitude is the New Environmental Paradigm (NEP) scale (Dunlap, 2008; Dunlap et al., 2000; Hawcroft and Milfont, 2010). It is a latent construct (see section 2.4.2) that covers general environmental topics and measures the overall relationship between humans and the environment from an eco-centric values perspective (Milfont and Duckitt, 2010). Environmental attitude, as measured by the NEP scale, has been positively associated with greater endorsement of PEB (Casey and Scott,,

2006; Clark et al., 2003; Dunlap et al., 2000), however, Whitmarsh and O'Neill (2010) found no association between the NEP scale and PEB.

Besides Environmental Attitude, there are some other socio-psychological traits associated with pro-environmental behaviour. These include Connection with Nature and the use of nature for Psychological Restoration. These are descriptors of an individual's relationship with nature and may help explain individual differences in PEB. Participation in outdoor recreation and socio-demographics have also been associated with PEB. I have not found Neighbourhood Satisfaction to be associated with PEB in the literature.

Connection with Nature

There is considerable variability in the extent to which individuals are drawn to or appreciate nature. Understanding why some people feel more strongly about nature than others is important to understanding their PEB. It has been postulated by eco-psychologists that a deep sense of connection with nature is required for people to engage in sustained environmentally responsible behaviour (e.g., Naess, 1973). Schultz (2000) agrees that the level of a person's environment concern is related to the degree to which they see themselves as an integral part of the natural world and this concern for and valuing of nature determines how they treat it .

Although people's PEB is often explained by their connection with nature, there are a limited number of studies that examine the relationship and, as with studies into wellbeing, the measures used vary. Environmental identity (as a measure of connection with nature) was reported as a significant determinant of PEB by Whitmarsh and O'Neill (2010) and Clayton (2003) and predicted people's behavioural intention for waste recycling (Terry et al., 1999). Nisbet et al. (2009) showed that Nature Relatedness correlated with PEB and environmental concern. An emotional affinity for nature predicted nature protective behaviour and traced back to experiences in nature (Kals et al., 1999). Hinds and Sparks (2008) demonstrated an affective connection to nature predicted people's intentions to engage in PEB. Finally, Brugger et al. (2011) showed that connection with nature predicted PEB. These studies indicate that a person's relationship or bond with nature may be

important in their engagement in PEB and may work along with environmental attitude in influencing PEB.

Psychological Restoration

Exposure to nature has been associated with gains in psychological restoration and emotional regulations as discussed earlier (Section 1.4). People may behave in environmentally responsible ways because they gain psychologically from restorative experiences in nature. This has been investigated in Norway by Hartig et al. (2007) who found a greater endorsement of nature for psychological restoration was associated with higher levels of ecologically responsible behaviour. This association was partially mediated by environmental concern (a similar measure to environmental attitude). Hartig et al.'s work was extended with German students by Byrka et al. (2010) to include a broader measure of environmental concern using the NEP scale (Dunlap et al., 2000). They also found the positive effect of psychological restoration on PEB was partially mediated by environmental concern. PEB was influenced both directly and indirectly by restorative experiences in nature. These restorative experiences appear to influence the way people think about and value nature and this in turn influences how they treat it. The strength of the effects was quite low. This could be because of the lack of variation in the participants' endorsement of nature for psychological restoration (most people endorsed it quite highly) or because the three item scale analysed as single items may have been unreliable (Byrka et al., 2010; Hartig et al., 2007).

Corral-Verdugo et al. (2012) investigated the reverse relationship between psychological restoration and PEB. They reported significant gains in perceived psychological restoration as an outcome of participating in PEB.

Demographics and Time Outdoors

Mixed patterns of socio-demographics have been significant predictors of PEB in previous studies, but they do not provide much insight into individuals' differences or drivers of PEB that might be enhanced. Females tend to display higher levels of environmental concern and environmentally responsible behaviour (Casey and Scott, 2006; Kollmus and Agyeman,

2002; Larson et al., 2011; Whitmarsh and O'Neill, 2010) but gender was not significant in the work of Corral-Verdugo et al. (2012). Higher education has also been linked to greater participation in PEB (Casey and Scott, 2006; Kollmus and Agyeman, 2002) as have higher incomes (Clark et al., 2003; Larson et al., 2011; Whitmarsh and O'Neill, 2010) and greater age (Corral-Verdugo et al., 2012; Whitmarsh and O'Neill, 2010). In Larson et al.'s (2011) study white, American park visitors reported lower levels of PEB than other ethnicities. Larger households were negatively associated with PEB in Clark et al.'s (2003) work on green electricity schemes but Whitmarsh and O'Neill (2010) found households with more children exhibited more PEB. The differences in the study outcomes for household size may be because the higher costs of participating in the green electric scheme are not affordable for larger families.

Two studies suggest that positive exposure to nature, through participating in outdoor recreation, may contribute to people's PEB. Tarrant and Green (1999) surveyed residents in the Appalachian Mountains, America (Larson et al., 2011). They found participation in appreciative recreational activities, such as hiking or bird watching, positively mediated the effect of environmental attitude on PEB. There was no such effect, however, for people who participated in consumptive activities, such as hunting or fishing or motorised activity, such as 4-wheel driving. In the second study, the amount of time spent in outdoor recreation by adult visitors to a state park in Atlanta, Georgia, had a stronger effect on PEB than either eco-centric or anthropocentric value orientations (Larson et al., 2011).

The predictors of pro-environmental behaviour are diverse and the models complex. Nevertheless, there is potential to investigate some of the individual associations between a person's connection with nature, use of nature for psychological restoration and environmental attitude to assess their effect on PEB. Perhaps this will lead to a more parsimonious way of understanding PEB and increasing people's engagement in PEB.

1.6 The Road Reserve Planting Scheme

Wellington City Council (WCC) manages 3,500 hectare of green space which is made up of bush, reserves, gardens, parks and walkways (Wellington City Council 2013a, 2013a). As part of the Wellington City Council's Community Greening initiatives under the Biodiversity Action Plan (Wellington City Council, 2007) and long-term Eco-city goals the council cultivates around 90,000 eco-sourced native plants each year (Wellington City Council 2013b). The Road Reserve Planting (RRP) scheme has supplied about 10,000 of these free plants each year since 1990 for residents and community environmental groups to plant on unmanaged public land adjacent to their properties. The remaining plants are either distributed to specific community planting initiatives or planted by council workers. The land adjacent to people's homes comprises public land and road reserves. Road reserves cover 1,200 km of road and are the strip of land between the impervious surfaces of the road or footpath and the boundary of the adjacent property. They are reserved for future road widening and vary in their size and characteristics with the topology of the city (Berentson, 2013; Wellington City Council, 2007).

At its inception the RRP scheme supplied exotic species to residents to aid the beautification of Wellington. This has developed over the last five years into an approach based on the principles of restoration ecology. The road reserve planting scheme is now seen as an integral part of the native plant species recovery plan (Wellington City Council, 2007). The WCC now uses native, eco-sourced plants that are better adapted to Wellington's conditions in an attempt to maintain Wellington's distinct local flora and avoid the planting of invasive exotic species. The motivations for the Community Greening initiative are to improve Wellingtonians' quality of life by increasing Wellington City's distinctive native plant population, providing habitat for our native animals, reducing weeds and involving the community in environmental projects (Wellington City Council, 2007).

The Road Reserve Planting scheme represents a significant investment by WCC which requires justification if funding is to continue. The success or otherwise of the scheme has not been investigated but records have been kept of the plants provided and site location's since its inception. My study was the third in a three-part series to evaluate the RRP

scheme. The first study investigated aspects of planting success and factors influencing participation in the programme (Berentson, 2013) and the second will survey the biodiversity associated with the planting. My study investigated the human dimensions of participating in the RRP scheme and the possible gains to residents' wellbeing and pro-environmental behaviour from urban vegetation in Wellington City.

1.7 This Study

My intention was to measure the benefits and value of plants and planting for urban residents. I was particularly interested in the measured benefits as a pathway to gain wider support for conservation through its role in improving the quality of life for urban residents. I aimed to evaluate and quantify the benefits of urban vegetation to the residents of Wellington City, New Zealand.

Neighbourhood vegetation provides sustained exposure to nature in the immediate vicinity of people's homes. The Road Reserve Planting scheme represents a more hands-on direct engagement with nature. I aimed to investigate the contribution of neighbourhood vegetation and participation in the RRP scheme to the wellbeing of residents by examining a number of possible mediators simultaneously. This would allow for the possible interrelationship of the mediators as well as provide an indication of their relative strengths. I also wanted to find out if neighbourhood vegetation or participating in the RRP scheme had a positive effect on residents' environmentally responsible behaviour, again by examining possible mediators.

Aims

My first aim was to describe the population of people who participated in the Road Reserve Planting scheme. I wanted to investigate their motivations for participating and any barriers they may have faced. Most importantly, I was interested in the kind of benefits they gained from participating with the aim of increasing engagement in urban conservation initiatives.

My second aim was to test four hypotheses concerning the relationship between people and the natural environment. These were:

1. Sustained exposure to the vegetation in the immediate vicinity of people's homes has a positive effect on people's wellbeing.
2. Participation in the Road Reserve Planting scheme is beneficial to people's wellbeing.
3. Exposure to vegetation in people's immediate neighbourhood and/or participation in the RRP scheme has a positive influence on people's pro-environmental behaviours.
4. The effect of nature on wellbeing or pro-environmental behaviour is mediated by a number of socio-psychological constructs. These mediators, as suggested by existing research, include Connection with Nature, use of nature for Psychological Restoration, Neighbourhood Satisfaction, (both environmental and social), Environmental Attitude and Outdoor activities. Pro-environmental behaviour is also a mediator of the nature – wellbeing relationship.

The hypothetical relationships between variables, derived from existing research and my hypotheses, are shown in Figure 1.1 below.

My final aim was to test whether my models, representing the relationships between nature, wellbeing and/or pro-environmental behaviour, were improved by the addition of socio-demographic variables. I expected the individual-based socio-psychological constructs to out-perform the influence of the socio-demographic indicators on wellbeing and Pro-environmental Behaviour.

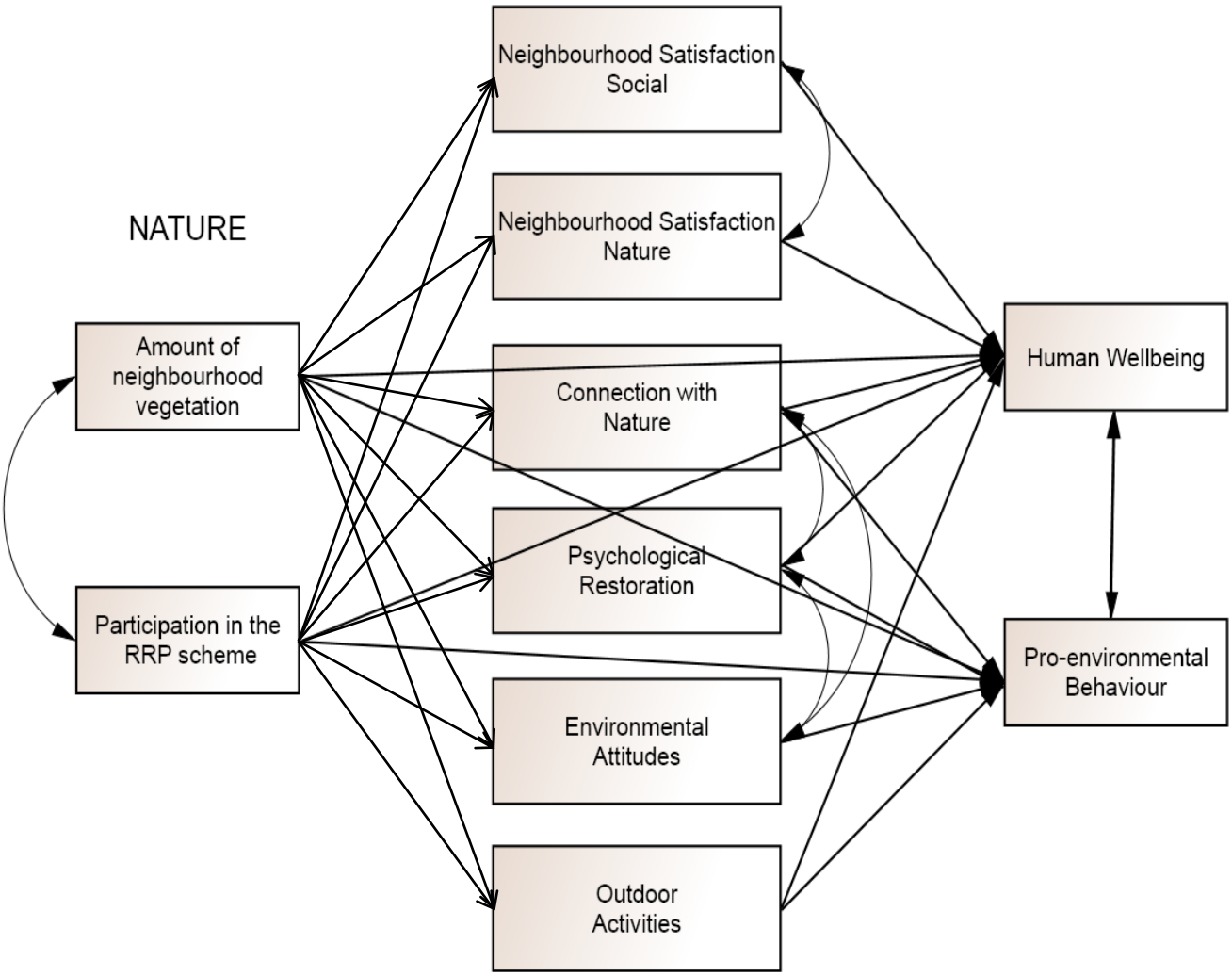

Figure 1.1 The hypothetical relationships between exposure to nature (amount of neighbourhood vegetation and participation in the Road Reserve Planting (RRP) scheme), human well-being and pro-environmental behaviour, mediated by the socio-psychological constructs and outdoor activities. The relationships between variables are suggested by the existing literature reviewed earlier.

Methods

2.1 The Study Area, Wellington, New Zealand

Description of Wellington

My study was carried out in Wellington City, Aotearoa New Zealand. Wellington, the capital city of New Zealand, is located at the south-western coast of North Island (41^{o} 29'S 174^{o}78'E). It is part of the greater Wellington Region and is bounded by Porirua City to the north, Lower Hutt City to the northeast, the Tasman Sea to the west and Cook Strait to the South. Wellington's 28,990 ha include a compact inner city situated on a deep-water harbour, Te Whanganui-a-tara, residential suburbs on the surrounding hills, outer suburbs and rural land. Wellington City's geographical and ecological identity is defined by the natural as much as the built landscapes. There is a substantial coastline with an outer green belt following the ridgeline from the South Coast northwards to the west of the city.

Wellington City Council, the local city government, manages 3,500 hectare of green space which is made up of forest, reserves, gardens, parks and walkways and includes a town green-belt of 425 ha on the first line of hills roughly encircling the inner city (Figure 2.1) (Wellington City Council 2013a, 2013b). This abundance of green space means that Wellington City is not typical of urban areas globally. Wellington City has over 200 m^2 of green space per person (Carmona et al., 2003). This compares favourably with other cities. Paris, France, and Canberra, Australia, have 80m^2 of green space per person; New York, USA has 18 m^2 per person and Hong Kong has 3 m^2 per person. The World Health Organisation recommends a minimum of 9 m^2 per person for carbon dioxide/oxygen balance and human wellbeing (Singh et al., 2010).

Wellington City has a mild, temperate climate. Mid-summer has a mean daytime temperature of 20.3^{o}C and mid-winter 5.9^{o}C. The average rainfall is 1249 mm with 2065 sunshine hours each year. The prevailing north-west airflow makes wind a feature of Wellington's climate with average wind speeds of 22 km per hour and 22 days each year

with persistent gale force winds (> 63 km per hour) (National Institute of Water and Atmospheric Research, 2012).

The Urbanisation of Wellington

The Wellington Region has a brief human history. Small groups of Māori arrived in Wellington from the 13th century. European settlement did not begin until the early 1840's (MacLean, 2013; Wellington City Council, 2013). Before European settlement Wellington's hills and valleys were covered with dense native forests with a few Māori villages and strategic settlements.

As Wellington's population grew, the demand for farmland and urban property increased resulting in deforestation. The populated area, once concentrated around the harbour, expanded over the surrounding hills. European settlers introduced predominantly northern hemisphere plants, birds and mammals rather than maintaining Wellington's natural heritage. Some of these introduced species became well established and were competition for and predators of the native species and so contributed to the loss of endemic flora and fauna.

Wellington became the capital and centre of New Zealand's government in 1865. Further population increases and improved transportation saw the city limits spread to its current bounds. Farmland was subdivided for residential areas, first in the areas with easiest access to the city, Newtown, Island Bay and Brooklyn, in the 1870 - 80's. In 1931 a tunnel connected the city to the eastern peninsula which opened up the east to development. The construction of an electric train-line towards the north of the city in 1938 saw the then small rural town of Johnsonville expand rapidly to become a continuous suburb with Wellington City. Urbanisation continues with the suburb Churton Park, in the northwest, established as recently as 1970 (MacLean, 2013).

Wellington continues to change and has become a vibrant modern city. A glimpse into the last thirty years has seen the gentrification of suburbs nearest the city (Newtown, Aro Valley and Kelburn) with the associated changes in their cultural composition. The inner city

waterfront has been re-developed to balance the need for buildings and high quality inner city green space. Otari-Wilton's Bush, a native plant sanctuary and forest reserve, is within 5 km of Wellington City centre and Zealandia, an native eco-sanctuary, has been created only about 2 km from the central city. The infrastructure for Zealandia represents a major investment in Wellington's natural heritage. The predator-proof fence alone cost $2.5 million (Zealandia, 2014). Wellington City Council is a partner in the Biophilic Cities Network and the 'Our Living City' project aims to strengthen urban-nature connections and build economic opportunities from a healthy environment (Wellington City Council, 2014).

Wellington's Population

New Zealand is a highly urbanised nation. Eighty-six percent of New Zealanders live in urban areas with over 70% of these in the main urban areas (Statistics New Zealand, 2007). The level of urbanisation globally is around 50% (World Health Organisation, 2005). The population of the Wellington Region was 410,328 at the last census. Wellington City's population was less than half of this, 187,699 (Statistics New Zealand 2006a)[1] and was estimated to be around 202,000 in 2013 (Wellington City Council, 2013c). Hilly terrain contributes to the high population density of 765.5 people per km^2 in Wellington City compared to the national average urban population density of 522.8 people per km^2 (Statistics New Zealand, 2007). Around 23,000 people commute to work in Wellington City each day from the greater Wellington Region and about 670,700 international tourists visited Wellington in 2012/13.

The demographics of Wellington City's population differ significantly from the rest of New Zealand. The latest census found Wellington City's population tended to be more highly educated than the national average; 55.5% had post-school qualifications compared to the national average of 39% and fewer people had no formal qualifications. Residents were relatively wealthy; 49% of households had an annual income over $70,000, with the national median income at $59,000. There was a higher than average population in the 18-49 year age bracket, 55.9%, compared to 45.1% nationally. Wellington City had higher proportions

[1] This is the most current Census information available, the 2011 census was abandoned because of extensive earthquakes in Christchurch, New Zealand.

of Europeans (76.8%) and Asians (12.7%) than New Zealand as a whole, and lower proportions of Maori (7.4%) and Pacific ethnicities (6.6%). Twenty-eight percent of residents were born overseas compared with 22.9% for New Zealand as a whole (Statistics New Zealand 2006a, 2006a).

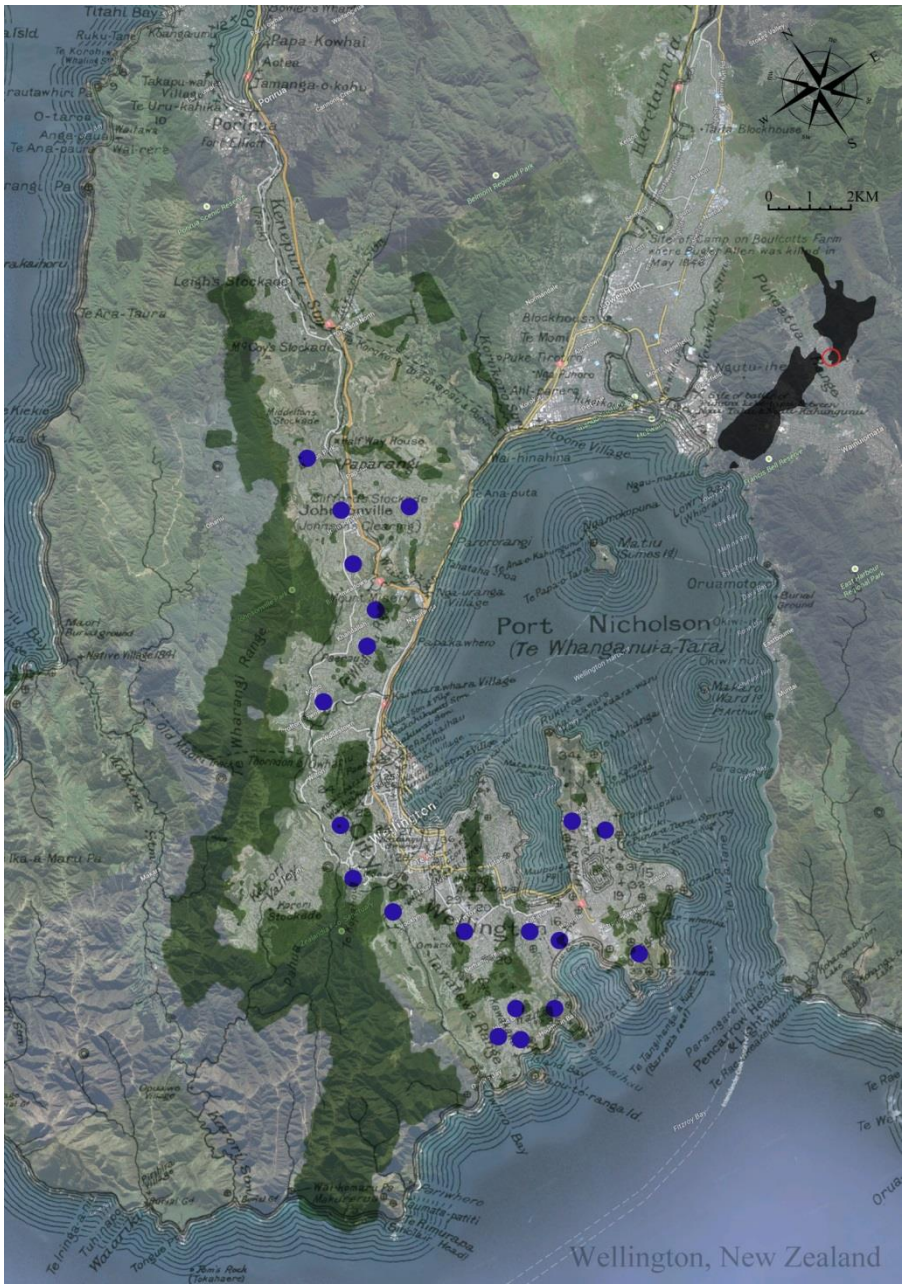

Figure 2.1 Wellington City, New Zealand, showing the location of the 20 study sites, ●, and the outer green-belt and the town green-belt (roughly encircling the inner city), ■, (Google Maps, 2014; Wellington City Libraries, 2014) .

2.2 Study Sites

My study used a quasi-experimental design where variation in neighbourhood populations and residents is used to structure empirical comparisons. This kind of design is common in social and psychological research and similar comparative designs have been used by some of the other researchers cited (e.g., Hartig et al., 2001; Honold et al., 2012; Kaplan, 2001). My study took advantage of the variation in vegetation level between neighbourhoods and participation in the RRP scheme amongst residents. Neighbourhood vegetation was objectively measured. Participation in the RRP scheme provided two groups of people in each neighbourhood, one who participated in the RRP scheme and one who did not, so that the effect of being involved in the RRP scheme could be measured.

A limitation of the quasi-experimental design is the non-random assignment of people to neighbourhoods. The characteristics of the individuals who chose to participate in my survey may differ significantly from others who chose not to participate, this can cause a bias and hinder the ability to generalise the results.

My study was carried out in 20 residential neighbourhoods. A 'neighbourhood' consisted of 60 adjacent single-residence households in adjoining roads and streets. I used 60 households because it is the smallest unit of a neighbourhood when defined as an area within 5-10 minutes' walk (Honold et al., 2012; Hur et al., 2010; Kearns and Parkinson, 2001). Each neighbourhood and household was given a unique code. To obtain 60 households I began at one end of the neighbourhood and counted 60 consecutive households including both sides of the street. If there were two or more residences for a street number, they were all included as separate residences, e.g., 41A, B, C.

Three criteria were used to select a stratified random sample of neighbourhoods:

1. Involvement of residents in Wellington City Council's Road Reserve Planting (RRP) scheme. Wellington City Council provided raw data from their RRP scheme from 1990-2010, this allowed the identification of neighbourhoods where RRP had occurred and the number of residents involved (Table 2.1). People generally

participated as individual households but there were some areas where co-ordinated planting efforts were undertaken (e.g., Churton Park Residents' Association organised several planting days). I chose neighbourhoods to reflect historical participation in the RRP scheme. This ranged from 0 - 35% of households per neighbourhood in the 20 neighbourhoods featured in my study. Within the neighbourhoods where RRP occurred I gathered data from two populations, residents who had been involved in the RRP scheme and those who had not. I also gathered data from three neighbourhoods where there was no involvement in RRP whatsoever.

2. The proximity to sites from Berentson's (2013) study of the RRP scheme planting success (Table 2.1).

3. The variation of vegetation cover and range of urban environments across Wellington City. The environmental variation in urban ecosystems can be ordered along gradients extending from the surrounding landscape towards the city centre (McDonnell and Pickett, 1990). I chose a variety of neighbourhoods that varied in their vegetation cover and geographical location in Wellington City. The neighbourhoods I selected bordered on Wellington's inner city and extended to the outer suburban areas. Some were adjacent to coastal areas, others had more rural outlooks. The amount of vegetation cover is described in detail in Section 2.3.

As a consequence of this selection process the study sites spanned 15 suburbs in Wellington City (Figure 2.1). These suburbs included Churton Park, Johnsonville, Newlands, Khandallah and Ngaio in the north, the city suburbs of Kelburn, Highbury, Brooklyn and Newtown, the more southerly suburbs of Island Bay and Southgate and lastly Kilbirnie, Miramar, Maupuia and Strathmore in the east. The neighbourhoods varied in housing density with the total area ranging from 447.5 to 1008.3 m^2 per household.

Table 2.1 A summary of the survey sites/neighbourhoods. Showing the number of households involved in the RRP scheme, both historically and as reported in my survey, whether the site is part of Berentson's (2013) previous study of planting success, the suburb and level of vegetation.

	Historical Involvement with RRP		Survey Involvement with RRP				
Site	Number of households (*N* = 126)	Percentage of all households	Number of Households (*N* = 61)	Percentage of all households	Near Berentson's (2013) Sites	Suburb	Vegetation Level
1	3	5.0	2	2.3	N	Johnsonville	6
2	5	8.3	5	8.3	Y	Johnsonville	4
3	21	35.0	4	6.7	Y	Churton Park	3
4	3	5.0	1	1.7	N	Newlands	1
5	7	11.7	5	8.3	Y	Khandallah	6
6	7	11.7	4	6.7	Y	Ngaio	6
7	9	15.0	3	5.0	N	Khandallah	3
8	9	15.0	6	10	Y	Highbury	7
9	1	1.7	1	1.7	Y	Kelburn	7
10	3	5.0	3	5.0	Y	Brooklyn	4
11	16	26.7	5	8.3	Y	Island Bay	4
12	7	11.7	1	1.7	Y	Island Bay	3
13	9	15.0	4	6.7	Y	Melrose	3
14	2	3.3	2	3.3	N	Island Bay	1
15	7*	11.7	10*	16.7	Y	Kilbirnie	5
16	0	0.0	0	0.0	N	Kibirnie	1
17	0	0.0	0	0.0	N	Newtown	2
18	9	15.0	3	3.5	Y	Miramar	5
19	8	13.0	2	3.2	N	Maupuia	2
20	0	0.0	0	0.0	N	Strathmore	2

*The number of survey respondents who indicated they had been involved in the RRP scheme at Site 15 exceeds the number according to WCC records. Perhaps these residents were involved at a previous address.

2.3 Level of Vegetation

The 20 neighbourhoods were grouped to represent seven different levels of vegetation. The vegetation levels were determined by site visits and using Google Maps (Google Maps, 2012) to measure the amount and type of vegetation cover. Site visits revealed notable differences between neighbourhoods with respect to the amount of vegetation cover and the diversity of vegetation. Some neighbourhoods were characterised by an abundance of mature trees (native and/or exotic species) which were under-planted with shrubs (< 3m) and smaller plants. These neighbourhoods did not have much lawn or grass. At the other end of the spectrum were neighbourhoods where bare grass predominated. The remaining neighbourhoods fell somewhere between these.

Quantitative analyses of vegetation cover were made by layering Google street maps, showing property boundaries and Google satellite maps, showing vegetation, on grids of 5 x 5 m^2 and 25 x 25m^2. A perimeter was drawn around the 60 households included in a particular neighbourhood. The total area, area of vegetation coverage and area of four types of vegetation were calculated for each neighbourhood (Table 2.2A) with the intention to categorise the 20 neighbourhoods into seven distinct vegetation levels.

The vegetation was classified into four types:

Mature, mixed vegetation with a canopy of mature trees, under grown with shrubs and smaller plants

Shrubs, shrubs < 3m high and smaller plants

Single trees, trees > 3m

Grass.

The mean total neighbourhood area was 4.4 ± 0.20 (SE) ha. The percentage of total vegetation cover ranged from 23.5 to 64.3% of the total neighbourhood area. The amount of each type of vegetation also varied, as a percentage of total vegetation cover, between neighbourhoods. Mature vegetation ranged from 16 - 84% of the total vegetation cover; grass from 7 - 63%; shrubs from 1 - 44% and single trees from 0 - 6% between neighbourhoods (Tables 2.2A).

Site visits indicated the most salient features of the neighbourhood vegetation were the total vegetation cover, amount of mature vegetation and amount of grass. Therefore, neighbourhoods were assigned to the vegetation levels determined by five criteria in the following order of importance, from the most to the least important: total vegetation cover, mature mixed vegetation, grass, shrubs and single trees in order of importance. I deemed mature vegetation a richer environment than grass and, therefore, Level 7 represents neighbourhoods that had higher percentages of total vegetation cover (48 - 64% of total neighbourhood area), high levels of mature vegetation (82 - 84% of vegetation cover) and low levels of grass (7 - 15%). Level 1 neighbourhoods had a lower percentage of total vegetation cover (25 - 41% of total neighbourhood area) with high levels of grass (53 - 62% of total vegetation) and low levels of mature vegetation (17 - 30% of total vegetation). The other five levels fall in sequence between these two. Most neighbourhoods were easily categorised based on the first three criteria. Neighbourhood 20 was not. Neighbourhood 20 had a total vegetation cover of around 48% but, compared to other neighbourhoods with around this level of vegetation cover, Neighbourhood 20 had a lower percentage of mature vegetation. Therefore, Neighbourhood 20 was placed in the level with the best fit considering all five criteria (Tables 2.2A & B).

Table 2.2A Vegetation cover and composition for the 20 neighbourhoods in Levels 1 - 7. This table shows the total area of each neighbourhood and the percentage of total vegetation cover. The various types of vegetation are a percentage of the total vegetation cover. NHD = neighbourhood; Veg = vegetation, *n* = number survey respondents. Total *N* = 423.

				Percentage of vegetation cover				
Level	NHD	*n*	Total Area (m^2)	Total Veg	Mature	Grass	Shrub	Single tree
1	14	22	37740	30.7	29.7	55.1	14.8	0.4
1	16	16	30175	24.9	17.3	62.5	20.3	0.0
1	4	16	48438	41.2	23.0	53.2	22.1	1.8
2	17	25	26850	23.5	32.3	34.1	32.1	2.2
2	19	11	36463	30.1	16.0	45.5	32.9	5.6
2	20	14	43050	47.8	27.0	55.7	11.0	6.0
3	12	17	48388	46.7	34.3	36.6	28.2	0.4
3	7	23	45538	44.3	42.7	33.6	23.7	0.0
3	3	16	51638	36.3	30.1	43.5	25.9	0.5
3	13	20	46613	43.9	17.6	38.0	44.4	0.0
4	10	24	52150	45.1	50.7	22.6	26.7	0.1
4	11	28	51488	59.9	58.7	22.3	18.0	1.1
4	2	17	45175	41.2	45.2	40.3	14.6	0.0
5	18	28	45838	56.8	67.9	19.6	12.7	0.0
5	15	28	33225	49.1	67.7	19.0	13.3	0.0
6	1	18	59488	62.7	69.2	19.7	11.1	0.0
6	5	24	57363	56.4	70.2	19.6	10.3	0.0
6	6	28	49738	53.3	76.8	15.5	7.7	0.0
7	8	23	40900	64.3	82.3	7.1	10.7	0.0
7	9	25	33825	48.2	83.5	15.2	1.3	0.0

Table 2.2B Summary of the vegetation cover and composition for neighbourhood vegetation Levels 1 to 7. This table shows the mean percentage of total vegetation cover and the mean percentage of each type of vegetation (as a percentage of total vegetation cover) for the seven vegetation levels. *n* = number of survey respondents. Total *N* = 423.

		Mean percentage of vegetation cover				
Level	*n*	Total Veg	Mature	Grass	Shrubs	Single tree
1	54	32	23	57	19	0.7
2	50	34	25	45	32*	5
3	76	43	31	38	31	0.2
4	69	49	52	28	20	0.4
5	56	53	68	19	13	0
6	70	57	72	18	10	0
7	48	56	83	11	6	0

*Except neighbourhood 20.

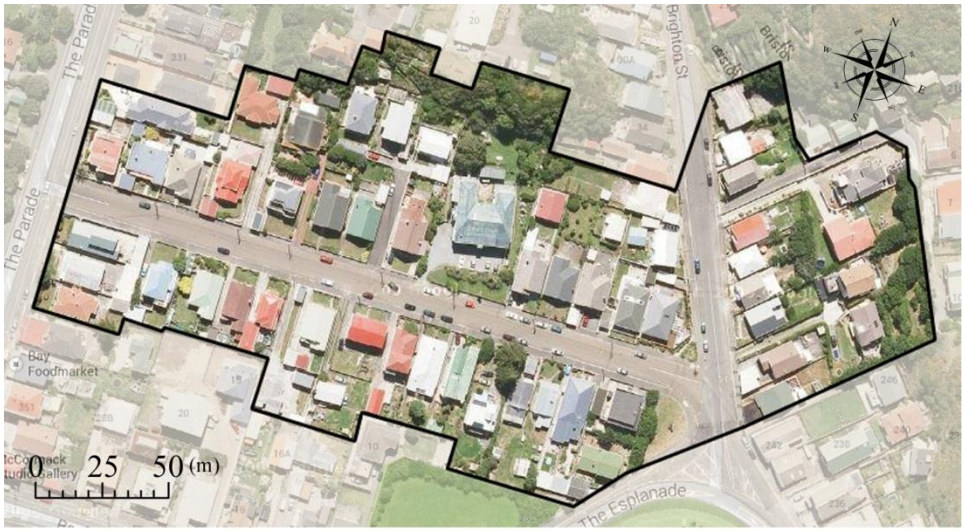

Figure 2.2A Vegetation Level 1.

Figure 2.2B Vegetation Level 3.

Figure 2.2A – D Representative examples of the neighbourhood vegetation for four of the seven Vegetation Levels. All neighbourhoods represent 60 households (Continued overleaf).

Figure 2.2C Vegetation Level 5.

Figure 2.2D Vegetation Level 7.

2.4 The Survey Questionnaire

A questionnaire was designed to collect information about Wellington City residents' involvement with the RRP scheme and to test my hypotheses. The content of the questionnaire is described below. It includes questions about people's involvement in the RRP scheme, measures for the socio-psychological constructs and wellbeing and, lastly, measures of the residents' socio-demographic indicators. The complete questionnaire is in Appendix VI.

2.4.1 Involvement in the Road Reserve Planting Scheme

The first section of the survey (Appendix VI, Section A) collected information about the experiences of residents who participated in the Wellington City Council's RRP scheme. This identified respondents who had participated in the scheme and any benefits they might have gained or barriers they might have faced participating. It also asked those who had not taken part if they would like to participate in the future and if anything might prevent them from doing so. This section had 16 questions with mixed formats for the responses depending on the question. The responses included yes/no answers, 5-point Likert scales or open ended questions. Question 3, asked about respondent's involvement in the RRP scheme and became the dichotomous variable, RRP.

2.4.2 Socio-psychological Constructs and Wellbeing Measures

Latent constructs were used to quantify the socio-psychological variables. That is, the socio-psychological constructs were estimated from a series of directly measured indicators that were thought to represent the latent construct. These included Neighbourhood Satisfaction, Connection with Nature, Use of Nature for Psychological Restoration, Environmental Attitude, Pro-environmental Behaviour and two of the three wellbeing measures: i.e., Mental Health and Satisfaction with Life. The dependent variables were all measured on a 5-point Likert scale. The highest values represented the highest or most positive response: 1 = strongly disagree; 2 = disagree; 3 = neutral; 4 = agree and 5 = strongly agree. Some questions in each construct were negatively phrased to encourage evaluation of each

question and avoid an agreement or disagreement bias. These scores were later inverted so that high scores always represented the positive response in analyses.

Neighbourhood Satisfaction

I wanted to investigate two components of neighbourhood satisfaction: i.e., satisfaction with the social aspects of neighbourhood life (NS Social) and satisfaction with the natural environment in the neighbourhood (NS Nature). Two constructs were developed to measure these based on previous research on neighbourhood satisfaction (Appendix VI Section B1 and B2).

The content of neighbourhood satisfaction measures used by other researchers varies but is generally concerned with social and/or physical aspects of the neighbourhood. Hur and Morrow-Jones (2008) and Hur et al. (2010) measured a range of neighbourhood characteristics that influenced neighbourhood satisfaction. For example, general appearance, distance from friends and family, sense of safety, vegetation density and housing density. Luck et al. (2011) also measured overall neighbourhood satisfaction which incorporated a sense of belonging, neighbourhood attachment, opportunities to relax and overall neighbourhood satisfaction. Kaplan (2001) separated neighbourhood satisfaction into two factors that she called Neighbourhood and Nature. Neighbourhood included items, such as, friendliness, security and sense of community whereas Nature included satisfaction with the amount of trees, private outdoor space, nearby nature and open space. Kearney's (2006) 41-item scale also had separate factors measuring neighbourhood satisfaction, some of which were similar to Kaplan's (2001) sense of community, satisfaction with shared outdoor space and satisfaction with nearby nature categories.

I selected items from these sets of questions to develop a measure for NS Social and NS Nature. NS Social investigated the sense of community. It included questions about perceived neighbourliness (friendliness and availability to help), sense of belonging and safety and problems with neighbours. NS Nature asked about satisfaction with the natural characteristics of the neighbourhood, such as the amount of trees and bird song, the amount of private and public outdoor space and access to nature. There were also

questions about length of residency and an overall evaluation of neighbourhood satisfaction. NS Social and NS Nature both had 11 items and three of these were negatively phrased. I asked people to indicate the extent to which they agreed or disagreed with the statements in the survey with respect to their immediate neighbourhood, which was defined for them as the area within five minutes' walk or one to two streets of their home.

Connection with Nature

The Disposition to Connect with Nature Scale, developed by Brügger et al. (2011), was used to assess a person's connection with nature (Appendix VI, Section C). This scale avoids the intellectually demanding self-reflection and associated recollection errors associated with other scales which measure connection with nature (e.g., Brügger et al., 2011; Clayton, 2003; Mayer and Frantz, 2004) and is introduced in Section 1.4. I selected 20 items from Brügger et al.'s (2011) original 40-item scale that were pertinent to Wellington City and yet retained a good overview of the 40 items. I included items such as 'I get up early to watch the sunrise', 'I personally care for plants' and some items that were more challenging to answer, such as 'I mimic the sounds of birds or animals'. I adapted some items make them more suitable for the Wellington City context. For example, hedgehog was changed to Little Blue Penguin in item 39 of Brügger et al.'s (2011) scale[2]. Hedgehogs are an introduced species in New Zealand and pose a threat to our endemic weta, skinks and the eggs of ground nesting birds. Little blue penguins, the world's smallest penguin, nest around the coast of Wellington City and are sometimes killed by cars on coastal roads. Their conservation status is 'near threatened' and there is a programme to establish a favourable habitat for them. Seeing a Little Blue Penguin that had been hit by a car is more likely to evoke feelings of sadness in a Wellingtonian than seeing a hedgehog that had been run over. Four of the 20 items were negatively phrased.

Use of Nature for Psychological Restoration

I expanded on a previous 3-item measure used by Byrka et al. (2010) and Hartig et al. (2007) to quantify the use of nature for Psychological Restoration (Appendix VI, Section D).

[2] "It makes me miserable to see a hedgehog that was hit by a car."

The poor psychometric qualities of Byrka et al's. (2010) and Hartig et al.'s (2007) measure of Psychological Restoration may have contributed to the modest level of associations found between Psychological Restoration, Environmental Attitude and PEB (Byrka et al., 2010). The 10 items making up my construct for Psychological Restoration are evaluative statements that describe aspects of people's interaction with nature that may support psychological restoration. For example, "When I'm feeling stressed I find being out in nature helps reduce my stress levels" and "I find time in nature an effective way to unwind after a busy day". Three items were from Gagnon Thompson and Barton's (1994) Eco-centrism Scale (questions D1, 2 and 4). These were the items used by Hartig et al. (2007) and Byrka et al. (2010) to measure the use of nature for psychological restoration. The content of the remaining 7 items was guided by Kaplan and Kaplan's (1989) deepening levels of restoration: i.e., clearing the head, recharging directed attention, processing cognitive residue and reflecting on one's own life (D3, 5, 7 and 8); Ulrich's (1984) perspective of emotional regulation/stress reduction (D2 and 6); and ideas around the intangible psychological benefits of spending time in nature (D9 & 10) (Curtin, 2009). One item was negatively phrased.

