Children's environmental psychology, behaviour and education and wellbeing: The role of connection to nature

By

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Abstract

A personal relationship with nature, which develops in childhood, is associated with wellbeing benefits and greater engagement in pro-environmental behaviour (PEB) in adulthood. This thesis investigates the relationships between children's connection to nature and their psychological wellbeing and engagement in PEB. It also tests whether nature-based environmental education can promote children's connection to nature and engagement in PEB.

The first study is a meta-analysis of the relationship between connection to nature and PEB. This meta-analysis demonstrated a significant positive, moderately-sized association between connection to nature and PEB. Standard tests indicated little effect of publication bias. Univariate categorical analyses showed that the scales used to measure connection to nature and PEB were significant moderators of the relationship and explained the majority of the between-study variance. The geographic location of a study, age of participants and the percentage of females in a study were not moderators.

I then conducted a longitudinal quasi-experiment (with control groups) with children aged 7-13 years from schools who attended environmental education programmes in Wellington City, New Zealand (N = 324). Data was collected via a self-administered questionnaire and a gifting experiment immediately before and four weeks after environmental education interventions. Structural equation modelling, followed by Information Theoretic model selection and inference was used to test theoretical models that explained how children's connection to nature, and other variables of interest, were associated with their wellbeing (vitality and life satisfaction) or their engagement in PEB. Mixed-design ANOVAs tested whether environmental education influenced children's connection to nature, PEB and wellbeing.

Structural equation models revealed that children's connection to nature had a direct, positive association with their vitality, but not their life satisfaction. The children's use of nature for psychological restoration had a direct, positive association with their vitality and their life satisfaction. The model explained 28% of the variance in vitality and 5%

of the variance in life satisfaction. Models that contained socio-demographic variables were not well supported.

Connection to nature had a direct, positive relationship with PEB. Connection to nature mediated the relationship of environmental attitude and the use of nature for psychological restoration with engagement in PEB. Knowledge was not significantly related to PEB. This model explained 71% of the variance of children's PEB. Models that contained socio-demographic variables were not well supported. Connection to nature had the strongest association with PEB of the variables tested.

Environmental education had no overall significant effect on children's connection to nature, environmental attitudes, use of nature for psychological restoration, vitality or life satisfaction. However, the effect of environmental education on children's connection to nature depended on their baseline level of connection to nature. Connection to nature increased after environmental education field-trips only in children with a relatively high baseline connection to nature. There was an increase in children's PEB, species' knowledge and financial support for conservation compared with children in the control group.

There are some limitations in this research. While the structural equation models imply directionality, they demonstrate correlational relationships between the variables. In addition, the survey data is collected by self-reports which can over-estimate associations between variables. A social desirability response bias, may also limit this research.

This research demonstrates the central importance of connection to nature for children's psychological wellbeing and PEB. This thesis advances previous work by (i) providing a quantitative summary of the existing research to show there is a moderately-sized, positive association between individuals' connection to nature and their engagement in PEB, (ii) advancing theory by demonstrating that children's affective connection to nature is positively associated with greater psychological wellbeing and greater engagement in PEB and (iii) demonstrating empirically that while environmental education did not promote affective connection to nature in most children, it did increase their support for conservation and engagement in daily PEBs and their species' knowledge.

Promoting connection to nature has implications for motivating PEB and increasing wellbeing. Environmental education can influence knowledge and beliefs, but may not consistently promote affective connection to nature. Environmental education could incorporate experiences that stimulate children's affective faculties to promote connection to nature.

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Chapter 1: General introduction

A personal relationship with (non-threatening) nature, which develops in childhood, is associated with wellbeing benefits and also greater engagement in pro-environmental behaviour (PEB) in adulthood (Chawla, 1998; Rosa, Profice, & Collado, 2018; Wells & Lekies, 2006). However, children mostly live in built environments, exposed to low levels of nature and diminished biodiversity (Soga, Yamanoi, Tsuchiya, Koyanagi, & Kanai, 2018; United Nations, 2012), and are spending more time indoors in sedentary pursuits than previous generations (Natural England, 2009; Ward, Duncan, Jarden, & Stewart, 2016; Wheeler, Cooper, Page, & Jago, 2010). This lack of exposure to nature may mean children develop a shallow relationship with nature or are disconnected from it. A disconnection from nature might have negative consequences for their physical and psychological wellbeing and cause children to care less for nature and natural environments (Louv, 2008; Pyle, 2003; Soga et al., 2018). In view of this, the idea that children need to re-connect to nature has received greater recent attention. However, our empirical understandings of children's relationship with nature, its ontogeny and implications for their wellbeing and engagement in PEB are little studied.

In light of these considerations, I investigated children's relationship with nature, in particular their connection to nature, and its relationship to psychological wellbeing and engagement in PEB. Specifically, my thesis had four main components. First, I did a meta-analysis of the existing literature, which measured the relationship between connection to nature and PEB, to provide a quantitative estimate of the strength of the relationship. Second, I investigated the relationships between children's connection to nature, their use of nature for psychological restoration and two aspects of their psychological wellbeing (vitality and life satisfaction). Third, I investigated whether children's connection to nature, their use of nature for psychological restoration, environmental attitude and/or knowledge were associated with their engagement in PEB. Fourth, I undertook a longitudinal field experiment to determine whether environmental education programmes in Wellington, New Zealand, could strengthen children's connection to nature and promote greater engagement in PEB.

This thesis drew from the disciplines of environmental psychology, conservation psychology and environmental education. Environmental psychology seeks to understand how people are influenced by the natural and built environments (Saunders, 2003). Conservation psychology, which is a relatively new field, draws from environmental psychology and incorporates research from the social, developmental, clinical, or cognitive areas. Conservation psychology focuses on understanding why people harm or help the environment, and on promoting environmentally sustainable behaviours (Clayton, 2009; Saunders, 2003).

The results of my research may highlight to local and national governments the importance of building children's connection to nature and encourage them to consider providing restorative natural environments, especially in cities, and motivating children's use of them. The results also have the potential to inform the design, resourcing and implementation of the environmental education programmes being delivered in Wellington, New Zealand, and internationally.

Humans are of course part of nature, but for the purpose of this research 'nature' is broadly defined as: any elements of the bio-physical world. It includes living organisms (such as plants and animals) and non-living features (such as landscapes, celestial bodies and qualities of the air, water and weather), across a range of scales from urban nature to pristine wilderness environments (Bratman, Hamilton, & Daily, 2012; Hartig, Mitchell, de Vries, & Frumkin, 2014; Zylstra, Knight, Esler, & Le Grange, 2014).

Here, before outlining the structure of this thesis, I introduce three concepts that capture aspects of the human-nature relationship: connection to nature, the use of nature for psychological restoration and environmental attitude. I then review the evidence that a relationship with nature, and in particular a connection to nature, is essential for an individual's psychological wellbeing and their engagement in PEB. I also review the part environmental education can play in promoting children's connection to nature, and thereby their engagement in PEB.

1.1 Connection to nature

Connection to nature refers to an individual's subjective sense of their relationship with nature (Nisbet, Zelenski, & Murphy, 2011), and can be conceptualised as a values-based attitude (Brügger, Kaiser, & Roczen, 2011). Connection to nature has similar qualities to personality traits in that it differs between individuals and groups, is relatively stable over time and in different situations, but is also open to change (Kaiser, Brügger, Hartig, Bogner, & Gutscher, 2014; Mayer & Frantz, 2004; Nisbet, Zelenski, & Murphy, 2009). Connection to nature can also be a state, that is, it can be increased or decreased in the short-term by exposure to nature (Mayer, Frantz, Bruehlman-Senecal, & Dolliver, 2009; Richardson & Sheffield, 2017). Although connection to nature is malleable, any long-lasting changes may require long-term or repeated exposures to nature (Kaiser et al., 2014; Schultz & Tabanico, 2007).

The theoretical basis of connection to nature comes from the biophilia hypothesis, eco-psychology and research into inter-personal relationships. The importance of the human-nature bond traces back to Fromm's concept of biophilia, defined as a "love of life or living systems" (Fromm, 1964, p. 41), which was further developed by Wilson (1984). The biophilia hypothesis suggests that humans have an innate (biologically-based) need to affiliate with nature (other living things and the natural environment). This tendency to associate with nature, which is hypothesised to have aided survival in our distant past, may remain important today (Kellert & Wilson, 1993; Wilson, 1984). For example, this tendency can be seen in people's preference for environments that support our wellbeing, such as environments that are psychologically restorative (Kellert, 1997).

The theoretical basis of connection to nature has been extended in the eco-psychology literature which views humans as an integral part of the eco-system they inhabit (e.g., Bragg, 1996; Naess, 1973; Roszak, 1995). This interconnectedness with nature requires "a fundamental redefinition of our human identity" (Tacey, 2000, p.163), at least in highly urbanised cultures. This redefinition of human identity involves an "expansive ….. sense of self, which ultimately includes all life forms, ecosystems, and the earth itself" (Bragg, 1996, p. 95), and transcends the human/nature dichotomy so prevalent in Western societies (Fischer 2012). Scholars in eco-psychology propose that recognising and nurturing a sense of

belonging with the non-human world is essential to human wellbeing and motivates a person's environmental care and environmentally protective behaviour (Leopold, 1970; Roszak, 1995).

Environmental psychologists also theorise that broadening self-identity to incorporate nature is important in motivating PEB (e.g., Clayton, 2003; Mayer & Frantz, 2004; Schultz & Tabanico, 2007). Research from inter-personal psychology has shown that the extent to which a person includes someone else as part of the self, determines the closeness of the relationship (Aron, Aron, Tudor, & Nelson, 1991). As relational closeness increases between individuals so does empathy and willingness to help (Cialdini et al., 1997). This may extend to human-nature relationships as well – as an individual develops a close bond with nature, empathy for the natural world and other living creatures develops, which motivates caring and even altruistic behaviour (Schultz, 2000).