Environmental Attitude

I used Dunlap's New Ecological Paradigm (NEP, Dunlap, 2008; Dunlap et al., 2000) to measure Environmental Attitude (Appendix VI, Section E). This is a revision of his 1978 scale and is currently the most widely used measure to assess people's environmental attitude (Hawcroft and Milfont, 2010). It measures a person's beliefs about the nature of the earth and humans' relationship to it (Dunlap et al., 2000). The revised scale consists of 15 items with 7 negatively phrased. The NEP scale investigates facets of a person's world view (Milfont, 2007). Hawcroft & Milfont (2010) undertook a meta-analysis of 69 studies that had used the NEP scale and made recommendations for reporting results that would optimise their usefulness[3]. They also recommended using the 12 or 15-item scale rather than the abbreviated six-item scale and a 5-point Likert scale. I have followed these recommendations and reported the recommended information in my Results.

[3] Mean and standard deviation, internal validity of the data, characteristics of the population sampled.

Pro-environmental Behaviour

The General Ecological Behavior (GEB) Scale (Kaiser, 1998; Kaiser and Wilson, 2004) was the basis of my measure for general Pro-environmental Behaviour (PEB) (Appendix VI, Section F). Several studies have confirmed the validity and reliability of the GEB scale (e.g., Kaiser and Wilson, 2004; Kaiser et al., 1999) and it has been used to investigate the relationships between the use of nature for psychological restoration, environmental attitudes and pro-environmental behaviour (Byrka et al., 2010). Kaiser and Wilson's (2004) scale is a general measure of PEB that incorporates 50 items and covers six domains of behaviour that could be described as supporting a pro-environmental stance: i.e., consumerism, energy consumption, mobility & transport, waste avoidance, recycling and social behaviours toward conservation. I selected 15 items from their scale, which covered the six domains, to measure general PEB.

Outdoor Activities

Participation in outdoor activities has been shown to correlate with wellbeing and pro-environmental behaviour (Kaplan, 2001; Larson et al., 2011; Luck et al., 2011). Section G of the questionnaire sought to quantify this relationship (Appendix VI, Section G). Four questions asked people to indicate the type of outdoor activities they participated in and the amount of time spent outdoors, both at the time of the survey and in their childhood between the ages of six and twelve. Some suggest that it is between the ages of 6 and 12 that experiences in nature can leave a lasting impression on a child which helps shape their relationship with nature well into adulthood (e.g., Kellert, 2002). The types of activity corresponded to the categories used by Rachel Kaplan (2001), i.e., outdoors, quiet nature and gardening. I also asked how easy it was for residents to visit local natural areas from their home.

The variable measuring the amount of time spent outdoors was strongly negatively skewed with most people involved in outdoor activities at least once a week (73.5%). Therefore, it was modelled as a dichotomous variable that indicated whether people spent time outdoors more than or less than once a week. The amount of time spent outdoors has been

measured as a dichotomous variable by other researchers (e.g., Larson et al., 2011; Luck et al., 2011).

Wellbeing

Wellbeing is a complex holistic state and is not simply the absence of disease. It embraces all aspects of human life including physical and mental health and social wellbeing (World Health Organisation, 2005). I measured three aspects of people's wellbeing: i.e., Mental Health, Satisfaction with Life and Physical Health (Appendix VI, Section H).

The World Health Organisation, WHO-5 Wellbeing Index, was used to measure mental wellbeing (World Health Organisation, 1998). This 5-point scale was originally 28 items but was revised in 1998 to its present form. WHO-5 captures current mental wellbeing as experienced over the previous two-week period. This measure shows excellent sensitivity and reliability when screening for depression and when measuring general mental wellbeing in a variety of populations (Bech, 2004; De Wit et al., 2007). It has five positively worded items that measure wellbeing rather than measuring distress symptoms. In clinical use, the score for the five items is transformed to a score out of 100. I have retained the raw score in line with my other measures.

Satisfaction with Life was assessed using Diener et al.'s (1985) Satisfaction with Life Scale. This scale shows high internal consistency and reliability over time as well as a sensitivity to change. It is a cognitive measure that does not tap into positive or negative affect and can be used to complement scales that do measure affect (Pavot and Diener, 1993). The Satisfaction with Life scale measures how people assess their satisfaction with life as a whole. They compare their circumstances to that which they judge is an appropriate standard and indicate the extent to which they agree with each question. It consists of five positively word statements.

Physical health was assessed using a single item rating overall physical health and by a list of medical conditions that have been linked to chronic stress. Single item health ratings are good predictors of unspecified general health problems and mortality (Idler and Benyamini,

1997; Wallenius, 2004) and have been used in studies similar to my own (de Vries et al., 2003; Maas et al., 2006; Mitchell and Popham, 2007). People were asked how they would describe their general health over the last three months on a scale of 1 (very poor) to 5 (excellent).

Long term exposure to stress has been linked, in part, to a number of medical conditions (Health Council of the Netherlands, 2004; Honold et al., 2012; Pearson et al., 2013). Exposure to nature may mitigate the negative effect of stress on people's health. If so, there would be an association with exposure to nature and the incidence of stress-related medical conditions. To determine whether the level of neighbourhood vegetation or participation in the RRP scheme was associated with these stress-related medical conditions survey participants were asked to indicate if they experienced any of eight health complaints, such as chronic pain, heart disease, cancer and asthma, in the year preceding my survey. The selection of these health complaints was informed by Honold et al. (2012) who investigated the effect of environmental stressors and resources, such as air quality and nearby green space, on self-rated health in urban residents in Berlin, Germany.

Kuo (2001) found residents' ability to manage the demands of poverty and cope with day-to-day life was correlated with the amount of vegetation around urban public-housing communities in Chicago. I wanted to determine if exposure to nature influenced other demanding life situations, such as experiencing a major life event. Major Life Events require a substantial life adjustment and are significantly correlated with the onset of illness (Holmes and Rahe, 1967). Holmes & Rahe (1967) developed a scale that rated 43 of these stressful events. Loss of a spouse has the highest rating (1/43) followed by divorce or separation (2 and 3/43), serving a jail term (4/43) and death of a close family member (5/43). Other life experiences also create stress, such as pregnancy (12/43), changes in residence (32/43) and even Christmas (42/43). I asked the survey participants if they had experienced any of the top five major life events in the previous three months, giving examples of the type of events I meant.

2.4.3 Socio-demographics

Information was gathered on socio-demographics that have been shown to influence the other variables I measured (Appendix VI, Section I). The socio-demographics were to determine if the survey population was representative of the general Wellington City population. Socio-demographics were also added to Structural Equation Models to determine whether they could be improved. Socio-demographic data gathered by the survey included gender, household income, age, marital status, the number of children less than 18 years of age, homeownership, education and ethnicity. These demographics were collected in a similar format to those in the most recent New Zealand Government census (Statistics New Zealand, 2006) to facilitate the comparison of the characteristic of my survey population with those of the general Wellington City population.

2.5 Survey Instrument Design and Distribution

The questionnaire was in the form of a self-administered mailbox survey. Although these surveys can have a low response rate and a non-response bias, they have the advantage of being cost and time effective when large numbers of respondents are required. Mail box surveys also eliminate interviewer bias and ensure respondents are presented with exactly the same questions (Dillman, 2009; White et al., 2005). The survey was piloted in 17 individuals from an ecological restoration group to ensure the directions and questions were clear and to find out how long it would take to complete. Comments from the pilot were used to improve layout and question clarity. The time taken to complete the survey was 25 - 30 minutes.

A large sample was important in my study as I had a large number of variables and I would be using Structural Equation Modelling (SEM). It is suggested that a sample size in excess of 200 - 300 cases is needed to obtain reasonable stability in the parameter estimates using SEM (Field, 2012; Kline, 2005). To get about 300 responses I delivered surveys to 1200 households. This number was based on a predicted response rate of 25-30% for self-administered postal surveys (Fox et al., 1988) and a response rates of 32.7-43% achieved by similar studies in Wellington (Berentson, 2013; Parker, 2009; Ryan, 2011).

I followed Dillman's (2009) Tailored Design Method to maximise the return rate. Once the questions had been finalised they were formatted into an attractive booklet. This was A4 sized paper folded in half. The opening questions were directly about the RRP scheme and easy to answer. The respondents were then led through sections on each of the socio-psychological variables to a final section containing the more personal, demographic data. This layout initially engages the respondent and once an individual begins a survey they are more likely to complete it. The survey booklet was 15 pages and exceeded the maximum of 11 pages suggested by Dillman (2009) where after response rates decline. I decided to retain all the sections so I could collect data I required to test my hypotheses and Wellington City residents appear to give response rates higher than average (Charles, 2013; Parker, 2009; Ryan, 2011 c.f. Dillman, 2009).

In an effort to show positive regard all correspondence was addressed to "A Representative of the Household" allowing self-selection of the respondent from each household. I signed each cover letter to make it seem more personal and can increase the response rate (Dillman, 2009). The logos for Victoria University of Wellington and the Centre for Biodiversity and Restoration Ecology were on all correspondence as association with a reputable research group increases the researcher's legitimacy and the likelihood of people completing the survey.

Delivery of the survey was preceded by an introductory letter describing the research, informing the residents that a self-administered questionnaire would be delivered the following week and inviting them to participate. The survey was hand-delivered one week later in October, 2012. It included the survey booklet, a one-page cover letter explaining the survey and giving instructions for the respondents, a voucher (see below) and an addressed postage-paid envelope for the survey's return. The survey booklet and associated letters and forms are in Appendices V and VI. Two weeks after the survey was delivered a follow-up letter was sent out thanking the residents who had already completed the survey and serving as a reminder for those who had not. I also reassured the participants on the confidentiality and security of the information they shared.

The survey could also be completed at an on-line survey site, www.surveymonkey.com. The content of the on-line survey was identical to the hard copy and instructions for completing it were included in the instruction sheet. Online surveys are increasingly used in research (Honold et al., 2012) and are able to cover a large geographical area with minimal cost, but they are not accessible to all people. A Wellington City study of residents' attitudes toward bird problems found 13% of total survey returns were completed online (Charles, 2013).
A voucher to participate in a draw for $200 of native plants, donated by the Wellington City Council (WCC) Plant Nurseries, was included with the survey. This was intended as a thank you for completing the rather complex survey and as an incentive to participate (Dillman, 2009). The voucher was returned in the same envelope as the survey booklet and I immediately separated the two once I received them to maintain the anonymity of the survey participants. The vouchers were collected and a winner drawn by Myfanwy Emeny, the Biodiversity Co-ordinator at Wellington City Council. The winner was contacted and plants delivered by a WCC ranger in mid-January 2013.

Human Ethics Approval for the survey was gained from Victoria University of Wellington's Human Ethics committee on 13 October 2012 (Reference number: JRM19506, Appendix IV). The data was collected from known street addresses, but the identity of the individuals completing the survey was unknown. The data for the surveys was stored with codes given to the various addresses and the information connecting physical address and code stored separately so that the data was effectively anonymous.

2.6 Recycling Survey

A follow-up on-site survey of residents' recycling behaviour was undertaken in early December 2012. This was to compare the results of an observed and self-reported pro-environmental behaviour because the survey relied on self-reports.

The Wellington City Council supplies wheelie bins (140 l capacity) or specially marked plastic recycling bags for residents to recycle waste paper, plastic or metal and 45 l plastic crates to recycle glass. The curbside recycling is collected weekly, alternating between the collection of the wheelie bins/recycling bags and the crates. I surveyed each of the 20 neighbourhoods

in my study on the day the wheelie bins and plastic bags were due for collection. I chose to survey the wheelie bins or recycling bags because the wheelie bins have a street address of the residence to which they belong, making it easier to identify which residence they belong to. I recorded which of the households, that had participated in my survey, had either the wheelie bin or plastic recycling bags outside their homes.

2.7 Statistical Analyses and Data Preparation

Raw data from the completed surveys was entered into an SPSS data sheet (IBM SPSS Statistics for Windows, Version 20.0). A random sample, of 10% of the surveys, was checked for accuracy. Less than 1% of the transcribed data from this sample required correction and repeat checks of those error types were made for the entire dataset. Scale inversions were made for reverse coded items so that all high scores represented the most positive or highest choice on the Likert Scale for each variable.

Missing Values Analysis

Returned social surveys can contain a lot of unanswered questions and, therefore, missing data. Cohen and Cohen (1983) suggest that levels of missing data up to 10% are unlikely to effect the interpretation of results, but according to Tabachnick and Fidell (2013) the pattern of missing data is more important than the actual amount. In addition, Cunningham (2010) recommends imputing missing data to maximise the information available in AMOS. I undertook a Missing Values Analysis in SPSS to examine the extent and patterns of missing data in my study that could perhaps lead to systematic bias. The pattern of missing data was used to determine whether these non-responses were Missing Completely at Random (MCAR), Missing at Random (MAR) or missing in a more systematic way (Not Missing at Random, NMAR).

The total percentage of unanswered questions in my data set was low (1.4%). Nineteen of the 423 surveys had a total of 5% or more missing responses with 11 of these over 10%. It appears most of those surveys with over 10% missing responses can be accounted for by

respondents mistakenly turned over two pages at once. This was a random occurrence and the data was not missing in a systematic way.

The majority of variables (individual survey items) had less than 5% missing values. Only four out of 113 variables had 5% or more of their values missing. The variables with 5% or more missing values were for questions about Household Income and Number of Children (5.0% missing responses) and Physical Health and Childhood Participation in Outdoor Activities (5.7% missing responses). The levels of missing data in the variables Number of Children and Childhood Participation in Outdoor Activities could in part be explained by the Likert scale lacking a "Not applicable" response. The questions about Household Income and Physical Health are personal and regarded as private information, so it is not surprising that they are associated with higher levels of missing data.

Separate Variance t-Tests in SPSS showed that the variables with 5% or more of missing data (Household Income, Physical health, Number of Children and Childhood Participation in Outdoor Activities) were significantly correlated with other variables in the data set and could therefore be predicted from these variables. The results of Little's MCAR test for this data set were statistically significant and indicate this data set cannot be considered MCAR ($\chi^2_{12190} = 13006$, $p = 0.000$). MAR can be inferred if Little's MCAR test is statistically significant but the missing values are predictable from other variables in the data set as indicated by the Separate Variance t-Tests (Tabachnick and Fidell, 2013). My data set meets these requirements and the missing responses can be considered MAR.

I then imputed missing values to my data set using the expectation-maximisation (EM) algorithm in SPSS (Cunningham, 2010). The imputed data were recoded to the nearest whole number in line with the raw data so it was easier to assess frequency plots.

Preliminary Analyses

The distributions of all variables were assessed for normality by measuring skew and kurtosis, using Bar graphs, Q-Q plots and the Shaprio-Wilk test in SPSS. The presence of

outliers or influential observations were detected by standardised scores (*z*) and measuring the Mahalanobis distances.

Two socio-demographic variables had non-normal distributions. Household Income and Number of Children showed significant negative and positive skew respectively and both showed positive kurtosis. Household Income was transformed using square root and logarithm transformations (Pallant, 2013) but neither improved the distribution and so non-parametric analyses were used for Household Income where appropriate (e.g., Spearman's rho). The number of children living in each household ranged from 0 to 5. There were two outliers with standardised scores (*z*) > 3.29. These outliers represented two households with 4 or 5 children. Therefore, the categories were changed to 0, 1, 2 and 3 or more children, which brought all *z* scores to an acceptable level.

The measure, Number of Health Conditions, showed positive skewness and kurtosis. The number of conditions ranged from 0 - 5 conditions per person. The standardised scores for outliers showed that *z* > 3.29 for six cases. Therefore, the categories were changed to 0, 1, 2, 3 or 4 or more medical conditions. This resulted in acceptable z scores in all but two instances, those people who had five medical conditions. These cases were retained in the data set.

The order of the categories for Marital Status was reversed to making reporting the results clearer. For example, being married or in a civil union was category 1 in the survey, this was changed to category 4.

The associations among constructs were assessed to understand patterns in the data that may indicate redundancies with the constructs. Associations were measured by: Pearson's Correlation Coefficient and Spearman's rho for normally and non-normally distributed ordinal-ordinal variable pairings; the point biserial correlation coefficient for ordinal-dichotomous pairings; the phi coefficient for dichotomous-dichotomous variables and Chi-square for variables with two or more categories (Pallant, 2013). Appendix I shows the matrix for the associations of independent and dependent variables. Appendix II is the

matrix of associations between the socio-demographic measures and the independent and dependent variables.

Analysis of Socio-demographics

Self-selection of interested or better-informed respondents can be a source of sampling bias in mail surveys (White et al., 2005). I expected residents who had previously been involved in the RRP scheme to be particularly interested in completing this survey. Chi-square tests were used to compare the demographics of the survey population with those of the general population of Wellington City, obtained from the 2006 New Zealand census (Statistics New Zealand, 2006). This was to determine if the survey population was representative of the Wellington City population. I also compared the demographics of survey respondents who had been involved in the RRP scheme with those respondents who had not, again using Chi-square tests, to see how they might differ.

Construct Confirmation

An Exploratory Factor Analysis (EFA) in SPSS was used to confirm the usefulness of the constructs and to identify the latent factors among each set of observed variables gathered in my survey (Fabrigar et al. 1999). The Kaiser-Meyer-Olkin Measure of Sampling Adequacy (KMO) and Bartlett's Test of Sphericity were used to assess the suitability of the data for factor analysis. Kaiser-Meyer-Olkin values of over 0.6 suggest the patterns of item correlations are relatively compact and an EFA should produce distinct and reliable factors (Cunningham, 2010; Field, 2012; Tabachnick and Fidell, 2013) (Table 2.3). Statistically significant results ($p < 0.05$) for Bartlett's Test of Sphercity indicate there are enough inter-correlations between variables to merit factor analysis (Table 2.3; Cunningham, 2010).

Once I determined the constructs were suitable for EFA, each construct was submitted to a Maximum Likelihood (ML) extraction followed by Oblimin rotation with Kaiser Normalisation as earlier tests revealed acceptable normal data distributions. Oblimin rotation was chosen as earlier bivariate correlations revealed positive correlations between

variables (Cunningham, 2010). Where the results of these extractions were unclear a ML single-factor extraction was used.

Table 2.3 Kaiser-Meyer-Olkin measures of Sampling Adequacy (KMO) and Bartlett's Test of Sphericity, *(p* = 0.000 for all constructs) determined each construct was suitable for factor analysis.

Construct	KMO	Bartlett's Test of Sphericity
NS Social	0.80	$\chi^2_{55} = 859.2$
NS Nature	0.73	$\chi^2_{55} = 746.9$
Connection with Nature	0.80	$\chi^2_{190} = 1578.6$
Psychological Restoration	0.95	$\chi^2_{45} = 3125.8$
Environmental Attitude	0.88	$\chi^2_{105} = 1755.8$
Pro-environmental Behaviour	0.78	$\chi^2_{105} = 996.9$
Outdoor activities	0.73	$\chi^2_{66} = 378.8$
Mental health	0.82	$\chi^2_{10} = 907.2$
Satisfaction with Life	0.88	$\chi^2_{10} = 1141.9$
Health Combined	0.89	$\chi^2_{55} = 2327.0$

Dunlap et al. (2000), in their discussion of the New Ecological Paradigm, argue that uni-dimensionality is not always a realistic goal when creating constructs. A high level of internal consistency alongside a reasonable rationale is adequate to combine a set of multi-dimensional variables into a single measure rather than create an *ad hoc* set of uni-dimensional factors (Dunlap et al., 2000). Following Dunlap (2000), uni-dimensionality was demonstrated by several factors:

- Patterns of Eigenvalues over 1. The first factor had a relatively higher value than the remaining factors, supported by scree tests that showed a sharp drop from the first to subsequent factors.

- The percentage of variance seen in the first factor was relatively larger than the other factors.
- Variable (item) loadings greater than 0.32 were acceptable (Tabachnick and Fidell, 2013).
- Corrected item-total correlations over 0.3 are acceptable (Field, 2012).
- Cronbach's alpha values of over 0 .70 for a set of variables in a construct are considered acceptable for research purposes (Cunningham, 2010; Kline, 2005).

In addition, I considered whether the variables loading on the same factor made theoretical sense and if variables loading on different factors measured something theoretically different. I also considered whether the items included some of the more challenging questions from the original survey.

Table 2.4 Results from the Exploratory Factor Analyses (EFA) to confirm the usefulness of the constructs. *N* = number of items, either the total number or the number of items retained after EFA. Extractions shown are Maximum Likelihood (ML) with (*italicised*) or without Oblimin rotation and Kaiser Normalisation and ML with one fixed factor. Loadings = the range of factor loadings. α = Cronbach's alphas.

					Loadings and Cronbach's alphas for the constructs						
					ML Unrotated/*rotated*			ML 1-factor			
Construct	Total *N*	Factors	Eigenvalues > 1	Variance (%)	*N*	Loadings	α	*N*	Loadings	α	Corrected item-total correlation
NS Social	11	1	3.25	29.53	*6*	*.34 - .93*	.76	7	.40 - .76	.70	.32 - .68
		2	1.32	11.99							
		3	1.13	10.28							
NS Nature	11	1	2.82	25.63				6	.38 - .77	.72	.35 - .58
		2	1.50	13.62							
		3	1.17	10.66							
		4	1.11	10.12							
Connection with Nature	20	1	4.35	21.77				12	.32 - .61	.80	.38 - .57
		2	1.66	8.27							
		3	1.40	7.02							
		4	1.24	6.18							
		5	1.12	5.58							
		6	1.09	5.44							
Psychological Restoration	10	1	6.43	64.28	10	.46 - .88	.93				.45 - .85

Continued overleaf

					Loadings and Cronbach's alphas for the constructs						
					ML Unrotated/*rotated*			ML 1-factor			
Construct	Total *N*	Factors	Eigenvalues > 1	Variance (%)	*N*	Loadings	α	*N*	Loadings	α	Corrected item-total correlation
Environmental Attitude	15	1	4.97	33.11	15	.35 - .71	.85				.33 - .62
		2	1.62	10.80							
		3	1.05	7.01							
Pro-environmental Behaviour	15	1	3.53	23.50				11	.32 - .63	.75	.31 - .49
		2	1.44	9.63							
		3	1.23	8.23							
		4	1.11	7.43							
		5	1.02	6.80							
Outdoor Activities	12	1	2.37	19.71				7	.32 - .52	.057	.12 - .34
		2	1.37	11.42							
		3	1.21	10.12							
Mental Health	5	1	3.18	63.55	5	.67 - .78	.85				.62 - .71
Satisfaction with Life	5	1	3.45	69.01	5	.66 - .86	.88				.63 - .79
Wellbeing measures combined	11	1	5.19	47.14	11	.40 - .81	.88				.40 - .71
		2	1.72	15.60							

Exploratory Factor Analysis Results for the Constructs

Kaiser-Meyer-Olkin values ranged between 0.73 and 0.95 for the constructs and Bartlett's test were all highly significant, $p = 0.000$ (Table 2.3), suggesting that all the theoretical constructs were suitable for factor analysis.

Neighbourhood Satisfaction, Social

The ML extraction suggested a three-factor solution (Table 2.4) for the variables intended to capture NS Social. The scree plot confirmed a strong first factor, which was also reflected in the Eigenvalues. Factor 1 represented 29.53% of the variance, which was relatively larger than the other factors. Six items loaded above 0.32 (0.34 - 0.93) on the first rotated factor. A subsequent ML single-factor extraction resulted in seven items loading above 0.32 (0.40 – 0.76). The corrected item–total correlations were 0.32 - 0.68 for the seven items. Cronbach's alpha (α) was 0.76, for both the six and seven-item constructs. The 7-item construct was selected as it included a broader range of items while meeting the requirements for construct uni-dimensionality. This included questions 1, 2, 3, 5, 7, 8 and 9 from the original 10. These combined items formed the construct measuring Neighbourhood Satisfaction, Social.

Neighbourhood Satisfaction, Nature

The ML extraction suggested four factors (Table 2.4) for the variables intended to capture NS Nature. The scree plot confirmed a strong first factor, which was also reflected in the Eigenvalues. Factor 1 represented 25.63% of the variance, which was relatively larger than the other factors. The content of the four factors suggested in the initial ML extraction did not represent clear or separate factors. A subsequent ML single-factor extraction resulted in six items loading above 0.32 (0.38 - 0.77). The corrected item-total correlations ranged from 0.35 to 0.58, with an acceptable alpha of 0.72. The six items, 3, 6, 7, 8, 9 and 11, formed the construct Neighbourhood Satisfaction, Nature.

Connection with Nature

Six factors were suggested by the ML extraction (Table 2.4) for the variables intended to capture Connection with Nature. The scree plot confirmed a strong first factor, which was also reflected in the Eigenvalues. Factor 1 represented 21.77% of the variance, which was relatively larger than the other factors. The content of the six suggested factors did not represent clear or separate factors. A subsequent ML single-factor extraction resulted in 13 items loading above 0.32 (0.32 – 0.61). Twelve of these items had satisfactory corrected item-total correlations (0.38 – 0.57) but item 19 was 0.26 and therefore was not retained in the construct. The 12-item construct had an alpha of 0.80, removing any further items decreased the alpha. Twelve of the original 20 items (1, 2, 3, 4, 5, 6, 7, 10, 12, 14, 15 and 17) made up the construct Connection with Nature.

Use of Nature for Psychological Restoration

The EFA results for the variables intended to capture use of nature for Psychological Restoration were very clear. One factor was suggested by the unrotated, ML extraction (Table 2.4). The Eigenvalue for this factor was 6.43 and the factor represented 64.28% of the total variance of the data. The scree plots confirmed a strong first factor. All 10 items loaded above 0.32 (0.46 - 0.88). The corrected item-total correlations were in the acceptable range and the alpha was a strong 0.93, confirming all 10 items formed a coherent construct. This construct measured the use of nature for Psychological Restoration.

Environmental Attitude

Three factors emerged from the ML extraction for the variables of the NEP scale which was intended to capture Environmental Attitude. The scree plot confirmed a strong first factor, which was also reflected in the Eigenvalues. Factor 1 represented 33.11% of the variance, which was relatively larger than for the other factors. All 15 items loaded above 0.32 on the first unrotated factor (0.35 – 0.71). The corrected item-total correlations were reasonably strong, ranging from 0.33-0.62. These 15 items had an alpha of 0.85, removing any item decreased the alpha value. The alpha value is consistent with the upper range reported in Hawcroft and Milfont's (2010) meta-analysis, where the alpha value ranged from 0.47 – 0.86

for the 15-item NEP scale. I retained all 15 items as a measure of Environmental Attitude as did Dunlap et al. (2000).

Pro-environmental Behaviour

Five factors were suggested by the ML extraction for the variables intended to capture PEB. The scree plot confirmed a strong first factor, which was also reflected in the Eigenvalues. Factor 1 represented 23.44% of the variance, which was relatively larger than the other factors. The ML and ML with rotation extractions did not reveal clear patterns in item loading. A subsequent ML single-factor extraction resulted in 11 items loading above 0.32. The corrected item-total correlations were acceptable (0.31 and 0.49), as was the alpha of 0.75. The alpha was within the range reported by others using versions of the GEB scale where the alpha ranged from 0.72 – 0.81 (Kaiser et al., 2003). The final construct had 11 items, 1, 3, 4, 5, 6, 7, 8, 10, 11, 12 and 14 which measured Pro-environmental Behaviour.

Outdoor Activities

Two questions were intended to measure outdoor activity, the type of activities people participated in and the amount of time they spent outdoors. An EFA on the types of activity resulted in three factors with the first explaining 19.7% of the variance. The content of these factors did not define clear categories. A ML single-factor analysis of these activities resulted in a seven-item construct with an $\alpha = 0.57$. Removing any items from the construct decreased the alphas. The corrected item-total correlations for the single factor extraction ranged from 0.12 - 0.34 with only two items above the required 0.30. Unfortunately, this did not create a meaningful construct. It would have been more useful to include a measure for the amount time people spent in each activity rather than a single measure of the time spent outdoors. The single measure of time spent outdoors was the variable used in further analyses as stated earlier (Section 2.4.2)

Mental Health

A single factor resulted from the ML extraction of the WHO-5 scale (World Health Organisation, 1998) items which I used to measure Mental Health (Table 2.4). The factor had an Eigenvalue of 3.18, which accounted for 63.55% of the total variance of the data. All five items loaded above 0.32 (0.67 - 0.78) on the un-rotated factor. The corrected item-total correlations were very strong at 0.62 - 0.71 as was Cronbach's alpha at 0.85. All five items were retained to measure Mental Health.

Satisfaction with Life

The unrotated, ML extraction revealed a single factor (Table 2.4) for Diener et al.'s (1985) Satisfaction with Life scale. This factor had an Eigenvalue of 3.45, which accounted for 69.01% of the total variance of the data. All five items loaded above 0.32 (0.66 - 0.86) on the ML extraction. The corrected item-total correlations were very strong, ranging from 0.63 - 0.79 with an alpha of 0.88. All five items were retained to represent Satisfaction with Life.

Wellbeing Measures Combined

An EFA was carried out on the three health measures together (Mental and Physical Health and SWL) to determine if they could be combined into a single measure of wellbeing (Table 2.4). The ML extraction suggested two factors with Eigenvalues of 5.19 and 1.72. This factor had 47.14% of the total variance and the second factor 15.60%. All 11 items loaded above 0.32 on the first un-rotated factor in the ML extraction (0.40 - 0.81) with an alpha of 0.88. The corrected item-total correlations were strong, ranging from 0.40 - 0.71. The two factors were correlated at 0.6.

The Pattern Matrix of the ML Oblimin rotated solution showed two clear factors corresponding to the separate Mental Health and Satisfaction with Life constructs (Table 2.5). The Satisfaction with Life items loaded from 0.64 - 0.86 on Factor 1 and the Mental Health items, together with Physical Health's single item, loaded at 0.40 - 0.83 on Factor 2. These two constructs could be combined into a single acceptable measure for wellbeing

based on the unrotated solution but the pattern of item loadings with ML rotated extraction suggests they contribute different information and give more insight into the data if retained as separate measures.

Table 2.5 The Pattern Matrix for the combined wellbeing measures with Maximum Likelihood extraction with Oblimin rotation and Kaiser Normalisation. SWL 1 - 5 represents the items in the construct Satisfaction with Life and M 1 - 5 represents the items in the Mental Health construct.

	Factor	
	1	2
SWL1	.86	
SWL2	.78	
SWL3	.84	
SWL4	.76	
SWL5	.64	
M1		.75
M2		.83
M3		.77
M4		.73
M5		.57
Physical Health		.40

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2.8 Structural Equation Modelling

2.8.1 Introduction

Structural equation modelling (SEM) tests causal relations among variables. It is a combination of path analysis, which examines the structural relationships between observed variables, and factor analysis, which provides measurement of theoretical constructs. It can be used as either a confirmatory or exploratory technique (Schumacker and Lomax, 2010). SEM extends multivariate statistical analyses in two important ways. First, SEM reduces the effect of measurement error of single measurement variables inherent in data which can distort the estimates of relationships between variables by using latent variables (Kline, 2005; MacKinnon, 2008). Second, SEM also produces goodness-of-fit indices that assess how well the sample data represent the specified hypothetical model. SEM can measure both the direct and indirect effects of independent variables (IV) on dependent variables (DV). Indirect effects can result from mediation where the effect of the IV passes on to the outcome variables through mediator/s (Jose, 2013). Confirmatory SEM requires *a priori* specification of a theoretical model with hypothesised causal relationships between variables. AMOS (IBM SPSS AMOS Version 20) was used to produce and test my SEMs.

2.8.2 Methods

A full SEM is methodologically superior to path analysis because the parcelling of indicator items for each latent variable results in better model fit solutions for uni-dimensional sets of data as measured by χ^2, CFI and RMSEA (Bandalos, 2002). I parcelled the individual items that made up each latent variable into two or three indicators variables, depending on the total number of items in each construct (Appendix III). Items in each parcel were selected using the high/low loadings from the latent variables confirmed by EFA. There was a similar number of items per parcel and a balance of negatively worded items across the parcels for each latent variable (Byrne, 2010; Kline, 2005). The latent variables for Mental Health and Satisfaction with Life each had five items, which I retained as five individual indicators.

I followed the method described by Paul Jose to test for mediation (Jose, 2013). I set up the full SEM model based on an *a priori* theoretical model and carried out a confirmatory factor analysis using the statistical software AMOS with Maximum Likelihood estimation procedures. I also estimated the covariance between the independent variables, among the mediators and among the outcome variables as I expected them to significantly related. After running the saturated models, I examined the AMOS output. I retained all statistically significant pathways and covariances (where $CR > \pm 1.96$, $p \leq 0.5$). I also examined the standardised residual matrices to check for miss-specifications (values should be < 2, Cunningham, 2010).

The criteria used for establishing a mediated effect have long been based on Baron and Kenny's (1986) procedures. More recently it has been argued that there does not necessarily need to be an initial significant direct effect between the independent and dependent variables. Instead, the only requirements for mediation are that each of the indirect pathways are statistically significant (MacKinnon, 2008; Zhao et al., 2010). Bootstrapping, a method for resampling the data, yields a more robust estimate of indirect effects than standard testing (Zhao et al., 2010) and makes the distributional requirements of AMOS less important (Byrne, 2010; Cunningham, 2010; Jose, 2013). I performed bootstrapping for each model with 1000 bootstrap iterations. I obtained estimates of the direct, indirect and total effects and bias-corrected confidence intervals.

Several absolute indices were used to evaluate the model fit:

- X^2/df ratio of less than 3:1 indicates a good fit. Chi square is sensitive to sample size and model complexity because it assumes the model perfectly fits the data which in reality is an unlikely event. In complex models it is difficult to obtain acceptable X^2/df levels (Byrne, 2010).
- Comparative Fit Index (CFI). Values of over 0.95 are acceptable (Byrne, 2010; Hu and Bentler, 1999).
- Non Normal Fit Index (NNFI). Values exceeding 0.95 are preferred (Hu & Bentler 1999).

- Root Mean Square Error of Approximation (RMSEA). Values < 0.08 indicate a reasonable fit and values < 0.06 a good fit. Ninety percent confidence intervals are also reported (Byrne, 2010).
- Standardised Root Mean Square Residual (SRMR): 0.08 is acceptable and less than 0.05 indicates a good fit (Hu & Bentler 1999).

Once candidate models were defined with a sound theoretical base and were well supported by the model fit indices, an Information Theoretic approach was used to select the single best model from several competing models. The Information Theoretic approach has advantages over traditional null hypotheses testing prevalent in ecological publications. As well as comparatively evaluating many models it can separate the information in the model from the noise (residual) in the data (Hobbs and Hilborn, 2006). Null hypothesis testing can only supply very limited information in that it can really only reject or not reject the null hypothesis. In contrast, the Information Theoretic approach can be used to rank models, estimate the relative likelihood of each and allow a set of alternative models (Anderson et al., 2000).

Akaike Information Criteria (AIC) were calculated as recommended by Burnham and Anderson (2002) using AMOS statistical software. AIC identifies the model that minimises the Kullback-Leibler distance, the distance between the model and the 'truth'. Second order Akaike Information Criterion (AICc) was used as the Information Theoretic Statistic. This is recommended when n/K < 40 (n = the number in the sample, and K = the number of parameters, Anderson and Burnham, 2002; Anderson et al., 2000). In my models n/K of the most highly parameterised model was 3.92. Competing models were ranked in order of AICc. Relative support was calculated by difference between each model's AICc and the minimum value from all the models (ΔAICc). A score of ΔAICc ≤ 2 indicates there is substantial support for the model, 4 - 7 indicates considerably less support and > 10 indicates that the model is implausible (Burnham and Anderson, 2002). Akaike weights (ω_i), to assess the relative probability of each model being the best (leading) model, were also calculated (Burnham and Anderson, 2002).

2.8.3 *A Priori* Theoretical Models

A priori models were designed to test my hypotheses based on the relationships between nature, the mediators, wellbeing indicators and pro-environmental behaviour suggested by the existing literature. I also used the results of my models to inform decisions about subsequent models. All the models were mediation models with multiple independent variables, mediators and outcome dependent variables. The independent variables (IV), representing exposure to/or engagement with nature, were the level of neighbourhood vegetation (Vegetation Level) and involvement in the Road Reserve Planting (RRP) scheme. The mediators were latent variables representing Neighbourhood Satisfaction (both the social and natural aspects), Connection with Nature, the use of nature for Psychological Restoration and Environmental Attitude. The outcome dependent variables (DV) measured wellbeing. Two were latent variables, Mental Health and Satisfaction with Life. Two variables were single item measures, Physical Health and Number of Medical Conditions. The latent variable, Pro-environmental Behaviour was both a mediator variable and an outcome dependent variable. The indicator items of the latent variables were parcelled as described above. The item parcels are not shown in the figures below for clarity. All theoretical models were fully saturated. That is, all possible pathways between variables were tested. This includes the direct pathways between IVs and outcome DVs. I also estimated the covariance between the IVs, among the mediators and among the outcome DVs, as I expected them to be significantly correlated. The statistically significant pathways, $p \leq 0.05$, were retained.

Wellbeing Models

A series of *a priori* theoretical models was developed to test the hypothesis that urban nature positively influenced human wellbeing. The set of competing models was developed in five stages.

Stage 1. All the mediators were modelled as first-order mediators of the relationship between nature (Vegetation Level and the RRP scheme) and the wellbeing measures (Figure 2.3, *Wellbeing* model).

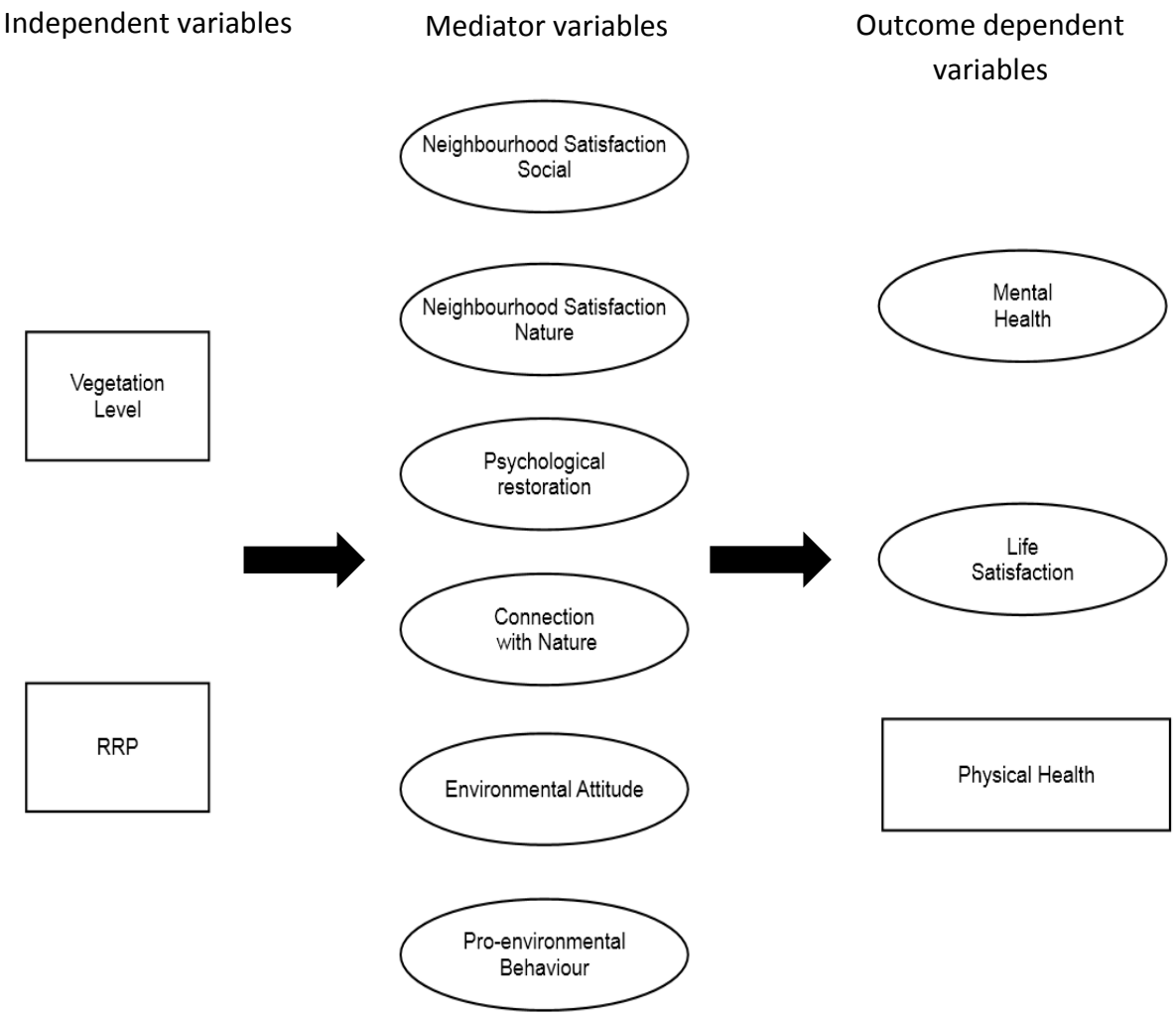

Figure 2.3 The *Wellbeing model*, the *a priori* theoretical model for the relationship between experiences in nature and wellbeing. Ellipses represent latent variables and rectangles represent measured variables. It was a fully saturated model, that is, all possible pathways between variables were tested.

Stage 2. Once the *Wellbeing* model was confirmed, each socio-demographic variable was simultaneously added as an IV to the *Wellbeing* model to determine if the contributed a better model (Figure 2.4). This resulted in the *Wellbeing + Demographics* model.

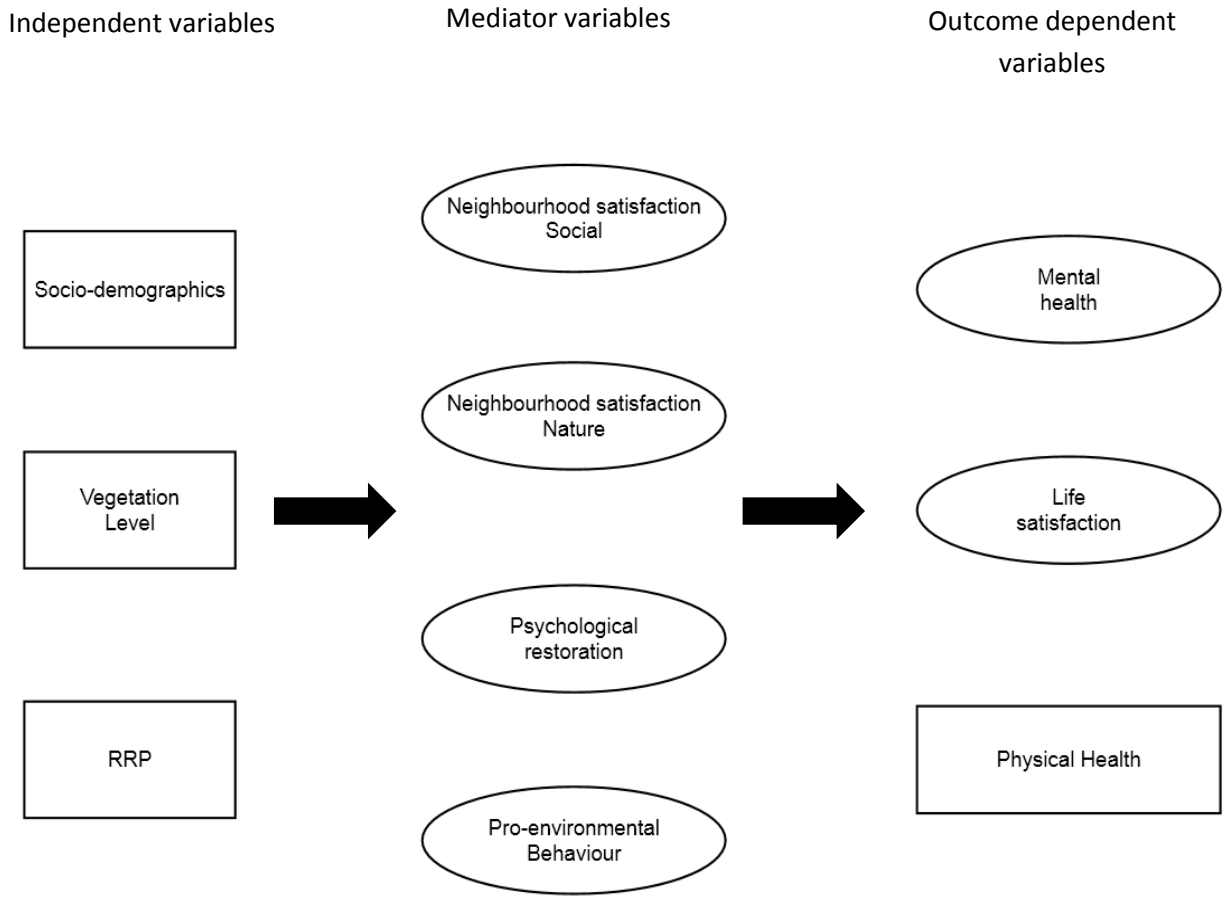

Figure 2.4 The *a priori Wellbeing + Demographics* model. The various socio-demographics were added as independent variables to the *Wellbeing* model. Ellipses represent latent variables and rectangles represent measured variables. It was a fully saturated model, that is, all possible pathways were represented.

Stage 3. Time outdoors was added as an IV to the *Wellbeing* model, in the same way as the socio-demographic variables. This was to determine the *Wellbeing* model could be improved. This created the *Wellbeing + Time Outdoors* model.

Stage 4. The Total Number of Medical Conditions was added separately as an outcome dependent variable to the *Wellbeing* model to investigate whether the level of neighbourhood vegetation or involvement in the RRP scheme influenced the number of medical conditions people experienced. This was the model *Wellbeing + Number of Medical Conditions.*

Stage 5. As part of investigating urban nature's influence on wellbeing I also investigated whether experiencing a major life event influenced people's relationship with nature or their wellbeing. A major life event includes experiences such as the death of a spouse or divorce. I expected the effects of experiencing a major event to be ameliorated to some extent in people who had a stronger relationship with nature. The variable, Major Life Event, was added as an IV to the *Wellbeing* model. This resulted in the *Wellbeing + Major Life Event* model.

Pro-environmental Behaviour Models

A series of *a priori* theoretical models was developed to investigate the determinants of general Pro-environmental Behaviour. The set of competing models was developed in three stages.

Stage 1. The mediators were modelled as first-order mediators of the relationship between nature and Pro-environmental Behaviour (Figure 2.5). This resulted in the *Pro-environmental Behaviour* model.

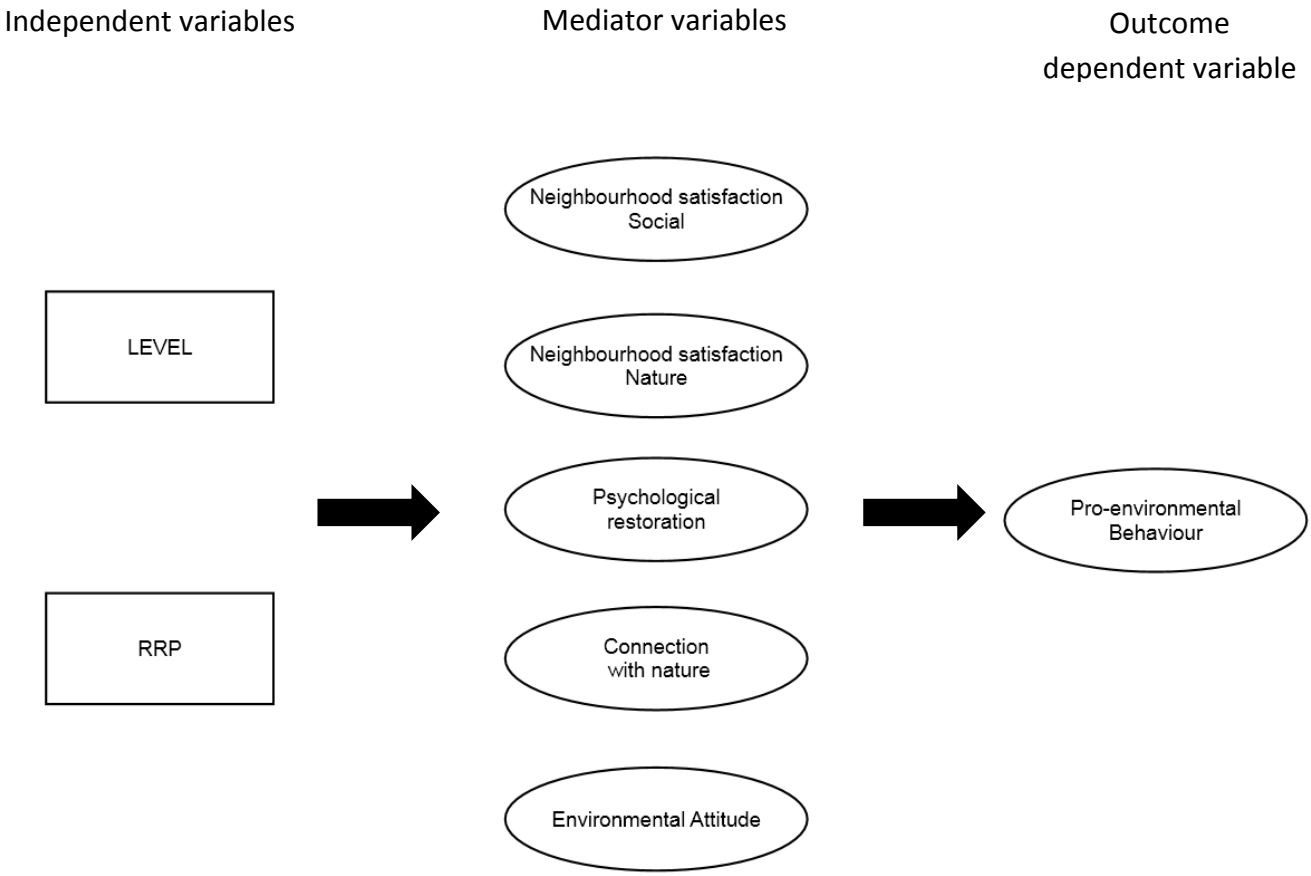

Figure 2.5 The *Pro-environmental Behaviour* model, the *a priori theoretical* model for the relationship between experiences in nature and Pro-environmental Behaviour. Ellipses represent latent variables. Rectangles represent measured variables. It was a fully saturated model, that is, all possible pathways between variables were represented.

Stage 2. Once the *Pro-environmental Behaviour* model was confirmed, each socio-demographic variable (IV) was simultaneously added to the *Pro-environmental Behaviour* model to see if they could improve the *Pro-environmental Behaviour* model (Figure 2.6). This was the *Pro-environmental Behaviour + Demographics* model.

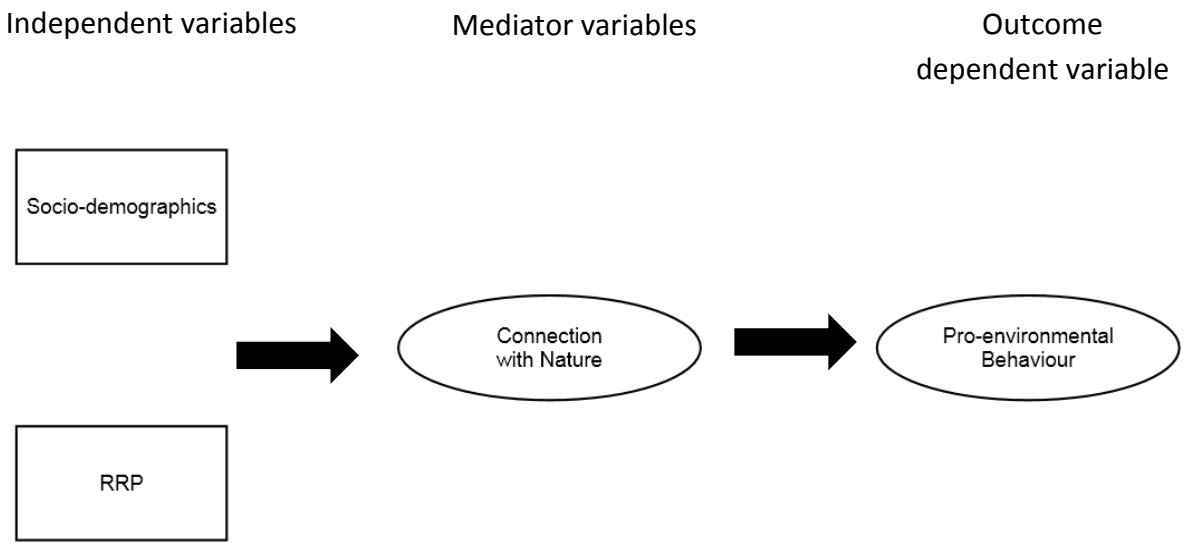

Figure 2.6 The *a priori Pro-environmental Behaviour + Demographics* model. Socio-demographics were added as independent variables to the *Pro-environmental Behaviour* model. Ellipses represent latent variables and rectangles represent directly measured variables. It was a fully saturated model; all possible pathways between variables were represented.

Stage 3. Time Outdoors was added as an IV to the Pro-*environmental Behaviour* model, in the same way as the socio-demographics. This was to see if adding the amount of time spent outdoors could improve the Pro-*environmental Behaviour* model. This created the *Pro-environmental Behaviour + Time Outdoors* model.

Relationships Among Mediators in the PEB Model

As part of the hypotheses testing of mediators I investigated a different structural relationship between potential mediators of the relationship between nature (Vegetation Level and the RRP scheme) and PEB with the intention of incorporating them into my model. First, I determined whether Environmental Attitude was a mediator of the relationship between the use of nature for Psychological Restoration and Pro-environmental Behaviour in my population. This was demonstrated by Byrka et al.(2010) and Hartig et al. (2007) and I tested the exact arrangement variables as Byrka et al. (2010) and Hartig et al. (2007) with my dataset (Figure 2.7). This resulted in the *Byrka-Hartig Pro-environmental Behaviour model.*

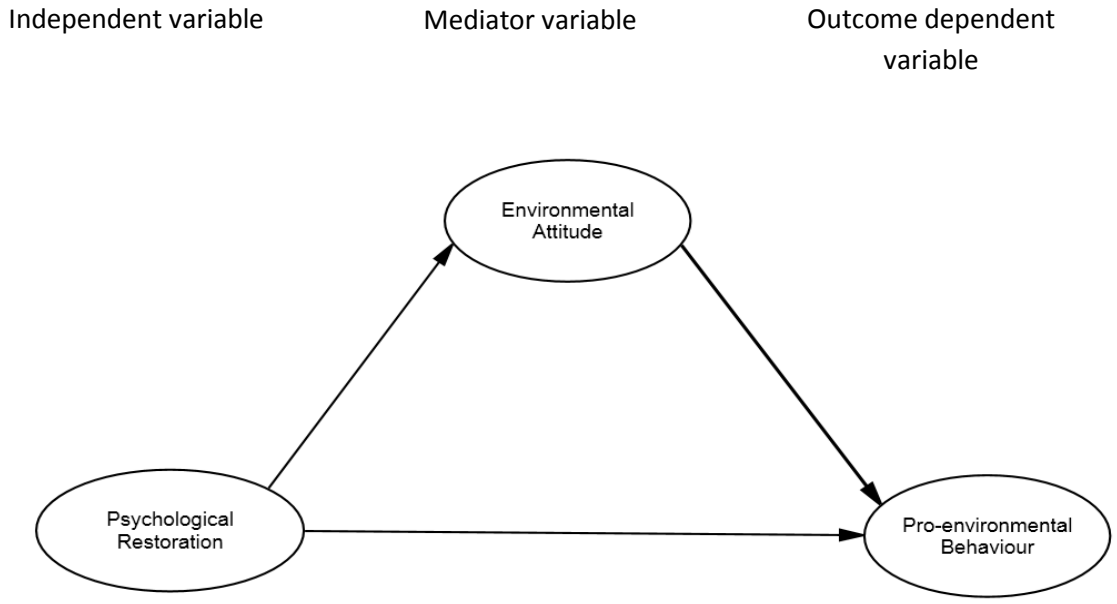

Figure 2.7 The *Byrka-Hartig Pro-environmental Behaviour* model. The theoretical model to test Environmental Attitude as a mediator of the use of nature for Psychological Restoration and general Pro-environmental Behaviour, as hypothesised by Byrka et al. (2010) and Hartig et al. (2007). Ellipses represent latent variables.

Once I confirmed Environmental Attitude partially mediated the relationship between Psychological Restoration and PEB, I rearranged the variables in the theoretical *Pro-environmental Behaviour* model so that Environmental Attitude mediated Psychological Restoration and PEB. As part of this I noticed a strong correlation between Connection with Nature and Psychological Restoration (r = 0.74). I hypothesised that Connection with Nature influenced the extent to which a person used nature for Psychological Restoration. To measure this I added a direct pathway between Connection with Nature and Psychological Restoration (Figure 2.8). I ran the saturated model which created the *Pro-environmental Behaviour + Psychological Restoration* model.

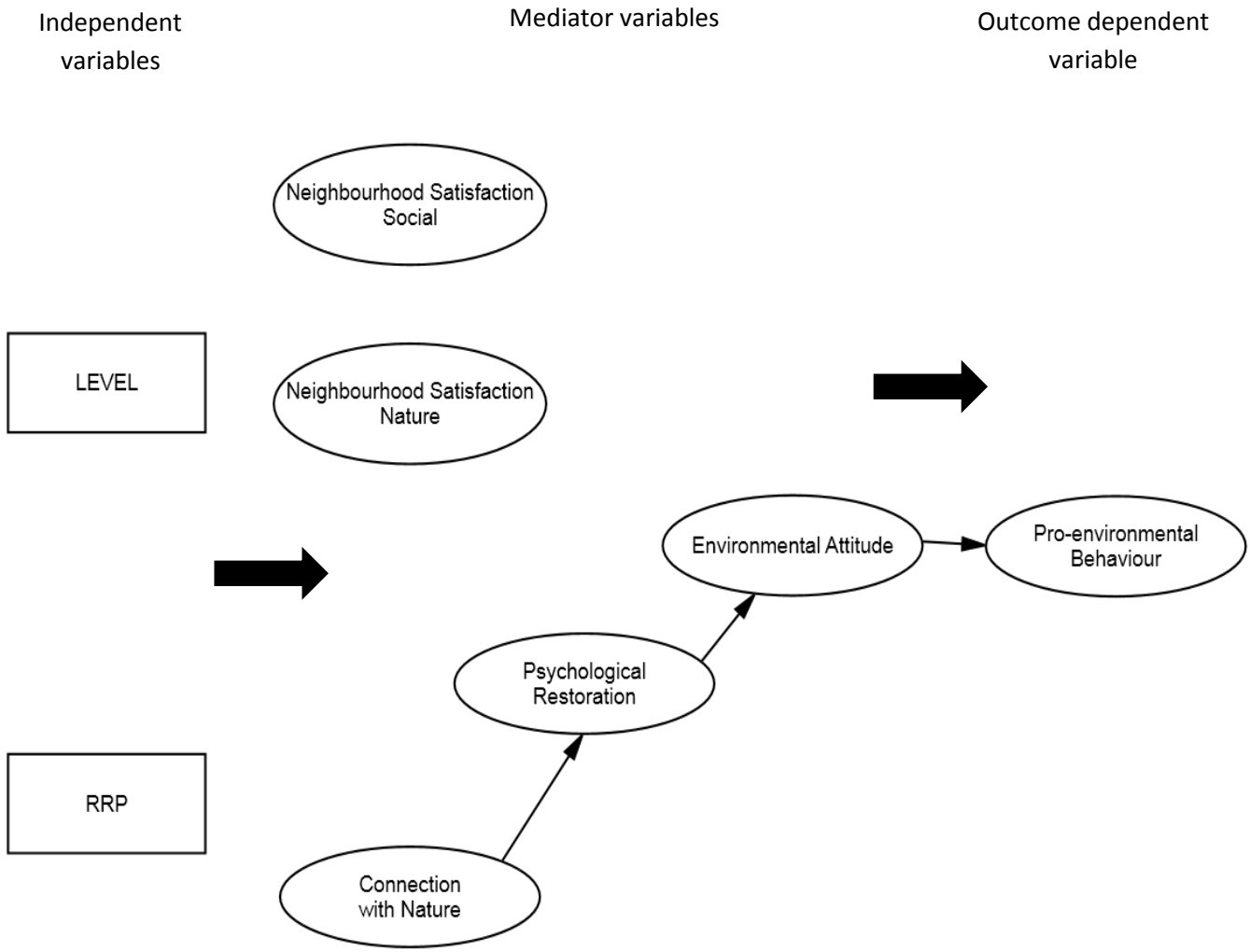

Figure 2.8 The *a priori* theoretical *Pro-environmental Behaviour + Psychological Restoration* model. The mediators have been rearranged compared to the *Pro-environmental Behaviour* model and include a second and third order of mediation. As with all the models, it was a saturated model and all possible pathways were tested.

Once the arrangement of the mediators had been confirmed the model *Pro-environmental Behaviour + Psychological Restoration* was combined with the *Wellbeing* model to create an overall model to demonstrate the interaction between experiences with nature, human wellbeing and people's pro-environmental behaviour. There was a strong correlation between the two measures of neighbourhood satisfaction ($r = 0.53$, $p < 0.001$) in the original *Wellbeing* model. Based on this, and the literature, I suspected NS Nature may directly influence NS Social and, therefore, I added a direct pathway between the two. I also added a direct pathway between NS Nature and Connection with Nature as I suspected the position of Connection with Nature had been miss-specified as a direct mediator of nature's influence on the wellbeing indicators in the *Wellbeing* model and it was correlated with NS Nature in a previous but unreported model ($r = 0.20$, $p < 0.001$). As with all the models, it was a saturated model and all possible pathways were tested. This resulted in the final *Wellbeing + Pro-environmental Behaviour* model.

Results

3.1 Descriptive Results

3.1.1 Survey Response

Four hundred and twenty-eight surveys were returned, resulting in a 36% response rate. This compares favourably with other similar surveys in Wellington (35% Ryan, 2011; 43% Parker, 2009; 30% Berentson, 2013) and surveys from overseas (34% Kaplan, 2001; 37.8% Hartig et al., 2007; 21.4% Honold et al., 2012 and 22% Dillen et al., 2012), especially since this was a long and complex survey booklet. The majority of surveys were returned by mail and about 30 were completed online (mail, *n* = 398*,* 93%; online, *n* = 30, 7%). I discarded five surveys because they were significantly incomplete (3) or had unidentifiable addresses (2) so could not be assigned to a neighbourhood. This left 423 usable surveys that constitute the following statistics. This was well above the minimum 300 I needed for my analysis by Structural Equation Modelling. There was an excellent response to the draw for free plants with 344 respondents (81%) returning the voucher. It appears that this incentive to participate was successful.

The number of useable surveys varied with neighbourhood, ranging from 11 - 28 responses out of a possible 60 (mean, 21.2 ± 1.2 1SE, Figure 3.1). There was a significant difference in the number of respondents across the 20 neighbourhoods ($\chi^2_{10} = 212.8$, $p = 0.000$). The number of responses also varied with the level of neighbourhood vegetation, ranging from 48 - 76 surveys per level (mean, 60.4 ± 4.2 1SE, Figure 3.2). There was, however, no statistical difference in the likelihood of responses across the levels of planting ($\chi^2_6 = 6.58$, $p = 0.360$).

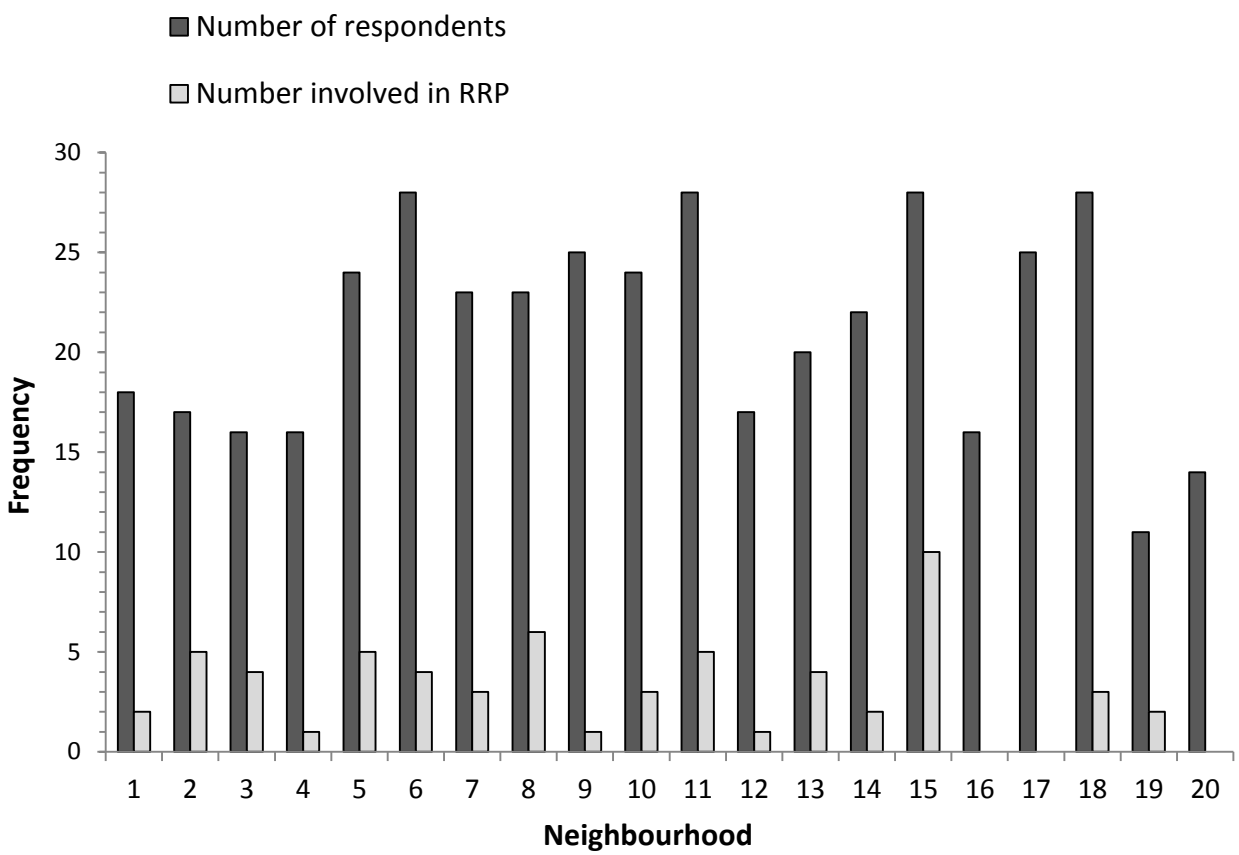

Figure 3.1 The number of survey respondents and the number of people involved in the Road Reserve Planting (RRP) scheme for each neighbourhood of 60 residences. The mean number of respondents per neighbourhood was 21.2 ± 1.2 (1SE) and the mean number involved in the RRP scheme per neighbourhood was 3.3 ± 0.2 (1SE). *N* = 423.

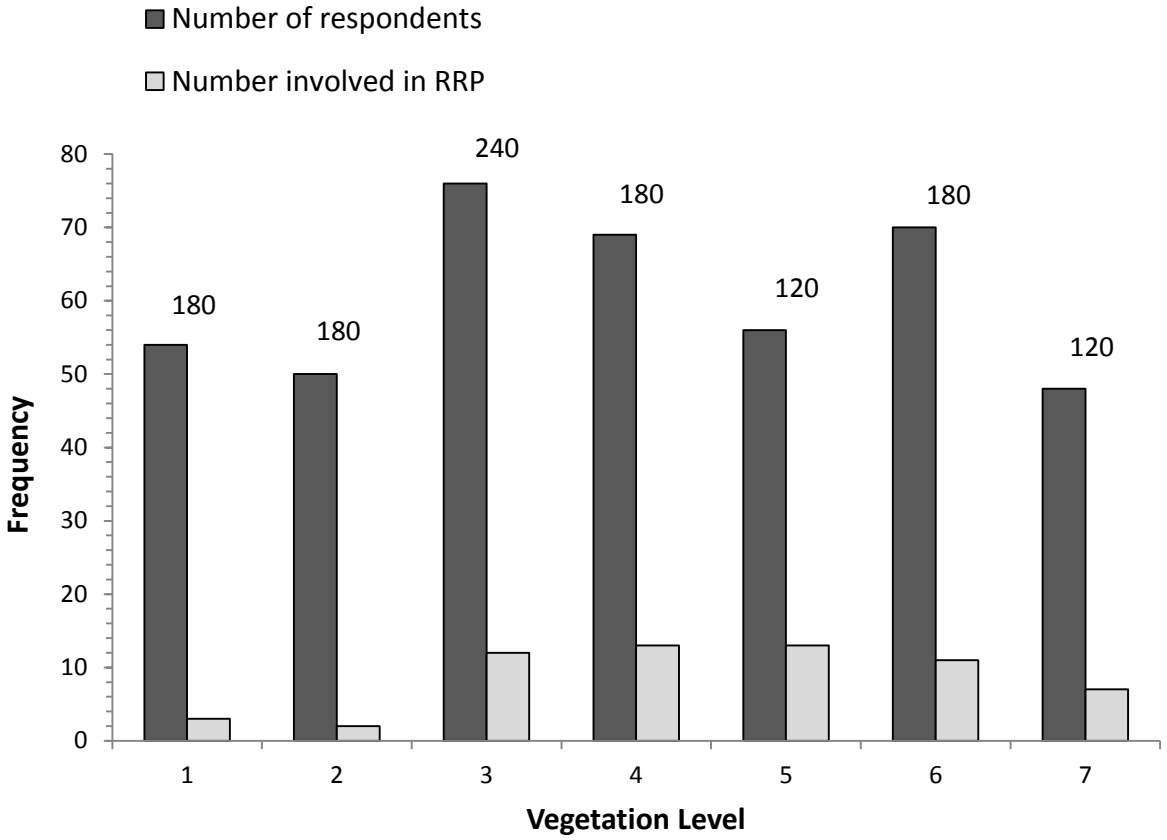

Figure 3.2 The number of survey respondents and the number of people involved in the Road Reserve Planting (RRP) scheme for each level of neighbourhood vegetation. The mean number of respondents per level was 60.4 ± 4.2 (1SE) and the mean number of households involved in the RRP scheme per level was 8.9 ± 0.4 (1SE). The numbers above each bar are the number of surveys delivered for each level. The total number of respondents = 423.

One hundred and fifty-five (37%) of the survey respondents had heard of the Road Reserve Planting (RRP) scheme before receiving this survey and 61 respondents (14%) had been involved. The degree of participation varied across neighbourhoods, ranging from zero to ten households per neighbourhood (mean, 3.3 ± 0.1 1SE) (Figure 3.1). The number of households involved in the RRP scheme also varied across the seven levels of neighbourhood vegetation. It ranged from a low of 3 in Level 1, to 13 in Levels 4 and 5 (Figure 3. 2). Neighbourhoods with moderate levels of planting (3 – 6) had the highest proportion of residents involved in the RRP scheme. The two lowest levels (1 and 2) and the highest level (7) showed a drop in involvement rates. These differences in participation

across the different levels of neighbourhood vegetation were statistically significant (χ^2_6 = 25.5, p = 0.000).

3.1.2 Demographics of Survey Participants

More females (61.7%) than males responded to my survey. The majority of respondents identified themselves as European (83.7%). The next most common ethnicities were Other (9.0%), Asian (2.6%) and Maori (2.1%). Respondents were highly educated (no-formal education, 5.7%; school qualifications, 15.1%; post school qualifications, 42.4% and post graduate qualifications, 36.6%) and had high incomes (61% of respondents had household incomes over $70,000). Most respondents were aged between 35 and 54 (54.0%) and 55-74 (29.8%) with few younger respondents (2.5% in the 18 - 24 and 8.3% in the 25 - 34 age brackets). The majority of participants were born in New Zealand (73.8 %) and the United Kingdom (16.4 %) with a number from Europe (3.3 %), Australia (2.6%), the United States of America (1.6 %) and South Africa (1.6 %). The remaining 3.3% of respondents came from Asia, Pacific Nations, other African nations, Canada and Russia.

The demographics of survey respondents differed significantly from the population of Wellington City in all measures apart from household income (Table 3.1). Respondents were more highly educated, older and more likely to own their own home than the general population. There were more female respondents, more Europeans and fewer Maori, Pacific ethnicities and Asians than in the census populations. More respondents were married or in partnerships and fewer households had children compared to the population of Wellington City.

Table 3.1 Comparison of socio-demographics for those who participated in the survey compared to the general population of Wellington City (Statistics New Zealand 2006b), using Chi-square tests. df = degrees of freedom; *p* = significance level, Two-tailed.

Demographic	df	Chi-Square	*p*
Gender	1	4.40	0.002
Income	5	5.60	0.350
Age	6	46.2	0.000
Marital status	3	64.3	0.000
Children in household	1	9.90	0.002
Home ownership	1	39.6	0.000
Education	3	53.7	0.000
Ethnicity	5	18.4	0.002

3.1.3 Descriptive Statistics for the Road Reserve Planting Scheme

People Involved in Road Reserve Planting

The first aim of this research was to describe the population involved in the RRP scheme and identify their motivations for being involved, any benefits they gained or barriers they faced to involvement. Understanding these things is important if any attempt to broaden participation in the RRP scheme is to be made.

Table 3.2 Comparison of the socio-demographics for survey respondents who participated in the RRP scheme compared to those who did not, using Chi-square tests. df = degrees of freedom; *p* = level of significance, Two-tailed.

Demographics	df	Chi-Square	*p*
Gender	1	0.002	0.970
Income	5	2.43	0.790
Age	6	7.79	0.250
Marital Status	3	13.1	0.015
Children	3	6.65	0.080
Home Ownership	1	0.23	0.630
Education	3	14.3	0.000

A comparison of the demographics of respondents who participated in the RRP scheme with those respondents who did not participate showed some significant differences (Table 3.2). Respondents who participated in the RRP scheme were twice as likely to be married or in a civil union as non-participant respondents, more likely to have postgraduate qualifications and less likely to have no-formal qualifications. Respondents who participated were more likely to be European (95%) or 'Other' (5%). There were no Māori, Pacific Peoples, Asian, Middle Eastern, Latin American or African ethnicities identified as taking part in RRP scheme.

People who participated in the RRP scheme were also more likely to be involved in other voluntary community endeavours than survey respondents who were not involved in the RRP scheme (55.7 % compared to 35.4%, respectively; $\chi^2_2 = 243$, $p = 0.000$). The patterns of difference in demographics and rates of volunteering suggest a socio-demographically unique group of people was involved in the RRP scheme.

Most residents who participated the in the RRP scheme prepared the ground and planted their plants on their own or with members of their own household (62%); fewer worked with neighbours or community groups (16%) (Figure 3.3). This is quite different from other community based planting schemes overseen by the Wellington City Council where planting is done in groups of interested people.

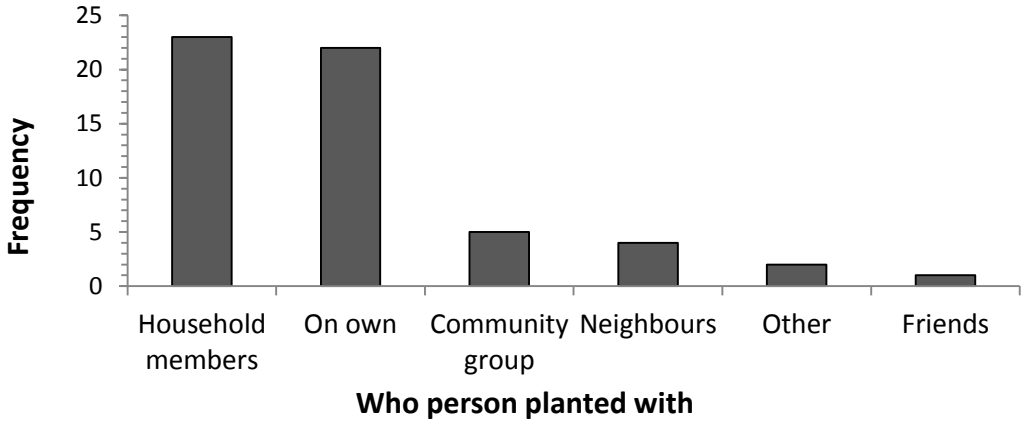

Figure 3.3 The frequency distribution of who the participants of the RRP scheme planted with. *n* = 57.

A large proportion of people who had no previous involvement in the RRP scheme said they would like to participate in the scheme given the opportunity. This amounted to 236 people or just over 70% of those who answered the question. The amount of interest varied with the level of vegetation. The highest interest was in neighbourhoods with Vegetation Levels 1, 2 and 7 where between 66 and 76% of people in these neighbourhoods indicated they would like to participate in the future. The most common barriers to future participation were lack of time because of commitments to work and families (53% of the reasons). Health issues and old age were also impediments to future involvement in the RRP scheme (16%, Figure 3.4).

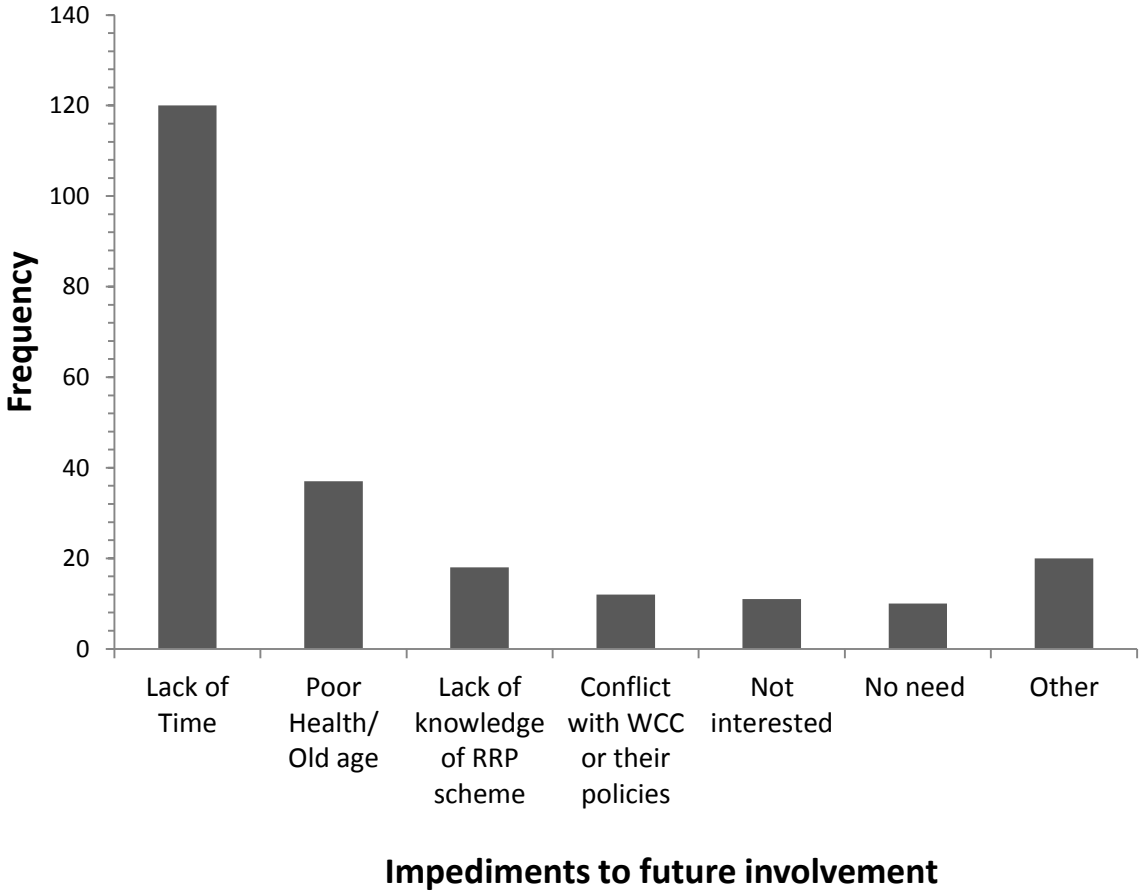

Figure 3.4 The frequency distribution of the impediments to future participation in the RRP scheme reported by survey respondents who had no previous involvement in the scheme. *n* = 226.

Motivations for Involvement in the RRP scheme

Residents were mostly motivated to participate in the RRP scheme to improve the appearance of the land around their properties (51%). Fewer were hoping to increase the amount of native vegetation (23%), contribute to their local community (12%) or manage environmental problems like erosion (8%) (Figure 3.5).

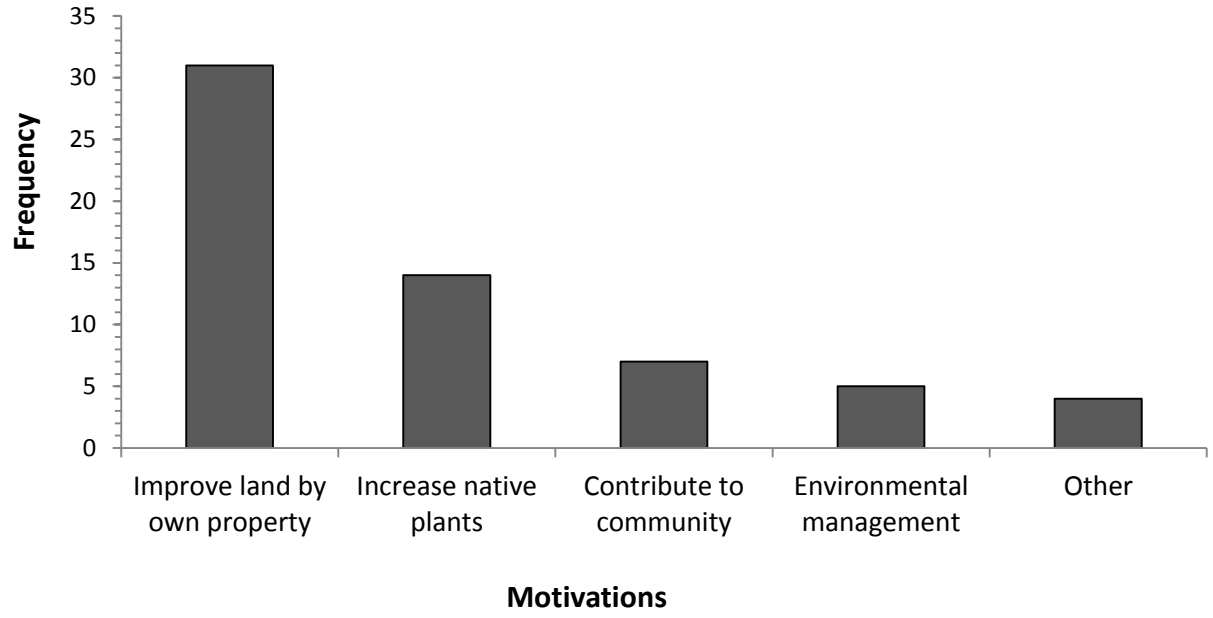

Figure 3.5 The frequency distribution of motivations for participating in the RRP scheme. *n* = 61.

Benefits of Participation in the RRP scheme

People who participated in the RRP scheme reported a variety of benefits, which could be organised into six categories (Figure 3.6). The most commonly listed benefits were improving the appearance of the neighbourhood (88.9% of those involved) and providing more habitats for animals (72.0%). Social outcomes of being involved, such as making new friends, were judged a lesser benefit. Thirty seven percent of people reported talking to neighbours more often, 26% reported making new friends and 19% said they had increased their involvement in their community as a result of being in the scheme. Eleven percent of people said they had learnt new skills. The majority (94.8%) of those who participated in the

planting scheme rated the RRP scheme as valuable or very valuable (on a 5-point Likert scale with 3 as neutral).