The operationalisation of connection to nature has resulted in a number of different measures or scales that all draw on the theory of biophilia, inter-personal psychology and/or eco-psychology. These measures of connection to nature are positively associated with meaningful differences in individual personality traits such as conscientiousness, extraversion, agreeableness and openness (Nisbet & Zelenski, 2013; Tam, 2013a), wellbeing (e.g., Capaldi, Dopko, & Zelenski, 2014; Nisbet et al., 2011; Pritchard, Richardson, Sheffield, & McEwan, 2019), environmental attitude (e.g., Brügger et al., 2011; Schultz, Shriver, Tabanico, & Khazian, 2004) and engagement in PEB (e.g., Mayer & Frantz, 2004; Nisbet & Zelenski, 2013; Tam, 2013a; Whitburn, Linklater, & Milfont, 2018). Most investigations into connection to nature and wellbeing and PEB have been in adults. However, there is a small body of evidence that shows similar results with children (Cheng & Monroe, 2012; Collado, Evans, Corraliza, & Sorrel, 2015; Müller, Kals, & Pansa, 2009; Otto & Pensini, 2017; Richardson, Sheffield, Harvey, & Petronzi, 2015; Roczen, Kaiser, Bogner, & Wilson, 2014).

1.1.1 How connection to nature develops

Exposure to nature is thought to increase connection to nature, but the evidence is still developing. Retrospective studies report that adults who have a strong bond with nature also report having spent more time in nature in their childhood (Chawla, 1998; Rosa

et al., 2018; Tam, 2013a). These studies, however, are subject to self-selection and recollection bias. There is some correlational evidence that spending time nature is associated with a stronger connection to nature in adults (Colléony, White, & Shwartz, 2019; Nisbet et al., 2009; Rosa et al., 2018; Tam, 2013a; Whitburn et al., 2018). For example, residents of Brisbane, Australia, with a stronger connection to nature (measured as Nature Relatedness) spent more time in their garden, and travelled further distance and made longer visits to parks than residents with a weaker Nature Relatedness (Lin, Fuller, Bush, Gaston, & Shanahan, 2014). Experimental studies have demonstrated that short walks in a nature reserve or urban nature increased American and Canadian university students' connection to nature compared with walks in a downtown urban setting or indoors (Mayer & Frantz, 2004; Nisbet & Zelenski, 2011). Similarly, connection to nature increased in English adults who were asked to notice three good things in nature each day for five days, compared with those in a control group who were asked to note three non-nature related things (Richardson & Sheffield 2017).

There is a small body of cross-sectional research in children that has shown that children's connection to nature is positively associated with their experiences in nature (Cheng & Monroe, 2012; Otto & Pensini, 2017). Experimental studies have shown that children's connection to nature increased immediately after participating in environmental education (Braun & Dierkes, 2017; Kossack & Bogner, 2012; Liefländer, Fröehlich, Bogner, & Schultz, 2013; Sellmann & Bogner, 2013). For example, Spanish children (N = 397, M_{age} = 10.9 ± 2.2 years, 46.1% female) who had attended camps in natural settings reported increased Emotional Affinity Toward Nature (connection to nature) compared with children who attended camps in an urban setting (Collado, Staats, & Corraliza, 2013).

1.1.2 Socio-demographics and connection to nature

It is important to understand how socio-demographic differences relate to children's connection to nature, because they are associated with wellbeing inequalities (Diener, Suh, Lucas, & Smith, 1999; Mitchell & Popham, 2008; New Zealand Government, 2018), participation in PEB (e.g., Kollmuss & Agyeman, 2002) and access to urban nature (Freeman, van Heezik, Stein, & Hand, 2015; Mitchell & Popham, 2008; Shanahan, Lin, Gaston, Bush, & Fuller, 2014). Gender, ethnicity, geographic location, and age may all influence children's

outdoor experiences (Kahn & Kellert, 2002). Some studies report that girls have a stronger connection to nature than boys (Bruni & Schultz, 2010; Department of Conservation, 2016; RSPB, 2013), but there were no gender differences reported by Bragg, Wood, Barton, and Pretty (2013). Younger children have reported higher levels of nature connection than older children (Liefländer et al., 2013). Children living in urban areas of the United Kingdom had a higher connection to nature than rural children (RSPB, 2013), but the opposite was seen in New Zealand (Department of Conservation, 2016). In addition, there are cultural differences in the way individuals relate to their environment, and understand and act on environmental issues (Boeve-de Pauw & Van Petegem, 2011; Evans, Juen, Corral-Verdugo, Corraliza, & Kaiser, 2007; Larson, Castleberry, & Green, 2010; Milfont & Schultz, 2016). For example, Asian children in New Zealand had a significantly lower connection to nature than non-Asian children (Department of Conservation, 2016; Freeman et al., 2015). Understanding socio-demographic differences can point to underlying causes of inequity. This understanding can inform the development and enhancement of interventions aimed to influence children's connection to nature and, in turn, their wellbeing and engagement in PEB.

1.2 Psychological restoration

Experiences in nature can be psychologically restorative and support psychological health, allowing individuals to function well (Gullone, 2000; Kaplan & Kaplan, 1989). Psychological restoration in nature can be defined as "the experience of a psychological and/or physiological recovery process that is triggered by particular environments and environmental configurations" (Joye & Van Den Berg, 2011, p. 58). There are two main lines of research that seek to explain how natural environments promote restoration. According to the Kaplans' (1989) Attention Restoration Theory, many activities in today's highly urbanised societies require levels of concentration or directed-attention that require mental effort to sustain. Directed-attention can become exhausted from over-use as the neural inhibitory mechanisms, which block out competing stimuli during periods of concentration, become fatigued. The consequences of fatigued directed-attention include decreased ability to concentrate, less effective functioning and problem solving, increased irritability and a greater proneness to making mistakes or having accidents. Elements in the natural environment, such as views of natural settings, draw on and effortlessly engage a person's

involuntary-attention. This effortless attention relieves the demands on directed-attention, allowing it the opportunity to recover. Natural environments are also conducive to other aspects of cognitive restoration - clearing the head, processing cognitive residue from the day and reflecting on important aspects of life.

The second perspective holds that the restorative potential of natural environments is related to their ability to support emotional regulation (the ability to effectively manage emotions and impulses) and stress reduction (Ulrich, 1983; Ulrich et al., 1991). Sustained exposure to situations that are emotionally taxing or threatening produces stress and anxiety. Prolonged stress can cause or exacerbate physical and psychological health conditions such as cardio-vascular disease, headaches, gastrointestinal disorders, depression and anxiety and can make it difficult to concentrate (McNamara, 2000). Spending time in nature can reduce stress and anxiety by regulating the physiological arousal associated with the fight/flight stress response initiated in stressful situations. These changes can be observed in the body's physiological responses such as heart rate, blood pressure and stress hormone levels. Stephen Kaplan (1995) has put forward an integrative model that suggests these two theories, Attention Restoration Theory and recovery from stress, are distinct but they fit together in the larger context of the relationship between humans and nature, this is the view adopted in this study.

1.3 Environmental attitude

Environmental attitude has been defined as "a psychological tendency … expressed by evaluating …. the natural environment, including factors affecting its quality, with some degree of favour or disfavour" (Milfont, 2007, p. 12). Environmental attitude can be distinguished from connection to nature in that the object of environmental attitude is environmental protection, whereas the object of connection to nature is nature itself (Kaiser, Hartig, Brügger, & Duvier, 2011). The most widely used measure of environmental attitude is the New Ecological (Environmental) Paradigm (NEP) scale (Dunlap, 2008; Dunlap, Van Liere, Mertig, & Jones, 2000; Hawcroft & Milfont, 2010). The NEP is a cognitive assessment of an individual's environmental attitude (Milfont & Duckitt, 2010). The NEP captures an individual's fundamental beliefs about nature and human's relationship to it, about the balance of nature, the existence of limits to growth and humanity's right to rule

over nature. Scoring highly on the NEP scale indicates an eco-centric environmental attitude, that is valuing nature for its own sake rather than for the benefits it can provide for humans (Thompson & Barton, 1994).

1.4 A relationship with nature promotes wellbeing

Psychological wellbeing generally involves the presence of positive affect and the absence of negative affect, the satisfaction of desires, functioning well and living a full and meaningful life (e.g., Ryan & Deci, 2001). Psychological wellbeing can be conceptualised as hedonic or eudaemonic wellbeing. Hedonic wellbeing relates to happiness and generally involves the presence of positive affect (or emotions) and the absence of negative affect as well as the satisfaction of desires (e.g., Ryan & Deci, 2001). Hedonic wellbeing is measured by scales such as the Satisfaction with Life Scale (Diener, Emmons, Larsen, & Griffin, 1985), Subjective Happiness Scale (Lyubomirsky & Lepper, 1999) and Positive and Negative Affect Schedule (Watson, Clark, & Tellegen, 1988). In contrast, eudaemonic wellbeing focuses more on functioning well and living a full and meaningful life. Eudaemonic wellbeing incorporates facets such as vitality, mastery, life purpose, autonomy, self-acceptance, positive-relatedness and personal growth (Ryff & Keyes, 1995). Both types of wellbeing are positively correlated; they describe distinct aspects of wellbeing but are not mutually exclusive. People who have the highest overall levels of wellbeing usually score highly in both hedonic and eudaemonic wellbeing (Forgeard, Jayawickreme, Kern, & Seligman, 2011; Huta & Ryan, 2010).

There is compelling evidence from a range of empirical and qualitative studies that exposure to nature benefits human wellbeing (e.g., Bowler, Buyung-Ali, Knight, & Pullin, 2010; Chawla, 2015; Gill, 2014; Keniger, Gaston, Irvine, & Fuller, 2013). One might expect connection to nature to be positively associated with wellbeing because people with a strong connection to nature are more likely to seek out experiences in nature (Cheng & Monroe, 2012; Collado et al., 2013; Hinds & Sparks, 2008; Kals, Schumacher, & Montada, 1999; Lin et al., 2014) and thus avail themselves of nature's wellbeing benefits. In doing so they would also satisfy the biophilic need to associate with nature (Kellert & Wilson, 1993; Wilson, 1984), and the psychological need to belong (Bragg, 1996; Ryan & Deci, 2001). Connection to nature could alternatively have a negative association with wellbeing. For

example, people who incorporate nature into their sense of self may experience harm done to nature as harm done to themselves and thus feel pain or grief (Roszak, 1995).