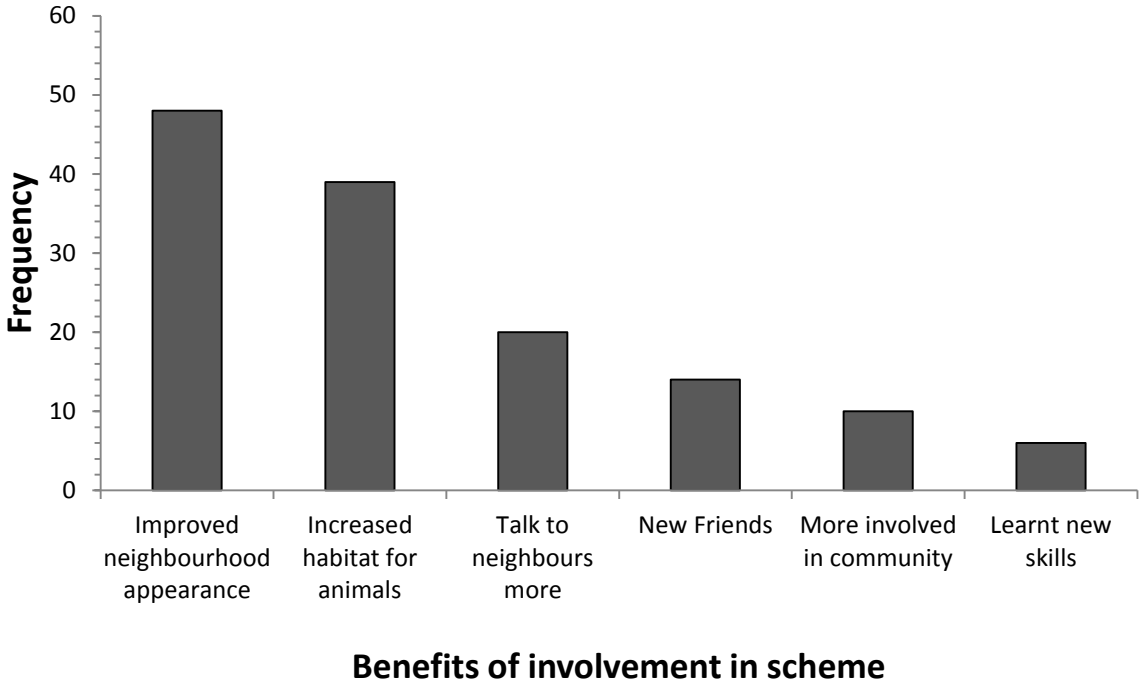

Figure 3.6 Frequency distribution of the benefits received from being involved in the RRP scheme. *n* = 61, some respondents listed more than one benefit.

The Value of Urban Vegetation

To determine the importance of urban vegetation to Wellington City residents, questions asked about the value of vegetation on the respondent's property, neighbourhood and wider city area. Most people reported that vegetation was important or very important to them on their own property (92%), in their immediate neighbourhood (93%) and in the surrounding suburbs (87%) (on a 5-point Likert scale with 3 as neutral). The natural reserves in Wellington City were highly valued with 96% of respondents rating them as important or very important. There were mixed responses, however, to whether plants in Wellington City should be native species. Nearly 64% thought native plantings were important or very important but about one third of people were neutral or thought them unimportant (Figure

3.7). The majority of survey respondents (88.4%) said they visited local natural areas like reserves, gardens or the coast. For most people these natural places were easy or very easy to access (86.5% of respondents). About 5% of people found access more difficult because of old age, health problems or lack of transport.

These results suggest that urban vegetation, both in residents' immediate neighbourhood and in the greater Wellington City, is valued by the residents. The RRP scheme is quite well known and is highly valued by those who participated. Those people who did not participate showed a high degree of interest in future participation. The reported benefits of taking part in the RRP scheme correspond to the participants' reported motivation that is primarily to improve the appearance of their own properties and immediate neighbourhood.

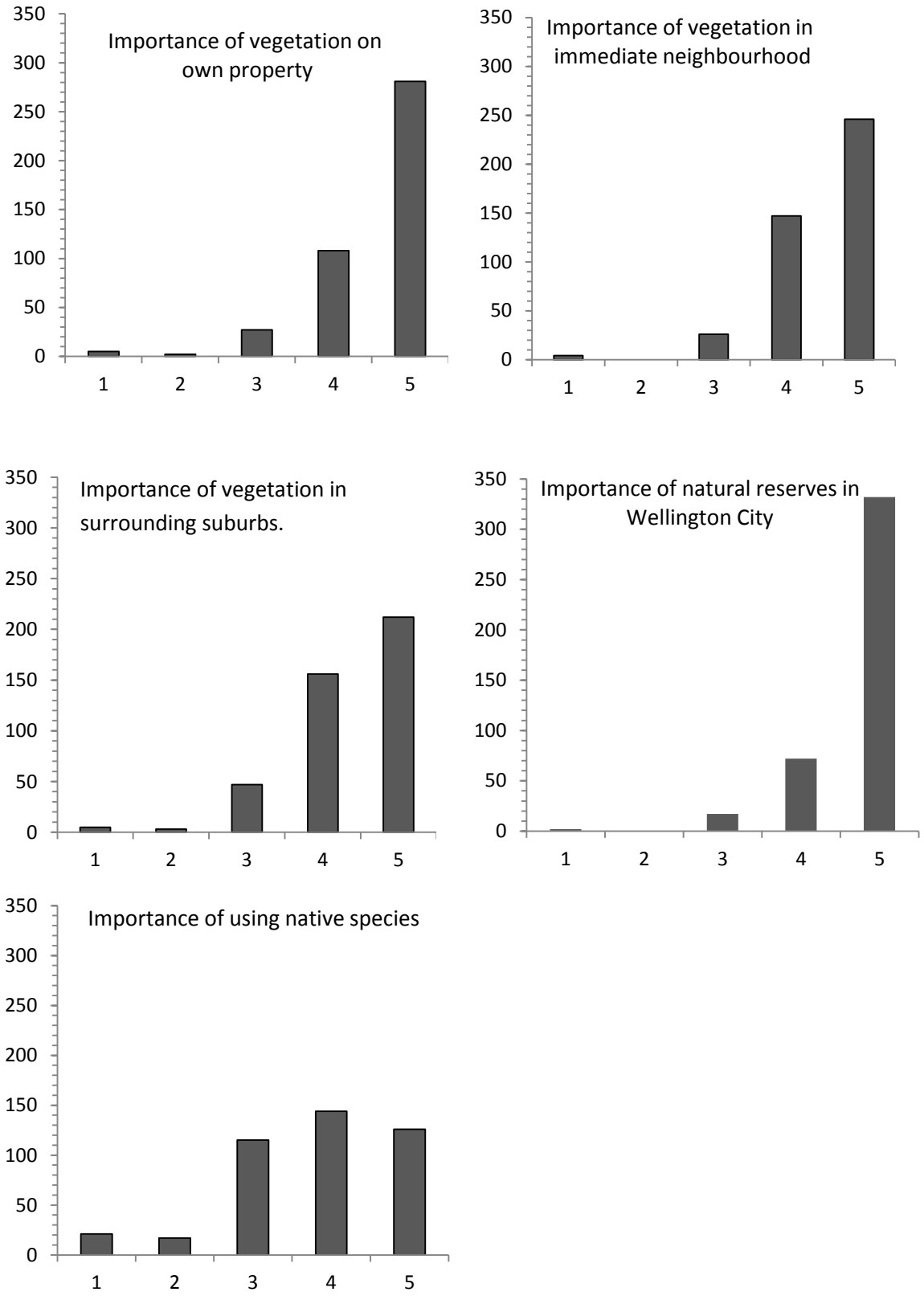

Figure 3.7 The importance of vegetation in people's properties, neighbourhoods, suburbs and reserves in Wellington City. The vertical axis represents the number of people and the horizontal axis the level of importance: 1, Unimportant; 2, Of little importance; 3, Neutral; 4, Important; 5, Very important. *N* = 423.

3.1.4 Descriptive Statistics for the Socio-psychological Constructs

The constructs to be used in Structural Equation Modelling (SEM) were formulated and subjected to an exploratory factor analyses to confirm their suitability as described in the Methods. The descriptive statistics are given in Table 3.3. The size of the sample, shape of the distributions and the size of the skewness and kurtosis are acceptable for SEM (Field, 2012; Tabachnick & Fidell, 2013).

Table 3.3 Descriptive statistics for the socio-psychological constructs and wellbeing measures. Mean, Cronbach's alphas, skewness and kurtosis are shown for each construct. SE = standard error, N = 423.

	Mean ± SE	α	Skew ± 1SE	Kurtosis ± 1 SE
Neighbourhood Satisfaction, Social	3.89 ± .0273	0.70	- .231 ±.119	.035 ± .237
Neighbourhood Satisfaction, Nature	3.94 ± .0276	0.72	- .490 ± .119	.357 ± .24
Connection to Nature	3.53 ± .0289	0.80	- .303 ± .119	- .039 ± .24
Psychological Restoration	3.99 ± .0340	0.93	- .592 ± .119	.502 ± .24
Environmental Attitude	3.61 ± .0282	0.85	- .045 ± .119	.102 ± .24
Pro-environmental Behaviour	3.50 ± .0292	0.75	- .190 ± .119	.717 ± .24
Mental Health	3.59 ± .0360	0.85	- .231 ± .119	.372 ± .24
Satisfaction with Life	3.73 ± .0362	0.88	- .483 ± .119	.216 ± .24
Physical Health	3.78 ± .0460		- .449 ± .119	-.124 ± .24

Neighbourhood Satisfaction

People were generally satisfied with both the social and natural aspects of their neighbourhoods. The distribution of responses for the two constructs measuring aspects of neighbourhood satisfaction (NS Social and NS Nature) followed a similar pattern (Figure 3.8). Nearly 77% of respondents were satisfied or very satisfied with the social aspects of their neighbourhood life, 22.2% were neutral and only 0.9% were dissatisfied. Most people were also satisfied with the amount of nature in their neighbourhood. Eighty-two percent (*n* = 347*)* of the respondents were satisfied or very satisfied with the nature in their immediate neighbourhood 1% were dissatisfied and around 17% were neutral.

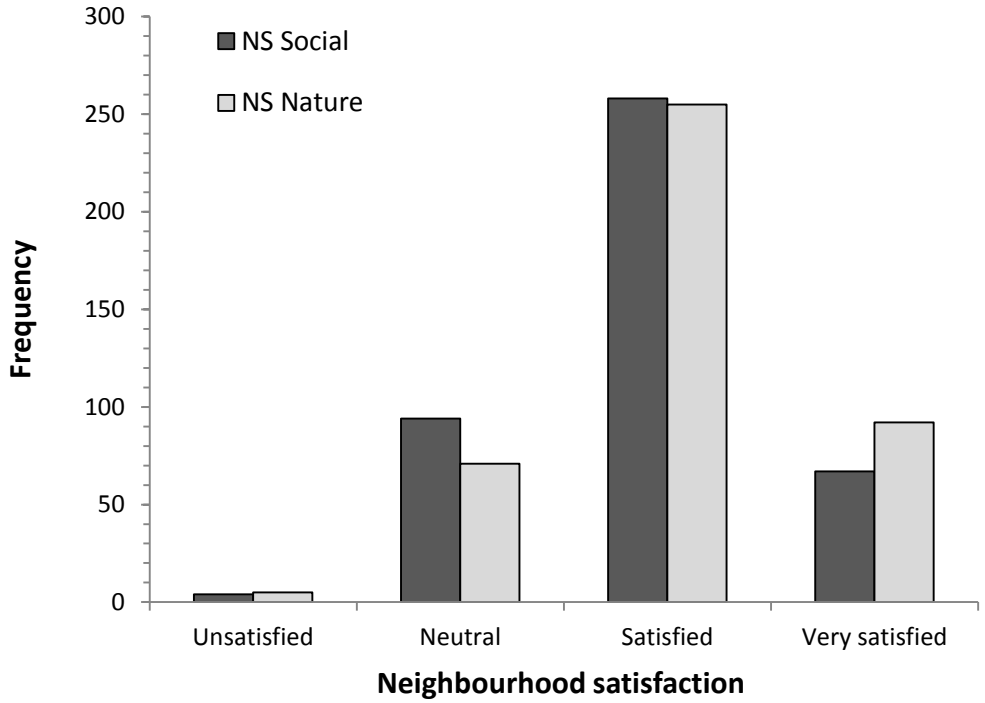

Figure 3.8 The frequency distribution of survey responses for Neighbourhood Satisfaction, Satisfaction with social aspects of neighbourhood life (NS Social) and satisfaction with the natural features of the neighbourhood (NS Nature). *N* = 423.

The high level of satisfaction reported with the social aspects of neighbourhood life was demonstrated by the individual items making up the construct NS Social. For example, most people were satisfied or very satisfied with the friendliness of their neighbours (77%). Most also had a sense of belonging (72%) and felt safe in their homes (94%). Respondents reported they could ask their neighbours for help in an emergency (88%) but fewer could ask for help with everyday tasks (42%).

Similarly, the high level of satisfaction with neighbourhood nature was demonstrated by most of the individual items making up the construct NS Nature. Over 80% of residents were satisfied or very satisfied with the amount of and access to nature near to where they lived (within 5 - 6 minutes' walk). Most were also satisfied with amount of their private outdoor space (70%). However, nearly 70% of people felt there was not enough communal outdoor space where they could interact with their neighbours.

Connection with Nature and Use of Nature for Psychological Restoration

The majority of respondents had a moderate (37.1%) to high (53.0%) Connection with Nature. Only 4.5% of people had a low connection with nature and 5.4% a very high connection (Figure 3.9).

There was some variance in the endorsement of individual items making up the construct Connection with Nature. A large percentage of people endorsed (agreed or agreed strongly) activities that were relatively easy to perform such as caring for plants (80%) or rescuing bees and butterflies trapped inside (89%). However, as the questions became progressively more demanding fewer people endorsed them. For example, 50% of people endorsed going outside even if it was cold or raining. This decreased further for the most demanding items, mimicking the sound of animals (26%) and getting up early to watch the sunrise (20%). This is in line expectations. The more barriers a person overcomes in expressing esteem for nature or in reporting bonding activities with nature, the stronger the person's connection with nature is.

Most people (80%) endorsed the use of nature for Psychological Restoration at a high to very high extent and only 2% were low or very low users (Figure 3.9). Interestingly, the

number of people who most fully endorsed using nature for Psychological Restoration was greater than the number who had a very high Connection with Nature (23 compared to 120).

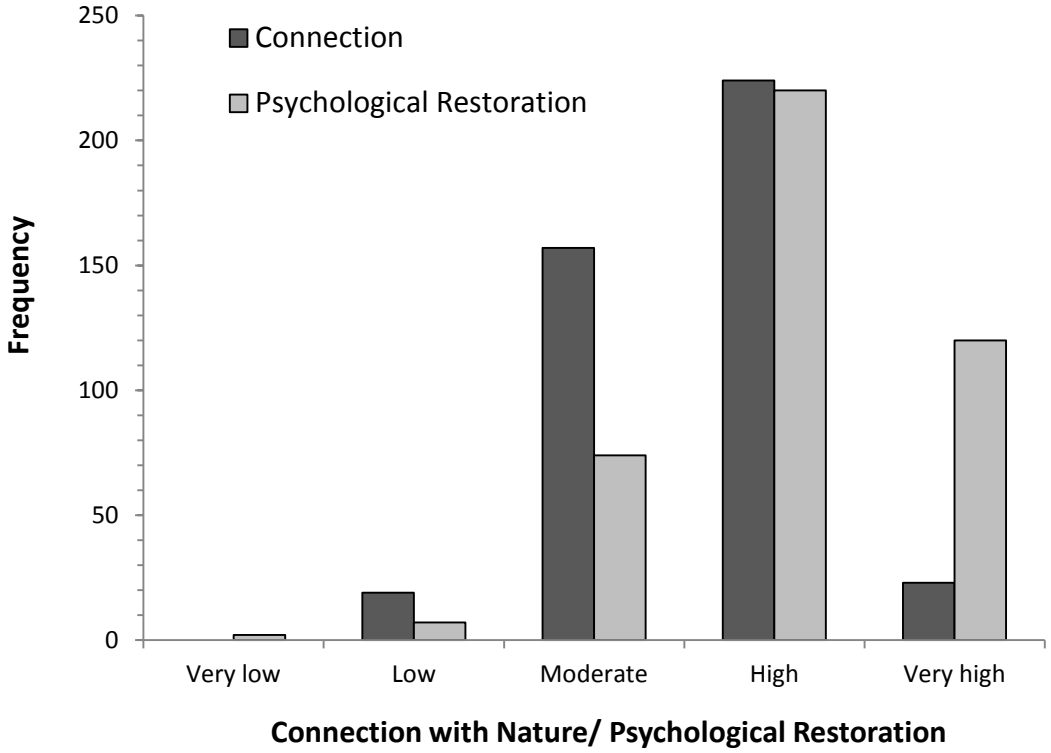

Figure 3.9 The frequency distribution of survey responses for Connection with Nature and use of nature for Psychological Restoration. *N* = 423.

Eight of the ten items making up the construct measuring the use of nature for Psychological Restoration showed a similar pattern of endorsement with around 70 - 85% of people endorsing the items at a high to very high level. These items covered deepening levels of restoration and stress reduction. This is in line with existing theory and research, that time in nature effects human wellbeing through cognitive restoration (Kaplan and Kaplan, 1989)and stress reduction (Ulrich et al., 1991). However, fewer people reported that spending time in nature helped calm them when they were upset or angry (62%) or that time in nature left them feeling spiritually revitalised (56%).

Environmental Attitude and Pro-environmental Behaviour

The frequency distribution of responses for Pro-environmental Behaviour was very similar to that of Environmental Attitude. Most respondents had moderate to strong attitudes to environmental issues (90%, *n* = 381) and engagement with pro-environmental behaviour (about 91%, *n* = 385). There were only low numbers of responses at the upper and lower extremes (Figure 3.10).

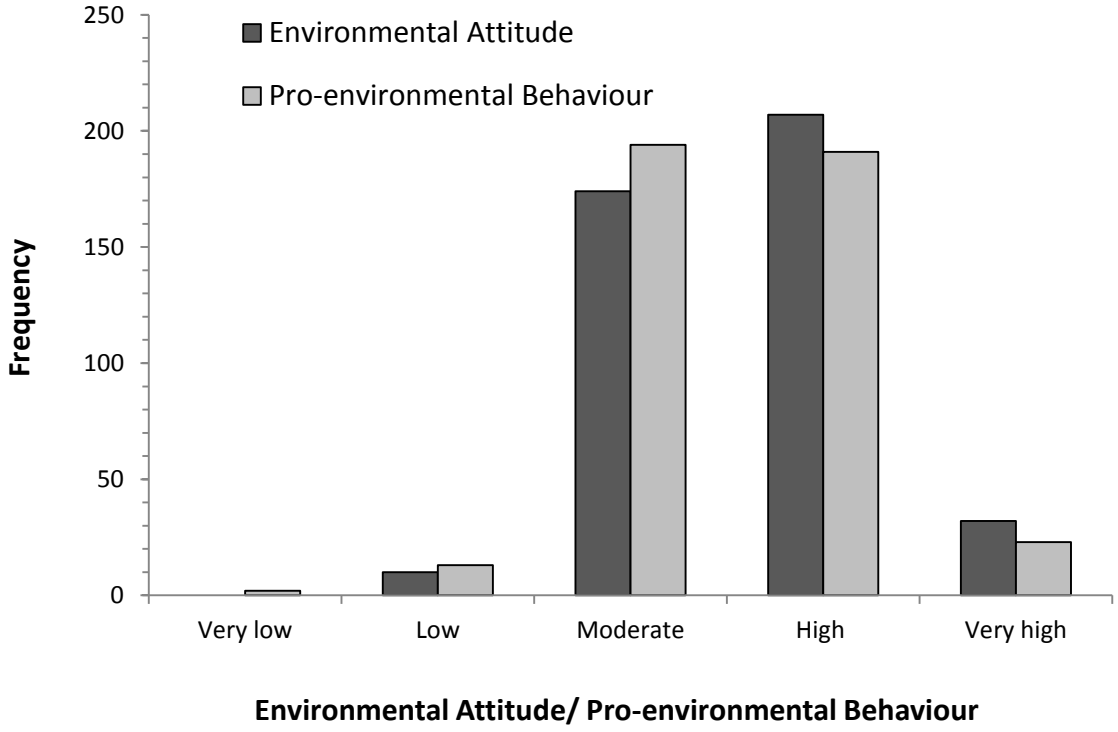

Figure 3.10 The frequency distribution of survey responses for Environmental Attitude and Pro-environmental Behaviour. *N* = 423.

Thirteen of the fifteen items making up the construct measuring Environmental Attitude showed a similar pattern of endorsement with around 57 - 65 % of people endorsing items at a moderate to high level. Two items had different patterns of endorsement. First, 80% of respondents indicated they agreed that plants and animals had as much right to exist as humans and 76% indicated they were less sure that the earth had enough natural resources if humans just learnt how to develop them.

Although the self-reported levels of Pro-environmental behaviour is moderate to high, some behaviours that benefit the environment are more fully endorsed than others (Figure 3.11). For example, most people indicated that they participated in the Wellington City Council curbside recycling scheme or did not leave litter behind when they visited natural areas (96 and 95% respectively). The use of reusable shopping bags and learning about environmental issues was somewhat less endorsed (around 70% of respondents). Thoughtful use of cars or belonging to car pools was reported by 30% and 22% of respondents respectively and 15% of respondents reported making donations to environmental groups. Pro-environmental behaviours that are more costly in terms of money or personal effort are less fully endorsed than those behaviours that are relatively easy to do.

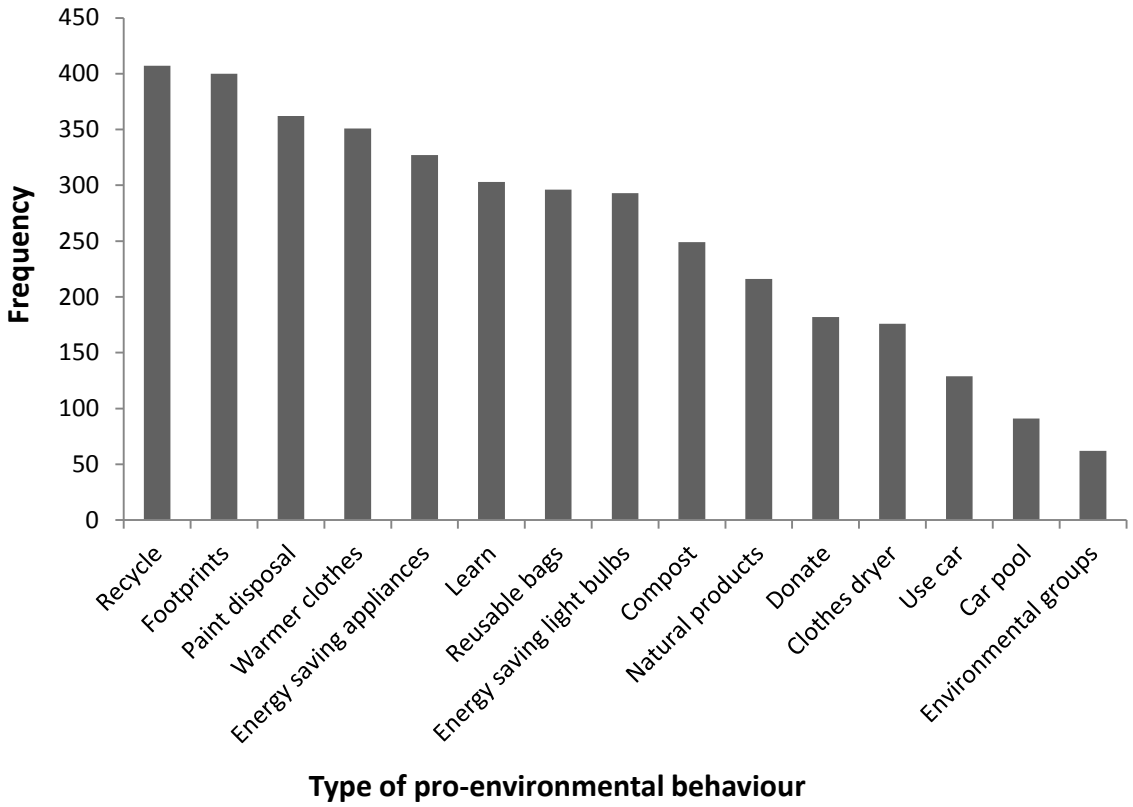

Figure 3.11 The frequency distribution of endorsement reported by the survey participants for the 15 pro-environmental behaviours. Endorsement of a behaviour consisted of agreement or strong agreement with that behaviour. *N* = 423.

Recycling Survey

The on-site survey of residents' recycling behaviour was undertaken to compare the results of an observed and self-reported pro-environmental behaviour because my survey relied on self-reports. Ninety-six percent of respondents to my survey reported they participated in curbside recycling. This is around the same proportion reported by the Wellington City Council (90 - 91% of residents surveyed between 2008 and 2010, Wellington City Council, 2012). My on-site observations revealed about 74% ± 5.2 (1 SE) of the survey respondents who said they participated in the curbside recycling did so on the day of the recycling survey. The results ranged from 45 - 92% of households in the neighbourhoods. There was a strong correlation between the self-reported and observed recycling, $r = 0.92$, $p = 0.00$, $n = 20$. The data fitted the linear relationship well with an $R^2 = 0.850$ (Figure 3.12).

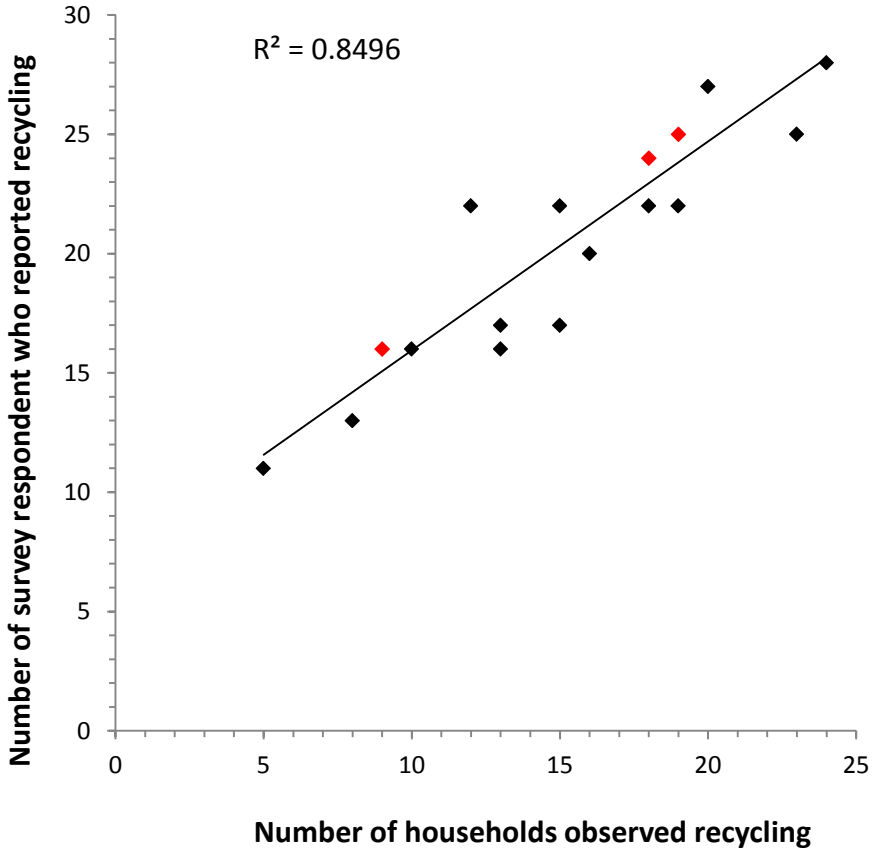

Figure 3.12 The relationship between observed and self-reported curb-side recycling for each of the 20 neighbourhoods. The red data point represents two neighbourhoods.

Wellbeing

The three measures used to determine people's wellbeing had similar frequency distributions (Figure 3.13). Most people had average to good health/wellbeing, with fewer people experiencing poor or excellent health. Bivariate correlations indicated that the three wellbeing measures were statistically correlated. These were Mental Health and Satisfaction with Life, $r = 0.45$; Mental and Physical Health, $r = 0.4$ and Satisfaction with Life and Physical Health, $r = 0.28$. $p < 0.01$ for all parings (Appendix I). This demonstrates that all aspects of human wellbeing are intimately connected.

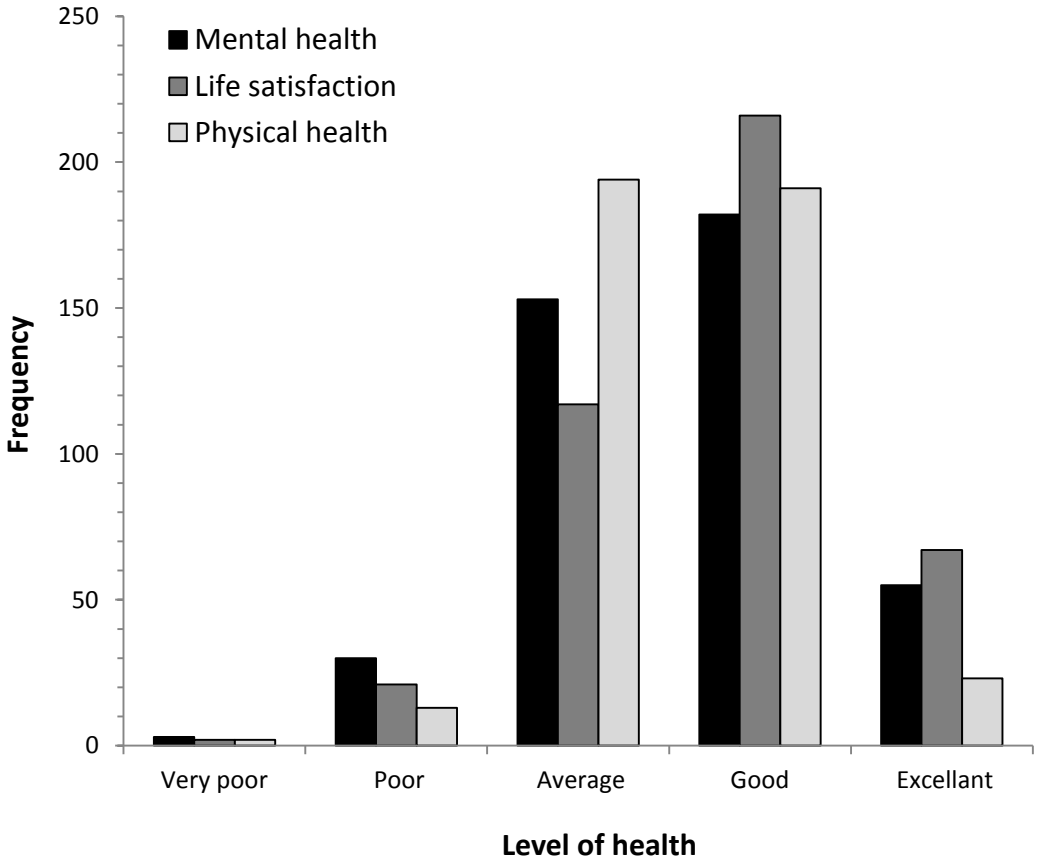

Figure 3.13 Frequency distribution of survey responses for the three measures of wellbeing, Mental Health, Satisfaction with Life and Physical Health. $N = 423$.

The total number of medical conditions experienced by respondents was determined as part of the measure of physical health (Figure 3.14). The number of conditions per person ranged from 0 to 5 in the year preceding the survey (mean = 1 ± 0.03 1SE). Two hundred and one people (47.5%) did not experience any of these medical conditions, 29.8% had one condition, 16.8% had two conditions, 4.5 % had three and 1.4% experienced four or five.

The most common medical conditions were chronic pain and gastrointestinal complaints (78 and 68 people respectively). Hypertension, repeated infections and asthma were the next most common (56, 55 and 52 people respectively). The more serious conditions, diabetes, heart conditions and cancer, were the least common (17, 16 and 11 people respectively) (Figure 3.14).

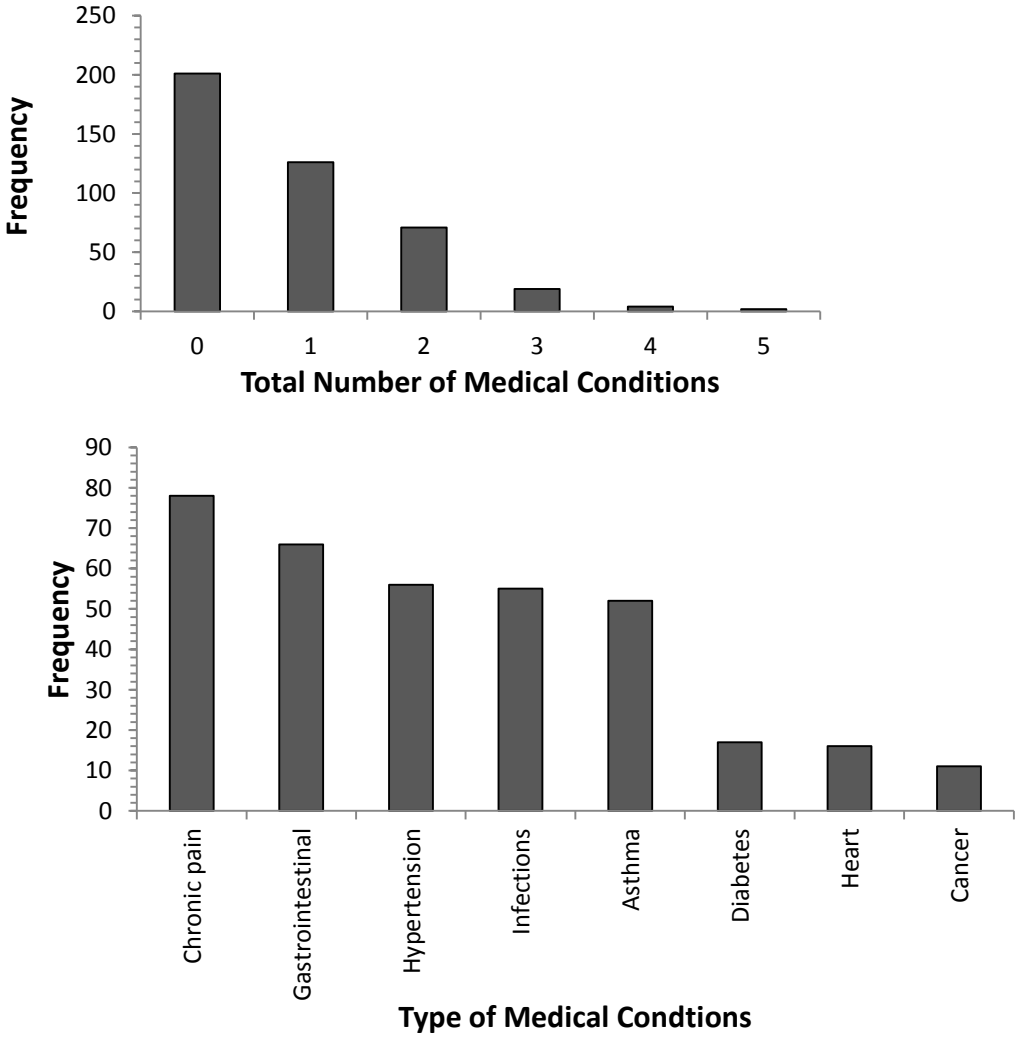

Figure 3.14 The total number and type of medical conditions experienced by people participating in the survey. Two hundred and twenty two people experienced one or more health condition, *N* = 423.

Time Spent Outdoors and Type of Outdoor Activities

The amount of time spent outdoors was measured to determine its influence on people's wellbeing and their Pro-environmental Behaviour. The majority of respondents indicated they spent time outdoors once a week or more (73.5%). Most (86.8%) also reported they spent time outdoors once a week or more as a child. The amount of time spent outdoors as a child correlated with the amount of time spent outdoors as an adult (r_s =0.15, *p =0.002,* N = 423.

Twelve outdoor activities were listed in the survey. The mean number of activities people participated in was 6.0 ± 0.10 (1SE) (Figure 3.15). Most people indicated they participated in between four and eight activities. The most popular outdoor activities (in descending order) were walking/running, visiting reserves, relaxing, gardening and socialising. Less frequent were swimming, biking, outdoor photography, bird watching and fishing, with 26 people indicating they surfed.

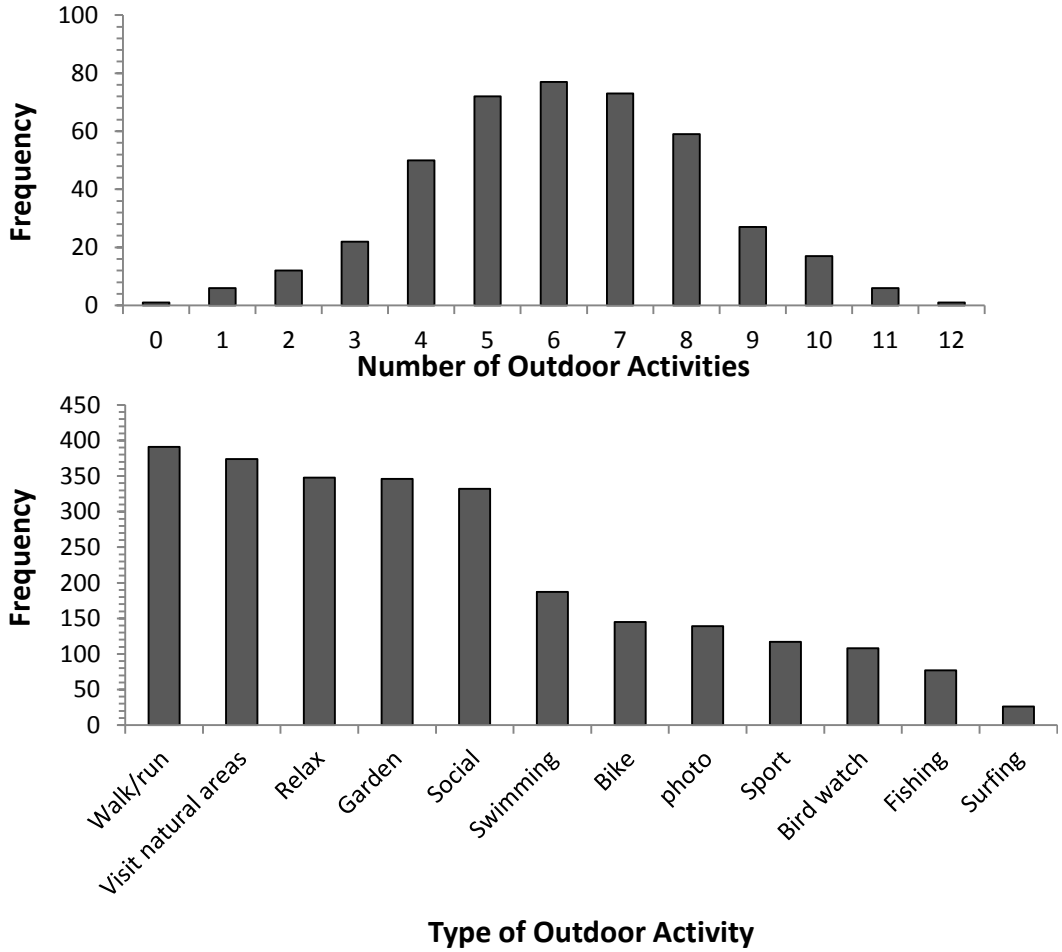

Figure 3.15 Frequency distribution of the total number and types of outdoor activities survey respondents participated in. *N* = 423.

Major Life Events

Survey participants were asked if they had experienced a major life event in the three months preceding the survey. This was to determine if experiences in nature mitigated the impact of these stressful life events on people's wellbeing. Eighty-four respondents (19.9%) had experienced such a major life event.

3.2 How Much Nature Do We Need?

Although determining the amount of neighbourhood vegetation people need for optimal wellbeing was not an aim of this study to, my results provide some insight about this. I investigated the distribution of mental health scores in relation to neighbourhood vegetation level. The scores for Mental Health (WHO-5 scale, World Health Organisation, 1998) were converted to a score out of 100 so I could compare them with means for the general population reported in the literature. General population studies have indicated that a mean score on the WHO-5 is around 70 and people suffering with depression score around 40 (Bech, 2004). The mean score for Mental Health in my study was 71.7 ± 14.8 (1SD), close to that reported by Bech (2004). Ten people in my survey scored below 40, indicating they may be experiencing depressive symptoms.

I compared the number of people with the highest and lowest Mental Health scores. There was an association between the level of neighbourhood vegetation and the percentage of people at the upper and lower ends of the mental health scale. There were comparatively more people with the highest mental health scores, above 86.5 (mean + 1 SD), in neighbourhoods with the highest levels of vegetation (Figure 3.16A). The reverse also occurred with comparatively more people with poorer mental health, below 57 (mean – 1 SD), in neighbourhoods with the lowest levels of vegetation (Figure 3.16B). In Levels 1 and 2, 20% of people score below 57, it decreases to 14 - 16% of people in Levels 3 and 4 and then drops to between 6.9 and 8.9 at Levels 5 and 7. The data fits this linear relationship particularly well for the lower levels of mental health (Figure 3.16B) with an $R^2 = 0.87$. The data fits reasonably well at the higher levels of mental health with an $R^2 = 0.25$ (Figure

3.16A). This means people living in neighbourhoods below about Level 3 or 4 have comparatively poorer Mental Health than those living in greener neighbourhoods.

My preliminary findings suggest that the amount and quality of neighbourhood vegetation found above Level 3 or 4 could contribute to significant gains in Mental Health. These neighbourhoods had about 135 m^2 of greenery per person[4], with about half of this in mature trees.

[4] Based on the mean of 2.6 people per household in Wellington City (Wellington City Council 2014a).

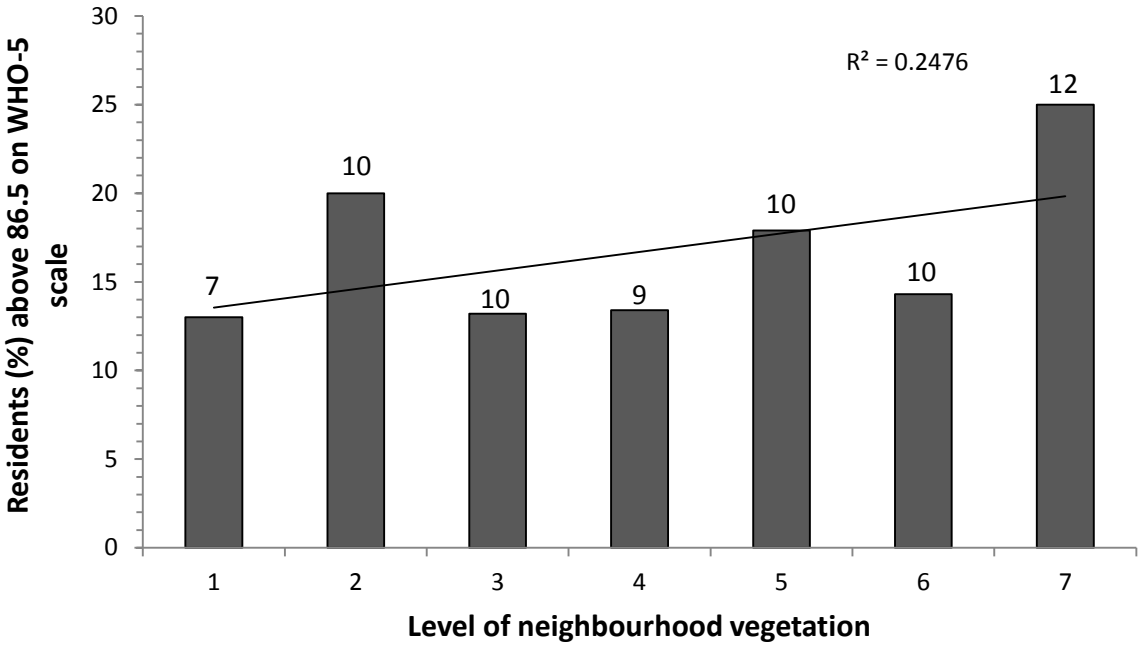

Figure 3.16A The percentage of survey respondents in each level of vegetation who scored above 86.5 (mean + 1 SD) on the WHO-5 scale for Mental Wellbeing. *n* = the numbers above each bar.

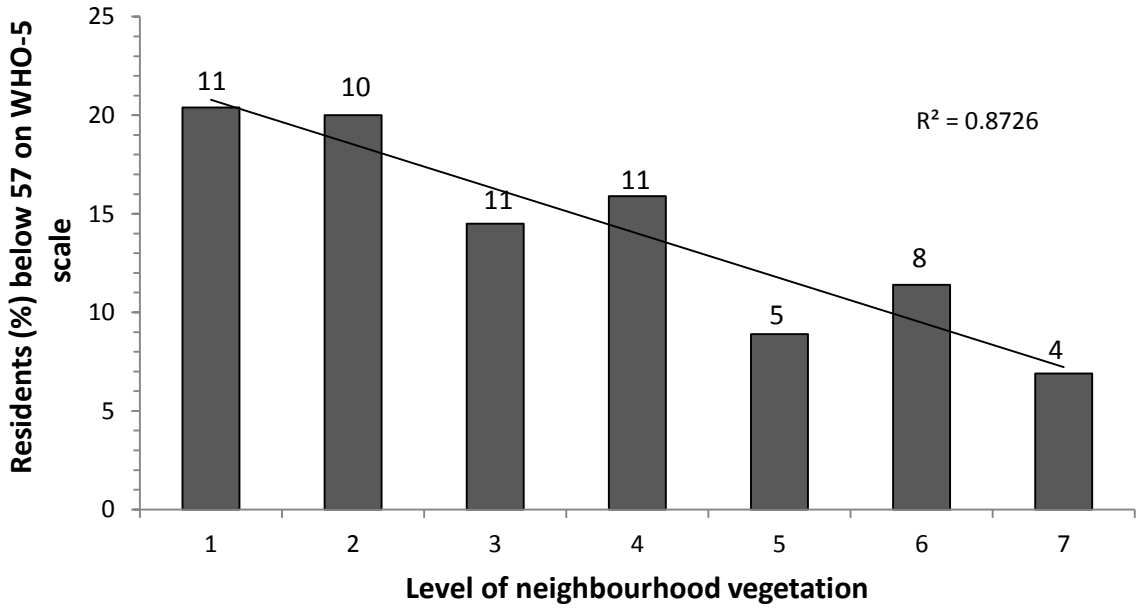

Figure 3.16B The percentage of survey respondents in each level of vegetation who scored below 57 (mean – 1 SD) on the WHO-5 scale for Mental Wellbeing. *n* = the numbers above each bar.

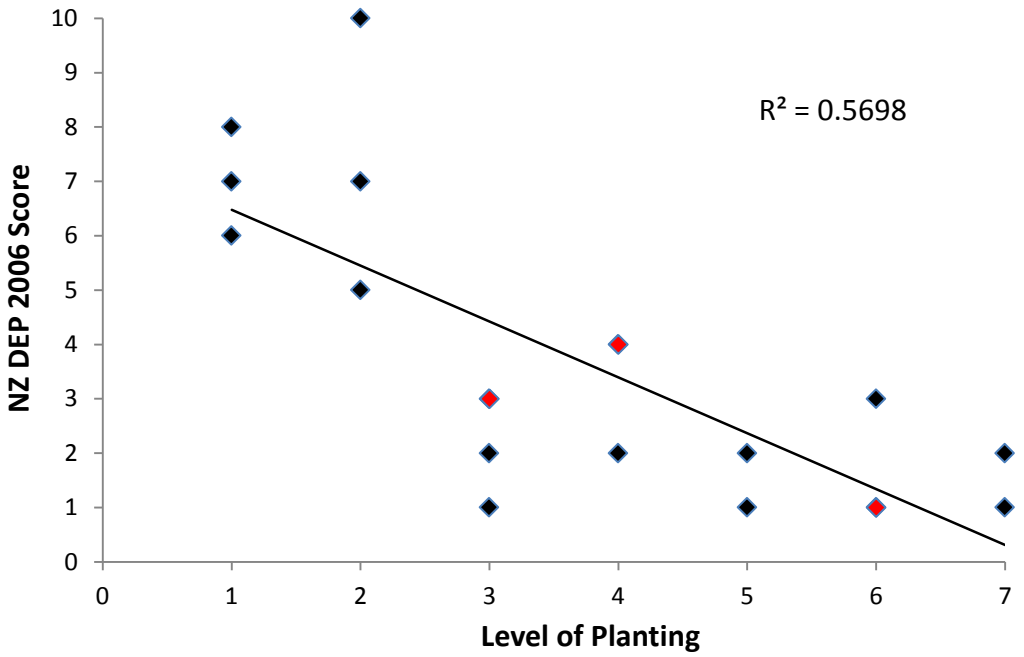

Figure 3.17 The score on the New Zealand Deprivation Index 2006 (NZ Dep 2006) for each of the 20 neighbourhoods within the appropriate level of neighbourhood vegetation. A score of 10 on the NZ DEP 2006 indicates the highest level of economic deprivation. There are neighbourhoods within some vegetation levels with the same NZ DEP 2006 score, so they appear as a single item on the graph and are shown in red. Each red data point represents two neighbourhoods.

I also investigated the relationship between economic indicators and the level of neighbourhood vegetation because bivariate correlations indicated there was a relationship between the socio-economic measures I used (household income, home ownership and education) and the neighbourhood vegetation level (Appendix II). The New Zealand Deprivation Index 2006 (NZ Dep 2006, Salmond and Crampton, 2012; University of Otago, 2012) is a measure of deprivation derived from 2006 census data. The measure is based on economic variables such as household income, employment and homeownership. A mesh-block is the smallest geographical area for the census data. I used the raw mesh-block data from the NZ Dep 2006, corresponding to the neighbourhoods in my survey, and plotted these against the appropriate neighbourhood vegetation level (Figure 3.17). The neighbourhoods with the lowest levels of vegetation correspond to the highest levels of deprivation according to the NZ Dep 2006. The data fits the linear relationship well with an

R^2 = 5.70 (Figure 3.17). This means that the people living in neighbourhoods with the least amount of greenery and with the highest proportion of poor mental health also have the highest levels of economic deprivation.

3.3 Results of the Structural Equation Models

3.3.1 Wellbeing Models

Wellbeing Model

The, *Wellbeing* model had a good fit to the data ($\chi^{2} = 389.64$; d/f = 214; $\chi^2/df = 1.82$; CFI = 0.96; NNFI = 0.95; RMSEA = 0.044; SRMR = 0.045) (Table 3.3.1). Neither level of vegetation nor involvement in the Road Reserve Planting scheme (RRP), directly predicts wellbeing (Figure 3.3.1). The effect of the independent variables on the wellbeing indicators is via multiple mediators. Thus the *Wellbeing* model is a full mediation model. This full mediation model explains 16%, 13% and 3% of the variance for Mental Health, Satisfaction with Life and Physical Health, respectively.

The effect of the neighbourhood vegetation level on the indicators of people's wellbeing is mediated by Neighbourhood Satisfaction (both satisfaction with the social and natural features of the neighbourhood) and the use of nature for Psychological Restoration (Figure 3.3.1). Satisfaction with Nature mediates the effect of Vegetation Level on all measures of wellbeing, showing it is the main route by which Vegetation Level affects people's wellbeing. Higher levels of vegetation in one's neighbourhood are associated with a greater satisfaction with nature, which in turn is associated with more positive psychological and physical health outcomes.

The effect of participating in the RRP scheme on wellbeing is mediated by both the use of nature for Psychological Restoration and Pro-environmental Behaviour, with Psychological Restoration mediating the effect on Satisfaction with Life and Pro-environmental Behaviour the effect on Mental Health. According to this model, participation in the planting scheme leads to a greater endorsement of the use of nature for Psychological Restoration and increases in Pro-environmental Behaviour, which in turn leads to a greater Satisfaction with Life and Mental Health, respectively.

The results show that the level of neighbourhood vegetation has an indirect effect on both psychological and physical health and involvement in the RRP scheme has an indirect effect

only on psychological health. The level of vegetation had a stronger effect on Satisfaction with Life and Mental Health than involvement in the RRP scheme (Table 3.3.2).

Some of the proposed mediators originally hypothesised in the theoretical *Wellbeing* model (Figure 2.3) did not mediate the relationship between Vegetation Level and/or the RRP scheme and the wellbeing indicators. Connection with Nature and Environmental Attitude were not retained in the *Wellbeing* model (Figure 3.3.1). There were some significant relationships however (e.g., Environmental Attitude negatively influenced Satisfaction with Life and Mental Health).

It is important to note that although the independent variables are correlated, as are some of the mediators and the outcomes measures (Figure 3.3.1), the independent variables predict different mediators, which in turn predict distinct wellbeing measures. These results provide further evidence for the discriminant validity of the constructs, meaning it is justifiable to treat them separately.

Table 3.3.1 The goodness-of-fit measures for all the *Wellbeing* models. All models are a good fit to the data. See the Methods section for details of the model fit indices. *N* = 423.

Models	χ^2	d/f	χ^2/df	*p*	CFI	NNFI	RMSEA	RMSEA CI (90%)	SRMR
Wellbeing	389.64	214	1.82	0.000	0.96	0.95	0.044	.037 - .051	0.045
Wellbeing + Demographics	459.12	278	1.65	0.000	0.96	0.96	0.039	.033 - .046	0.045
Wellbeing + Time Outdoors	408.23	234	1.74	0.000	0.96	0.96	0.042	.035 - .049	0.045
Wellbeing + Major Life Event	429.83	236	1.82	0.000	0.96	0.95	0.044	.037 - .051	0.055

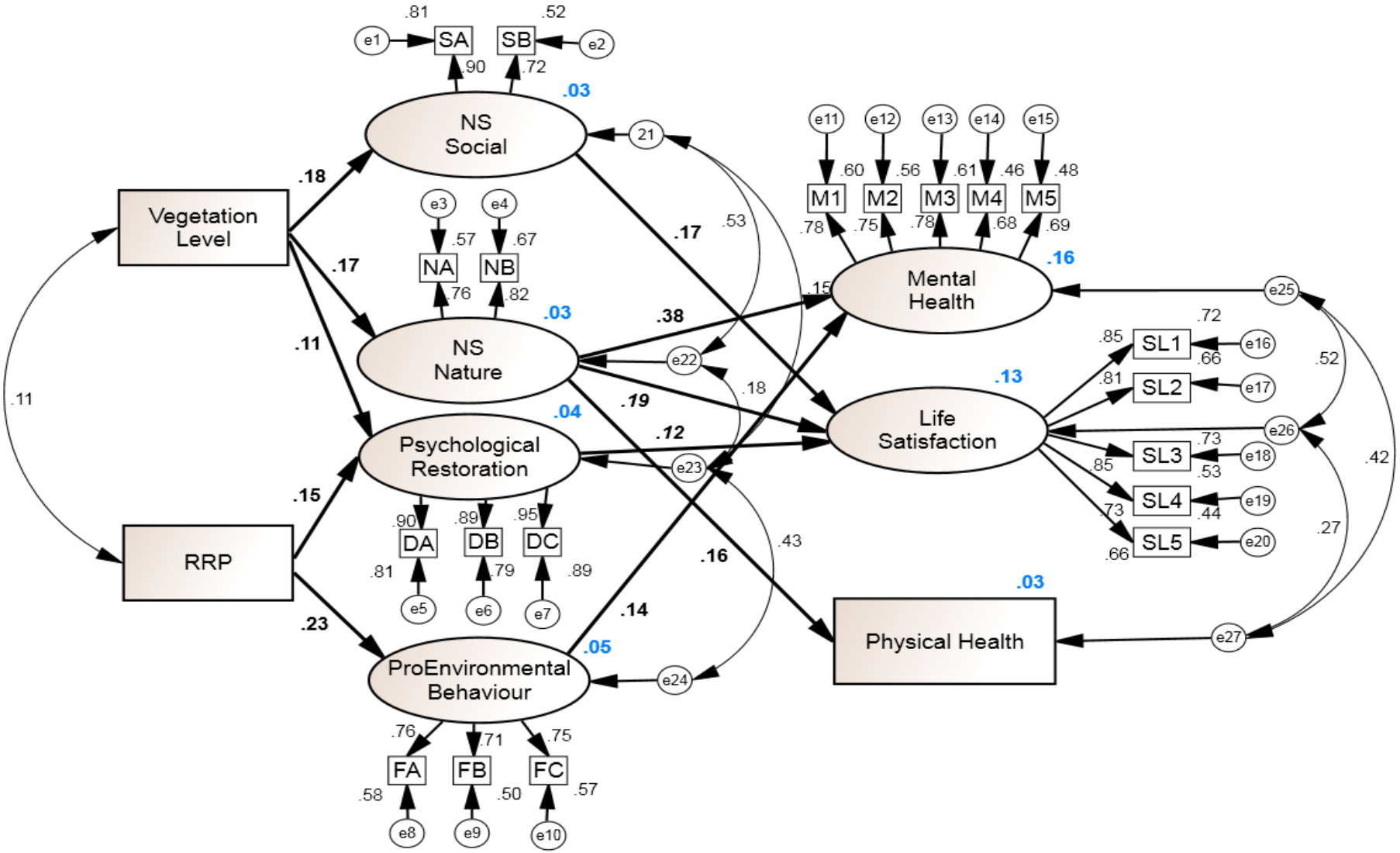

Figure 3.3.1 The *Wellbeing* model showing the effect of experiences in nature on the wellbeing indicators via the mediators, Neighbourhood Satisfaction (NS Social and NS Nature), Psychological Restoration and Pro-environmental Behaviour. Coefficients are the standardised effects (β); double-ended arrows indicate correlations (Pearson's correlation coefficient); the numbers on the right above the constructs represent R^2. $p < 0.05$ for all pathways (Two-tailed significance). The total effects of the independent variables on the wellbeing indicators are given in Table 3.3.2.

Table 3.3.2 The total effects of the independent variables, level of neighbourhood planting (Level) and participation in the RRP (RRP) scheme, on the three wellbeing measures in the *Wellbeing* model (Figure 3.3.1). The table shows the total indirect standardised effects (β), the 95% confidence intervals from the bootstrap analysis (CI) and statistical significance, (Two-tailed) *(p*).

	Mental Health	Satisfaction with Life	Physical Health
Level			
β	0.064	0.076	0.027
CI	(0.026 - 0.12)	(0.033 - 0.13)	(0.004 - 0.063)
p	0.002	0.002	0.006
RRP			
β	0.033	0.018	
CI	(0.008 - 0.071)	(0.004 – 0.046)	
p	0.006	0.01	

Wellbeing + Demographics Model

Socio-demographic measures were added to the *Wellbeing* model to examine whether it could be improved. The resulting *Wellbeing + Demographics* model, including significant relationships for age, number of children and household income (Figure 3.3.2), also had a good fit to the data (χ^2 = 459.12; d/f = 278; χ^2/df = 1.65; CFI = 0.96; NNFI = 0.96; RMSEA = 0.039; SRMR = 0.045) (Table 3.3.1) but it did not improve on the explanatory power of the original *Wellbeing* model.

The structural relationships between the existing variables were unaltered by adding socio-demographics but three of the eight socio-demographics did have significant effects on Satisfaction with Life (Figure 3.3.2). A greater number of children living in a household directly increased Satisfaction with Life. Age and household income indirectly effect Satisfaction with Life and their influence was mediated by NS Social and the use of nature for Psychological Restoration, respectively. Education, homeownership, gender, marital

status and ethnicity were not significantly correlated with any wellbeing measures either directly or indirectly.

The number of children in a household had the strongest effect on Satisfaction with Life suggesting that households with more children enjoyed greater life satisfaction (Table 3.3.3). Increasing age led to greater satisfaction with the social aspects of neighbourhood life and consequently a greater overall satisfaction with life. Higher levels of household income had a negative impact on the endorsement of nature for Psychological Restoration and a subsequent negative influence on Satisfaction with Life (Table 3.3.3).

Household Income and Age were positively correlated with the level of neighbourhood vegetation. That is, older and economically advantaged people lived in neighbourhoods with greater amounts and diversity of plants, particularly mature trees. Participation in the RRP scheme was not correlated with any socio-demographics.

Table 3.3.3 The total effects of the socio-demographic variables on Satisfaction with Life from the *Wellbeing + Demographics* model (Figure 3.3.2). The table shows total, direct or indirect standardised effects, the 95% confidence intervals from the bootstrap analysis (CI) and statistical significance (Two-tailed) *(p*).

Demographics	Satisfaction With Life
Number of Children	
Total Direct Effect	
β	0.093
CI	(0.018 - 0.17)
p	0.014
Age	
Total Indirect effect	
β	0.022
CI	(0.003- 0.057)
p	0.007
Income	
Total Indirect effect	
β	-0.011
CI	(-0.033 - 0.000)
p	0.04

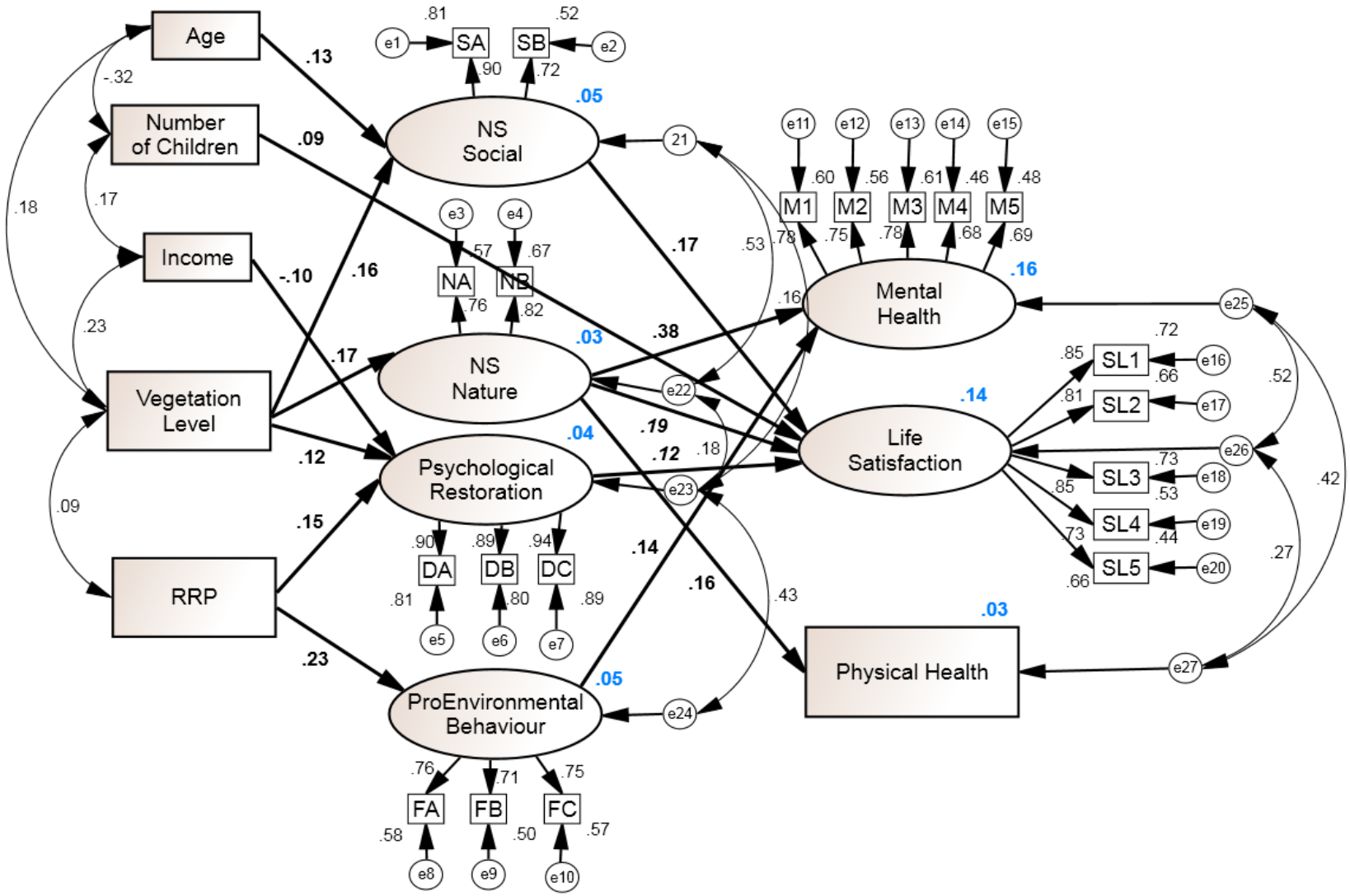

Figure 3.3.2 The *Wellbeing + Demographics* model showing the direct and indirect effects of socio-demographics on the *Wellbeing* model. Coefficients are the standardised effects (β); double-ended arrows indicate correlations (Pearson's correlation coefficient); the numbers on the right above the constructs represent R^2. $p < 0.05$ for all pathways (Two-tailed significance).The total effects of the socio-demographic variables on the wellbeing indicators are given in Table 3.3.2.

Wellbeing + Time Outdoors Model

The amount of time spent outdoors as an adult (Time Outdoors) was added to the *Wellbeing* model, to examine whether it could be improved. The resulting *Wellbeing + Time Outdoors* model also had a good fit to the data (χ^2 = 408.23; d/f = 234; χ^2/df = 1.74; CFI = 0.96; NNFI = 0.96; RMSEA = 0.042; SRMR = 0.045) (Table 3.3.1) but did not improve on the explanatory power of the original *Wellbeing* model.

The structural relationships between the existing variables of the *Wellbeing* model were unaltered by adding Time Outdoors (Figure 3.3.3). The amount of time spent outdoors indirectly influenced all three measures of wellbeing. The effects were mediated by the Neighbourhood Satisfaction variables and the use of nature for Psychological Restoration. The strength of the effect of Time Outdoors on the wellbeing measures was about the same size as the effect from the Vegetation Level and greater than that from participation in the RRP scheme (Tables 3.3.2 and 3.3.4). According to this model, greater amounts of time spent outdoors are associated with a greater satisfaction with people's neighbourhoods and leads to a greater use of nature for psychological restoration, which in turn leads to more positive psychological and physical health outcomes. The amount of time spent outdoors was not significantly correlated with either Vegetation Level or involvement in the RRP scheme.

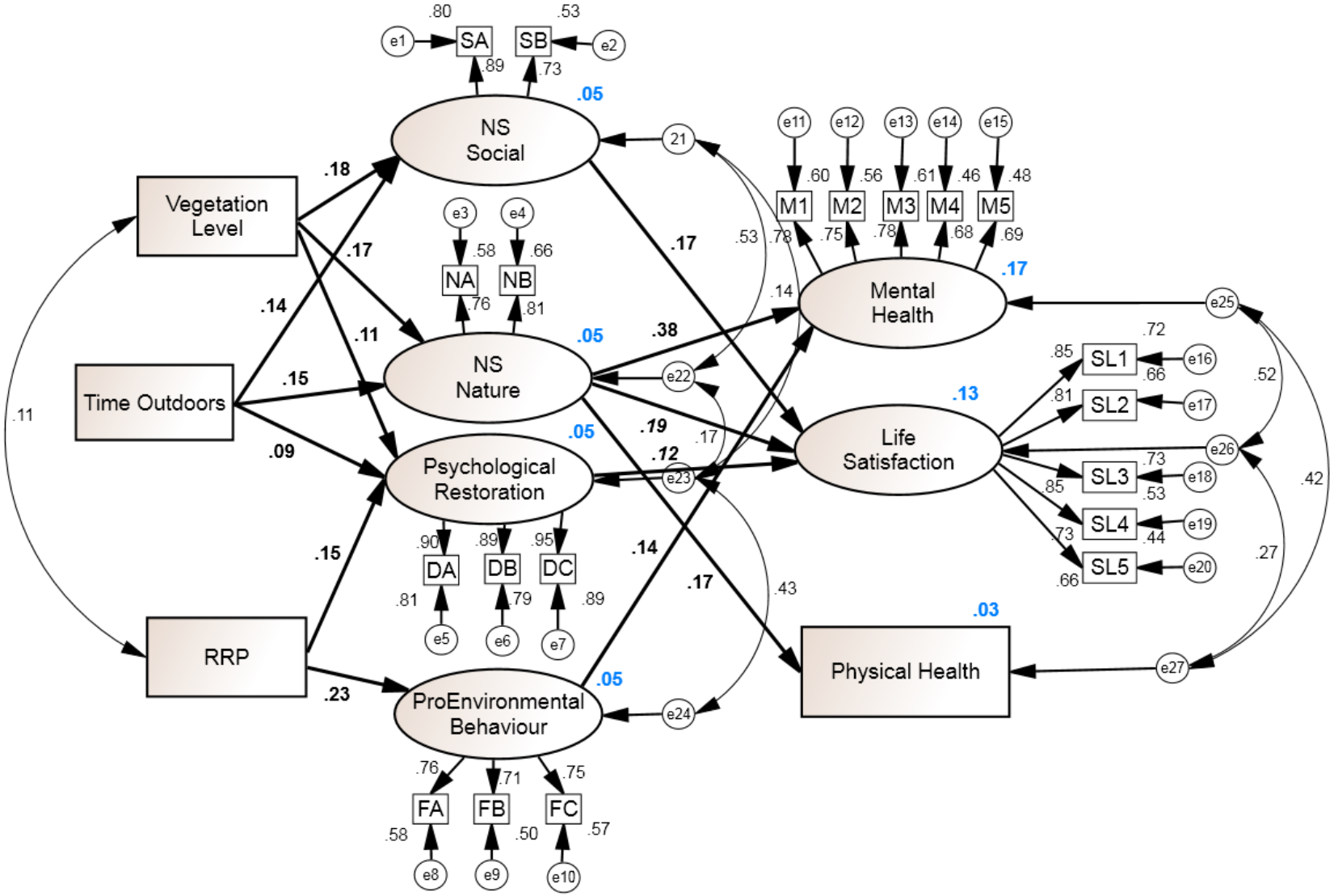

Figure 3.3.3 The *Wellbeing + Time Outdoors* model showing the effect of Time Outdoors on the *Wellbeing* model. Time Outdoors indirectly affects the wellbeing indicators via various mediators. Coefficients are the standardised effects (β); double-ended arrows indicate correlations (Pearson's correlation coefficient); the numbers on the right above the constructs represent R^2. $p < 0.05$ for all pathways (Two-tailed significance).The total effect of Time Outdoors on the wellbeing measures is given in Table 3.3.4.

Table 3.3.4 The total effect of the amount of time spent outdoors on the wellbeing measures from the *Wellbeing + Time Outdoors* model (Figure 3.3.3). The table shows total indirect standardised effects (β), the 95% confidence intervals from the bootstrap analysis (CI) and statistical significance (Two-tailed) *(p*).

Time Outdoors	Mental Health	Satisfaction with Life	Physical Health
β	0.055	0.063	0.024
CI	(0.02 - 0.11)	(0.026 - 0.11)	(0.005 - 0.06)
p	0.002	0.001	0.003

Wellbeing + Number of Medical Conditions Model

The Total Number of Medical Conditions was added as an outcome dependent variable to the wellbeing models to investigate whether the level of neighbourhood vegetation or involvement in the RRP scheme influenced the number of medical conditions people experienced. There were no statistically significant associations between the independent variables or the mediators and the number of medical conditions and so this model was not examined further. It is pertinent to note that a greater number of medical conditions was negatively correlated with all the wellbeing indicators. The relationships between the number of medical conditions and Mental Health, Satisfaction with Life and Physical Health were, β = -0.13, -0.15 and -0.37, respectively ($p < 0.05$).

Wellbeing + Major Life Event Model

The *Wellbeing + Major Life Event* model explored how people's relationship with nature might influence their wellbeing after experiencing a major life event, for example, the death of a partner (Figure 3.4.4). The *Wellbeing + Major Life Event* model had a good fit to the data ($\chi^{2\,=}$ 429.83; d/f = 236; χ^2/df = 1.82; CFI = 0.96; NNFI = 0.95; RMSEA = 0.044; SRMR = 0.055) (Table 3.3.1) but did not improve on the explanatory power of the original *Wellbeing* model.

The addition of the variable, Major Life Event, to the theoretical *Wellbeing* model, did not change the structural relationships between the existing variables. Experiencing a major event did affect people's wellbeing with a direct negative influence on both mental and physical health. It also had a positive effect on use of nature for Psychological Restoration (Figure 3.3.4). Table 3.3.5 shows that the total effect of a Major Life Event on a person's Satisfaction with Life is β = 0.02. This model demonstrates that although experiencing a major life event led to poorer mental and physical health, it also led to a greater use of nature for Psychological Restoration, which in turn led to a greater Satisfaction with Life at a time when people were under mental and physical stress.

Table 3.3.5 The total effect of experiencing a Major Life Event in the three months preceding the survey on the wellbeing indicators, from the *Wellbeing + Major Life Event* model (Figure 3.3.4). The table shows the direct and indirect standardised effects (β), the 95% confidence intervals from the bootstrap analysis (CI) and statistical significance (Two-tailed) *(p*).

Major Life Event	Mental Health	Satisfaction with Life	Physical Health
Total Direct Effect			
β	-0.10		-0.09
CI	(-0.21 - -0.006)		(-0.18 - -0.009)
p	0.04		0.03
Total Indirect Effect			
β		0.02	
CI		(0.001 - 0 .04)	
p		0.02	

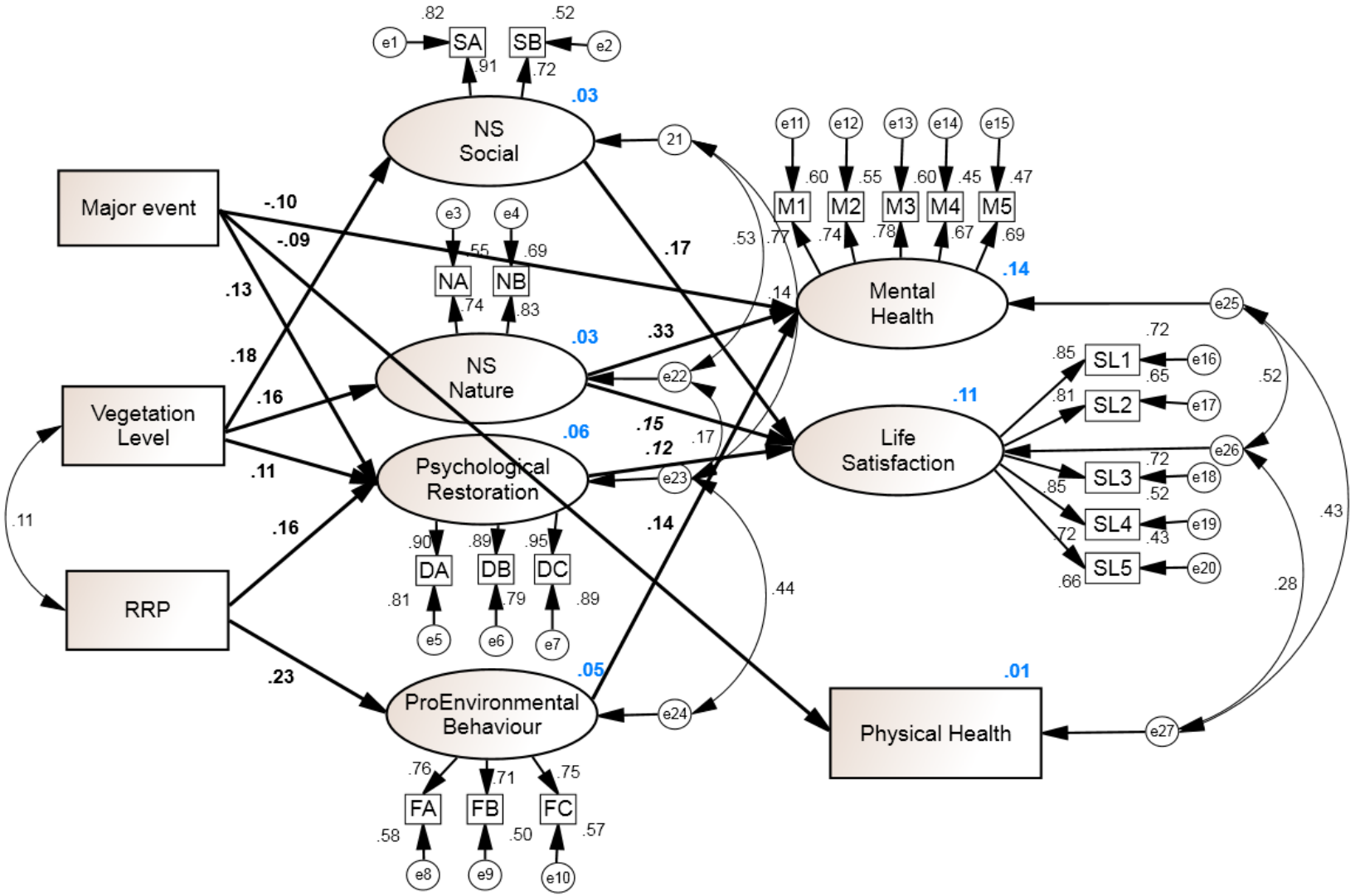

Figure 3.3.4 The *Wellbeing + Major Life Event* model showing the effect of a experiencing a major life event, in the three months preceding the survey, on the *Wellbeing* model. The direct effects on Mental and Physical Health are negative. Coefficients are the standardised effects (β); double-ended arrows indicate correlations (Pearson's correlation coefficient); the numbers on the right above the constructs represent R^2. $p < 0.05$ for all pathways (Two-tailed significance).Table 3.3.5 gives the total effect of the Major Event on Satisfaction with Life.

Information-Theoretic Model Selection for Wellbeing Models

The four competing wellbeing models just presented (*Wellbeing, Wellbeing + Demographics, Wellbeing + Time Outdoors* and *Wellbeing + Major Life Event)* all have a good fit to the data (Table 3.3.1). The ratio of the χ^2/df is outside the level of acceptable fit for all models (3:1) but it is difficult to obtain acceptable χ^2/df ratios in complex models (Byrne, 2010). The competing models also explain similar amounts of the variance in mental health (16%), Satisfaction with Life (13-14%) and Physical Health (3%).

The second order Akaike Information Criteria for the three candidate models are shown in Table 3.3.6. The most parsimonious original *Wellbeing* model is the only model that had substantial support (ΔAIC ≤ 2). The Akaike weight was 1.000. All other competing models had comparatively trivial Akaike weights (<0.000) and were relatively implausible (ΔAIC > 10). The *Wellbeing* model is thus the best and most parsimonious of the candidate models. It minimises the Kullback-Leibler distance (the difference between the model and the 'truth'). These results show that the inclusion of socio-demographic measures and the amount of time spent outdoors did not improve the original *Wellbeing* model.

Table 3.3.6 The second order Akaike Information Criterion (AICc) for the three candidate *Wellbeing* models. The models are ranked in order of AICc. The model, *Wellbeing,* is the only model with substantial support (ΔAIC ≤ 2). K = Number of Parameters, ω_i is the Akaike weight and *N* = 423.

Model	K	AICc	ΔAIC	ω_i
Wellbeing	95	569.42	0.00	1.000
Wellbeing + Time Outdoors	97	598.73	29.31	0.000
Wellbeing + Major Life Event	97	616.33	46.91	0.000
Wellbeing + Demographics	106	676.91	107.49	0.000

3.3.2 Pro-environmental Behaviour Models

Pro-environmental Behaviour Model

The *Pro-environmental Behaviour* model (Figure 3.3.5) has a good fit to the data ($\chi^{2} = 9.95$; d/f = 12; χ^2/df = 0.83; CFI = 1.00; NNFI = 1.00; RMSEA = 0.000; SRMR = 0.020) (Table 3.3.7). It represents a partial mediation model with a single mediator. That is, participation in the RRP scheme both directly and indirectly influences pro-environmental behaviour. The indirect influence of the RRP scheme on Pro-environmental Behaviour is mediated by Connection with Nature, which was not significant in the *Wellbeing* model. The model explains 38% of the variance in Pro-environmental Behaviour (much more than the 5% explained in the *Wellbeing* model, Figure 3.3.1). The direct and indirect influences on PEB are about the same strength (direct, β = 0.12; indirect, β = 0.11) (Table 3.3.8). According to this partial mediation model, Connection with Nature partially explains the mechanism by which participation in the planting scheme leads to increased Pro-environmental Behaviour.

The level of neighbourhood vegetation did not directly or indirectly influence Pro-environmental Behaviour (PEB). Some of the proposed mediators originally hypothesised in the theoretical *Pro-environmental Behaviour* model (Figure 2.5) did not mediate the effect of the RRP scheme on Pro-environmental Behaviour (Figure 3.3.5). This included the variables measuring Neighbourhood Satisfaction, use of nature for Psychological Restoration and Environmental Attitude.

Table 3.3.7 The goodness-of-fit measures for all the *Pro-environmental Behaviour* (PEB) models. All models are a good fit for the data. See the Methods section for the details of the model fit indices. CI = Confidence limits for RMSEA, *N* = 423.

							RMSEA		
Models	χ^2	d/f	χ^2/df	*p*	CFI	NNFI	RMSEA	CI (90%)	SRMR
Pro-environmental Behaviour	9.95	12	0.83	0.62	1.00	1.00	0.000	.000 - .042	0.020
PEB + Demographics	19.58	25	1.97	0.77	1.00	1.01	0.000	.000 - .028	0.025
PEB + Time Outdoors	13.22	18	0.75	0.78	1.00	1.01	0.000	.000 - .030	0.020
Byrka-Hartig PEB	48.26	24	2.01	0.002	0.99	0.98	0.049	.028 - .069	0.039
PEB + Psychological Restoration	138.00	71	1.94	0.00	0.98	0.97	0.047	.035 - .059	0.043

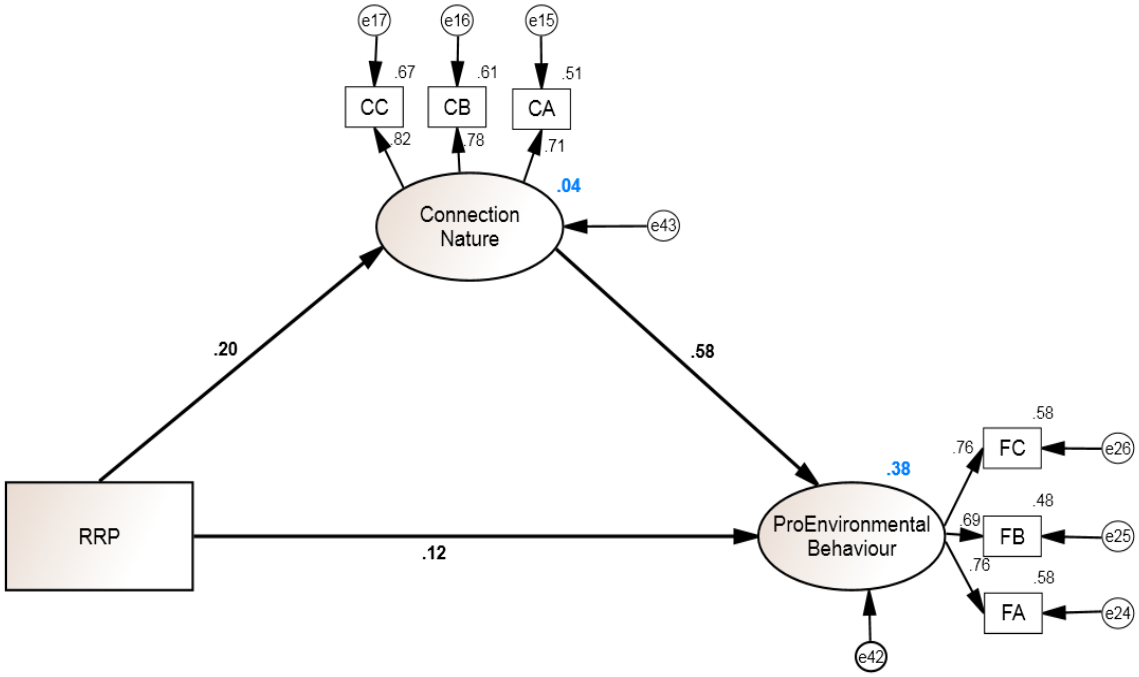

Figure 3.3.5 The *Pro-environmental Behaviour* model showing the effect of participation in the Road Reserve Planting (RRP) scheme on Pro-environmental Behaviour both directly and indirectly via the mediator, Connection with Nature. Coefficients are the standardised effects (β); the numbers on the right above the constructs represent R^2. $p < 0.05$ for all pathways (Two-tailed significance). The total effect of RRP on Pro-environmental Behaviour (β = 0.23) is given in Table 3.3.8

Table 3.3.8 The effect of involvement in the Road Reserve Planting (RRP) scheme on Pro-environmental Behaviour (PEB) for the *Pro-environmental Behaviour* model (Figure 3.3.5). Coefficients are the standardised effects (β) with 95% confidence limits (CI) and statistical significance (Two-tailed) (*p*).