A stronger connection to nature in adults has been associated with higher levels of subjective wellbeing - measured as life satisfaction (Capaldi et al., 2014; e.g., Mayer & Frantz, 2004; Tam, 2013a; Zelenski & Nisbet, 2012) and greater positive affect and lower negative affect (Wolsko & Lindberg, 2013). Connection to nature has also been positively associated with aspects of eudemonic wellbeing, such as finding meaning in life, personal growth, flourishing and vitality (Cervinka, Röderer, & Hefler, 2011; Nisbet et al., 2011; Pritchard et al., 2019; Wolsko & Lindberg, 2013; Zelenski & Nisbet, 2012). In contrast, some researchers have found no significant associations between connection to nature and life satisfaction (Cervinka et al., 2011; Leary, Tipsfors, & Tate, 2008; Nisbet et al., 2011; Whitburn, 2014), mental wellbeing (Whitburn, 2014) or positive affect (Howell, Dopko, Passmore, & Buro, 2011).

Experiences in nature are particularly important to children's physical, cognitive and psychological development, and help to shape their connection to nature (Bento & Dias, 2017; Chawla, 2015; Louv, 2008; Windhorst & Williams, 2015). Few researchers have investigated the relationship between children's connection to nature and their wellbeing (Richardson et al., 2015; Whitten et al., 2018). Richardson et al. (2015) reported a weak, but significant correlation between English children's connection to nature and their life satisfaction (r = 0 .14, p < 0.01) and also with a single-item measure of general health (r = 0.09, p < 0.01) (N = 775; age = 10 - 11 years, 47.5% female). Whitten et al.'s (2018) epidemiological survey of children from New South Wales, Australia (N = 26,848, M_{age} = 11.9 ± 0.4 years, 49.7% female), reported children's connection to nature had a weak positive association with their self-satisfaction and pro-social behaviours. Although the current evidence suggests that connection to nature is associated with a range of wellbeing benefits in adults, there is little research examining the relationship between children's connection to nature and their wellbeing.

Psychologically restorative experiences in nature can have a positive influence on children's wellbeing (Collado & Staats, 2016). A few exploratory and longitudinal studies have demonstrated that nature around home, *en route* to school and within school

playgrounds can have a positive influence on children's cognitive function (measured as their ability to concentrate) and development; (e.g., Dadvand et al., 2015; Dadvand et al., 2017; Faber Taylor, Kuo, & Sullivan, 2002; Wells, 2000). For example, a recent, longitudinal study, with a large sample of young Spanish children (*N* = 2623 age = 7 – 10 years) monitored children over the course of one year. Children who experienced more vegetation in their school and on their route to school had greater cognitive development (better working memory and greater reduction in inattentiveness) than children who experienced less vegetation (Dadvand et al., 2015). Improved concentration after exposure to nature has decreased symptoms in children with attention disorders (Faber Taylor & Kuo, 2009; van den Berg & van den Berg, 2011). However, some researchers have found no association between exposure to nature and children's ability to concentrate (Kelz, Evans, & Roderer, 2015; Stevenson, Dewhurst, Schilhab, & Bentsen, 2019).

Nature near to where children live and go to school can also act as a buffer or moderator of stress (e.g., Chawla, 2014; Chawla, Keena, Pevec, & Stanley, 2014). Cross-sectional studies have demonstrated that the amount of vegetation around children's homes or schools was positively associated with fewer symptoms of psychological distress, in spite of stressful life events (such as being bullied or getting into trouble at school) (Corraliza, Collado, & Bethelmy, 2012; Wells & Evans, 2003). A longitudinal experiment with Austrian children, examined the effects of a school playground renovation to include more trees and shrubs (*N* = 133; M_{age} = 14.4 years, 49% female) (Kelz et al., 2015). The children who experienced the renovated school playground had lower indicators of physiological stress (blood pressure and heart rate) and enhanced self-reported psychological wellbeing after six to seven weeks exposure to the renovated playground compared with children in a control group (at schools where no renovations occurred). Although this experiment can speak to causation, the improvements in children's wellbeing may not be solely attributable to the small increases in nature content of the school playground. The school also added seats, sporting equipment and a drinking fountain. Perhaps the students engaged in more physical or social activity as a result of these other renovations, which also contribute to the playground's restorative capacity and may explain the psychological and physiological benefits (Bagot, Allen, & Toukhsati, 2015).

Children can distinguish among environments that have varying degrees of restorativeness (Berto, Pasini, & Barbiero, 2015; Collado & Corraliza, 2012; Collado & Corraliza, 2015; Kelz et al., 2015). For example, children in Aosta, Italy (*N* = 48, age = 9 - 11 years, 60.4% female), rated their experience of a 90-minute walk in an alpine environment as more restorative than spending 90 minutes in their school playground or in mindful silence in their school classroom (Berto et al., 2015). These children participated in different activities within each of the environments, so it is unclear whether the activity, the environment or an interaction between the two, accounts for the results.

Understanding how exposure to nature is associated with children's wellbeing is key to predicting health outcomes and identifying what interventions are possible (Bell, Phoenix, Lovell, & Wheeler, 2014; Cleary, Fielding, Bell, Murray, & Roiko, 2017). But little is known about the extent to which children's connection to nature is related to their use of nature for psychological restoration and to aspects of their psychological wellbeing, such as vitality or life satisfaction.

1.5 A relationship with nature promotes engagement in PEB

PEBs are those "actions which contribute to environmental protection and/or conservation" (Axelrod, 1993, p. 153). There is a range of behaviours a person can choose to undertake to express their desire to engage in PEB. These behaviours can include private every-day behaviours, behaviours at work, political actions or environmental activism (Stern, 2000). People generally favour more convenient, socially acceptable behaviours over more demanding or costly ones (Kaiser et al., 2011). Whether a person acts on their desire to behave pro-environmentally can depend on barriers they might encounter. These barriers can include personal cost (finance, time), lack of structural support (e.g., recycling schemes, efficient public transport) or knowledge (e.g., type of PEB that is effective) (Jagers, Linde, Martinsson, & Matti, 2017; Kaiser, Byrka, & Hartig, 2010). Therefore, personal choice and contextual factors can create unpredictability with respect to a person's engagement in a particular PEB. Measuring individual's PEB with scales that contain several domains of behaviour can, therefore, capture the person's general tendency to engage in PEB (Kaiser & Wilson, 2004).

The most common way to measure PEB is by using self-report surveys adapted from other scales already in use (in particular, Kaiser, 1998; Schultz & Zelezny, 1998; Whitmarsh & O'Neill, 2010). The scales measuring PEB can vary from 6 - 97 items, contain one or more dimensions and vary in their internal reliability and the factor analysis of their multiple dimensions (Markle, 2013). Objectively measured PEB is somewhat rare because of the difficulty in discreetly observing behaviour, but it has been achieved in measuring energy usage (e.g., Frantz & Mayer, 2014) and recycling behaviours (Whitburn et al., 2018).

Children are generally aware of environmental problems (Kahn, 1999) and even young children (aged 5 – 6) can be familiar with common PEBs (Kos et al., 2016). However, simply translating adult PEB scales to use with children can be problematic. Children face barriers to engagement in PEB related to their age and may have limited resources to carry out environmental actions (Evans, Brauchle et al., 2007). In addition, children can lack control over some behaviours that are measured in the adults' scales, such as whether to purchase organic or fair trade products (Nisbet 2009). Therefore, researchers often measure children's willingness or intention to take environmental action, rather than measuring behaviour (Cheng & Monroe, 21012; Müller et al., 2009; Richardson et al., 2015). Although behavioural intention is an immediate antecedent of behaviour (Ajzen, 1991), there is only a moderate correlation between behavioural intentions and behaviour (Bamberg & Möser, 2007; Grimmer & Miles, 2017). If researchers prefer to measure children's self-reported PEB, they must design scales that carefully consider behaviours that are within children's volitional control (Evans, Brauchle et al., 2007).

Connection to nature, environmental attitude, knowledge and gaining from psychologically restorative experiences in nature have been used to explain why some adults behave more environmentally than others (e.g., Whitburn et al., 2018). It may be that these factors are also positively associated with children's PEB.

An adult's connection to nature is positively associated with self-reported PEB (Brügger et al., 2011; Mayer & Frantz, 2004; Nisbet & Zelenski, 2013; Schultz et al., 2004; Tam, 2013a; Whitburn et al., 2018), environmentalism (Mayer & Frantz, 2004; Nisbet & Zelenski, 2013) and the intention or willingness to engage in nature protective behaviours (Kals et al., 1999). There is a small body of evidence investigating these motivators of PEB in

children and adolescents. Cross-sectional studies demonstrate that children and adolescents (13 - 17 years of age) with a stronger connection to nature also report greater engagement in self-reported PEB (Collado, Evans, et al., 2015; Otto & Pensini, 2017; Roczen et al., 2014) and a greater intention or willingness to perform environmentally friendly behaviours (Cheng & Monroe, 2012; Müller et al., 2009; Richardson et al., 2015), such as energy and water conservation and recycling.

Although all studies report a positive association between connection to nature and PEB, the strength of this relationship varies (r = 0.14 to 0.68). The diversity of scales poses a barrier to integrating results across studies and scales. Therefore, it would be useful to do a quantitative summary of the existing research to determine the strength of the relationship between connection to nature and PEB. Further, it is unclear how variation in scales measuring connection to nature and PEB affect the strength of the relationship between these two variables. In addition, there is little empirical research investigating the relationship between children's connection to nature and their engagement in PEB.

Benefitting from psychological restoration in nature, has been suggested as a motivation to engage in PEB (e.g., Hartig, Kaiser, & Strumse, 2007). Theoretically, individuals may be motivated to protect the environment from which they have received benefit. Indeed, the use of nature for psychological restoration is positively associated with self-reported engagement in PEB in adult populations from America, Norway (Hartig, Kaiser, & Bowler, 2001; Hartig et al., 2007), Germany (Byrka, Hartig, & Kaiser, 2010), Mexico (Corral-Verdugo, Garcia, Tapia-Fonllem, & Fraijo-Sing, 2012) and New Zealand (Whitburn et al., 2018). In some studies, this association with PEB was partially mediated by environmental attitude (Byrka et al., 2010; Hartig et al., 2001; Whitburn et al., 2018).