	Total Effect	Direct effect	Indirect effect
RRP → PEB			
β	0.23	0.12	0.11
CI	(0.12 – 0.33)	(0.004 - 0.22)	(0.06 - 0.18)
p	0.002	0.04	0.001

Pro-environmental Behaviour + Demographics Model

Socio-demographics were added to the model, *Pro-environmental Behaviour*, to examine whether it could be improved (Figure 3.3.6). The *Pro-environmental Behaviour + Demographics* model had a good fit for the data ($\chi^{2\,=}$ 19.58; d/f = 25; χ^2/df = 1.97; CFI = 1.00; NNFI = 1.01; RMSEA = 0.000; SRMR = 0.025) (Table 3.3.7) but did not improve on the explanatory power of the original *Pro-environmental Behaviour* model.

Although the structural relationships between the exisiting variables of the original *Pro-environmental Behaviour* model were unaltered by adding socio-demographics, Home ownership and Number of Children in a household, did have significant effects on Pro-environmental Behaviour. These effects were indirect and mediated by Connection with Nature. The other socio-demographics measured (i.e., age, income, education, marital status and ethnicity) had no signifcant effect on a person's level of Pro-environmental Behaviour. Age is the only demographic that correlated with participation in the RRP scheme (*r* = 0.05, *p* = 0.04).

The model shows that owning your home, as opposed to renting it, leads to a lesser Connection with Nature and subsequently lesser engagement in general Pro-environmental Behaviour. In contrast, a greater number of children leads to a higher level of Connection

with Nature and through this a greater engagement in Pro-environmental Behaviour (Table 3.3.9). The size of the total effect of involvement in the RRP scheme on Pro-environmental Behaviour is stronger than the effects of the demographics (β = 0.23 for the RRP scheme, compared to -0.08 for Home Ownership and 0.07 for Number of Children; Tables 3.3.8 and 3.3.9).

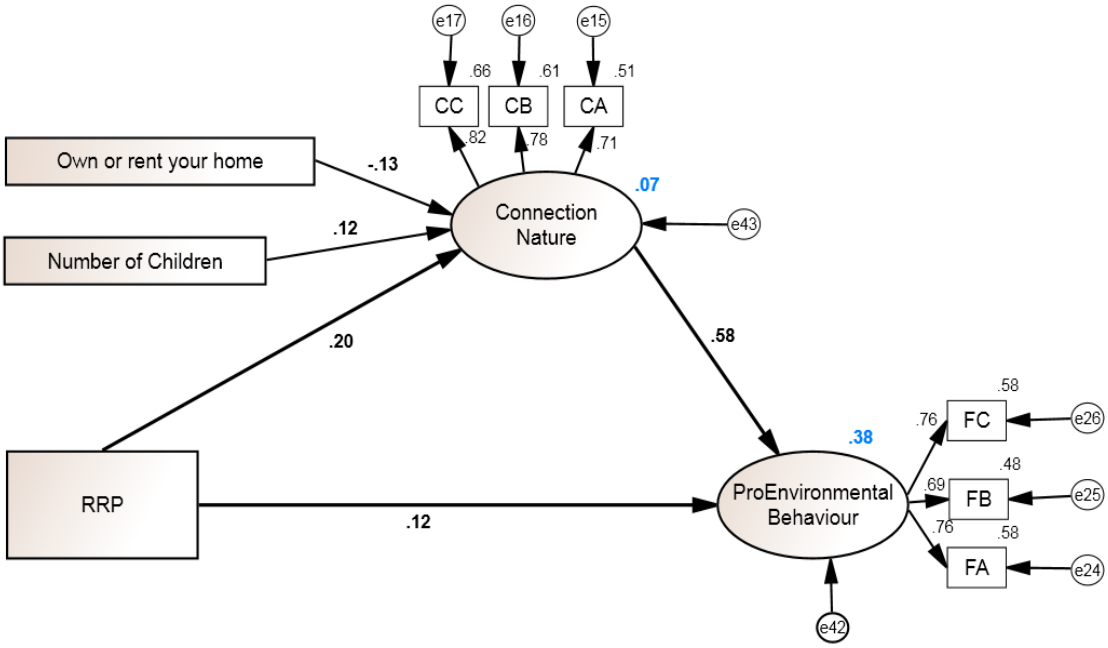

Figure 3.3.6 The *Pro-environmental Behaviour + Demographics* model showing the effect of the significant socio-demographics on the *Pro-environmental Behaviour* model. Both demographics indirectly affect Pro-environmental Behaviour through the mediator, Connection with Nature. The effect of owning one's own home is negative. Coefficients are the standardised effects (β); the numbers on the right above the constructs represent R^2. $p < 0.05$ for all pathways (Two-tailed significance). Table 3.3.9 shows the total effect of the demographics on PEB.

Table 3.3.9 The total effect of the significant socio-demographics on Pro-environmental Behaviour for the *Pro-environmental Behaviour + Demographics* model (Figure 3.3.6). Coefficients are the total, standardised effects (β) with 95% confidence limits (CI) and statistical significance (Two-tailed) (*p*).

Demographic Variable	Pro-environmental Behaviour
Home ownership	
β	-0.075
CI	(-0.13 - -0.02)
p	0.008
Number of Children	
β	0.069
CI	(0.015 - 0.14)
p	0.02

Pro-environmental Behaviour + Time Outdoors Model

The amount of time spent outdoors (Time Outdoors) was added to the model *Pro-environmental Behaviour* to see whether it could be improved. The *Pro-environmental Behaviour + Time Outdoors* model had a good fit to the data ($\chi^{2} = 13.22$; d/f = 18; χ^2/df = 0.75; CFI = 1.00; NNFI = 1.01; RMSEA = 0.000; SRMR = 0.020) (Table 3.3.7), but did not improve on the explanatory power of the *Pro-environmental Behaviour* model.

Although the structural relationships between the existing variables were unaltered by adding Time Outdoors (Figure 3.3.7), the amount of time spent outdoors did have an indirect influence on Pro-environmental Behaviour, mediated by Connection with Nature. Spending time outdoors more than once a week is associated with a greater Connection with Nature, which leads to a higher engagement in Pro-environmental Behaviour, although the effect is weaker than participation in the RRP scheme (β = 0.06 and 0.23 for the effect of Time Outdoors and the RRP scheme, respectively) on Pro-environmental Behaviour.

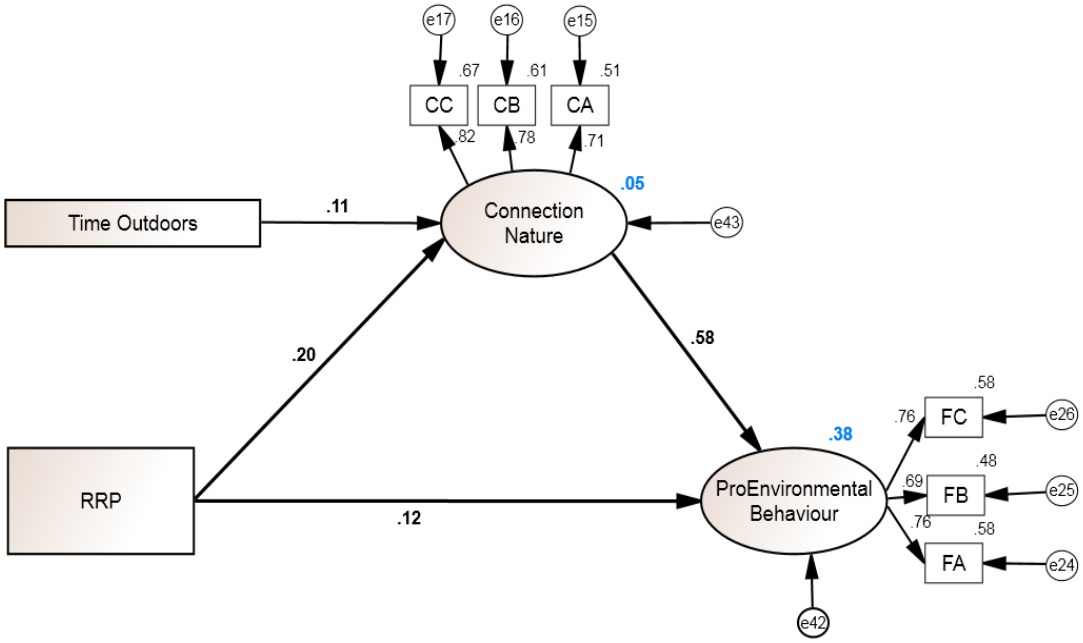

Figure 3.3.7 The *Pro-environmental Behaviour + Time Outdoors* model showing the effect of spending time outdoors more than or less than once a week on Pro-environmental Behaviour (PEB). The effect is indirect and mediated by Connection with Nature. The total effect of Time Outdoors on PEB is β = 0.062 (CI = 0.006 - 0.14, p = 0.03). Coefficients are the standardised effects (β); the numbers on the right above the constructs represent R^2. p < 0.05 for all pathways, two-tailed significance.

Information-Theoretic Model Selection - Pro-environmental Behaviour Models

All three competing Pro-environmental Behaviour models presented above (*Pro-environmental Behaviour, Pro-environmental Behaviour + Demographics and Pro-environmental Behaviour + Time Outdoors*) show a good fit to the data (Table 3.2.7) and explain the same amount of variance in Pro-environmental Behaviour (38%).

The second order Akaike Information Criteria for the three candidate models is shown in Table 3.2.10. The *Pro-environmental Behaviour* model is the only model that has substantial support (ΔAIC < 2.0). The model *Pro-environmental Behaviour + Time Outdoors* has less support (ΔAIC < 10) but is still plausible and the model incorporating the socio-demographic variables was implausible (ΔAIC > 10). The Akaike weight of the *Pro-environmental Behaviour* model was 0.98 making it more than 50 times more likely than *Pro-environmental Behaviour + Outdoors* model. The results show that the original *Pro-environmental Behaviour* model best represents the data and minimised the Kullback-Leibler distance. The addition of socio-demographics or Time Outdoors did not improve on the original *Pro-environmental Behaviour* model.

Table 3.3.10 The second order Akaike Information Criterion (AICc) for the three candidate models for Pro-environmental Behaviour. The models are ranked in order of AICc. The *Pro-environmental Behaviour* model is the only model with substantial support (ΔAIC ≤ 2). K = Number of Parameters, ω_i is the Akaike weight and N = 423.

Model	K	AICc	ΔAIC	ω_i
Pro-environmental Behaviour	26	45.49	0.000	0.98
Pro-environmental Behaviour + Time Outdoors	28	53.34	7.85	0.02
Pro-environmental Behaviour + Demographics	30	64.33	18.83	0.00

Byrka-Hartig Pro-environmental Behaviour Model

The *Byrka-Hartig Pro-environmental Behaviour* model (Figure 3.3.8), which tested Byrka et al.'s (2010) and Hartig et al.'s (2007) findings, was a good fit for my data (χ^2 = 48.26; d/f = 24; χ^2/df = 2.01; CFI = 0.99; NNFI = 0.98; RMSEA = 0.049; SRMR = 0.039 (Table 3.3.7). It demonstrates that the use of nature for Psychological Restoration both directly and indirectly influences Pro-environmental Behaviour. The indirect influence of Psychologcal Restoration on Pro-environmental Behaviour is mediated by Environmental Attitude. This model explained 32% of the varaince in Pro-environmentla Behaviour, slightly less than the 38% explained by the original *Pro-environmental Behaviour* model. The strength of the direct effect is around twice that of the indirect effect (β = 0.32 compared to 0.15 for the direct and indirect effect respectively; Table 3.3.11). According to this partial mediation model, Environmental Attitude partially explains the mechanism by which using nature for Psychological Restoration leads to increases in Pro-environmental Behaviour. This confirms the associations found by Byrka et al. (2010) and Hartig et al. (2007) in German and Norwegian populations are more widely applicable.

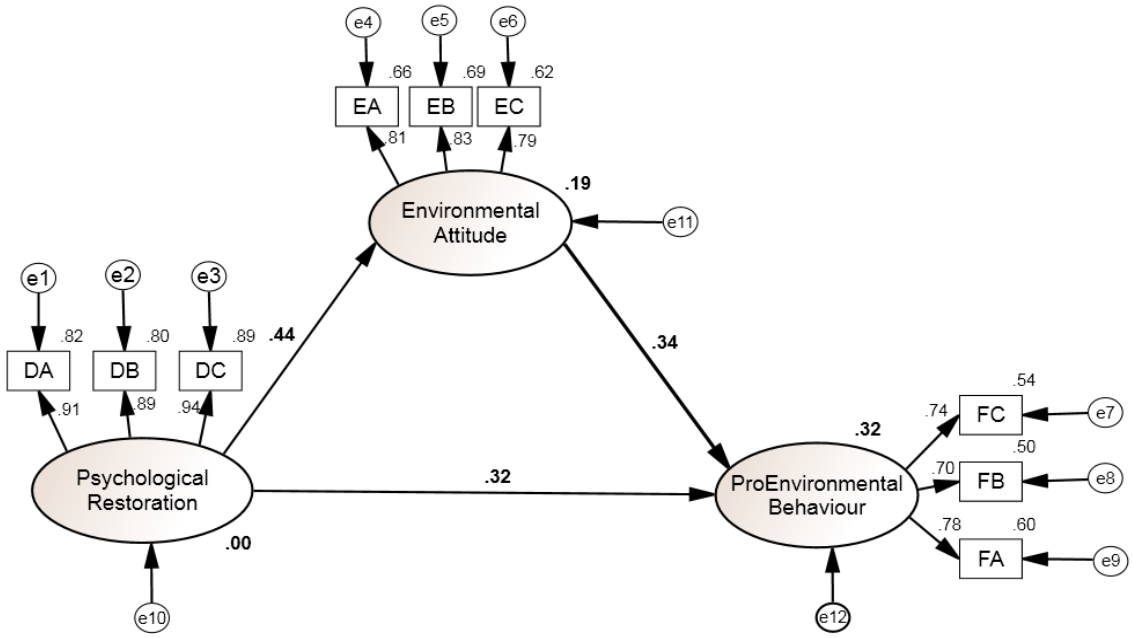

Figure 3.3.8 The *Byrka-Hartig Pro-environmental Behaviour* model. This demonstrates the effect of using nature for Psychological Restoration on Pro-environmental Behaviour, both directly and via the mediator, Environmental Attitude. Coefficients are the standardised effects (β); the numbers on the right above the constructs represent R^2. $p < 0.05$ for all pathways (Two-tailed significance). Table 3.3.11, below, gives the total effect of Psychological Restoration on PEB.

Table 3.3.11 The effect of using nature for Psychological Restoration on Pro-environmental Behaviour (PEB) for the *Byrka-Hartig Pro-environmental Behaviour* model (Figure 3.3.8). Coefficients are the standardised effects (β) with 95% confidence limits (CI) and statistical significance (Two-tailed) (*p*).

	Total Effect	Direct effect	Indirect effect
Psychologcial Restoration → PEB			
β	0.47	0.32	0.15
CI	(0.37 – 0.57)	(0.21 - 0.43)	(0.10 - 0.22)
p	0.002	0.002	0.002

Pro-environmental Behaviour + Psychological Restoration Model

The *Byrka-Hartig Pro-environmental Behaviour* model was incorporated into the *Pro-environmental Behaviour* model. The resulting *Pro-environmental Behaviour + Psychological Restoration* model fitted the data well ($\chi^{2} = 138.00$; d/f = 71; χ^2/df = 1.94; CFI = 0.98; NNFI = 0.97; RMSEA = 0.047; SRMR = 0.043 (Table 3.3.7). It represents a partial mediation model with multiple mediators (Figure 3.3.9). That is, the level of vegetation and involvement in the RRP scheme indirectly predict Pro-environmental Behaviour and involvement in the RRP scheme also directly predicts Pro-environmental Behaviour. The model explains 45% of the variance in Pro-environmental Behaviour, compared to 38% in the original *Pro-environmental Behaviour* model (Figure 3.3.5).

Although the variables from the *Pro-environmental Behaviour* model are retained, there are three noteworthy differences between my first model and the *Pro-environmental Behaviour + Psychological Restoration*. First, the level of neighbourhood vegetation has an indirect influence on Pro-environmental Behaviour, mediated by the use of nature for Psychological Restoration and Environmental Attitude. Higher levels of vegetation in one's neighbourhood are associated with a greater endorsement of nature for Psychological Restoration and higher levels of Environmental Attitude, which in turn leads to greater self-reported Pro-environmental Behaviour.

Second, participation in the RRP scheme still has a direct and indirect effect on people's pro-environmental behaviour but now it also has a secondary indirect effect as well. Participation in the RRP scheme now influences Pro-environmental Behaviour via Psychological Restoration and Environmental Attitude as well as Connection with Nature. The two indirect pathways combined have about the same size effect on PEB as the direct pathway (i.e., is about 0.12, Figure 3.3.9; Table 3.3.12). According to this partial mediation, increased connectedness to nature is a route by which involvement in planting leads to increased endorsement of nature for psychological restoration, environmental attitude and pro-environmental behaviour.

Third, Environmental Attitude is a significant mediator of Psychological Restoration and Pro-environmental Behaviour. That is, both the level of vegetation and participation in the RRP scheme are associated with higher levels of Environmental Attitude (via the respective mediators) and the increase in Environmental Attitude leads to higher levels of self-reported Environmental Behaviour.

The total effect of participation in the RRP scheme on PEB is the same as in the *Pro-environmental Behaviour* model (β = 0.23) and this participation has a stronger influence on Pro-environmental Behaviour than the level of neighbourhood vegetation (i.e., RRP scheme, β = 0.23; Level of Vegetation, β = 0.014, Table 3.3.12). The main difference between these models is that the level of vegetation now has a significant effect on people's Pro-environmental Behaviour and Psychological Restoration and Environmental Attitude are introduced as mediators. Although this model is less parsimonious, it predicts more of the variance in Pro-environmental Behaviour than the *Pro-environmental Behaviour* model.

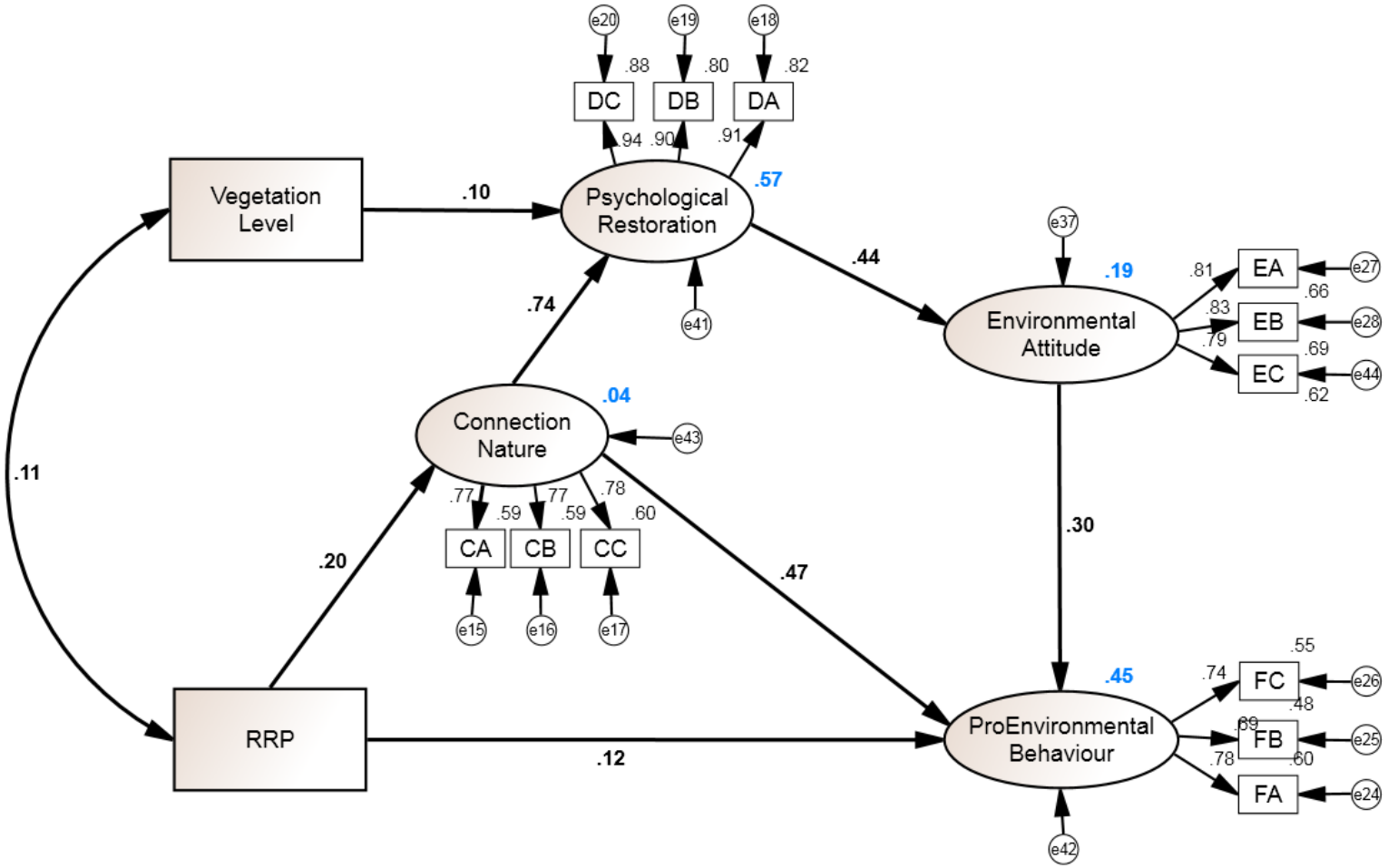

Figure 3.3.9 The *Pro-environmental Behaviour + Psychological Restoration* model. Both Level of neighbourhood vegetation and participation in the RRP scheme effect general Pro-environmental Behaviour. Coefficients are the standardised effects (β). $p < 0.05$ for all pathways. The total effects of RRP and Vegetation Level, Connection with Nature and Psychological Restoration on PEB is given in Table 3.3.12.

Table 3.3.12 The effects of the independent variables and the mediators on Pro-environmental Behaviour which are not shown on the graphic for the *Pro-environmental Behaviour + Psychological Restoration* model (Figure 3.3.9). The table shows the standardised effects (β), the 95% confidence intervals from the bootstrap analysis (CI) and statistical significance (Two-tailed) *(p*).

Variable		Pro-environmental Behaviour
Level - Total Indirect effect		
	β	0.014
	CI	(0.004 - 0.03)
	p	0.005
RRP - Total Effect		
	β	0.23
	CI	(0.12 - 0.32)
	p	0.002
RRP - Indirect Effect		
	β	0.11
	CI	(0.058 - 0.17)
	p	0.002
Connection to Nature Total Effect		
	β	0.57
	CI	(0.48 - 0.67)
	p	0.001
Connection to Nature Total Indirect Effect		
	β	0.10
	CI	(0.06 - 0.15)
	p	0.001
Psychological Restoration Total Indirect Effect		
	β	0.13
	CI	(0.074 - 0.20)
	p	0.002

3.3.3 Combined *Wellbeing + Pro-environmental Behaviour* Model

In the final *Wellbeing + Pro-environmental Behaviour* model (Figure 3.3.10)**,** the variables represented in the *Pro-environmental Behaviour + Psychological Restoration* model were added to the *Wellbeing* model and slight structural changes made to the relationships between some variables. The model is a good fit to the data ($\chi^{2\,=}$ 585.08; d/f = 333; χ^2/df = 1.76; CFI = 0.96; NNFI = 0.95; RMSEA = 0.042 (0.04 – 0.05); SRMR = 0.05), and represents a full mediation model with multiple mediators. The model explains more of Mental Health (22%), Satisfaction with Life (16%) and Pro-environmental Behaviour (45%) than the *Wellbeing* model.

The total effects of both vegetation level and involvement in the RRP scheme on the wellbeing measures are comparable to those observed for the *Wellbeing* model (Tables 3.4.2 and 3.4.13). This full model explains more of the variance in Mental Health and Satisfaction with Life but does not explain Physical Health. There are four main differences between the models: (1) Vegetation Level no longer has an effect on Physical Health, but (2) does have an indirect effect on Pro-environmental Behaviour, (3) the mechanism of the effect of the RRP scheme on Pro-environmental Behaviour is explained more fully (explaining 45% of the variance compared to 5% in the *Wellbeing* model) and (4) the structure of the relationships between the Neighbourhood Satisfaction variables and between Satisfaction with Nature and Connection with Nature has changed. I elaborate on these differences below.

First, Vegetation Level no longer affects Physical Health. That is, in this model, neither the level of neighbourhood vegetation nor participation in the RRP scheme influences Physical Health.

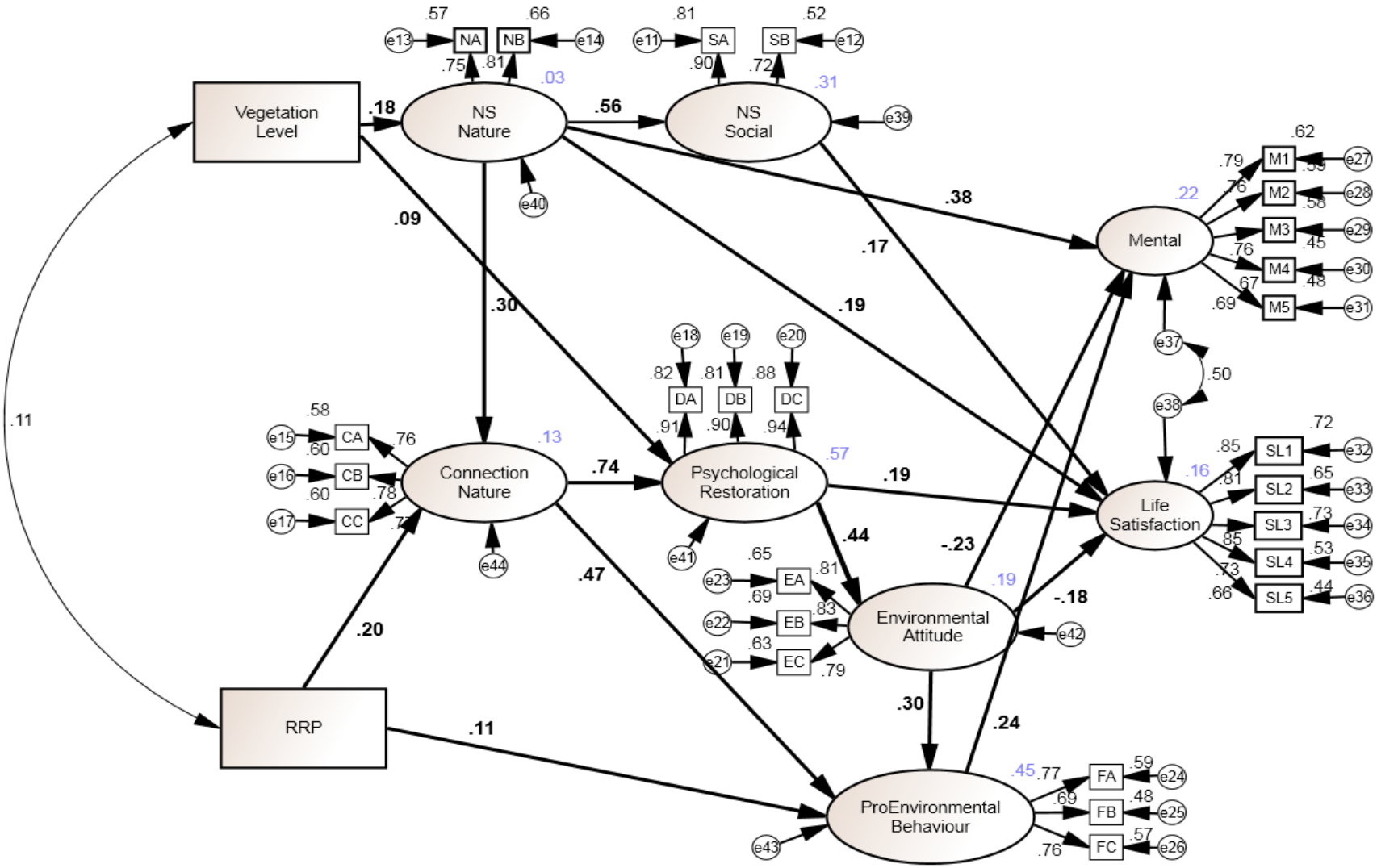

Figure 3.3.10 The final *Wellbeing + Pro-environmental Behaviour* model showing the effect of experiences in nature on the indicators of psychological wellbeing and on Pro-environmental Behaviour, via a number of mediators. Coefficients are the standardised effects (β,) the numbers on the right above the constructs represent R^2. $p < 0.05$ for all pathways (Two-tailed significance). The total effect of the independet variables on the wellbeing measures and on Pro-environmental Behaviour are given in Table 3.3.13.

Table 3.3.13 The total effects of the independent variables, (Vegetation Level and participation in the RRP scheme (RRP)) on the measures of psychological wellbeing and Pro-environmental Behaviour for the final *Wellbeing + Pro-environmental Behaviour* model (Figure 3.3.10). The effects of Satisfaction with Nature (NS Nature) and Connection with Nature are also shown. The table shows the total standardised effects (β), the 95% confidence intervals from the bootstrap analysis (CI) and statistical significance (Two-tailed) *(p*).

Variable	Mental Health	Satisfaction with Life	Pro-environmental Behaviour
Vegetation Level			
β	0.065	0.066	0.043
CI	(0.026 - 0.12)	(0.028 - 0.12)	(0.023 - 0.07)
p	0.003	0.003	0.001
RRP			
β	0.04	0.02	0.23
CI	(0.009 - 0.080)	(0.002 - 0.04)	(0.12 - 0.32)
p	0.01	0.033	0.002
NS Nature			
β	0.40	0.31	0.017
CI	(0.29 - 0.51)	(0.2 - 0.42)	(0.10 - 0.26)
p	0.002	0.002	0.002
Connection with Nature			
β	NS*	0.086	0.57
CI		(0.00 - 0.17)	(.48 - .67)
p		0.048	0.001

*The indirect effect of Connection with Nature on Mental Health is not statistically significant.

Second, the vegetation level now has an indirect effect on Pro-environmental Behaviour via two mediated pathways (1) via Psychological Restoration and Environmental Attitude and (2) via NS Nature and Connection with Nature. According to this, greater levels of neighbourhood vegetation lead to a greater use of nature for Psychological Restoration and a stronger Environmental Attitude, which leads to greater PEB. In addition, greater levels of neighbourhood vegetation lead to greater satisfaction with nature in the neighbourhood and a stronger Connection with Nature, which also leads to greater PEB. The effect of Vegetation Level on PEB is much less than the effect of participating in the RRP scheme (Vegetation Level, $\beta = 0.043$; RRP scheme, $\beta = 0.23$) (Table 3.3.13).

Thirdly, Connection with Nature and Environmental Attitude are additional mediators of the effect of participating in the RRP scheme on PEB. In addition, Environmental Attitude now has a negative effect on both Mental Health and Satisfaction with Life. That is, increases in Environmental Attitude have a detrimental effect on psychological health.

Finally, Satisfaction with Nature (NS Nature) now mediates the effect of Vegetation Level on NS Social. According to this model, greater levels of neighbourhood vegetation lead to a greater satisfaction with the nature in the neighbourhood. This in turn leads to greater satisfaction with the social aspects of neighbourhood life and a greater Satisfaction with Life. Therefore, it is not just the objective measure of neighbourhood vegetation that influences people's wellbeing but their evaluation that the amount of neighbourhood vegetation is adequate for their needs.

NS Nature also mediated the effect of Vegetation Level on Connection with Nature. According to this, greater levels of neighbourhood vegetation lead to a greater satisfaction with the nature in the neighbourhood. This in turn leads to a stronger Connection with Nature and, via other mediators, a greater Satisfaction with Life. Connection with Nature had no significant effect on Mental Health.

The strength of the effect of NS Nature on Mental Health is about the same as in the original *Wellbeing* model ($\beta = 0.40$ here, 0.38 in the *Wellbeing* model) but the effect on Satisfaction

with Life is about twice as much in this final model (β = 0.31 here, compared to 0.17 in the original *Wellbeing* model).

3.3.4 Model Evaluation

Information Theoretic model selection and inference using Akaike Information Criterion was used to select the single best model from several competing models when investigating the influence of exposure to nature on human wellbeing and Pro-environmental Behaviour. This method gives preference to the most parsimonious model of a group of competing models that are all a good fit to the data. It does not necessarily give support for a particular model over the alternatives (Hull et al, 1995), but provides a meaningful and parsimonious explanation for the observed relationships of independent variables and mediators with dependent variables, using a theoretically meaningful model (MacCullum, 1995).

The *Wellbeing* model (Figure 3.3.1) was clearly the best model in the set of wellbeing models I tested. It explained 16%, 13% and 3% of people's Mental Wellbeing, Satisfaction with Life and Physical Health respectively. The *Pro-environmental Behaviour* model (Figure 3.3.5) best explained how exposure to nature influenced pro-environmental behaviour. It was a very parsimonious model and explained 38% of the variance in PEB of the study population. Policy makers, under time and resource pressure, may prefer to have quantitative evidence presented in such a way that facilitates their decision-making, i.e., the most parsimonious model. Variables of theoretical importance may not always be those of the greatest practical interest. However, the more complex models, *Wellbeing + Pro-environmental Behaviour* (Figure 3.3.10) and Pro-*environmental Behaviour + Psychological Restoration* (Figure 3.3.9)*,* are theoretically important and explain more of the mechanisms of how nature impacts wellbeing and pro-environmental behaviour. For example, the final *Wellbeing* + *Pro-environmental Behaviour model* (Figure 3.3.10) explains more of the variance in PEB than the more parsimonious *Pro-environmental Behaviour* model (45% compared to 38%) and explains more of the variance in Mental Health (22% compared to 16%) and Satisfaction with Life (16% compared to 13%) than the *Wellbeing* model (Figure 3.3.1) but this is at the cost of parsimony.

Discussion

4.1 Overview

The challenges ahead for sustainability and biodiversity conservation require a better understanding of the relationship human beings have with the natural environment. The resources available to conservation depend on how the natural environment is valued by the public and by government. Human wellbeing may be enhanced by, or even dependent on, a relationship with nature. Understanding the contribution of urban biodiversity to the wellbeing of city residents contributes another dimension to conservation by providing a greater motivation for investment in it. I examined the influence of urban nature – specifically, living in neighbourhoods with greater amounts of vegetation and participation in a city-wide planting scheme – on the wellbeing of Wellington City residents and found the published benefits attributed to spending time in wilderness areas were echoed for urban nature in my study.

My study demonstrated that exposure to nature in urban environments is important for residents' relationship with nature and has significant consequences for their wellbeing, particularly their psychological wellbeing. The two measures of exposure to nature, the sustained exposure to neighbourhood vegetation and participation in an urban planting scheme, influenced wellbeing differently. Higher levels of neighbourhood vegetation were associated with greater mental and physical health and satisfaction with life. People living in neighbourhoods with higher vegetation cover and more mature trees had higher levels of wellbeing than people living in neighbourhoods with minimal vegetation. People in the more highly planted neighbourhoods were also more satisfied with their natural surroundings and the social aspects of neighbourhood life. They had a greater tendency to use nature as a resource for stress reduction or to restore depleted mental faculties (i.e., through psychological restoration). Participation in the planting scheme was also associated with higher levels of psychological health through greater use of nature for psychological restoration and through greater participation in environmentally protective behaviours. This

provides support for Biophilia Theory (Wilson, 1984) - humans have a biological tendency to affiliate with nature and a connection to the natural world has remained adaptive for human wellbeing.

Experiences of urban nature are not only important for human wellbeing but are also positively associated with people's pro-environmental behaviour (PEB). Living in neighbourhoods with more plants and participating in the planting scheme were both positively associated with self-reported environmental behaviour. This study indicates that as people develop a relationship with nature they become more willing to protect it. The key message from this study is that urban nature is good for us and what is good for us also benefits the environment.

4.2 Nature, Wellbeing and Pro-environmental Behaviour

The following discussion follows the same order as the hypothesis testing. First, I discuss the effect of the independent variables on wellbeing and the role of the socio-psychological mediators. Second, I discuss the effect of the independent variables on pro-environmental behaviour and the relevant mediators.

4.2.1 Exposure to Urban Nature and Human Wellbeing

My results support the generally accepted view than nature has a positive effect of on human wellbeing (e.g., Matsuoka and Kaplan, 2008). Wilderness studies (Hartig et al., 1991; Kaplan and Kaplan, 1989), as well as studies of urban populations (e.g., Grahn and Stigsdotter, 2003; Korpela et al., 2014; Maas et al., 2009, 2008; van den Berg et al., 2010; Ward Thompson et al., 2012), demonstrate that exposure to nature has positive outcomes for wellbeing. Despite this consensus, there have been conflicting results as to the type and extent of nature that is influential. For example, some researchers found positive associations between wellbeing and green space within 1-3 km of a person's home but no association between wellbeing and green space within 1 km of home (de Vries et al., 2003; Nutsford et al., 2013; van den Berg et al., 2010) . Others contradicted this and found green space within 1 km of home had a stronger influence on residents' wellbeing than that within

the 3 km boundary (Maas et al., 2009; Stigsdotter et al., 2010; Van Herzele and de Vries, 2012; Ward Thompson et al., 2012). In addition, the mechanisms that explain the association between human wellbeing and nature are not clearly understood and so limit our ability to explain the contradictions or apply them in policy.

My study of urban neighbourhoods focussed on the immediate neighbourhood around residents' homes (within five to ten minutes' walk, or less than 1 km) and measured all vegetation to a fine scale (5 x 5 m). I demonstrated in the *Wellbeing* model that green space in the immediate vicinity of people's homes had a significant contribution to their wellbeing: their mental and physical health and satisfaction with life. I, like Honold et al. (2012), found no significant correlation between green space and the number of health conditions but some studies did (e.g., Maas et al., 2009). The finding that greenery in the immediate vicinity is significant for wellbeing contrasts with some of the existing research (de Vries et al., 2003; Nutsford et al., 2013; van den Berg et al., 2010) . This could be because other measures of green space did not include the fine-scale measurement of all the vegetation in neighbourhoods. They only measured green space over one hectare in size, even when they considered green space within 1 km of a person's home. Neighbourhoods can be very green but not have sizeable areas of green space within the proximity and the reverse is also true. Another reason could be that my study has shown the association between nature and wellbeing is indirect; it was only detected in the presence of the mediators.

My *Wellbeing* model (Figure 3.3.1) also demonstrates that participating in the Road Reserve Planting (RRP) scheme is associated with higher levels of Mental Health and increased Satisfaction with Life but had no association with Physical Health. The RRP scheme is part of the Wellington City Council's Biodiversity Strategy (Wellington City Council, 2007) and, although not strictly an ecological scheme (Clewell & Aronson, 2007), the planting of native species adds to the indigenous biodiversity of the city. The benefits of participating in the RRP scheme for people's psychological wellbeing is consistent with other research into government or non-government planting schemes or community gardening initiatives (e.g., Cleghorn et al., 2010; Cowie, 2010; Miles et al., 1998). However, self-reported increases in physical health and fitness have been found by other researchers (Kingsley et al., 2009;

Pillemer et al., 2010). To my knowledge, this is the first study to quantify the benefits of involvement in a community greening scheme in New Zealand.

Many researchers focus on the cognitive, affective and behavioural determinants of PEB, but there are also psychological consequences, such as an associated increase in mental health and satisfaction with life. Some authors suggest that participating in behaviour that benefits the environment can be associated with personal cost and deprivation, which implies a certain loss of personal happiness (e.g., Brown and Kasser, 2005; Lindenberg and Steg, 200). In my study, people who participated in the RRP scheme also reported higher levels of mental health. This is supported also by Bechtel & Corral-Verdugo's (2010) findings that happiness was higher in those who practiced environmentally sustainable behaviour.

Although my study demonstrates that engagement in the community greening scheme is associated with higher levels of wellbeing, causation has not been proven. Higher levels of wellbeing might influence the desire to act pro-environmentally or people with better mental health or a greater satisfaction with life may have more external and internal resources that enable them to be more pro-environmental. Whichever the direction of causality it is, nonetheless, an important finding that human wellbeing is compatible with, and enhanced by, participating in activities that benefit the environment.

I investigated just two aspects of urban nature (neighbourhood vegetation and participation in the RRP scheme). The cumulative effect of including other aspects of urban nature to the study might show a stronger effect, more closely approximating the diversity of nature's influence in people's lives. For example, a future study could examine the influence of nearby parks, reserves and coastal areas, and wildlife. This more comprehensive approach could add greatly to our understanding of the relationship human beings have with the natural environment.

It is remarkable that sustained exposure to neighbourhood vegetation or participation in the planting scheme is associated with measurable increases in wellbeing (Table 3.2.2). Although these effects on wellbeing may seem small, they are similar to the size of the gains in wellbeing attributed to being married (Haring-Hidore et al., 1985) or seen in the variation

of income within countries (Diener et al., 2013) and the influence of satisfaction with the natural features of the neighbourhood (NS Nature) on mental health is much greater (β = 0.38., Figure 3.3.1).

Findings in subjective wellbeing research demonstrate that people's level of wellbeing is particularly resistant to change. Increases in wealth or experiencing major life events, for example, have a short-lived influence on a person's happiness which dissipates rapidly (Diener, 2000). In light of the literature on subjective wellbeing, the amount of psychological wellbeing accounted for by my models is quite substantial, that is 16% for Mental Health and 13% for Satisfaction with Life in the *Wellbeing* model and 22% for Mental Health and 16% for Satisfaction with Life in the final *Wellbeing +Pro-environmental Behaviour* model. In addition, the gains in mental health associated with greener neighbourhoods appear to be more sustained than other changes (Alcock et al., 2014). One might expect it to be difficult to detect associations between green space and health outcomes given Wellington City's prevalence of green space (Nutsford et al., 2013). This makes my findings even more important. If the associations are significant in a well-planted city they may be more marked in cities with greater variations in green space and may also have greater consequences for their residents' health.

The independent variables representing exposure to nature, level of neighbourhood vegetation and participation in the RRP scheme, were correlated. People in more highly planted neighbourhoods were more likely to participate in the RRP scheme. This is consistent with Berentson's (2013) findings that the number of trees outside a resident's home was a factor in their involvement in the same RRP scheme. The neighbourhoods with lower levels of planting (Levels 1-2) had fewer residents involved in the RRP scheme. Participation also was lower in the greenest neighbourhoods (i.e., Level 7). This may be because of a lack of space for planting, a selection bias or perhaps there is simply a lack of interest from residents.

The typography of Wellington City results in a wide variation in the geographic features of road reserves (Berentson, 2013). Two neighbourhoods in the lowest levels of vegetation (Levels 1 and 2) commonly have impervious surfaces up to property boundaries. The most

obvious opportunity to increase vegetation in such a context is in residents' private gardens. Other neighbourhoods with low vegetation levels do have areas which appear to be suitable for planting because they have grassed areas between the road and residents' properties or adjacent to their properties. In contrast, Level 7 neighbourhoods are well planted. Some respondents from Level 7 neighbourhoods commented that they were not interested in participating in the RRP scheme because their neighbourhood didn't need any more trees. Lack of suitable planting areas or adequate levels of existing vegetation may explain some of the lower levels of participation. There is space available, however, in most other neighbourhoods. Designing and managing low vegetation neighbourhoods for increased vegetation may be an important community health policy.

Are residents in neighbourhoods with low levels of vegetation just not interested in the RRP scheme? Overall, there was a lot of interest in participating in the RRP scheme from people who had no previous involvement (around 70% of non-participants). Interest in the scheme from previous non-participants was highest in Levels 1, 2 and 7, so resident lack of interest does not seem to explain low rates of involvement. Another possible explanation for the association between the amount of neighbourhood vegetation and participation in the RRP scheme is selection bias (see Section 4.3). Residents who enjoy the presence of trees may select neighbourhoods with higher levels of vegetation (Zhang et al. 2007). This may also influence them to participate in the RRP scheme.

I have demonstrated that experiences in nature are positively associated with human wellbeing. My work also investigated the mediators that facilitate this relationship.

The role of mediators

It is important to identify the mechanisms that facilitate the relationship between nature and human wellbeing to help understand what drives the relationships and where interventions may be possible. Some potential mediators have been identified but research is not conclusive as to the mechanisms that underlie the relationship or the relationships that exist between the mediators (e.g., Korpela et al., 2014; Maas et al., 2008; Sugiyama et al., 2008; Van Herzele and de Vries, 2012). Mine is the first comprehensive study of these

particular socio-psychological constructs as mediators of the relationship between nature and human wellbeing. The *Wellbeing* model demonstrates the independent but synergistic effect of Neighbourhood Satisfaction, the use of nature for Psychological Restoration and Pro-environmental Behaviour on the wellbeing measures. However, Connection with Nature and Environmental Attitude were not significant mediators in this model but were significant in the final *Wellbeing + Pro-environmental Behaviour* model, which is discussed in a later section.

Neighbourhood Satisfaction

The *Wellbeing* model demonstrates that greater levels of neighbourhood satisfaction (satisfaction with both the social and natural features of the neighbourhood) are positively associated with the amount of neighbourhood vegetation but not participation in the RRP scheme. Satisfaction with Nature in the neighbourhood is the most influential mediator in the *Wellbeing* model (Figure 3.3.1). It is associated with all three wellbeing measures. The influence of NS Nature to the social aspects of neighbourhood life is seen in the final *Wellbeing + Pro-environmental Behaviour* model (Figure 3.3.10). It indicated that NS Nature fully mediated the relationship between the measured level of neighbourhood vegetation and social satisfaction with the neighbourhood (NS Social). That is, greater amounts of neighbourhood vegetation are associated with greater satisfaction with nature in the neighbourhood which in turn leads to increased social satisfaction.

Most studies into the role of nature on human wellbeing have not investigated the possibility that neighbourhood satisfaction mediates the relationship between nature and wellbeing. However, some did measure the effect of nature on neighbourhood satisfaction. My results are in agreement with the general finding that nature positively influences people's neighbourhood satisfaction. For example, natural elements in views from home were associated with greater neighbourhood satisfaction by Kaplan (2001) and Kearney (2006). The percentage of vegetation cover had an indirect effect on neighbourhood satisfaction in Hur et al.'s (2010) study in Ohio but the strength of the effect was slightly less than I found, $\beta = 0.05$ compared to $\beta = 0.18$ for NS Social and $\beta = 0.17$ for NS Nature in my study (Figure 3.3.1). Honold et al. (2012) also found neighbourhood satisfaction was

associated with residents' perception of adequate green space in Berlin, Germany, the strength of the association was similar to that found in my study (β = 0.21, *p* = 0.000).

Two studies have investigated aspects of neighbourhood satisfaction as potential mediators of nature's effect on wellbeing. Van Herzele and de Vries (2012) in Ghent, Belgium, demonstrated that overall neighbourhood satisfaction mediated the positive association between neighbourhood greenness and general wellbeing or happiness. Social cohesion, a second potential mediator and similar to my measure of NS Social, was not a significant mediator in their study. Aspects of social cohesion have, however, been linked to greener neighbourhoods by Maas et al. (2009). They showed that people living with more green space felt less lonely and experienced more social support and that these aspects of social cohesion partially mediated the relationship between green space and the health indicators they measured. This relationship was especially strong for people who had limited mobility, (such as the elderly and children) and those on lower incomes and with less education.

Kuo, Sullivan and their colleagues focused their work on disadvantaged communities in high-rise apartments in Chicago. They found that natural landscaping, particularly trees, increased the use of outdoor spaces, the number of social interactions, the strength of social ties and the sense of community amongst individuals (Coley et al., 1997; Kuo et al., 1998; Kweon et al., 1998; Sullivan et al., 2004). The generalizability of their findings to broader socio-economics groups in residential neighbourhoods is still being determined (Kuo, 2010). One might expect the relationship to be less important in lower density Wellington City neighbourhoods where standards of living are higher and public green space more common. My study indicates that the same relationship might apply, even if it is of a different magnitude. Kuo et al., (1998) found shared outdoors areas with more greenery were associated with increases in neighbourhood social ties with a β = 0.40, *p* =0.001. The strength of this effect was around twice the strength of the effect of neighbourhood vegetation on residents' satisfaction with social aspects of their neighbourhood in my study (β =0.18, *p*< 0.05).

In my study, the neighbourhoods with the highest levels of planting contained mature trees with a mixture of smaller plants in the under-storey. The lowest levels of vegetation had

mainly grass and lone small trees or shrubs. The more mature and complex vegetation found in the higher vegetation levels may provide a more inviting environment to linger and interact with neighbours, which increases the opportunity to develop mutually supportive relationships (Kuo et al., 1998; Sullivan et al., 2004). Social support is an important external resource for coping with life. My study provided evidence that the environmental context is important in the development of satisfactory social support as well. People who lived in neighbourhoods with higher levels of vegetation also reported higher levels of social satisfaction. This included an increased likelihood of asking for and receiving help from neighbours and having a greater sense of belonging and safety.

Respondents' satisfaction with nature in their neighbourhood (NS Nature) had a stronger association with their wellbeing than my objective measure of vegetation level ($\beta = 0.38$ compared to 0.06 for Mental health; 0.19 compared to 0.08 for Satisfaction with Life; 0.16 compared to 0.03 for Physical Health). NS Nature increased linearly, but modestly, with the measure of neighbourhood vegetation. It is interesting that the perceived suitability of neighbourhood nature rather than the objective measure is most strongly associated with wellbeing. This might be because objective measures capture important structural aspects of the environment, such as the percentage of vegetation cover, but might not capture how residents are exposed to, experience or interact with their neighbourhood in ways that influence wellbeing (Weden et al., 2008). For example, perceptions of safety often influence how residents perceive and use neighbourhood space with respect to psychological restoration or physical activity (Maas et al., 2008). My findings point to the importance of considering residents' perceptions in the planning and design of neighbourhood communities to enhance urban dwellers' quality of life and wellbeing.

Involvement in the RRP scheme was not associated with either measure of neighbourhood satisfaction in my *Wellbeing* model. This was surprising as improved neighbourhood appearance was the most commonly reported benefit by those survey respondents who participated in the RRP scheme. In addition, increased social contacts were reported by a substantial proportion of them: 37% talked to neighbours more, 26% made new friends and 19% were more involved in community activities. These benefits are in line with other

studies that show social benefits have been associated with participation in restoration projects (Cleghorn et al., 2010; Cowie, 2010; Earle, 2011; Kingsley et al., 2009). I expected such benefits to be reflected in the quantitative findings but they were not. One reason for this may be that the amount of vegetation in the neighbourhood is more influential in neighbourhood satisfaction than being involved in planting. The lack of significant difference in neighbourhood satisfaction between residents who participated in the RRP scheme and those who did not may also be because all neighbourhood residents are exposed to the sustained benefits of the planting. Thus, while planting is necessary for neighbourhood greening, the greatest benefits might be the shared outcomes.

My work supports previous findings that neighbourhood vegetation is an important contributor to neighbourhood satisfaction and in turn human wellbeing. A strength of my study is measuring both environmental (NS Nature) and social (NS Social) aspects of neighbourhood satisfaction. My work extends existing research by showing a person's satisfaction with nature in the neighbourhood directly influences their overall wellbeing. It also extends the work of Kuo and her colleagues to include suburban neighbourhood communities with a broader socio-demographic base. Mine, to my knowledge, is the first study of this kind in New Zealand to demonstrate the direct influence of neighbourhood vegetation on residents' neighbourhood satisfaction.

Psychological Restoration

A third mediator, the use of nature for Psychological Restoration, is a pivotal mediator in the *Wellbeing* model (Figure 3.3.1). It mediates the positive effect of both the level of neighbourhood vegetation and participation in the RRP scheme on people's Satisfaction with Life. In the final combined *Wellbeing + Pro-environmental Behaviour* model (Figure 3.3.10) it also positively influences mental health.

The positive effect of experiences in nature on cognitive function and stress reduction is well established in the literature (e.g., Kaplan and Kaplan, 1989; Kaplan, 2001; Kuo, 2001; Ulrich et al., 1991). My findings are similar to these earlier studies. I also demonstrated that a greater use of nature for Psychological Restoration, and the assumed achievement of that

restoration, is associated with higher levels of Satisfaction with Life. Satisfaction with Life measures a person's satisfaction with their life as a whole and entails achievement of important goals and of living a life close to a person's ideal life. An adequate level of psychological functioning is crucial to achieving life satisfaction. In contrast, unrelenting levels of cognitive depletion or emotional stress can lead to a chronic neglect of pivotal life issues and passivity as people become overwhelmed (Kuo, 2001). The non-taxing stimuli of nature, such as neighbourhood trees and plants, can have a restorative effect on fatigued cognitions and be emotionally calming. The associated decrease in physiological responses to stress supports a person's ability to function effectively in their daily lives and may be especially important in managing life's more challenging issues (Kuo, 2001). Adequate levels of neighbourhood vegetation may provide opportunities for micro-restoration close to home, echoing the benefits of extended times in the wilderness (Kaplan and Kaplan, 1989).

This psychologically restorative effect of nature was particularly evident in respondents who had experienced a major life event in the three months preceding my survey. Respondents who had experienced a major event used nature more for Psychological Restoration than those who had not experienced such an event. This greater psychological restoration was, in turn, associated with higher levels of Satisfaction with Life. Experiencing a major life event had a negative effect on Mental and Physical health yet the people experiencing these events had greater Satisfaction with Life scores (*Wellbeing + Major Life Event* model, Figure 3.3.4). Along similar lines, Wells and Evans (2003) showed that nature acted as a buffer for the impact of stress on children in rural towns. Nature's effect was greatest for those children experiencing the highest levels of life stress. Van den Berg et al. (2010) have also demonstrated that people with more green space within 3 km of their homes are less affected by stressful life events than people with low levels of green space. These results suggest that nature's can be a resource for coping and may ameliorate the impact of major life stressors on an individual's overall Satisfaction with Life. At a time of extraordinary mental and physical stress, psychological restoration may enable the maintenance of an adequate level of psychological functioning.

The extent of a person's use of nature for psychological restoration may be part of individual differences in people's ability to cope with day-to-day life and especially difficult

life issues. Designing and providing neighbourhoods with natural places and spaces and encouraging people to spend time in natural environments that they find restorative, could be a focus for public health promotions and interventions to help people manage their psychological wellbeing. This may be especially important in neighbourhoods with the highest levels of economic deprivation (as measured by the New Zealand Deprivation Index) where psychological challenges can be greater and mental health poorest but vegetation levels are lowest.

Pro-environmental Behaviour

The final mediator of nature's effect on wellbeing in the Wellbeing model was Pro-environmental Behaviour. PEB was higher in people who participated in the RRP scheme than those who did not. Greater self-reported participation in PEB was in turn associated with higher levels of Mental Health (*Wellbeing* model*,* Figure 3.3.1) but PEB did not significantly affect Satisfaction with Life or Physical Health. The level of neighbourhood vegetation did not influence PEB in this model but its effect was evident in the final combined *Wellbeing + Pro-environmental Behaviour* model (Figure 3.3.10).

Others have found positive correlations between involvement in environmentally responsible behaviour and aspects of human wellbeing. Bechtel and Corral Verdugo (2010) demonstrated that happiness was greater in those who participated in environmentally responsible behaviours than those who did not. The strength of the effect ranged from r = 0.22 in American students to r = 0.45 in Mexican students (Bechtel and Corral Verdugo, 2010). These relationships are stronger than those found in my study where the effect of PEB on Mental Health was $\beta = 0.14$. Brown and Kasser (2005) also found a positive relationship between subjective wellbeing (similar to my Satisfaction with Life) and PEB of $\beta = 0.20$, but I did not. The way I measured subjective wellbeing may account for the differences between our two studies. Brown & Kessler had one composite measure of wellbeing, which included some satisfaction with life items and some items measuring affect. My measure for Satisfaction with Life did not include affect. Hence, there is relationship of PEB with Mental Health but not with Satisfaction with Life in my models.

It is interesting that greater participation in PEB was not associated with greater Satisfaction with Life in the same way that involvement in the RRP scheme was. Participation in the RRP scheme is, after all, a PEB. My PEB measure was based on the General Ecological Behaviour Scale (Kaiser, 1998; Kaiser and Wilson, 2004). It was made up of items that could be described as supporting a pro-environmental stance. The RRP scheme represents a direct engagement with nature whereas the behaviours making up the PEB construct do not require any direct exposure to nature. Thus, Satisfaction with Life may be enhanced by PEB that involves more direct experiences with nature.

The final combined *Wellbeing + Pro-environmental Behaviour* model added important information about the contribution of additional mediators, Connection with Nature and Environmental Attitude, to human wellbeing.

Connection with Nature

The psychological construct Connection to Nature was not a significant mediator in the *Wellbeing* model. I had expected it to be closely associated with human wellbeing based on theory and reports in the literature (e.g., Mayer and Frantz, 2004; Mayer et al., 2009; Zelenski and Nisbet, 2012). In the final combined *Wellbeing + Pro-environmental Behaviour* model, Connection with Nature is a partial and indirect mediator of both independent variables and Satisfaction with Life. The strength of the total effect of Connection with Nature on Satisfaction with Life is about the same strength as that shown by Vegetation Level, $\beta = 0.09$ and 0.08 respectively, in the *Wellbeing + Pro-environmental Behaviour* model.

Connection with Nature has varying associations with different measures of wellbeing in the literature. Connection with Nature has been associated with aspects of psychological restoration, positive affect and personal growth and autonomy (Mayer and Frantz, 2004; Mayer et al., 2009; Nisbet et al., 2011). Connection with Nature's association with Satisfaction with Life, however, is inconsistent. Mayer and Frantz, (2004) and Zelenski and Nisbet (2012) found their various connection with nature scales correlated with life satisfaction but Nisbet et al. (2011) found no significant effect (as measured by Diener et al.'s, (1985) scale). Others who did find a significant correlation between Connection with

Nature and Satisfaction with Life reported stronger associations than my study. I found β = 0.09, compared to r = 0.31 - 0.44, p < 0.001 (Zelenski and Nisbet, 2012) and r = 0.20, p = < 0.01 (Mayer and Frantz, 2004). In my study, the effect of Connection with Nature on Satisfaction with Life was indirect and that might explain why my results contrast with Nisbet et al. (2011). In addition, I measured the relative effect of the five mediators on the Satisfaction with Life measure. Whereas, Zelenski and Nisbet (2012) and Mayer and Frantz (2004) investigated the effect of only Connection with Nature on Satisfaction with Life which may explain the smaller size of the effect in my study.

My study is, to my knowledge, the first time that Brügger et al.'s (2011) Disposition to Connect with Nature scale has been used in relation to wellbeing and I found it did have a significant positive association with Satisfaction with Life but not Mental Health in the final *Wellbeing + Pro-environmental Behaviour* model.

Environmental Attitude

The final model, *Wellbeing + Pro-environmental Behaviour* model, which sought to integrate wellbeing and PEB, showed a second additional mediator, Environmental Attitude, to be important. Environmental Attitude had a negative influence on both Mental Health and Satisfaction with Life but was positively correlated with greater PEB which, in turn, had a positive influence on Mental Health. The relationship of Environmental Attitude and wellbeing, therefore, is more nuanced than the other mediators.

Increased awareness and concern of environmental problems can lead to feelings of guilt, depressive emotions, hopelessness and internal conflict. However, alongside fear and anxiety, curiosity and personal responsibility may be engaged and lead to increases in activities that benefit the environment (Doherty and Clayton, 2011). Greater engagement may mitigate, to some extent, the negative effect of high levels of environmental concern on people's psychological health. I found a direct negative effect of Environmental Attitude on Mental health was β = -0.23 but the effect via PEB was β = 0.07 (Figure 3.3.10). Participating in behaviour that benefits the environment can provide a sense of empowerment and participation in addressing environmental problems. For people who are

concerned about environmental degradation this can help them feel they have a meaningful role and perhaps prevent a sense of helpless developing and so enhance mental health (Kaplan and Kaplan, 1989).

Other influences: Socio-demographics and Time Outdoors

In addition to the mediators, a role for socio-demographics and the construct Time Outdoors was tested by adding them as independent variables to the *Wellbeing* model. The addition of socio-demographics to the *Wellbeing* model (Figure 3.3.2) did not improve it (Table 3.2.6) nor explain any more of the variance in mental or physical health. It did, however, explain slightly more (1%) of Satisfaction with Life. The socio-demographics did not change the structure of the relationships between the existing variables and had only a very slight effect on the strength of the relationships (e.g., Vegetation Level to NS Social decreased by $\beta = 0.02$). Demographics have been used to explain the differences of health outcomes in New Zealand (e.g., Dew and Matheson, 2008). My analysis shows that the amount of neighbourhood vegetation and involvement in the RRP scheme were more influential on wellbeing than the socio-demographic indicators tested. This means that nature has an independent positive effect on people's wellbeing regardless of their socio-demographic status. People's socio-demographic circumstances are generally not changeable (e.g., gender or age) or may not be easily changed (e.g., income or education), thus it can be empowering to individuals and government to know that increasing the vegetation in a neighbourhood or being involved in a community planting scheme may contribute measurably to residents' quality of life.

The addition of Time Outdoors to the *Wellbeing* model (Figure 3.3.3) did not improve it. The model *Wellbeing + Time Outdoors* shows, however, that spending time outdoors once a week or more was positively associated with greater levels of neighbourhood satisfaction and greater endorsement of nature as a resource for psychological restoration. This in turn led to higher levels of all three wellbeing measures. It had about the same size effect on wellbeing as the Vegetation Level, but was not correlated with either the Vegetation Level or participation in the RRP scheme. Spending time outdoors incorporated a myriad of activities from actively engaging with nature (e.g., bird watching or gardening or walking in

nature) to activities where nature may be more incidental to the activity (e.g., outdoor sports). Whatever the activity spending time outdoors was beneficial. This finding is similar to the findings of Korpela et al. (2014) who reported the amount of time spent in nature-based activities had a significant positive effect on emotional wellbeing also mediated by psychological restoration. Maas et al. (2008) found physical activity did not mediate the positive effect of green space on health. Although it was my intention to investigate physical activity as a mediator my measure was not suitable as discussed in my Methods (Section 2.6).

One mechanism postulated to explain the positive effect of nature on wellbeing is that nature's presence encourages people to spend more time outdoors and be more physically active (see Humpel et al. (2002) and Owen et al., (2004) for reviews). In my study, greener neighbourhoods were not associated with spending more time outdoors.

My study also showed that the amount of time spent outdoors as an adult was significantly associated with the amount of time spent outdoors as a child (r_s =0.15, *p =0.002, N* = 423). Larson et al. (2011) found a stronger correlation between the amount of time spent outdoors as a child and the amount of time spent in outdoor recreation as an adult (β = 0.43). This is also consistent with Ward Thompson et al.'s (2008) findings that adult visits to woodlands or green space were significantly associated with the frequency of childhood visits to such places. Spending time actively engaged with nature in early childhood is thought to develop an interest and connection with nature (Chawla, 1998; Parsons, 2011). There is concern for children who, because of safety issues and the increase in electronic entertainment, may not spend as much time in nature as their predecessors. This lack of contact with nature may affect their relationship with nature and their mental and physical wellbeing both in childhood and then as an adult. Where childhood experiences of nature appear to be critical to adult engagement with nature and wellbeing, the greening of urban neighbourhoods and the creation of natural spaces for children to explore may be a long-term investment in community health.

The picture I and the literature have developed is one of complex associations between mediators. It is clear, however, that experiences with nature positively affect a person's

relationship with nature and are associated with wellbeing. One of the most interesting aspects of my study is that the effect of both neighbourhood vegetation level and participation in the RRP scheme on wellbeing are mediated, in the first instance, by conceptual constructs that quantify a person's relationship with nature. Connection with nature and satisfaction with the natural elements in the neighbourhood (NS Nature) both describe an affective appreciation or bond with nature, which has positive consequences for psychological wellbeing. My study provides evidence that our biophilic tendencies are still adaptive in today's highly urbanised society and that acting on our desire to affiliate with nature has measurable benefits to at least our psychological wellbeing.

4.2.2 Exposure to Urban Nature and Pro-environmental Behaviour

Past researchers have tried to understand the gap between possessing environmental knowledge and awareness and the motivation to carry out environmentally sustainable behaviours. My preferred model, *Pro-environmental Behaviour,* is a parsimonious addition to this on-going discussion (Figure 3.3.5). It demonstrates that active engagement with nature (in the form of the RRP scheme) is directly associated with a greater participation in other PEBs and also positively influences a person's Connection to Nature, which itself leads to greater participation in PEB. The strength of the direct and indirect effects is about the same.

My study confirms that a connection with nature is positively associated with environmental action. The strength of the association is relatively high and more than twice the strength of the effect of participating in the RRP scheme ($\beta = 0.58$ compared to $\beta = 0.23$). The size of the association between Connection with Nature and PEB ($\beta = 0.58$, $p = 0.00$) is similar to that found by Brügger et al., (2011) when they tested the Disposition to Connect with Nature scale as a single determinant of PEB ($\beta = 0.49$, $p < 0.001$). My work confirms the validity of Brügger et al.'s (2011) findings in a different population with a more parsimonious scale. I used a shorter version of Brügger et al.'s (2011) scale (12 items instead of 40) and modified it to suit the Wellington City population. My modification of Brügger et al.'s (2011) scale still retained an excellent internal consistency ($\alpha = 0.80$, Table 2.4).

Others have also found a positive association between various measures of connection to nature and environmentally protective behaviour. Nisbet et al. (2009) showed that Nature Relatedness correlated with PEB. Nisbet et al.'s (2009) effects ranged from $r = 0.39 - 0.45$. They recommended caution because of their small sample sizes ($N = 57 – 135$) but the size of their effects are of same order of magnitude as found in my study with a sample size of $N = 423$. Mayer and Frantz (2004) also reported a similar strength correlation between their Connectedness to Nature scale and PEB, $r = 0.44$, $p < 0.01$. Hinds and Sparks (2008) demonstrated an affective connection to nature predicted people's intentions to engage in a particular PEB but the size of their effect was much smaller than I found (B = 0.23 compared to my B = 0.82, unstandardized coefficients). Finally, Whitmarsh and O'Neill (2010) reported that a pro-environmental self-identity strongly predicted PEB, along with past experiences of PEB. The position of Connection with Nature as a mediator of the effect of experiences in nature on PEB has not often been investigated. One study found an emotional affinity for nature mediated the effect of experiences in nature and nature protective behaviour (Kals et al., 1999). This general consistency in the size of the effect of connection with nature on PEB, using a number of different measures, that indicates that a person's bond with nature is an important factor in explaining environmentally sustainable behaviour.

In addition to the effect of the mediators, various socio-demographic variables and Time Outdoors were added, as independent variables, to the *Pro-environmental Behaviour* model. The addition of socio-demographics *(Pro-environmental Behaviour + Demographics* model, Figure 3.3.6) did not improve the model (Table 3.2.9). They did not explain any more of the variance in PEB or change the structure or strength of the relationships. Involvement in the RRP scheme was more influential on PEB than the socio-demographics tested. This means that participation in the planting scheme had an independent, positive effect on people's PEB regardless of their socio-demographic status. This has implications for increasing public engagement in PEB. Continuing to involve people in community planting and perhaps other urban conservation initiatives may increase their PEB, irrespective of socio-demographic facilitators and barrier's that have traditionally used to explain PEB (e.g., Kollmus and Agyeman, 2002).

There is considerable variation in the reported effect of socio-demographics on PEB in the literature. Homeownership and the number of children in a household were the only socio-demographics that had a significant, and positive, influence on PEB in my study. Both were mediated by Connection with Nature in the model *Pro-environmental Behaviour + Demographics* (Figure 3.3.6). Reports of the effect of socio-demographics on PEB are varied. Females tend to display higher levels of environmental concern and PEB (Casey and Scott, 2006; Kollmus and Agyeman, 2002; Larson et al., 2011) but gender was not significant in my work or that of Corral-Verdugo et al., (2012). Ethnicity (Larson et al., 2011) and age (Corral-Verdugo et al., 2012) have been associated with PEB but are not significant in my model. Socio-economic variables have also been linked with greater participation in PEBs. Higher levels of education (Casey and Scott,, 2006; Kollmus and Agyeman, 2002) and greater incomes (Clark et al., 2003; Larson et al., 2011) have been associated with PEB but the only significant socio-economic variable in my study was Homeownership. Larger households were negatively associated with PEB by Clark et al. (2003) but I found, like Whitmarsh and O'Neill (2010), that a greater number of children in a household was positively associated with greater PEB. The effect of socio-demographics appears to vary with characteristics of the different studies and populations sampled which makes using them as a general tool to explain PEB problematic, beyond the fact that socio-demographics are less amenable to change than neighbourhood vegetation and participation in community planting.

The addition of Time Outdoors *(Pro-environmental Behaviour + Time Outdoors* model, Figure 3.3.7) did not improve the model (Table 3.2.9). However, the effect of spending time outdoors once a week or more was associated with a greater Connection with Nature and greater participation in PEB in my model. Larson et al. (2011) found a much stronger positive relationship between time spent outdoor recreation and self-reported PEBs (β = 0.54) than reported here (β = 0.06).

In my study, Connection with Nature is the most significant socio-psychological construct in motivating pro-environmental action. Bamberg and Möser (2007) identified various psycho-social constructs that influence PEB using a model that combined Norm Activation Theory and the Theory of Planned Behaviour. Their model explained 27% of the variance in PEB. My parsimonious *Pro-environmental Behaviour* model explains 38% and *Pro-environmental*

Behaviour + Psychological Restoration predicts 45%. This suggests that it might be worthwhile including a measure of connection to nature in Bamberg and Möser's (2007) model to improve its predictive value (Whitmarsh and O'Neill, 2010).

Pro-environmental Behaviour and Psychological Restoration

Nature's role in psychological restoration has been associated with greater participation in PEB by Byrka et al. (2010) and Hartig et al. (2007).

My *Byrka-Hartig Pro-environmental Behaviour* and *Pro-environmental Behaviour + Psychological Restoration* models confirmed Environmental Attitude as a mediator of the effect of Psychological Restoration on PEB. My *Byrka-Hartig Pro-environmental Behaviour* model indicates that the strength of the effect of Psychological Restoration on PEB was stronger (β = 0.47) than that found by Byrka et al. (2010) (β = 0 .27) or Hartig et al. (2007) (β = 0.21). It also explained more of the variance in PEB (32% compared to 14% and 20% for Byrka and Hartig, respectively). My results suggest their findings for populations in Germany and Norway are more widely applicable.

Corral-Verdugo et al. (2012) investigated the reverse relationship between psychological restoration and PEB. They reported significant gains in psychological restoration as an outcome of participating in PEB and the strength of their effect was similar to mine (β = 0.59). All of these studies, including my own, have shown correlation rather than causation so the direction of the effect has not been proven.

Testing the mediation of one variable in isolation provides useful information but gives no indication of its relative importance. Once I confirmed the associations above I added them to the *Pro-environmental Behaviour* model as described in the Methods (Section 2.8.3). The more complex *Pro-environmental Behaviour + Psychological Restoration* model deepens our understanding of the relationships between the variables that effect PEB. This model explained more of the variance found in PEB than the more parsimonious *Pro-environmental Behaviour* (45% compared to 38%). It also demonstrated that the amount of

neighbourhood vegetation positively influenced PEB (mediated by the use of nature for Psychological Restoration and Environmental Attitude). In this model the effect of Psychological Restoration on PEB was fully mediated by Environmental Attitude rather than the partial mediation seen in the *Byrka-Hartig* model.

In the *Pro-environmental Behaviour + Psychological Restoration* model, the strength of the effect of Psychological Restoration on PEB was much less than in my *Byrka-Hartig Pro-environmental Behaviour* model (β = 0.13 compared to 0.47) and less than that reported by Byrka et al. (2010) and Hartig et al. (2007). Connection with Nature had a much stronger effect on PEB (β = 0.57), which was unchanged from the parsimonious *Pro-environmental Behaviour* model. It indicates that there may be some overlap between the two constructs and Connection with Nature is replacing some of the effect of Psychological Restoration. Hartig et al. (2007) suggested that the low strength of the effects between Psychological Restoration and Environmental Attitude on PEB may be because Psychological Restoration did not show much variance in their data set. The variation was similar in my study, that is, most people (80%) endorsed the use of nature for Psychological Restoration. The small size of the effect of Psychological Restoration may instead be because Connection with Nature is more influential.

The other new variable, Environmental Attitude (as measured by the New Environmental Paradigm (NEP, Dunlap, 2008; Dunlap et al., 2000), was indirectly influenced by both independent variables through Connection with Nature, Psychological Restoration and NS Nature. This demonstrates that experiences in nature that translate into a bond with nature are influential in forming people's environmental attitude. An active engagement with nature, in the form of participation in the RRP scheme, positively influenced Environmental Attitude a little more strongly (β = 0.064) than the more passive but sustained influence of neighbourhood vegetation (β = 0.045). Environmental Attitude in turn influences PEB (β = 0.30). Casey and Scott (2006) also found a positive association between NEP and PEB (*r* = 0.45); slightly more than my study. However, Whitmarsh and O'Neill (2010) found no such association when using the NEP scale.

Environmental attitude has been an inconsistent predictor of PEB in the literature (Kollmus and Agyeman, 2002). My study shows that Environmental Attitude and any accompanying motivation to act pro-environmentally appear to be linked to valuing nature in a very personal way. The recognition that one gains psychologically from experiences in nature, both through its restorative value and through an emotional bond with nature, positively contribute to a person's Environmental Attitude and through this their pro-environmental behaviour. People are moved to protect what they value (Schultz, 2000). My findings support Leopold's (1970) and others assertion that it is feeling a sense of connection to nature, and not simply our cognitions (i.e., Environmental Attitude), that shapes how we treat the environment.

Other unmeasured variables could also be important in determining PEB. The most notable is probably environmental education. This has been associated with participation in PEB in other studies (e.g., Kals et al., 1999; Nisbet et al., 2009; Parker, 2009). As a single predictor education has not always been strongly associated with promoting PEB (Schultz, 2014a) but does effect environmental attitude which in turn can predict PEB. Future investigation of environmental education as a potential mediator of nature's effect on PEB would be worthwhile.

The direction of the arrows in the Structural Equation Models infers causation of the effect. The results are, however, correlational. The direction of the association between variables could be reversed or could form a positive feedback loop; undertaking PEBs may increase a person's connectedness to nature or, as Corral-Verdugo et al. (2012) suggest, psychological restoration. Although this is possible, it seems that a person's connection with nature or experience of psychological restoration is driven by engagement with nature. The items I and Corral-Verdugo et al. (2012) used in the constructs to quantify PEB did not involve direct experiences with nature. Whichever the direction of association, involvement in the RRP scheme and connection with nature are positively associated with PEB.

Experiences in nature have a positive effect on people's PEB. Direct experiences, such as the RRP scheme, appear to have a stronger influence than more passive experiences, such as neighbourhood vegetation. My findings support existing research but I have also extended

understanding by demonstrating the synergistic influence of three socio-psychological constructs: Connection with Nature, use of nature for Psychological Restoration and Environmental Attitude, which together explain nearly half of the variance in PEB. I also identified Connection with Nature as the most influential mediator of the relationship between neighbourhood vegetation level and community planting and PEB.

4.3 Evaluation of Study Design and Methods

Structural Equation modelling was used to test the predicted relationships between the variables. As discussed earlier, it is superior to path analysis in that it examines both the structural relationships between variables and provides measures of the relationships between variables. The use of latent variables and parcelling of the indicator items also reduces measurement error. The Information Theoretic method of model selection that I applied to SEM comparisons also has advantages over traditional null hypotheses testing. The Information Theoretic approach comparatively evaluates many models and separates the information in the model from the noise (residual) in the data (Hobbs and Hilborn, 2006). Null hypothesis testing can only supply very limited information in that it can only reject or not reject the null hypothesis. In contrast, the Information Theoretic approach can be used to rank models, estimate the relative likelihood of each and allow a set of alternative models to be evaluated (Anderson et al., 2000).This is why it is referred to as a multi-model inference and selection (Burnham and Anderson, 2002). Most other researchers (e.g., Brügger et al., 2011; Byrka et al., 2010; Fuller et al., 2007; Hartig et al., 2007; Hur and Morrow-Jones, 2008; Korpela et al., 2014) have used hierarchical regression analyses with Null Hypothesis Testing when investigating the relationships between nature, wellbeing and pro-environmental behaviour but such approaches are prone to errors of models under or over-fitting data. The statistical methods used in my study are an important advance that strengthens many of the previous findings and quantify the relationships between variables.

The quasi-experimental design of my study is common in social/psychological research and similar comparative designs have been used by some of the researchers cited (e.g., Hartig et al., 2001; Honold et al., 2012; Kaplan, 2001). My study took advantage of the variation in

vegetation level between neighbourhoods and participation in the RRP scheme among residents. A strength of my study was that, the independent variable, level of neighbourhood vegetation, was objectively measured and PEB checked against an observable PEB (i.e., curb-side recycling) in my survey population. In addition, participation in the in the RRP scheme provided a control group where some people in each neighbourhood participated in the scheme and some did not, so the effect of being involved in the RRP scheme could be measured. These objective measures alleviated the possibility of same-source bias that can arise where neighbourhood qualities and wellbeing are both assessed by self-report (Weden et al., 2008). Traditional experiments, investigating the relationship between nature and human wellbeing, rely on artificial situations and often have a limited diversity of participants and small sample size (e.g., university students, Hartig et al., 1991, Study 2; Tennessen and Cimprich, 1995) which limits their generalizability. A traditional experiment was not possible for my study, although I hope studies like mine might lead to experiments where neighbourhood are 'greened' and wellbeing improvements evaluated. Although my population were not randomly assigned to the various neighbourhoods, I did have a broad socio-demographic base across a diverse range of suburbs.

My survey instrument was a self-reported questionnaire. Self-report can be unreliable but is a suitable method for obtaining the kind of information I sought (Dillman, 2009; White et al., 2005). Corral-Verdugo (1997) found discrepancies between self-reported and observed ecological data in a population of housewives in Hermosillo, Mexico. In this study, the reported and observed recycling of aluminium and cardboard were significantly correlated (r = 0.44 and 0.22 for aluminium and cardboard respectively) but there was no correlation between the reported and observed levels of glass or paper recycling. The pressure to appear socially responsible may lead to an over-estimation of socially desired behaviours, such as PEB. In contrast, Kaiser (1998) reported that social desirability had only a marginal influence on ecological behaviour and in a later study showed a high correlation between self-reported and observed PEB (Kaiser et al., 2001). There could be some level of social desirability in the self-reported measures, including PEB, in my study. However, I found that the observed recycling of waste plastic, paper and metal PEB correlated strongly with self-reports of recycling behaviour (r = 0.92, p = 0.000, n = 20). This compared favourably with

Kaiser et al.'s (2001) study where the correlation between observed and self-reported PEB was $r = 0.78$. The high correlation between observed and self-reported recycling behaviour supports the reliability of the associations demonstrated in my study.

The results of my research are correlational, like the majority of the studies cited in this thesis. Although the relationships are theoretically very plausible they need to be confirmed by longitudinal experiments.

There may also have been some self-selection of survey participants. People who had an affinity for trees or an interest in tree planting may have been more likely to participate in my survey. I also expected people who had been involved in the RRP scheme to be over-represented. If self-selection did occur, those people might be more predisposed to the positive influence of nature than people with a lower affinity for trees. This may result in a statistical bias. I wanted to investige the possibility of self-selection. I could not calculate the proportion of the Wellington City population who had been involved in the RRP scheme since its inception because of some missing and inaccessible data. However, 10.7% (126) of all the households who received my survey had at some point participated in the RRP scheme (see Table 2.1) and 14% of the people who responded to my survey had participated in the RRP scheme. This indicates a low self-selection bias of just over three percent and suggests self-selection of survey respondents was not a major influence on my findings.

One of the limitations of my work is that the survey population was not representative of the population of Wellington City. The demographics of the survey population differed significantly from the population of Wellington City in all measures apart from household income. This limits the generalizability of my findings. I did not re-survey the non-respondents and so I do not know if, or how, they differed from those who did respond. Nevertheless, the addition of socio-demographic variables to my models did not improve on the *Wellbeing* or *Pro-environmental Behaviour* models' explanatory power. This suggests that the amount of neighbourhood vegetation or participation in the RRP scheme had a stronger independent influence on the wellbeing and PEB of the survey population than the

socio-demographics. Therefore, my findings may well be more widely applicable. Future research should investigate the characteristics of non-respondents.

The individual questions in my survey formed sound constructs which had high internal consistencies and made theoretical sense. The constructs independently predicted or were predicted by different variables, even where there were some correlations, so this is further evidence of the discriminant validity of the constructs. The only construct I would make major changes to is the measure for outdoor activities which end up being represented by a binary variable in my study. Valuable information could be gained by indicating how much time was spent at the various types of outdoor activity and measuring it with a finer temporal scale.

4.4 Applications

4.4.1 Local and National Government Context

Urban-planting programmes from national and local governments intend to provide a better quality of life for urban residents. Unfortunately, these programmes are not routinely evaluated and are largely based on assumed benefits to residents. Continued financing of these programmes requires justification of their usefulness. The Road Reserve Planting (RRP) scheme is one such programme, managed by the Wellington City Council, with the intent of improving the quality of life for Wellington City residents (Wellington City Council, 2007). It has been running for over 20 years and my study is part of the first quantitative evaluation of its success and benefits.

I have demonstrated that the resources put in to greening the city add significantly to the quality of residents' lives, especially their health, alongside any gains to biodiversity or improvements in air quality, climate control, mitigation of water run-off and countering of the urban heat-island effect (World Health Organisation, 2005). People who lived in greener neighbourhoods had significantly higher levels of wellbeing than people who lived in neighbourhoods with less vegetation. I have also demonstrated that participation in the RRP

scheme was of benefit to the participants' psychological wellbeing and positively influenced residents' participation in other pro-environmental behaviours. This adds another dimension to evaluations of the RRP scheme. Berentson (2013) found plant survival was generally poor but native trees were 4.3 times more likely to survive than exotics. Even though planting success has been poor, the RRP scheme achieved other successes for participants such as measurable increases in psychological wellbeing and PEB, as well as the benefits reported by the participants of improved neighbourhood appearance and increases in social connections among neighbours.

My results show the value of neighbourhood planting in the immediate vicinity of people's homes. It is apparent that the efforts put into greening urban neighbourhoods, for example streetscapes, make a significant contribution to residents' wellbeing. The results of my study may give support for the continued implementation of the RRP scheme and motivate further investment in community greening initiatives. The continued greening of the Wellington City is especially needed in biologically depauperate neighbourhoods with low amounts of vegetation which score highly on the New Zealand Deprivation Index.

Local and National Government has a duty to make decisions that support the wellbeing of all New Zealanders. The multiple benefits of urban green space could be considered as a cost-effective public health intervention with a preventative focus that can support people's physical and psychological health as well as a valuable contributor to increasing urban biodiversity.

4.4.2 Planting Participation

One aim of this study was to describe the population involved in the RRP scheme. This may be of importance to the Wellington City Council who manage the scheme, especially if they want to recruit new volunteers to this or other restoration schemes or broaden participation. The socio-demographics of people who participated in the RRP scheme were significantly different from those in the survey population who did not participate with respect to marital status, education and ethnicity (Table 3.2). There were no differences in gender, age, number of children in the household, household income or homeownership.

Cowie's (2010) Wellington study of participants in restoration groups also found no gender differences, although women are generally over-represented when it comes to environmental care and action (Kollmuss and Agyman, 2002). Cowie's (2010) groups, like my study, had a predominance of New Zealand Europeans. Other studies have found greater education, age, home ownership and income have helped explain public participation in greening or restoration groups (Berentson, 2013; Cowie, 2010; Martinussen and Lloyd, 2013; Zhang et al., 2007). I have found no other studies where marital status effected participation in city greening or environmental restoration schemes.

Cowie (2010) suggests that the restoration group represented people with high levels of cultural capital and capabilities. That is, as New Zealand Europeans belonging to the dominant cultural group, they are able to navigate social structures and participate in society more easily (Cowie, 2010). In my study, people involved in the RRP scheme had a greater connection with nature, used nature more for psychological restoration and had higher levels of environmental attitude and pro-environmental behaviour than those who did not participate in the RRP scheme. They also volunteered in other areas at a higher rate than people who did not participate (55.7% compared to 35.4%, results not given). These socio-psychological differences suggest another way of understanding participation and provide additional insights into why some individuals participate in environmental conservation and others do not, that is defined by their bond with nature.