Children's self-reported use of nature for psychological restoration has received little attention. There is evidence to suggest that children who perceive their school playground as more restorative also report stronger environmental attitudes (Collado & Corraliza, 2011) and greater engagement in PEB (Collado & Corraliza, 2015) than children who report their playground as less restorative. For example, a cross-sectional study of children from 20 different schools in Spain (N = 832, M_{age} = 10.0 ± 1.3, 51% female) demonstrated that the perceived restorativeness of their school playground explained 37% of the variance in the

children's PEB, such as using less water when bathing and helping to separate recycling at home (Collado & Corraliza, 2015). The relationship between the perceived restorativeness of the playgrounds and children's PEB was mediated by their environmental attitude (Collado & Corraliza, 2015), in the same way as seen in adults (Byrka et al., 2010; Hartig et al., 2007).

Environmental attitude is commonly used to explain why some people engage in PEB more than others (Kollmuss & Agyeman, 2002). Theoretically, individuals with a stronger environmental attitude are more likely to report greater engagement in PEB than individuals with weaker environmental attitudes. However, the association between environmental attitude and PEB can be tenuous. Cognitively based environmental attitudes do not always translate into pro-environmental action (Gifford & Nilsson, 2014; Grimmer & Miles, 2017; Kennedy, Beckley, McFarlane, & Nadeau, 2009; Kollmuss & Agyeman, 2002). Researchers have demonstrated that environmental attitude has only a small to moderate correlation with environmental behaviour (e.g., Casey & Scott, 2006; Dunlap et al., 2000; Whitburn et al., 2018) and the association does not hold in all countries (Schultz & Zelezny, 1998). In addition, environmental attitude explains between 0.06 and 27% of the variation in study participants' PEB (Casey & Scott, 2006; Dunlap et al., 2000; Hini, Gendall, & Kearns, 1995).

This gap between attitude and action can be partially explained by barriers a person encounters when engaging in PEB, such as personal cost (finance, time), lack of structural support (recycling schemes, efficient public transport), knowledge (e.g., type of PEB that is effective) or other motivations to behave pro-environmentally (Jagers, Linde, Martinsson, & Matti, 2017; Kaiser, Byrka, & Hartig, 2010). In addition, a lack of specificity between the constructs that are used to measure attitude and behaviour may help explain the environmental attitude-PEB gap. That is, a general measure of attitude is less likely to predict a specific PEB than a scale assessing a person's attitude toward a specific behaviour. But general attitudes can predict general trends in behaviour or a generalised conservation ethic (Gifford & Sussman, 2012).

Little is known about how children's environmental attitude relates to their PEB. Generally, the research has been concerned with developing reliable scales (Evans, Brauchle, et al., 2007; Larson, Green, & Castleberry, 2011; Manoli, Johnson, & Dunlap,

2007), which is important because children require different measures that adults (Larson, Green, et al., 2011). Researchers in Spain have demonstrated that children's environmental attitude has a small, positive relationship with their engagement in PEB (Collado, Evans, et al., 2015; Collado et al., 2013; Corraliza, Collado, & Bethelmy, 2013). Environmental attitude has also been associated with individual's connection to nature in adults (Brügger et al., 2011; Mayer & Frantz, 2004; Nisbet & Zelenski, 2013; Whitburn et al., 2018). The relationships between children's environmental attitudes, connection to nature and engagement in PEB (Collado et al., 2013) would benefit from further research.

Environmental knowledge is required to understand environmental issues, and address specific actions (Heimlich & Ardoin, 2008). Models that explain PEB usually consider knowledge to be an influential factor (Gifford & Nilsson, 2014). Different kinds of knowledge contribute to engagement in PEB, namely ecological or systems knowledge and action-related knowledge. Ecological or systems knowledge is factual knowledge about the natural processes within ecosystems and the human impact on these ecosystems (Frick, Kaiser, & Wilson, 2004). Action-related knowledge involves knowing how to act; it refers to the potential behaviours that can be changed and the relative effectiveness of these behavioural changes (Frick et al., 2004). Action-related knowledge also includes a child's beliefs they are able perform such behaviour with a positive outcome (Collado & Evans, 2019).

Aspects of an individual's relationship with nature, such as their connection to nature, use of nature for psychological restoration, environmental attitude and knowledge, have been positively associated with their engagement in PEB. However, most of the empirical research has focused on adults. Further, the relationships between these four factors and their relative contribution to engagement in PEB are unclear.

1.6 Environmental education

Environmental education has risen to prominence since the 1970s (Carter & Simmons, 2010). Environmental education in school-aged children has focused on improving an individual's environmental awareness, knowledge, attitudes, values and skills and their PEB (Chawla & Cushing, 2007; Hungerford & Volk, 1990; Rickinson, 2001; Stern, Powell, &

Hill, 2014). Environmental education has also aimed to increase children's self-esteem, interest in nature and outdoor skills.

Motivating behaviour change is an important aim of environmental education. Traditionally, influencing pro-environmental behaviour change was thought to be a linear process: providing more environmental knowledge would increase children's awareness and influence their attitudes which in turn would result in increased PEB. This approach has been found to be too simplistic as imparting knowledge does not necessarily translate into behaviour change (Gifford & Nilsson, 2014; Heimlich & Ardoin, 2008; Hungerford & Volk, 1990; Kollmuss & Agyeman, 2002; Manfredo, Teel, & Bright, 2003) (Gifford & Nilsson, 2014) or stronger environmental attitudes (Manfredo et al., 2003). Neither does promoting environment attitude necessarily result in behaviour change (Gifford & Nilsson, 2014; Kollmuss & Agyeman, 2002; Manfredo et al., 2003)

A consistent finding is that exposure to nature as a child is associated with stronger environmental attitudes and greater engagement in PEB (Evans, Otto, & Kaiser, 2018; Wells & Lekies, 2006), and a stronger connection to nature as an adult (Berk, 2004; Chawla, 1998; Kellert, 2002). In addition, connection to nature is positively associated with PEB (Brügger et al., 2011; Otto & Pensini, 2017; Rosa et al., 2018; Whitburn, Abrahamse, & Linklater, 2019). Therefore, some researchers recommend that reconnecting children to nature may be an effective lever for behaviour change and should be an expected outcome of nature-based environmental education (Frantz & Mayer, 2014; Giusti, Svane, Raymond, & Beery, 2018; Zylstra et al., 2014). There is also emerging interest from environmental educators to promote children's connection to nature (Giusti et al., 2018; Phenice & Griffore, 2003). However, few researchers have evaluated the effectiveness of environmental education in promoting connection to nature (Braun & Dierkes, 2017; Collado et al., 2013; Ernst & Theimer, 2011; Kossack & Bogner, 2012; Liefländer et al., 2013; Sellmann & Bogner, 2013).

Environmental education policy in New Zealand is influenced by international declarations such as the Tbilisi Declaration (UNESCO, 1978), and the obligations of the Treaty of Waitangi (New Zealand's founding document). But there is no mandatory requirement for schools to include environmental education as part of the New Zealand Curriculum Framework (Eames, Cowie, & Bolstad, 2008). However, the New Zealand

Ministry of Education has produced guidelines that state a balanced environmental education programme should be *in* the environment, *about* the environment and *for* the environment. These guidelines are underpinned by four concepts: interdependence, sustainability, biodiversity and personal and social responsibility in ways that embrace a Māori worldview (Ministry of Education, 2015). Some schools have developed a comprehensive whole-school approach to environmental education while others offer little or none, and in some cases the environmental education programme is driven by a single enthusiastic teacher (Eames et al., 2008). Beyond formal education, environmental and community groups, universities and non-government organisations are important contributors to environmental education for school children. This is especially important in schools without strong environmental education programmes.

The current research is timely as the national and local governments and non-governmental environmental organisations have policies and interventions to connect children with nature (Rickinson, 2001). For example, The New Zealand Department of Conservation recognises its role is broader than conservation of New Zealand's unique environmental heritage. The Department's 'stretch goal' for the next decade is that 90% of New Zealanders' lives are 'enriched' through a connection to our natural environment (New Zealand Department of Conservation, 2015). At a local government level, the Wellington City Council has connecting Wellington residents with nature as one of the four main goals of its Biodiversity Strategy (Wellington City Council, 2015). In addition, environmental education providers in the Wellington region aim to connect children to nature as an outcome of their programmes. Although these goals are commendable, these organisations invest a great deal of money, time and effort to implement interventions while there remains little evidence of their effectiveness in increasing connection to nature.

1.7 Thesis structure

The objective of my research is to understand children's relationship with nature, in particular their connection to nature, and how it relates to their psychological wellbeing and their engagement in PEB. In addition, I want to determine whether environmental education of short duration could increase children's connection to nature.

In this thesis I address four gaps in the literature:

(i) Although researchers have investigated the relationship between connection to nature and PEB, the strength of the relationship varies. There are also a variety of instruments and methods used to measure connection to nature and PEB. This poses a barrier to integrating research findings (Tam, 2013a). Therefore, I completed a meta-analysis of the existing research to provide a quantitative estimate of the strength of the relationship (Chapter 2).

(ii) Research on the link between connection to nature and psychological wellbeing is almost completely confined to adults (e.g., Capaldi et al., 2014). Although there is a call to reconnect children to nature (Louv, 2008), there is little empirical evidence that demonstrates how children's connection to nature is associated with their psychological wellbeing. I used data, collected via a written survey, to test theoretical models that explained how children's connection to nature and their use of nature for psychological restoration were associated with their vitality and life satisfaction (Chapter 3).

(iii) A strong connection to nature is thought to motivate PEB (Brügger et al., 2011; Nisbet & Zelenski, 2013; Tam, 2013a), but there are currently relatively few studies that investigate this in children (Cheng & Monroe, 2012; Collado, Evans, et al., 2015; Otto & Pensini, 2017). In addition, it is unknown how other factors thought to motivate engagement in PEB adults (use of nature for psychological restoration, environmental attitude and knowledge) are inter-related with connection to nature, or what their relative contribution is to children's engagement in PEB. I used data, collected via a written survey, to test theoretical models that explained how children's connection to nature was associated with their engagement in PEB (Chapter 4).

(iv) Environmental education in natural environments has the potential to promote children's connection to nature, and thereby increase their engagement in PEB and conservation. Although many programmes aim to promote connection to nature, few assess whether they have been effective (e.g., Liefländer et al., 2013; Otto & Pensini, 2017). To the best of my knowledge, there have been no published studies evaluating connection to nature as an outcome of environmental education in New Zealand. Therefore, I undertook a longitudinal field experiment, with intervention and control groups, to investigate whether half-day environmental education field-

trips in Wellington, New Zealand, could increase children's connection to nature. In addition, I tested whether the intervention increased children's environmental attitude, knowledge, conservation behaviour, PEB and wellbeing (Chapter 5).

Finally, in Chapter 6, I summarise my findings, discuss the implications and make some recommendations.

Notes:

Chapters 2 – 5 are presented as stand-alone studies, either published or to be published as journal articles. The methods used to collect and analyse the written survey data are fully described in the Methods section of Chapter 3. The methods are subsequently summarised in Chapters 4 and 5 to avoid excessive repetition

A version of Chapter 2, the meta-analysis of connection to nature and PEB has been published as: Whitburn, Abrahamse & Linklater (2019). Meta-analysis of human connection to nature and proenvironmental behavior. *Conservation Biology*. DOI: 10.1111/cobi.13381

Chapter 2: Meta-analysis of connection to nature and pro-environmental behaviour[1]

2.1 Abstract

Understanding what drives environmentally protective or destructive behaviour is important to the design and implementation of effective public policies to encourage people's engagement in pro-environmental behaviour (PEB). Research shows a connection to nature is associated with greater engagement in PEB. However, the variety of instruments and methods used in these studies pose a major barrier to integrating research findings. I conducted a meta-analysis of the relationship between connection to nature and PEB. I identified studies through a systematic review of the literature and used Comprehensive Meta-Analysis software to analyse the results from 37 samples (N = 13,237) and to test for moderators. A random-effects model demonstrated a positive and significant association between connection to nature and PEB (r = 0.42, 95% CI [0.36, 0.47], p < 0.001). People who are more connected to nature reported greater engagement in PEB. Standard tests indicated little effect of publication bias in the sample. There was significant heterogeneity among the samples. Univariate categorical analyses showed that the scales used to measure connection to nature and PEB were significant moderators and explained the majority of the between-study variance. The geographic location of a study, age of participants, and the percentage of females in a study were not significant moderators. I found that a deeper connection to nature may partially explain why some people behave more pro-environmentally than others and that the relationship is ubiquitous. Facilitating a stronger connection to nature may result in greater engagement in PEB and conservation, although more longitudinal studies with randomised experiments are required to demonstrate causation.

[1] A version of this chapter is published as Whitburn, Abrahamse & Linklater, 2019.

2.2 Introduction

Environmental degradation, perhaps humanity's greatest current challenge (e.g., IPCC 2014), is largely anthropogenic and driven by habitat destruction, invasive species, pollution, overharvesting, and human over population (Wilson, 2002). Attempts to promote sustainable lifestyles or conservation behaviours must, therefore, focus on changing people's behaviour (Schultz, 2011) (Ehrlich & Kennedy, 2005). Understanding what motivates environmentally protective or destructive behaviour can be used to encourage pro-environmental behaviour (PEB) and conservation and inform government policies requiring broad-based public support.

An individual's connection to nature may motivate their engagement in PEB (Mayer & Frantz, 2004). Conversely a lack of connection to nature has been blamed for people's apathy toward environmental degradation and protection (Pyle, 2003; Soga & Gaston, 2016). In human relationships, as the closeness between individuals increases so does empathy and willingness to help (Cialdini, Brown, Lewis, Luce, & Neuberg, 1997), and this phenomenon may extend to human-nature relationships. That is, a close bond with nature may foster empathy for the natural world, which in turn may motivate caring and altruistic behaviour (Schultz, 2000).

One might expect a person with a strong connection to nature to behave pro-environmentally. However, even though there is generally a high level of concern about environmental problems and support for environmental protection there has not been widespread movement toward more sustainable lifestyles (IPCC, 2014; Schultz et al., 2004; Steffen et al., 2015). This gap is partially explained by barriers a person encounters when engaging in PEB, such as personal cost (finance, time), lack of structural support (recycling schemes, efficient public transport), knowledge (e.g., type of PEB that is useful), or other motivations to behaviour pro-environmentally (Jagers et al., 2017; Kaiser et al., 2010). It is unclear whether the same gap exists with connection to nature and PEB.

2.2.1 Operationalisation of connection to nature and PEB

There are at least 17 different scales that measure connection to nature (Tam, 2013a). The items in these scales reflect three inter-related dimensions of the human

relationship with nature: affect (feelings toward nature), cognition (understanding, knowledge and beliefs about nature) and behaviour (actions and experiences in nature). Some scales measure connection to nature as a single dimension. These uni-dimensional scales can emphasize an emotional attachment to nature (Kals et al., 1999; Mayer & Frantz, 2004; Perkins, 2010). For example, the Connectedness to Nature scale was designed to assess people's "affective sense of connectedness" or kinship with nature (Mayer & Frantz, 2004, p. 504). In contrast, Schultz (2002) argues that connection to nature is inherently cognitive and defines it as the "extent to which an individual includes nature within his/her cognitive representation of self" (Schultz, 2002, p. 67). Other scales are multi-dimensional. For example, the Nature Relatedness scale (Nisbet et al., 2009) has three dimensions (NR-self, NR-perspective, and NR-experience) that encompass affective, cognitive and experiential aspects of the human-nature relationship. The scales have 1 to 40 items. Most are self-report surveys requiring responses on a 5- to 7-point Likert-type scale, and some include pictorial components (Davis, Green, & Reed, 2009; Dutcher, Finley, Luloff, & Johnson, 2007; Martin & Czellar, 2016; Schultz, 2002). These different scales are highly correlated, can be loaded onto a single factor and correlate similarly with criterion variables (Tam, 2013a). Thus, the scales may measure the same underlying construct of connectedness to nature. But there is a small amount of divergence among some scales in their association with criterion variables, such as subjective well-being and PEB. Differences between cognitive and non-cognitive components of connection to nature may explain this divergence (Tam, 2013a).

I defined PEB broadly as "actions which contribute to environmental protection and/or conservation" (Axelrod, 1993, p. 153), to include as many studies as possible. Scales measuring PEB aim to capture whether an individual generally behaves pro-environmentally and include self-reported and objectively measured PEB. Objectively measured PEB is rare because of the difficulty in discreetly observing behaviour, but it has been achieved in measuring energy usage (e.g., Frantz & Mayer, 2014) and recycling behaviour (Whitburn et al., 2018). The most common way to measure PEB is through self-report surveys adapted from other scales (e.g., Kaiser, 1998; Schultz & Zelezny, 1998; Whitmarsh & O'Neill, 2010). The scales measuring PEB vary from 6 - 97 items, contain ≥ 1 dimension, and vary in their internal reliability and the content of their multiple dimensions (Markle, 2013).

Although all studies report a positive association between connection to nature and PEB, the strength of this relationship varies (r = 0.14 to 0.68). In addition, the diversity of scales poses a barrier to integrating results across studies and scales. Further, it is unclear how the variation in scales measuring connection to nature and PEB affect the strength of the relationship between these two variables.

There have been two meta-analyses (Bamberg & Möser, 2007; Hines, Hungerford, & Tomera, 1987) of socio-psychological determinants of PEB, but they did not include connection to nature. I sought to provide a quantitative synthesis of the current research on the relationship between connection to nature and PEB, and to examine the effect of moderators on this relationship.

Through meta-analysis I aimed to provide an estimate of the size of the relationship between connection to nature and PEB, determine whether there was significant variability across the sample and examine possible moderators. Moderators included instruments used to measure connection to nature and PEB, geographic location of samples (the strength of the relationship can vary with location, Tam, 2013a) and age and gender of study participants (being older and female is associated with greater environmental attitude and PEB, Kollmuss & Agyeman, 2002; Whitmarsh & O'Neill, 2010). I tested the sample for publication bias to determine whether it was broadly representative of the existing research.

2.3 Methods

I searched electronic databases (Web of Science, Science Direct, ProQuest Science and Technology, PSYCHInfo, ProQuest Dissertations, and Theses Global) for combinations of the following keywords: *connection to/with nature*, *connectedness to nature*, *nature relatedness*, *inclusion of nature in self*, *disposition to connect with nature*, *environmental identity*, *emotional affinity toward nature*, *connectivity to nature*, *commitment to nature and connection to nature index*; *pro-environmental*, *environmental*, *ecological*, *environmentally friendly*, *environmentally responsible*, and *conservation and sustainable behaviour*. Abstracts of promising studies were examined and the full-text located of studies that merited further investigation. I manually examined reference sections of papers that met the inclusion criteria for additional studies. I contacted study authors if connection to nature and PEB were measured but their relationship was not reported.

Studies were included in the meta-analysis if they examined the relationship between connection to nature and PEB, included a self-report assessment of explicit connection to nature and an assessment of PEB and included an effect size or information to calculate an effect size. Pearson's correlation coefficients were preferred. However, Fischer's *Z* scores, used to calculate the effect size, can also be calculated from sample size and significance level in studies where the correlation coefficient is not provided (e.g., Gosling & Williams, 2010). Samples were independent (i.e., individual participants were included only once). Longitudinal interventions required reporting the effect size before an intervention was implemented.

Connection to nature was measured by 12 different scales (Table 2.1). When ≥ 1 scale of connection to nature was used, I selected the scale that was the main focus of the study, rather than alternative scales used to provide evidence of convergent validity (e.g., Brügger et al., 2011; Davis et al., 2009; Mayer & Frantz, 2004). I also selected explicit rather than implicit scales (Geng, Xu, Ye, Zhou, & Zhou, 2015), because the implicit measure of connection to nature is poorly correlated with other scales, may measure a different concept (Brügger et al., 2011) and may lack a clear theoretical basis (Fazio & Olson, 2003). I selected the Nature Relatedness scale from Tam's (2013a) comparative study because he concluded it was perhaps the most reliable scale. This scale and its short form (NR-6) were

treated as a single scale when calculating the overall and moderator effects because NR-6 is derived from and strongly correlated to the Nature Relatedness scale (Nisbet & Zelenski, 2013). This decision was supported by the results of the moderator analyses. The Nature Relatedness scale had a correlation with PEB of 0.51, the NR-6 of 0.50, and when the scales were analysed as a single entity, $r = 0.51$.