There was a very low participation by non-New Zealand Europeans in the RRP scheme. Yet there was no association between ethnicity and the socio-psychological constructs Connection with Nature, use of nature for Psychological Restoration, Environmental Attitude or Pro-environmental Behaviour. The 2006 New Zealand Census showed that Māori, for example, participated in voluntary work at higher rates (19%) than that of the overall New Zealand population (15%) (Statistics New Zealand, 2006b), yet there were no people who identified as Māori participating in the RRP scheme. My study sheds no light on the reasons for this. Is it the way the scheme is prompted or administered discouraging participation by people of ethnicities other than New Zealand European? This requires further investigation.

There was a high level of interest in the RRP scheme from non-participants (around 70% of non-participants) suggesting there may be an untapped source of willing volunteers. If managers of the RRP scheme wished to broaden the range of participants they could focus on enlisting demographics outside of those already over-represented so the benefits of greater wellbeing and connection with nature could be extended to the wider population.

Another way my findings could be used when promoting participation in future RRP schemes (and probably others) is using principles of Community Based Social Marketing. Removing or reducing any barriers and enhancing facilitators and benefits is a key to increased implementation of a particular behaviour (Schultz, 2014a). My study showed a perceived lack of time, due to work or family commitments, was the main reported barrier to future participation in the RRP scheme. Of the people who did participate in the RRP scheme, 33% planted and prepared the ground with other members of their household. The benefits of participating included improvement to psychological wellbeing and improved neighbourhood appearance. These findings could be used to encourage participation when promoting the RRP scheme by emphasising social norms (i.e., “Others are already doing it in your neighbourhood”), removing barriers (i.e., “You can spend time with family while doing it”) and emphasising the benefits (i.e., improved psychological health and a more attractive neighbourhoods).

4.4.3 Time in Nature as a Public Health Intervention

My work has added to the existing evidence that exposure to nature is beneficial to humans. It has implications for health promotions or interventions, urban planning and public policy. This study suggests that having adequate amounts of green space, particularly mature trees, enhances the quality of life of urban residents. The benefits to wellbeing may accumulate from many episodes of exposure, providing a long-term connection with the natural environment that is beneficial for psychological restoration and stress reduction and through this positively influences psychological and physical health.

Urban nature is a health resource. My results suggest some innovative approaches to health and wellbeing are possible. On an individual level, spending time in nature or participating in

community gardens, community greening, environmental conservation or restoration initiatives could be an effective way to manage stress and recover from the '*wear and tear*' of daily life. This might be particularly beneficial to people who are coping with difficult life situations, poor mental health, or are less mobile or socially isolated.

The New Zealand Ministry of Health already encourages General Practitioners write Green Prescriptions which entails advising patients to be physically active as part of their treatment (New Zealand Ministry of Health, 2014). If Green Prescriptions included encouragement to exercise in nature people would be subject to the combined benefits offered by physical activity and exposure to nature. This suggestion is supported by the work of Barton and Pretty (2010) who demonstrated that people who exercised in nature reported better mood and self-esteem than those who exercised in non-natural environments. The positive effect could be seen in as little as five minutes and was still evident after a full day's activity. These findings were irrespective of the activity tested in both healthy people and those with mental health disorders.

Nature-based therapies already exist. Eco-therapy, which emphasizes connection with nature is used in the treatment of depression and stress or to develop a sense of purpose or hopefulness (Buzzel and Chalquist, 2009). Horticultural therapy is a tool for helping disadvantaged or at risk people (e.g., McChesney, 2014) and animal therapy with friendly, well-behaved dog improves the lives of people in hospitals, hospices and homes for the elderly (Canine Friends, 2014). In Sweden, restorative natural areas are combined with horticultural therapy and traditional occupational, physiotherapy and psycho-therapy (Grahn et al., 2010).

The rising cost of mental health treatment is of growing concern both in New Zealand and overseas and the use of nature as a health resource is a relatively low-cost preventative or supplement to other forms of treatment. Future studies could attempt to quantify the health savings that my study suggests might be associated with urban nature. Such a study might usefully apply the New Zealand Ministry of Health's Health Tracker, which collates a wide range of data from primary care and mental health services, mortality registers and hospitals, as used by (Nutsford et al., 2013) in their Auckland City study.

4.4.4 Promoting Pro-environmental Behaviour

My study demonstrated that participation in the planting scheme and having a greater Connection with Nature were both associated with greater endorsement of self-reported PEB. Of the two, Connection with Nature was the most influential. These findings may be useful for agencies aiming to encourage the public participation in environmental initiatives or looking for cost effective, socially acceptable ways encourage participation in PEBs.

Calls aimed at promoting pro-environmental behaviours that rely solely on information-based appeals do not often lead to behavioural changes (Kollmus and Agyeman, 2002; Schultz, 2011). Appealing to people's sense of altruism can generate the idea that activities that benefit the environment come at a cost to their quality of life and can also generate feelings of helplessness (Kaplan, S., 2000). The *Wellbeing* model showed pro-environmental behaviour had a positive effect on wellbeing. Perhaps framing involvement with environmental activities in terms of the gains to people's wellbeing, both social and psychological, will attract wider participation or changes in policy to incentivise participation.

Steg and Vlek (2009) suggest that the effectiveness of behavioural interventions increased when they are aimed at the antecedents of the particular behaviour. A person's connection to nature tends to remain relatively stable and can be increased by direct engagement with nature (Schultz, 2014b). Finding ways to encourage people's connection with nature may result in associated gains in environmentally protective behaviour. The development of direct hands-on learning experiences in nature (e.g., in schools) is more likely to create affective bonds that have a positive influence on environmental attitude and behaviour than just been taught about nature. For example, experiences in the wilderness or nature sanctuaries, reserves and zoos may give people direct experience with nature perhaps stimulating their curiosity and interest to engage and enjoy nature more. Improving people's connection with nature is however, a long-term initiative that requires life-style adjustments.

Getting people involved in planting schemes may also have a positive association with other environmentally protective behaviours. The reported motivations of people involved in the RRP scheme did not generally include environmental restoration. It is exciting to find that, even if it was unintentional, this involvement had a significant influence on participants' connection with nature and their PEB. It suggests that getting people actively involved in community planting schemes close to their homes or even planting on their own properties improves their connection with nature and might have a consequence which results in more environmentally friendly behaviours. Whitmarsh and O'Neill (2010) also report some '*spill over'* effects of participating in PEB. It would be a fruitful to investigate if this environmental care expanded into care of New Zealand's endangered flora and fauna.

4.4.5 Environmental Equity

There is substantial variation in greenery and biodiversity across urban landscapes. I found inequity in the richness of vegetation in neighbourhoods across Wellington City which was associated with socio-economic differences and measures of wellbeing. My study showed that exposure to nature benefitted people's wellbeing irrespective of their socio-demographic status, both psychological and physical wellbeing increased linearly with the amount and quality of vegetation cover. Urban greening, therefore, has implications for equity and justice across city neighbourhoods and communities.

The household income of the survey respondents was significantly associated with the level of neighbourhood vegetation in the model *Wellbeing + Demographics*. Other demographics dropped out of the model because they were not significantly associated with the mediators or the wellbeing variables, but there were significant correlations between the level of neighbourhood vegetation and the other economic indicators (Education and Home Ownership) and Ethnicity (Appendix II). My results also show that the neighbourhoods with lowest levels of vegetation correspond to the highest levels of deprivation according to the New Zealand Deprivation Index (Figure 3.17). This means that people who are more economically advantaged and identify as New Zealand Europeans are more likely to live in neighbourhoods with a greater richness of vegetation and their wellbeing is more likely to benefit. Although it was not an aim of this study to determine the amount of

neighbourhood vegetation people need for optimal wellbeing, my results suggest that people are disadvantaged by living in neighbourhoods with a vegetation level below Level 3 or 4. Where there is less total vegetation cover, fewer mature trees and more grass, and comparatively more people had poorer mental health (Section 3.1).

A more equitable distribution of urban green space may go some way to address these inequalities. There is evidence that people who are less mobile (e.g., the elderly and children) with lower household incomes and less education benefit most from contact with nature (Maas et al., 2009). Mitchell and Popham (2008), working with English populations, found that there were less income related health inequalities in populations living in greener areas. Research on restorative environments has paid little attention to the negative health implications of chronic stress that may result from lack of access to nature (Van Den Berg et al., 2007). Future work could focus on the effect of biologically depauperate neighbourhoods on their residents' wellbeing and investigate other ways of facilitating people's connection with nature because my estimate of 135 m^2 of green space per person (Section 3.1) may be unattainable in densely populated cities. There are particular concerns for children over their lack of direct engagement with nature and their increasing focus on electronic entertainment (Louv, 2008). The long-term effects of a disconnection with nature may be detrimental to their health (Kahn and Kellert, 2002) and impair the development of a positive bond with nature that my work demonstrates is associated with the development of environmental concern and pro-environmental action.

4.5 Conclusion

My study has integrated ecological, behavioural and social science to further understand the relationship between humans and nature and shows the importance of residents' relationship with nature for their wellbeing. I demonstrated that the wellbeing of residents' of Wellington City was positively associated with greater amounts of neighbourhood vegetation and participation in a local-government planting scheme. Participation in the planting scheme was also positively associated with increases in pro-environmental behaviour. My findings strengthen those of other researchers, who found nature was beneficial to human wellbeing, through the use of Structural Equation Modelling (SEM) and

Information Theoretic (IT) analyses. SEM minimises measurement error through using latent variables and is also more powerful in detecting associations than multiple regression analyses. IT allows us to identify parsimonious models that have easier utility in environmental policy.

My study advanced existing knowledge in four main ways. It demonstrated that the amount of vegetation in residents' immediate home environment affects their wellbeing. Others have shown that largish areas of public nearby green space is associated with wellbeing but they usually did not include private gardens or measure the vegetation, such as street trees, in people's immediate neighbourhood.

Second, I have identified, for the first time, some socio-psychological constructs that mediate the relationship between urban vegetation, participation in a planting scheme and human wellbeing and PEB. The relationship humans have with nature is still adaptive, and humans benefit from the urban ecosystem.

Third, the benefits of nature on wellbeing and increases in PEB were consistent across all socio-demographic groups and independent of socio-demographic status. This may influence the way appeals for public participation in environmental initiatives are focused, rather than aiming for a particular demographic, such as gender or age, programmes to improve people's wellbeing or promote PEB can be more widely based.

Finally, I have identified evidence of inequity in the distribution of neighbourhood vegetation associated with socio-economic status across Wellington City. The inequitable distribution of vegetation was also associated with a higher proportion of people with poorer mental health. This suggests that increasing the level of vegetation, especially in less green neighbourhoods, may have a positive effect on the residents' mental wellbeing. It may also go some way address socio-economic related health inequalities. Future research could focus on the consequences of living in biologically depauperate neighbourhoods on residents' wellbeing and perhaps investigate other ways of facilitating people's connection with nature

My findings may be valuable in promoting population-wide health interventions. For example, public health agencies could promote time in nature or participation in environmental groups as a ways of managing individual mental health or stress. This might be particularly relevant for people with poorer levels of mental health or people facing particularly difficult life situation. This could improve people's quality of life and translate into cost saving for mental health services. Further research is needed to quantify any cost savings, perhaps with respect to number of mental health treatments. My findings could also be applied to public housing, hospitals and mental health treatment centres where the presence of trees may aid recovery or help manage the stress. My work is correlational. A longitudinal experiment testing the effect of increasing vegetation in people's living environment would be needed to prove causation and is an important next step.

I have established that the resources put into greening Wellington City add to the residents' quality of life. This might give continued support for the RRP scheme, even in the face of the limited survival rates of the plantings. It may also motivate public support and government policy and investment into urban greening and conservation outside of urban areas.

I have suggested ways of using my findings to increase people's PEB. Agencies aiming to effect behaviour change could take a two pronged approach, through engaging direct contact with nature, such as participation in planting, and through developing people's bond with nature, which I found had the strongest influence on PEB. This approach could be applied anywhere where one wants to promote care of the environment, in environmental education, zoos, sanctuaries or schools.

The resources for the conservation of New Zealand's flora and fauna are limited. Gaining greater financial and political support for conservation depends on demonstrating the diversity and magnitude of nature's benefits and value to a wider public and government. My work has made some important advances towards this.

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Appendix I

A matrix showing associations between independent and dependent variables. Correlations between ordinal-ordinal or scale-ordinal variables were measured by Pearson's Correlation Coefficient (*r*) or Spearman's rho (r_s) for normally distributed and non-normally distributed data respectively. Associations between dichotomous-ordinal variables were measured by the point biserial correlation coefficient (*r*pb) and between dichotomous-dichotomous variables by the phi coefficient . *N* = 423. Level = Vegetation Level; RRP = Participation in the RRP scheme; NS = Neighbourhood Satisfaction; CN = Connection with Nature; PR = Psychological Restoration; EA = Environmental Attitude; PEB = Pro-environmental Behaviour SWL = Satisfaction with Life.

	Level	RRP[1]	NS Social	NS Nature	CN	PR	EA	PEB	Mental	SWL	Physical Health	Time Outdoors	Major Event
RRP[1]													
Coefficient	.109*												
Significance	.024												
NS Social													
Coefficient	.16**	.11*											
Significance	.001	.02											
NS Nature													
Coefficient	.16**	-.027	.36**										
Significance	.001	.59	.000										
Connection with Nature													
Coefficient	-.012	.19**	.082	.14**									
Significance	.81	.000	.092	.003									
Psychological Restoration													
Coefficient	.13**	.15**	.15**	.10*	.53**								
Significance	.006	.005	.002	.036	.000								
Environmental Attitude													
Coefficient	.007	.065	.037	-.026	.24**	.37**							
Significance	.884	.183	.450	.592	.000	.000							

** $p \leq 0.01$, * $p \leq 0.05$. [1]Dichotomous variables; [2]Ordinal, non-normal.

Continued overleaf.

	Level	RRP[1]	NS Social	NS Nature	CN	PR	EA	PEB	Mental	SWL	Physical	Time Out doors	Major Event
PEB													
Coefficient	.002	.18**	.034	-.009	.44**	.34**	.32**						
Significance	.97	.000	.48	.85	.000	.000	.000						
Mental Health													
Coefficient	.075	.028	.19**	.28**	.16**	.12*	-.07	.068					
Significance	.12	.56	.000	.000	.001	.01	.16	.16					
Satisfaction with Life													
Coefficient	.12**	.026	.22**	.23**	.17**	.17**	-.057	.067	.45**				
Significance	.007	.59	.000	.000	.000	.001	.24	.17	.000				
Physical													
Coefficient	.110*	-.025	.13**	.137**	.097*	.085	-.045	.027	.41**	.28**			
Significance	.023	.68	.008	.005	.045	.082	.36	.58	.000	.000			
Time[1] Outdoors													
Coefficient	.104*	.036	.077	.098*	.28**	.31**	.068	.22**	.087	.19**	.08		
Significance	.032	.46	.12	.043	.000	.000	.16	.000	.073	.000	.10		
Total Number Conditions[2]													
Coefficient	.03	-.04	-.079	-.066	-.035	-.008	.074	-.058	-.22**	-.17**	-.44**	-.09	-.16**
Significance	.54	.47	.10	.17	.47	.88	.12	.23	.001	.003	.000	.07	.001
Major Event[1]													
Coefficient	-.011	-.053	.12*	.061	.082	.109*	.100*	-.015	-.071	.011	-.105*	.023	
Significance	.83	.28	.014	.21	.093	.025	.039	.76	.15	.82	.030	.634	

** $p \leq 0.01$, * $p \leq 0.05$. [1]Dichotomous variables; [2]Ordinal, non-normal.

Appendix II

A matrix showing associations between socio-demographics and the independent and dependent variables. Correlations between ordinal-ordinal or scale-ordinal variables were measured by Pearson's Correlation Coefficient (*r*) data or Spearman's rho (r_s) for normally distributed and non-normally distributed data respectively. Correlations between dichotomous-ordinal variables were measured by the point biserial correlation coefficient (r_{pb}). Dichotomous-dichotomous variables were measured by the phi coefficient and variables with more than two categories were measured using Chi-square tests. *N* = 423. [1] = ordinal, normal distribution; [2] = ordinal, non-normal; [3] = dichotomous; [4] = categorical (> 2 categories).

	Level[1]	RRP[3]	NS Social[1]	NS Nature[1]	Connect Nature[1]	Psych Rest[1]	Envir Attitude[1]	PEB[1]	Wellbeing Mental[1]	Wellbeing SWL[1]	Wellbeing Physical[1]	Time Outdoors[3]
Age[1]												
Coefficient	.121*	.095*	.126*	.016	-.010	-.020	.004	-.067	.022	.032	-.009	-.160**
Significance	.013	.050	.010	.735	.842	.680	.930	.717	.658	.517	.862	.001
Education[1]												
Coefficient	.197**	.054	-.017	.032	.015	.026	.031	.029	-.047	.017	.044	.089
Significance	.000	.266	.732	.512	.754	.594	.531	.557	.335	.734	.372	.067
Income[2]												
Coefficient	.181**	-.018	-.002	.056	-.137**	- .121*	-.058	-.066	.012	.027	.065	.059
Significance	.000	.710	.966	.251	.005	.016	.237	.174	.798	.577	.181	.230
Children[2]												
Coefficient	-.020	-.041	.023	.047	.064	.062	-.009	.036*	-.001	.10*	.010	.016**
Significance	.69	.403	.64	.34	.19	.200	.85	.046	.98	.04	.86	.001
Gender[3]												
Coefficient	-.080	.003	.01	.017	.06	.090*	.078	.085	.032	.048	-.029	.050
Significance	.10	.951	.84	.73	.24	.05	.11	.08	.52	.32	.554	.308
Home ownership[3]												
Coefficient	.15**	.021	.102*	.122*	-.092	-.075	.069	-.071	-.005	.038	.02	-.051
Significance	.002	.66	.037	.02	.06	.12	.155	.14	.91	.43	.62	.294
Marital Status[4]												
Coefficient	34.284	7.032	9.768	20.163	10.076	13.562	8.730	11.555	16.709	22.743	12.027	3.557
Significance	.080	.134	.636	.064	.609	.631	.726	.774	.405	.121	.742	.469
df	24	4	12	12	12	16	12	16	16	16	16	4
Ethnicity[4]												
Coefficient	45.883*	-.12*	30.06*	19.96	23.845	14.922	18.145	16.052	10.054	29.445	14.039	2.306
Significance	.032	.01	.012	.17	.068	.781	.255	.713	.967	.079	.828	.805
df	30	5	15	15	12	20	15	20	20	20	20	5

** $p \leq 0.01$, * $p \leq 0.05$.

Appendix III Item Parcels for SEM Constructs

The items in each construct were divided into parcels to be used in the Structural Equation Models (SEM). Items in each parcel were selected using the high/low loadings from the original Exploratory Factor Analysis, with a similar number of items per parcel and a balance of negatively worded items across the parcels.

Mediator		Parcels of items for SEM
NS Social		
	SA	3, 5, 8, 7
	SB	1, 2, 7
NS Nature		
	NA	2, 7, 8
	NB	6, 9, 11
Connection with Nature		
	CA	5, 10, 14, 17
	CB	2, 6, 7, 12
	CC	1, 3, 4, 15
Psychological Restoration		
	DA	2, 6, 7, 8
	DB	1, 4, 9
	DC	3, 5, 10
Attitude		
	EA	2, 7, 9, 10, 15
	EB	8, 11, 12, 13, 14
	EC	1, 3, 4, 5, 6
Pro-environmental Behaviour		
	FA	1, 6, 10, 14
	FB	3, 4, 7, 11
	FC	5, 8, 12

Appendix IV Human Ethics Approval

TE WHARE WĀNANGA O TE ŪPOKO O TE IKA A MĀUI
VICTORIA
UNIVERSITY OF WELLINGTON

Phone 0-4-463 5676

Fax 0-4-463 5209

Email Allison.Kirkman@vuw.ac.nz

MEMORANDUM

TO	Julie Whitburn
COPY TO	Wayne Linklater Taciano Milfont
FROM	Dr Allison Kirkman, Convenor, Human Ethics Committee

DATE	13 October 2012
PAGES	1

SUBJECT	**Ethics Approval: 19506** **Urban Planting in Wellington, New Zealand: Impact on human wellbeing and pro-environmental behaviour**

Thank you for your application for ethical approval, which has now been considered by the Standing Committee of the Human Ethics Committee.

Your application has been approved from the above date and this approval continues until 31 May 2014. If your data collection is not completed by this date you should apply to the Human Ethics Committee for an extension to this approval.

Best wishes with the research.

Allison Kirkman
Human Ethics Committee

Appendix V Survey Letters and Accompaniments

1. Letter Introducing the Survey
2. Participant Information Sheet
3. Free Plants Voucher
4. Follow Up Letter: Thank you & Reminder

VICTORIA UNIVERSITY OF WELLINGTON
Te Whare Wānanga o te Ūpoko o te Ika a Māui

22 October 2012

To a Representative of Your Household,

About a week from now you will receive in the mail a request to fill out a questionnaire for an important research project being conducted at Victoria University of Wellington New Zealand.

The purpose of this 30 minute questionnaire is to investigate the relationship between people and vegetation in Wellington City. It will provide information to enhance both the environment and human wellbeing. Your address has been chosen because of its geographic location in a neighbourhood where plants have been planted as part of the Wellington City Council's Community Greening programme (formerly the Free Plants Programme). We have no additional personal details about you.

I am writing in advance because many people like to know ahead of time that they will receive a survey. Your answers on the questionnaire are confidential. The results of the questionnaire will only be used for our study. Once the study is complete, a summary report will be made available to you and all other participants. A reminder to complete the questionnaire will be sent about two weeks after it arrives.

Thank you for your time and contribution to this important research. It's only with the generous help of people like you that our research can be successful.

Sincerely,

Julie Whitburn

Centre for Biodiversity and Restoration Ecology, Victoria University of Wellington

Email: whitbujuli@myvuw.ac.nz Mobile: 027 293 5941

CENTRE FOR BIODIVERSITY & RESTORATION ECOLOGY
Te Tumu Whakaoho Mauri o te Ao Koiora

VICTORIA UNIVERSITY OF WELLINGTON
Te Whare Wānanga o te Ūpoko o te Ika a Māui

Survey on Planting in Wellington City

Participant Information Sheet

30 October 2012

To a Representative of Your Household,

I am writing to ask for your help in a study investigating the relationship between people and vegetation in Wellington City. Results from this study will be useful for planning future vegetation in Wellington. This study has been approved by the Human Ethics Committee at Victoria University of Wellington (Number: JRM19506).

Your address has been chosen because it is located in a neighbourhood where planting of public land, as part of the Wellington City Council's (WCC) Community Greening programme (formerly called the Free Plants Programme), has taken place in the past. I am inviting a representative of your household (over 18 years of age) to participate in this questionnaire that will take about 30 minutes to complete. As part of this study we will also make observations of vegetation and kerbside recycling in your neighbourhood. If you prefer you can complete the survey on-line at: www.surveymonkey.com/s/Planting_in_Wellington.

Your responses to the questionnaire are confidential. The information from all returned questionnaires will be combined for analysis. Only my supervisors, Dr Wayne Linklater (Centre for Biodiversity and Restoration Ecology, wayne.linklater@vuw.ac.nz, 04 463 5233 ext. 8575) and Dr Taciano Milfont (School of Psychology) and I will have access to completed questionnaires.

This questionnaire is voluntary. However, I hope you will take the time to help with this research. Your consent, to use the information you share in a research thesis, scientific publications and reports, is implied by returning the completed questionnaire. You may withdraw from the research at any time before the data is analysed by contacting me.

As a token of our appreciation for sharing your experience and taking the time to complete the questionnaire all participants have the opportunity to go into a draw for $200 worth of plants donated by the WCC Community Greening programme. If you would like to be in this draw please fill out the enclosed form and return it in the envelope with your questionnaire. The form for the draw will be separated from your questionnaire when I receive it. A reminder to complete this survey will be sent to you in about two weeks.

If you have any other questions about this project contact me from the details provided on this sheet. A summary of our findings will be available at www.victoria.ac.nz/biodiversity or I can send you a copy if you tick the box at the end of the questionnaire.

Thank you very much for helping with this important study!

Sincerely,

Julie Whitburn

Centre for Biodiversity and Restoration Ecology, Victoria University of Wellington

Email: whitbujuli@myvuw.ac.nz Mobile: 027 293 5941

CENTRE FOR BIODIVERSITY & RESTORATION ECOLOGY
Te Tumu Whakaoho Mauri o te Ao Koiora

BE IN TO WIN $200 OF PLANTS!

Complete the enclosed survey and fill in your details below, and we will enter you in a draw to win $200 worth of plants for you personal use donated by the Wellington City Council's

Community Greening Programme.

VICTORIA UNIVERSITY OF WELLINGTON
Te Whare Wānanga o te Ūpoko o te Ika a Māui

13 November 2012

To a Representative of Your Household,

Recently a questionnaire about planting in your neighbourhood and the Wellington Region was mailed to you. Your address was chosen because it is in a neighbourhood where Wellington City Council has previously provided plants for the Community Greening programme. As such your participation in this survey makes an important contribution to the questionnaires also received from your neighbours.

If you have already completed and returned the questionnaire, please accept my sincere thanks. If not, it would be much appreciated if you could do so. The survey can be downloaded from the internet if it has been misplaced. Visit the following site to obtain the survey:

www.victoria.ac.nz/biodiversity or complete it on-line at
www.surveymonkey.com/s/Planting_in_Wellington

I'm especially grateful for your help because it is only by asking people like you to share your experience that we can investigate the relationship between people and vegetation cover in neighbourhoods. The study is an important one because it will provide information that will help shape the quality our city's vegetation.

Thank you very much for helping with this important study,

Sincerely,

Julie Whitburn

Centre for Biodiversity and Restoration Ecology, Victoria University of Wellington

Email: whitbujuli@myvuw.ac.nz Mobile: 027 293 5941

CENTRE FOR BIODIVERSITY & RESTORATION ECOLOGY
Te Tumu Whakaoho Mauri o te Ao Koiora

Appendix VI Survey Booklet

TE WHARE WĀNANGA O TE ŪPOKO O TE IKA A MĀUI
VICTORIA
UNIVERSITY OF WELLINGTON

A Survey on Planting in Wellington

CENTRE FOR BIODIVERSITY & RESTORATION ECOLOGY
Te Tumu Whakaoho Mauri o te Ao Koiora

Thank you for participating in this research.

Your consent to use the information you share in a research thesis, scientific publications and reports, is implied by returning the completed questionnaire.

A. Questions about Wellington City Council's Community Greening Programme.

1. Before this survey had you heard of the Wellington City Council's (WCC), Community Greening Programme? Please tick (✓) answer.	☐ No ☐ Yes
2. If 'Yes', how did you hear about it?	
3. Have you received plants through this programme?	☐ No ☐ Yes
If you have answered 'No', please ➔ 15.	
4. When you received the plants, who did you prepare the ground and plant them with?	
On your own	☐
With members of your household	☐
With your neighbours	☐
With friends	☐
With a community group	☐
With others. Please specify. _____	☐
5. What motivated you to join in the planting?	
6. Did anything make it difficult for you to take part in the planting programme? Please specify.	☐ No ☐ Yes
7. How valuable do you think this planting programme is? On the scale of 1-5. Please circle your response.	1=Of no value 2=Of some value 3=Unsure 4=Valuable 5=Very valuable
	1 2 3 4 5

To what extent do you agree that you have experienced the following benefits from being involved in the Community Greening Programme? On a scale of 1-5, please circle your answer.	1=Strongly **dis**agree 2=Disagree 3=Neutral 4=Agree 5=Strongly agree
8. I have made new friends.	1 2 3 4 5
9. I talk to people in my neighbourhood more often.	1 2 3 4 5
10. It has encouraged me to become involved in other community activities.	1 2 3 4 5
11. I have learnt new skills.	1 2 3 4 5
12. The planting has improved the appearance of my neighbourhood.	1 2 3 4 5
13. The planting provided habitat for animals.	1 2 3 4 5
14. What other benefits have you gained from being involved?	

Please ➔ Part B1.

15. If you answered 'No' to question 3 of Part A: Would you participate in this community planting programme if you had the opportunity? Please tick (✓) answer.	☐ No ☐ Yes
16. What might prevent from participating, should you wish to?	

B1. This section is looking at how satisfied you are with your neighbourhood and wider community.

When thinking about your immediate neighbourhood (within one or two streets of your home or 5-6 minutes walk), on a scale of 1-5 to what extent do you agree with the following statements? Please circle your answer.	1=Strongly **dis**agree 2=**Dis**agree 3=Neutral 4=Agree 5=Strongly agree N/A=Doesn't apply
1. The people living in this neighbourhood are friendly.	1 2 3 4 5
2. Living here I am in good proximity to family and/or friends.	1 2 3 4 5
3. I feel like I belong in this neighbourhood.	1 2 3 4 5
4. I would like more opportunities to interact with my neighbours.	1 2 3 4 5
5. I could ask my neighbours for help with household or garden tasks if I needed it.	1 2 3 4 5
6. I am having ongoing problems with my neighbours or their visitors.	1 2 3 4 5
7. In an emergency my neighbours and I would help one another (e.g. earthquake).	1 2 3 4 5
8. I would be sad to leave the neighbourhood.	1 2 3 4 5
9. I feel safe in my home.	1 2 3 4 5
10. I am likely to be a victim of crime outside my home in this neighbourhood.	1 2 3 4 5
11. My children are safe playing inside my property.	1 2 3 4 5 N/A
12. I worry about my children being a victim of crime while playing in the neighbourhood.	1 2 3 4 5 N/A

Now thinking about your wider community (within about a 5-10 minute drive from your home) which community activities do you participate in?	Please ✓ answer	
13. Groups (e.g. Mother's groups, book groups, church meetings, art groups, political meeting, Rotary).	☐ No	☐ Yes
14. Public events (e.g. cinema, theatre, festivals, sports events).	☐ No	☐ Yes
15. Volunteer work (e.g. in schools, hospitals, churches, community groups).	☐ No	☐ Yes
16. Please list the three groups you attend or volunteer for most regularly.	_____	
_____	_____	

17. Overall how often would you participate in these community activities?	Please ✓ answer
Not at all	☐
Once or twice a year	☐
About once a month	☐
Two or three times a month	☐
Once a week or more	☐

How important are the following things to you? Please circle your answer.	1=Unimportant 3=Neutral 5=Very important				
18. Trees and other vegetation on your own property.	1	2	3	4	5
19. Trees and vegetation in your immediate neighbourhood.	1	2	3	4	5
20. Trees and vegetation in surrounding suburbs you might travel through.	1	2	3	4	5
21. Natural reserves within Wellington City.	1	2	3	4	5
22. The vegetation in your neighbourhood and the wider city are native species.	1	2	3	4	5

B2. This section explores the natural environment in your neighbourhood.

Please indicate how much you agree with each of the following statements. Please circle your responses.	1=Strongly **dis**agree 2=Disagree 3=Neutral 4=Agree 5=Strongly agree				
1. I enjoy the view from my home.	1	2	3	4	5
2. There is too much bird song around my property.	1	2	3	4	5
3. I have about the right amount of private outdoor space for my needs.	1	2	3	4	5
4. I would like to see more trees and other plants in my neighbourhood.	1	2	3	4	5
5. I am dissatisfied with the general appearance of my neighbourhood.	1	2	3	4	5
6. There is enough communal outdoor space where I can socialise with my neighbours.	1	2	3	4	5
7. There is enough nature nearby my home (bush, parks, gardens, coastal areas).	1	2	3	4	5
8. I can easily access nearby outdoor facilities (play areas, sports grounds).	1	2	3	4	5
9. There are enough opportunities to walk, run or bicycle in my wider neighbourhood.	1	2	3	4	5
10. How many years have you been living at your current address?	_____				

	1=Very **un**satisfied 3=Neutral 5=Very satisfied				
11. Thinking of your overall experience of living here, how satisfied are you?	1	2	3	4	5

C. Listed below are things that might be part of your connection to nature.

To what extent do you agree or disagree with these statements?	1=Strongly **dis**agree 3=Neutral 5=Strongly agree				
1. I get up early to watch the sunrise.	1	2	3	4	5
2. I consciously smell the flowers.	1	2	3	4	5
3. I prefer to walk in natural rather city areas.	1	2	3	4	5
4. I collect objects from nature such as shells, stones, butterflies.	1	2	3	4	5
5. I deliberately take time to watch the stars.	1	2	3	4	5
6. I walk or run in nearby reserves.	1	2	3	4	5
7. I personally care for plants.	1	2	3	4	5
8. The noise of cicadas gets on my nerves.	1	2	3	4	5
9. I feel like I am causing harm if I carve a tree.	1	2	3	4	5
10. If a bee or butterfly is in my home I prefer to catch and release it rather than kill it.	1	2	3	4	5
11. I prefer spending time with friends to spending time alone in nature.	1	2	3	4	5
12. I mimic the sounds of birds or animals.	1	2	3	4	5
13. I prefer to live in the city.	1	2	3	4	5
14. My favourite place is in nature.	1	2	3	4	5
15. Even if it is cold or rainy I like to go outside.	1	2	3	4	5
16. I prefer indoor rather than outdoor sports and exercise.	1	2	3	4	5
17. The sounds of nature relax me.	1	2	3	4	5
18. Pets are part of the family.	1	2	3	4	5
19. Logging in native forests upsets me.	1	2	3	4	5
20. I would feel sad to see a Little Blue Penguin hit by a car.	1	2	3	4	5

D. These questions explore the role the natural environment might play in your psychological wellbeing.

Nature can be anything from your own garden or a nearby natural area to beaches and mountains. **How strongly do you agree or disagree with the following statements?**	1=Strongly **dis**agree 3=Neutral 5=Strongly agree				
1. I need time in nature to be happy.	1	2	3	4	5
2. When I am feeling stressed I find being out in nature helps reduce stress levels.	1	2	3	4	5
3. When I have lost my ability to concentrate, time in nature replenishes me.	1	2	3	4	5
4. Sometimes when I am unhappy I find comfort in nature.	1	2	3	4	5
5. I can easily think about personal matters when I am out in nature.	1	2	3	4	5
6. Time in nature helps calm me when I am upset or angry.	1	2	3	4	5
7. I find time in nature an effective way to unwind after a busy day.	1	2	3	4	5
8. I find being outdoors is **not** the best place for me to gain perspective on my life.	1	2	3	4	5
9. I feel spiritually revitalised after being in nature.	1	2	3	4	5
10. After being out in nature I feel a heightened sense of wellbeing.	1	2	3	4	5
11. What natural place, if any, do you find most effective for refreshing yourself?					
12. What other things do you find helpful when you are stressed, tired or unhappy?					

E. Listed below are some attitudes or beliefs about humans and their relationship to the environment.

How strongly do you agree or disagree with the each statement?	1=Strongly **dis**agree 3=Neutral 5=Strongly agree				
1. We are approaching the limit of the number of people the earth can support.	1	2	3	4	5
2. Humans have the right to modify the natural environment to suit their needs.	1	2	3	4	5
3. When humans interfere with nature it often produces disastrous consequences.	1	2	3	4	5
4. Human ingenuity will ensure that we do **not** make the earth unliveable.	1	2	3	4	5
5. Humans are severely abusing the environment.	1	2	3	4	5
6. The earth has plenty of natural resources if we just learn how to develop them.	1	2	3	4	5
7. Plants and animals have as much right as humans to exist.	1	2	3	4	5
8. The balance of nature is strong enough to cope with the impacts of modern industrial nations.	1	2	3	4	5
9. Despite our special abilities humans are still subject to the laws of nature.	1	2	3	4	5
10. The so-called 'ecological crisis' facing humankind has been greatly exaggerated.	1	2	3	4	5
11. The earth is like a space ship with very limited room and resources.	1	2	3	4	5
12. Humans were meant to rule over the rest of nature.	1	2	3	4	5
13. The balance of nature is very delicate and easily upset.	1	2	3	4	5
14. Humans will eventually learn enough about how nature works to be able to control it.	1	2	3	4	5
15. If things continue on their present course, we will soon experience a major ecological catastrophe.	1	2	3	4	5

F. Listed below are some behaviours that indicate concern for the environment.

How strongly do you agree or disagree with these statements?	1=Strongly **dis**agree 3=Neutral 5=Strongly agree				
1. I compost organic waste.	1	2	3	4	5
2. I recycle my glass, paper and cans in kerbside recycling.	1	2	3	4	5
3. I take reusable bags when shopping.	1	2	3	4	5
4. I use energy saving light-bulbs.	1	2	3	4	5
5. I participate in activities or volunteer with local environmental groups.	1	2	3	4	5
6. If I can afford it I donate money to groups who work to improve or protect the natural environment.	1	2	3	4	5
7. I like to learn about environmental issues (e.g., through reading, internet, TV).	1	2	3	4	5
8. I put on warmer clothes before turning on the heat.	1	2	3	4	5
9. I dispose of paint into the storm water drains.	1	2	3	4	5
10. I use natural/environmentally friendly detergents, soaps or cleaners.	1	2	3	4	5
11. I use my car whenever it suits me, even if it pollutes the air.	1	2	3	4	5
12. I choose energy saving appliances when I need to replace them.	1	2	3	4	5
13. When I visit outdoor areas I leave only footprints.	1	2	3	4	5
14. I use a clothes dryer	1	2	3	4	5
15. I car pool.	1	2	3	4	5

G. Below are some outdoor activities that you might participate in.

1. Which outdoor activities do you participate in?	Please ✓ as many as apply
Social activities (e.g. BBQs, picnics, playing with children)	☐
Walking or running	☐
Bicycling	☐
Outdoor photography	☐
Bird watching	☐
Relaxing outdoors	☐
Gardening	☐
Outdoor sports (e.g. soccer, netball)	☐
Fishing	☐
Swimming	☐
Surfing	☐
Visit local natural areas (e.g. reserves, gardens, walkways, coastal areas)	☐
Other(s); please specify.	

2. Overall, how often would you participate in these activities?

Not at all	☐
Once or twice a year	☐
About once a month	☐
Two or three times a month	☐
Once a week or more	☐

3. Which 3 gardens, parks, reserves, coastal areas or walkways, in Wellington, have you visited most often in the past year?

4. In general, how easy or difficult is it for you to visit local natural areas (public park, reserve, garden, coastal area) from where you live?

Very difficult	☐
Difficult	☐
Neither	☐
Easy	☐
Very easy	☐

5. If it is difficult or very difficult to get to outdoor areas why is this?

6. What kind of outdoor activities, if any, did you participate in most often as a child between the ages of 6 and 12 years old?

7. About how often would you take part in these outdoor activities as a child?

8. Was there anyone special who regularly shared these activities with you? Please ✓ answer ☐ No ☐ Yes

9. What was their relationship to you?

Nearly there!

H. Next are some questions about your personal wellbeing.

Please indicate which is the closest to how you have been feeling over the last two weeks.	1=Strongly **dis**agree 3=Neutral 5=Strongly agree				
1. I have felt cheerful and in good spirits.	1	2	3	4	5
2. I have felt calm and relaxed.	1	2	3	4	5
3. I have felt active and full of life.	1	2	3	4	5
4. I woke up feeling fresh and rested.	1	2	3	4	5
5. My daily life has been filled with things that interest me.	1	2	3	4	5

6. How has your general health been over the last three months?	1=Very poor 3=Average 5=Excellent				
Please circle your answer	1	2	3	4	5

7. Have you had any of these conditions in the last year?	Please ✓	
Chronic pain.	☐ No	☐ Yes
Gastrointestinal complaints.	☐ No	☐ Yes
Frequent infectious diseases (e.g. colds).	☐ No	☐ Yes
Hypertension.	☐ No	☐ Yes
Heart disease.	☐ No	☐ Yes
Cancer.	☐ No	☐ Yes
Diabetes.	☐ No	☐ Yes
Asthma.	☐ No	☐ Yes

8. Have you experienced a major event in your life over the last three months (e.g. Death of a spouse or child, divorce, separation, imprisonment, death of close relative or friend)	☐ No	☐ Yes

Thinking about your life overall, to what extent do agree with these statements?	1=Strongly **dis**agree 3=Neutral 5=Strongly agree				
9. In most ways my life is close to my ideal.	1	2	3	4	5
10. The conditions of my life are excellent.	1	2	3	4	5
11. I am satisfied with my life.	1	2	3	4	5
12. So far I have got the important things I want in life.	1	2	3	4	5
13. If I could live my life over, I would change almost nothing.	1	2	3	4	5

One more page to go!

I. The following questions are adapted from NZ census data to help us describe the population of people who return the survey.

Can you please tell us some things about yourself?	Please ✓
1. What is your gender?	
Male	☐
Female	☐
2. What is the approximate annual income for your household?	
Nil or loss	☐
$1,000 – 5,000	☐
$5,001 – 10,000	☐
$10,001 – 20,000	☐
$20,001 – 30,000	☐
$30,001 – 40,000	☐
$40,001 – 50,000	☐
$50,001 – 70,000	☐
$70,001 – 100,000	☐
$100,001 or more	
3. Which age range do you come into?	
18 - 24	☐
25 – 34	☐
35 – 44	☐
45 – 54	☐
55 – 64	☐
65 – 74	☐
75 +	☐

4. What is your current marital status?	
Married, Civil Union	☐
Live with partner	☐
Separated, Divorced, Widowed	☐
Never married	☐
5. How many children (18 and under) live with you?	_____
6. Do you own or rent the home you currently live in?	☐ Own ☐ Rent
7. What is your highest level of education?	
No formal qualifications	☐
High School qualifications (e.g. NCEA, School Certificate, Bursary)	☐
Post-school qualifications (Vocational, Trade, Bachelor's degree)	☐
Post Graduate qualifications	☐
8. What is your occupation, paid or unpaid, (e.g. plumber, care giver, retired teacher, student)?	_____
9. Which ethnic group do you belong to?	
NZ European	☐
NZ Māori	☐
Pacific Peoples	☐
Asian	☐
Middle Eastern, Latin American, African	☐
Other (Please specify)	_____
10. In which country were you born?	_____
11. Would you like a summary of our findings posted to you?	☐ No ☐ Yes

Thank you so very much for your help.

Please return this survey in the Freepost envelope provided.
Don't forget to fill out the form to go into the draw for $200 worth of plants.