Table 2.1 The 12 connection to nature scales included in the meta-analysis of connection to nature and pro-environmental behaviour (in chronological order of development).

Author	Scale	Country of origin
Kals et al. (1999)	Emotional Affinity Toward Nature	Germany
Schultz (2002)	Inclusion of Nature in Self	USA
Clayton (2003)	Environmental Identity	USA
Mayer & Frantz (2004)	Connectedness to Nature	USA
Dutcher et al. (2007)	Connectivity with Nature	USA
Davis et al. (2009)	Commitment to the Natural Environment	USA
Nisbet et al. (2009)	Nature Relatedness	Canada
Perkins (2010)	Love and Care for Nature	Australia
Brügger et al. (2011)	Disposition to Connect with Nature	Switzerland
Nisbet & Zelenski (2013)	NR-6 (Nature Relatedness – short form)	Canada
Tam (2013b)	Dispositional Empathy with Nature	China
Beery & Wolf-Watz (2014)	Environmental Connectedness	Sweden

I classified the content of each scale, taking into account the authors' description of the scale. I categorised each item as cognitive (associated with thoughts and beliefs: e.g., "I have a deep understanding of how my actions affect the natural world" [Mayer & Frantz, 2004], or nature is part of a person's cognitive representation of self [Schultz, 2002]); affective (associated with emotions: e.g., "I feel a deep love for nature " [Perkins, 2010], and "I feel very connected to all living things and the earth" [Nisbet et al., 2009]) or behavioural

(associated with experiences in nature: e.g., "I take notice of wildlife wherever I am" [Nisbet et al., 2009] or "I get up early to watch the sunrise" [Brügger et al., 2011]).

Researchers measured PEB with 8 different scales, including multi-dimensional latent constructs of self-reported PEB, single-dimensional self-reported PEB, and observed PEB. The multidimensional scales contained items that measure PEB in the areas of energy and water conservation, waste avoidance, recycling, transport, purchasing (anti-consumerist behaviour), self-education and social or political actions in various combinations. Studies with one-dimensional scales, which measure similar behaviours, were combined for the analyses. These scales were self-reported behavioural measures such as native vegetation protection in farmland (Gosling & Williams, 2010) and pro-environmental gardening and farming (Dresner, Handelman, Braun, & Rollwagen-Bollens, 2015; Sanguinetti, 2014). When authors reported ≥ 1 PEB measure, I selected for analysis the scale that most closely reflected multidimensional self-reported PEB. For example, actual commitment to ecological behaviour (which measured self-reported PEB) was selected over verbal commitment (Nisbet & Zelenski, 2013) and environmentalism (Mayer & Frantz, 2004; Nisbet & Zelenski, 2013). Perkins (2010) and Beery and Wolf-Watz (2014) reported correlation coefficients between connection to nature and individual items of their PEB scales. The weighted mean of the effect size of the PEBs was calculated to avoid double-counting participants.

Some studies measure the relationship between connection to nature and behavioural intentions or willingness to engage in PEB. Although the Theory of Planned Behaviour (Ajzen, 1991) incorporates intention as the immediate antecedent of behaviour, there is only a moderate correlation between behavioural intentions and behaviour (Bamberg & Möser, 2007; Grimmer & Miles, 2017). Behavioural intentions may capture a different concept than self-reported behaviour. Therefore, studies reporting intention or willingness to engage in PEB were excluded.

The following information was collected (if available) for each sample: authors' names, publication year, geographic region (North America, South America, Europe, Australasia and Asia), measure of connection to nature and PEB, effect size, sample size, significance of effect, percentage of female and age of participants. A number of potentially

eligible studies did not report statistics needed for the meta-analysis, and the data could not be obtained from the authors.

I assessed the possibility of publication bias by examining funnel-plot symmetry, which displays effect sizes (as Fischer's *Z*) plotted against standard error. An unbiased sample shows a symmetrical cloud of data points around the overall effect size in a pattern resembling a funnel (Borenstein, 2005). I used Egger, Smith, Schneider and Minder's (1997) regression test to quantify asymmetry in the funnel plot. Next, I undertook a trim and fill analysis (Duval & Tweedie, 2000) to determine the adjusted effect, taking into account bias seen in the funnel plot. Finally, I calculated the fail-safe *N*s. Rosenthal's (1991) *N* is the number of missing samples with an effect size of 0 that are needed to render the current overall effect non-significant. Orwin's *N* (1983) takes into account samples that have a negative effect size.

2.3.1 Data analyses

Comprehensive Meta-Analysis software (version 3) (Borenstein, 2014) was used to calculate the overall effect size and to assess whether the effect size depended on any moderator variables. Fischer *Z* transformations were used to determine the effect size (Hedges & Olkin, 1985) because some of the reported correlations between connection to nature and PEB were > 0.30 (Borenstein, Hedges, Higgins, & Rothstein, 2009). The Fischer's *Z* scores were converted to correlation coefficients for ease of use.

Random effects models were used because I expected the effect size to vary randomly among studies (Hedges & Vevea, 1998). Separate univariate categorical analyses were used to obtain an effect size for each subgroup of moderator variables. Moderators included the measures of connection to nature and PEB, geographic location of samples, age group of participants, and percentage of female participants. I selected pooled variance for the moderator analyses because I expected variance to be comparable across subgroups, and because there were < 5 samples in some of the subgroups; pooling increased accuracy of the τ^2 (variance of true effect sizes across studies) (Borenstein et al., 2009). Random effects meta-regression with method-of-moments estimation was used to assess whether the continuous covariate, percentage of females, moderated the relationship between connection to nature and PEB.

No outliers were identified in the sample (Hanson & Bussière, 1998). Although Cochran's *Q* was significant (*Q* = 406.59), when the sample with the lowest (*r* = 0.14, Beery & Wolf-Watz, 2014) or highest (*r* = 0.66, Otto & Pensini, 2017) effect size was removed from the meta-analysis, the *Q* statistics did not decrease by 50% (*Q* = 264.66 and 375.59 respectively).

2.4 Results

2.4.1 Sample characteristics

Thirty-seven independent samples were identified from 26 studies to 3 June 2018. The total sample was 13,237 individuals (adults, university students, and children) from 11, mostly western, countries (Table 2.2).

2.4.2 Relationship between connection to nature and PEB

The relationship between connection to nature and PEB was positive and moderately sized[2] across samples: $r = 0.42$, 95% CI [0.36, 0.47], $p < 0.001$ (Figure 2.1). Thus connection to nature was relatively higher among people who reported greater participation in PEB. Sample heterogeneity was significant among effect sizes: Q (36) = 406.59, $p < 0$ .001. A substantial portion of total variance was attributable to systematic differences in effect size between samples ($I^{2} = 91.15$); hence, it was important to investigate moderator variables.

Publication bias had only a minor influence on observed effect size. The distribution of samples around the observed effect was approximately symmetrical with an absence of a few samples on the mid to lower right-hand side of the funnel plot (Figure 2.2). Egger's et al.'s (1997) regression coefficient was not significant (intercept = -0.20 95% CI [-2.56, 2.15], t (35) = 0.17, $p > 0.05$ [2 tailed]), indicating a lack of bias in the data. Rosenthal's fail safe N indicated an additional 8952 samples, with an effect size of zero, would be required for the observed effect size to be non-significant. Orwin's fail-safe N showed that 293 missing samples would be needed to make the correlation non-significant. The trim and fill analysis imputed two samples to the right of the mean and produced an adjusted effect of $r = 0.45$, 95% CI [0.43, 0.46], which is slightly stronger than the observed effect.

[2] Effect sizes are small, < 0.3; moderate, 0.3 - 0.50; and large > 0.5, Cohen, 1992.

Table 2.2 Summary of studies used in the meta-analysis of the relationship between connection to nature and pro-environmental behaviour. Abbreviations are at the bottom of the table.

Study[a]	*n*	Connection to nature scale	Dimensions in connection to nature scales[b]	Pro-environmental behaviour scale[c]	Location	Age group	% female[d]	Source[e]
Clayton (2003)	73	Environmental Identity	A + C + B	PEB	USA	student	-	B
Mayer & Frantz (2004) S2	65	Connectedness to Nature	A + C	PEB	USA	student	58.8	J
Mayer & Frantz (2004) S4	135	Connectedness to Nature	A + C	PEB	USA	adult	74.2	J
Mayer & Frantz (2004) S5	57	Connectedness to Nature	A + C	PEB	USA	student	-	J
Schultz et al. (2004)	98	Inclusion of Nature in Self	C	PEB	USA	student	60	J
Raudsepp (2005)	987	Emotional Affinity Toward Nature	A	PEB	Estonia	adult	-	B
Dutcher et al. (2007)	513	Connectivity with Nature	A + C	PEB	USA	adult	21	J/T
Davis et al. (2009) S1	71	Commitment to the Natural Environment	A + C	GEB*	USA	student	63.4	J

Gosling & Williams (2010)	131	Connectedness to Nature & Connectivity with Nature	A + C	Vegetation protection on farm	Australia	adult	14	J
Perkins (2010) S4	235	Love & Care for Nature	A	PEB	Australia	adult	58	J
Brügger et al. (2011)	1186	Disposition to Connect with Nature	A + B	GEB*	Switzerland	adult	45.2	J
Hoot and Friedman (2011)	195	Connectedness to Nature	A + C	PEB	USA	adult	46.2	J
Nisbet & Zelenski (2013) S1	184	Nature Relatedness	A + C + B	Ecology scale**	Canada	student	67.4	J
Nisbet & Zelenski (2013) S3	354	Nature Relatedness	A + C + B	Ecology scale**	Canada	student	59.9	J
Nisbet & Zelenski (2013) S4 *A*	84	NR-6 (Nature Relatedness short form)	A + C	Ecology scale**	Canada	adult	78.6	J
Nisbet & Zelenski (2013) S4 *B*	123	NR-6	A + C	Ecology scale**	Canada	student	77.2	J
Tam (2013a) S1	322	Nature Relatedness	A + C + B	Ecological behaviour^	Hong Kong	student	45.3	J
Tam (2013a) S2	185	Nature Relatedness	A + C + B	Ecological behaviour^	U.S.A.	adult	63.8	J
Tam (2013b) S1	288	Dispositional Empathy with Nature	A + C	Ecological behaviour^	Hong Kong	student	45.1	J
Tam (2013b) S2	172	Dispositional Empathy with Nature	A + C	Ecological behaviour^	U.S.A.	adult	62.2	J

Tam (2013b) S3	104	Dispositional Empathy with Nature	A + C	Ecological behaviour^	Hong Kong	student	66.3	J
Tam (2013b) S4	175	Dispositional Empathy with Nature	A + C	Ecological behaviour^	Hong Kong	student	47.4	J
Tam (2013b) S5	78	Dispositional Empathy with Nature	A + C	Ecological behaviour^	Hong Kong	student	30.8	J
Beery & Wolf-Watz (2014)	1374	Environmental Connectedness	A + C	PEB	Sweden	adult	-	J
Roczen et al. (2014)	1907	Disposition to Connect with Nature	A + B	GEB*	Germany	adolescent	57	J/PC
Sanguinetti (2014)	477	Inclusion of Nature in Self	C	Gardening, farming or animal husbandry	U.S.A.	adults	60	J
Dresner et al. (2015)	165	Environmental Identity	A + C + B	Pro-environmental gardening	U.S.A.	adult	50	J
Geng et al. (2015)	113	Connectedness to Nature	A + C	CSEBQ*	China	student	44.3	J
Pereira & Forster (2015)	74	Connectedness to Nature	A + C	PEB	Australia	student	75.0	J
Collado et al. (2015)	107	Emotional Affinity Toward Nature	A	PEB	Spain	children	54.9	J

Barbaro & Pickett (2016) S1	308	Connectedness to Nature	A + C	PEB ***	U.S.A.	student	68	J
Barbaro & Pickett (2016) S2	296	Connectedness to Nature	A + C	PEB ***	U.S.A.	adult	60	J
Soliman (2017)	230	Connectedness to Nature	A + C	Observed PEB	Canada	student	70.2	J
Forstmann & Sagioglou (2017)	1487	Nature Relatedness	A + C + B	PEB ***	U.S.A.	adult	61.4	J/PC
Otto & Pensini (2017)	255	Disposition to Connect with Nature	A + B	GEB*	Germany	children	-	J/PC
Whitburn et al. (2018)	405	Disposition to Connect with Nature	A + B	GEB*	New Zealand	adult	62	J
Rosa et al. (2018)	224	Connectedness to Nature	A + C	PEB	Brazil	students	62.5	J

Abbreviations:

[a]: S, study; S*x* (*A* = community sample, *B* = undergraduate student sample).

[b]: A, affect; C, cognition; B, behaviour or experience.

[c]: PEB, pro-environmental behaviour; GEB, General Ecological Behaviour scale; CSEBQ, College Student Environmental Behaviour Questionnaire. * Adapted from Kaiser (1998). ** Ecology Scale, actual commitment, Maloney et al. (1975). ^ Adapted from Kaiser (1998) and Schultz & Zelezny (1998). *** Adapted from Whitmarsh and O'Neill (2010).

[d]: Data unavailable (-).

[e]: J, peer-reviewed journal; R, report; T, PhD dissertation; B, book chapter; PC, personal communication with author.

Study name	Correlation	Lower limit	Upper limit	*Z*-Value	*p*-Value
Otto & Pensini, 2017	0.66	0.58	0.72	12.59	0.00
Clayton, 2003	0.64	0.48	0.76	6.34	0.00
Davis et al., 2009, S1	0.60	0.43	0.73	5.72	0.00
Tam, 2013A, S2	0.60	0.50	0.68	9.35	0.00
Forstmann, 2017	0.59	0.56	0.62	26.11	0.00
Nisbet & Zelenski, 2013, S3	0.57	0.50	0.64	12.13	0.00
Barbaro & Pickett, 2016, S2	0.55	0.47	0.62	10.58	0.00
Nisbet & Zelenski, 2013, S4B	0.50	0.35	0.62	6.02	0.00
Roczen et al., 2014	0.50	0.46	0.53	23.74	0.00
Brügger et al., 2011	0.49	0.45	0.53	18.44	0.00
Whitburn et al., 2018	0.48	0.40	0.55	10.49	0.00
Tam, 2013B, S2	0.46	0.33	0.57	6.47	0.00
Mayer & Frantz, 2004, S4	0.45	0.30	0.58	5.57	0.00
Nisbet & Zelenski, 2013, S4A	0.45	0.26	0.61	4.36	0.00
Mayer & Frantz., 2004, S2	0.44	0.22	0.62	3.72	0.00
Rosa et al., 2018	0.44	0.33	0.54	7.02	0.00
Perkins, 2010, S4	0.42	0.31	0.52	6.82	0.00
Nisbet & Zelenski, 2013, S1	0.42	0.29	0.53	6.02	0.00
Tam, 2013B, S5	0.41	0.21	0.58	3.77	0.00
Mayer & Frantz, 2004, S5	0.39	0.14	0.59	3.03	0.00
Tam, 2013B, S4	0.39	0.26	0.51	5.40	0.00
Geng et al., 2015	0.39	0.22	0.54	4.32	0.00
Hoot & Friedman, 2011	0.37	0.25	0.49	5.45	0.00
Pereira & Forster, 2015	0.36	0.14	0.54	3.18	0.00
Tam, 2013A, S1	0.34	0.24	0.43	6.32	0.00
Barbaro & Pickett, 2016, S1	0.34	0.24	0.44	6.18	0.00
Dutcher et al., 2007	0.32	0.24	0.40	7.49	0.00
Tam, 2013B, S3	0.31	0.12	0.47	3.22	0.00
Collado et al., 2015	0.31	0.13	0.47	3.27	0.00
Soliman, 2017	0.29	0.17	0.40	4.50	0.00
Dresner et al., 2015	0.27	0.13	0.41	3.58	0.00
Raudsepp, 2005	0.27	0.21	0.33	8.68	0.00
Schultz et al., 2004	0.26	0.06	0.44	2.59	0.01
Tam, 2013B, S1	0.26	0.15	0.36	4.49	0.00
Sanguinetti, 2014	0.24	0.15	0.32	5.33	0.00
Gosling & Williams, 2010	0.22	0.05	0.38	2.58	0.01
Beery & Wolf-Watz, 2014	0.14	0.09	0.19	5.22	0.00
Overall random effect	0.42	0.36	0.47	14.15	0.00

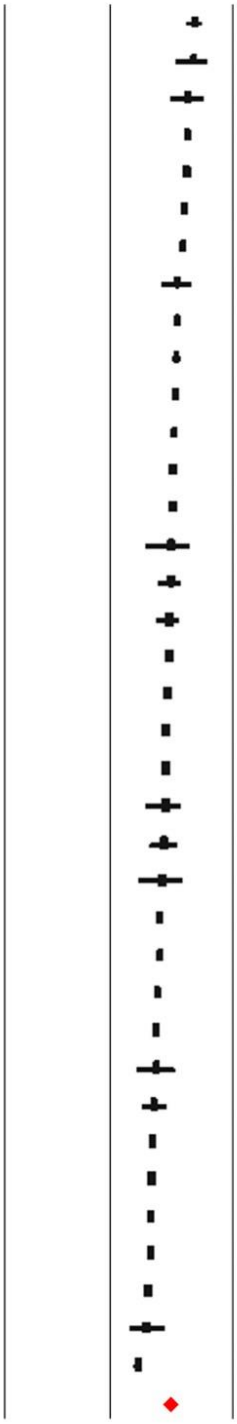


Figure 2.1 Forest plot showing the overall relationship (◆) between connection to nature and pro-environmental behaviour, and the relationships for individual samples, listed from the strongest to weakest effect size. Abbreviations: S*x*, study number; A, Community sample; B, Undergraduate sample. Lower and upper limits are 95% CI values.

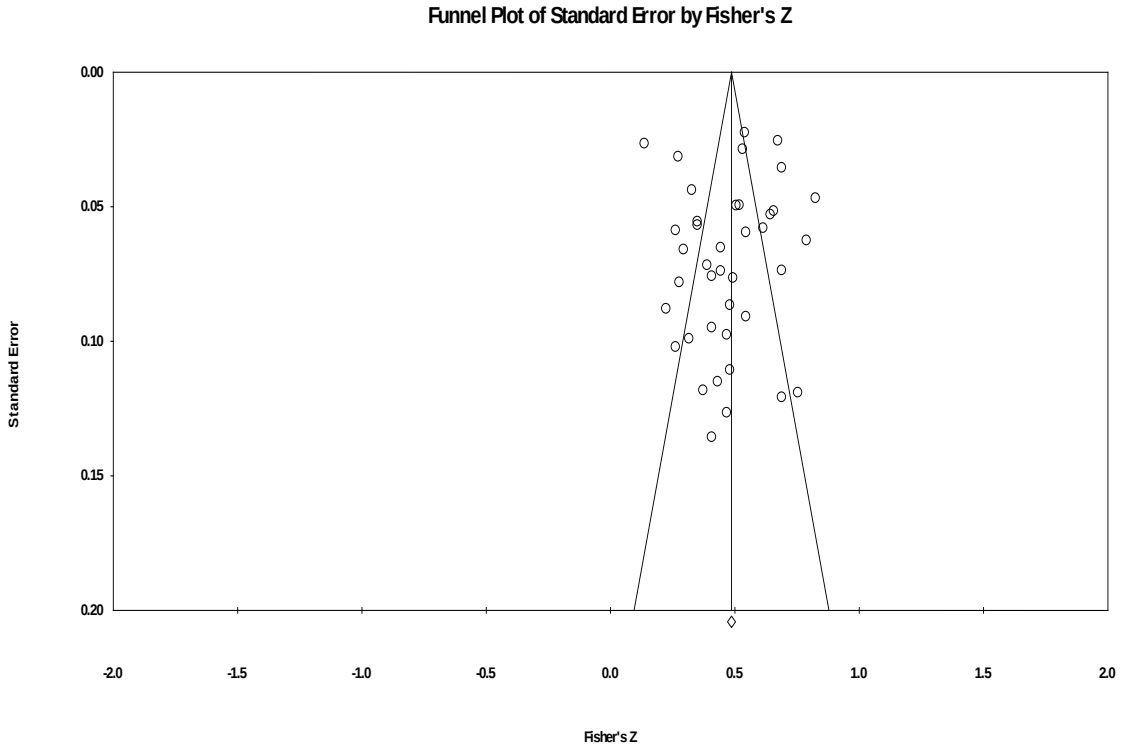


Figure 2.2 Funnel plot showing distribution of the effect size (as Fischer's *Z*) plotted against the standard error for each study, in relation to the overall effect.

2.4.3 Relationship moderators

The scale used to measure connection to nature significantly moderated the overall relationship between connection to nature and PEB (Q (10) = 36.29, $p < 0.001$, $N = 37$), and explained 69% of the between-sample variation (Table 2.3). Mean effect sizes for the types of connection to nature ranged from 0.14 to 0.60 (Table 2.3). The relationship was strongest for Commitment to the Environment ($r = 0.60$) and weakest for Inclusion of Nature in Self ($r = 0.25$). Environmental Connectedness included zero in the 95% CIs, indicating a non-significant relationship. Results for moderator subgroups with few samples can be problematic. Therefore, I repeated the moderator analysis for connection to nature scales with ≥ 3 samples per subgroup. The results were robust to the change in threshold of inclusion: $r = 0.45$; Q (3) = 13.62, $p < 0.001$; $R^2 = 0.37$; $n = 27$.

Multidimensional scales that contained affect and behaviour or affect, behaviour and cognition had the strongest relationship with PEB ($r = 0.52$ and 0.50 respectively) (Table

2.3). These included Disposition to Connect with Nature, Nature Relatedness, and Environmental Identity scales. The one-dimensional cognitive scale had the weakest relationship (r = 0.25). The content and dimensions of the connection to nature scales (affective, cognitive or behavioural) significantly moderated the relationship between connection to nature and PEB: Q (4) = 15.90, $p < 0.001$; R^2 = 0.46; N = 37. This result held when I tested subgroups with ≥ 3 samples: r = 0.46; Q (2) = 12.21, $p < 0.001$; R^2 = 0.40; n = 27.

Number of items in a scale also moderated the relationship: Q (3) = 28.6, $p < 0.001$; R^2 = 0.47; N = 37 (Table 2.3). Scales with a moderate number of items (20 to 29) (i.e., Nature Relatedness and Environmental Identity) had the strongest relationship with PEB (r = 0.55); those with < 9 items had the weakest (r = 0.29) (i.e., Environmental Connectedness, Connectivity with Nature, Inclusion of Nature in Self)

Scales used to measure PEB also moderated the overall relationship between connection to nature and PEB: Q (5) = 15.53, $p < 0.01$, N = 37, and explained 52% of the between-sample variance (Table 2.3). The relationship with connection to nature for the different scales of PEB ranged from 0.25 to 0.51. The scales based on Whitmarsh and O'Neill (2010) had the strongest relationship with connection to nature (r = 0.51). Other self-reported PEB scales (i.e., Ecology, General Ecological Behaviour, and general PEB scales) fell in the midrange (r = 0.36 - 0.49) and observed PEB (Soliman, Peetz, & Davydenko, 2017) was at the low end of the range (r = 0.29). Results were robust to change in the threshold of inclusion of ≥ 3 samples: r = 0.42; Q (4) = 14.4, $p < 0.01$; R^2 = 0.53; n = 36. Scales used to measure connection to nature and PEB together explained 75% of between-study variance: Q (15) = 53.75, $p < 0.001$.

The correlation between connection to nature and PEB was strongest for children (r = 0.51) and weakest for students (r = 0.41) and adults (r = 0.40). Neither age group (Q (2) = 1.29, $p > 0.05$, N = 29) nor participant mean age (Q (1) = 0.00, $p > 0.05$, N = 37) were significant moderators (Table 2.3). All age subgroups had ≥ 3 samples.

The relationship between connection to nature and PEB was strongest in samples from North and South America (r = 0.44) and Europe (r = 0.41) and weakest for Asia (r = 0.35) and Australasia (r = 0.38). However, the geographic location of samples did not

influence the strength of the relationship between connection to nature and PEB: Q (4) = 1.78, $p > 0.05$, $N = 37$ (Table 2.3). Similarly, meta-regression showed the percentage of females in the samples was not a moderator of the relationship: Q (1) =3.70, $p > 0.05$, $n =$ 32.

Table 2.3 Effect of moderators on the relationship between connection to nature and pro-environmental behaviour. Abbreviations at the bottom of the table.

Moderators[a]	*k*	*n*	Effect size (*r*)	95% CI lower	upper	Test null (2 tailed) *Z*	*p*[b]	Test of model
Connection to nature scales								
Commitment to the natural environment	1	71	0.60	0.37	0.76	4.44	0.001	
Disposition to connect with nature	4	3753	0.53	0.45	0.60	10.98	0.001	
Nature relatedness	7	2739	0.51	0.44	0.57	12.33	0.001	
Environmental identity scale	2	238	0.44	0.27	0.58	4.82	0.001	
Love and care for nature	1	235	0.42	0.21	0.59	3.78	0.001	
Connectedness to nature scale	11	1828	0.39	0.32	0.45	10.50	0.001	
Dispositional empathy with nature	5	817	0.36	0.26	0.46	6.58	0.001	
Connectivity with nature	1	513	0.32	0.12	0.50	3.07	0.001	
Emotional affinity toward nature	2	1094	0.28	0.13	0.43	3.52	0.001	
Inclusion of nature in self	2	575	0.25	0.08	0.40	2.92	0.001	

Environmental connectedness	1	1374	0.14	-0.06	0.33	1.38	0.17*	
Test of model	37	13237						$Q(10) = 36.29$, $p < 0.001$, $R^2 = 0.69$
Dimensions of connection to nature scales								
Affect + behaviour	6	3960	0.52	0.43	0.60	9.97	0.001	
Affect + cognition + behaviour	7	2770	0.50	0.41	0.57	10.06	0.001	
Affect + cognition	19	4603	0.37	0.31	0.43	11.27	0.001	
Affect	3	1329	0.33	0.18	0.47	4.20	0.001	
Cognition	2	575	0.25	0.05	0.43	2.45	0.011	
Test of model	37	13237						$Q(4) = 15.90$, $p < 0.001$, $R^2 = 0.46$
Number of items in scales of connection to nature								
1 – 9	10	3176	0.32	0.22	0.41	6.04	0.001	
10 - 19	18	4108	0.43	0.38	0.48	14.11	0.001	
20-29	7	2860	0.57	0.50	0.64	12.44	0.001	
30+	2	3093	0.49	0.34	0.62	5.67	0.001	
Test of model	37	13237						$Q(3) = 28.60$, $p < 0.001$, $R^2 = 0.47$

PEB scales								
PEB (Whitmarsh & O'Neill)*	3	2091	0.51	0.39	0.61	7.26	0.001	
Ecology scale**	4	745	0.49	0.37	0.59	7.23	0.001	
General ecological behaviour***	13	5261	0.46	0.40	0.52	12.54	0.001	
PEB general^	13	4137	0.36	0.29	0.43	9.13	0.001	
Observed PEB	1	230	0.29	0.02	0.52	2.13	0.03	
Pro-environmental gardening or farming	3	773	0.25	0.09	0.36	3.12	0.001	
Test of model	37	13237						$Q(5) = 15.53$, $p < 0.01$, $R^2 = 0.52$
Age group								
Children	3	2269	0.51	0.32	0.48	8.96	0.001	
Students	18	2941	0.41	0.33	0.49	9.17	0.001	
Adults	16	8027	0.40	0.32	0.48	8.96	0.001	
Test of model	37	13237						$Q(2) = 1.29$, $p > 0.05$, $R^2 = 0.00$

Mean age (years)								
Test of Model	29							$Q(1) = 0.00$, $p > 0.05$, $R^2 = 0.00$
Geographic location								
North America	20	5272	0.44	0.37	0.51	10.76	0.001	
South America	1	3045	0.44	0.09	0.69	2.45	0.01	
Europe	6	5816	0.41	0.28	0.53	5.68	0.001	
Australasia	4	845	0.38	0.20	0.53	4.05	0.001	
Asia	6	1080	0.35	0.20	0.48	4.47	0.001	
Test of model	37	13237						$Q(4) = 1.78$, $p > 0.05$, $R^2 = 0.00$
Percent female								
Test of model	32							$Q(1) = 3.70$, $p > 0.05$, $R^2 = 0.10$

Abbreviations:

[a]: PEB, pro-environmental behaviour. *, Adapted from* Whitmarsh & O'Neill (2010). **, Ecology Scale, Actual Commitment, Maloney, Ward, & Braucht (1975). ***, Adapted from Kaiser (1998). ^, From mixed sources.

[b] :*, Non-significant effect size

2.5 Discussion

The relationship between connection to nature and PEB was positive, significant and moderately sized (r = 0.42)**.** Individuals who were more strongly connected to nature demonstrated a greater engagement in self-reported PEB. This relationship held across gender, geographic location and age group. Publication bias did not greatly influence the observed effect; thus, I have confidence in the observed effect I found. My findings support the stance that feeling deeply connected to nature influences how individuals treat it and has implications for increasing general PEB and biodiversity conservation. This meta-analysis complements two meta-analyses that quantified the relationship between connection to nature and human wellbeing (Capaldi et al., 2014; Pritchard et al., 2019). Connection to nature had a small, positive association with vitality and life satisfaction (Capaldi et al., 2014), and measures of eudaemonic wellbeing, such as personal growth, autonomy and self-acceptance (Pritchard et al., 2019). Together, these meta-analyses suggest that a close connection with nature is beneficial for human and environmental well-being.

The large amount of heterogeneity in the dataset was largely explained by the scales used to measure connection to nature and PEB (which together explained 75% of between-study variance). It is somewhat surprising that scales measuring connection to nature moderated the relationship with PEB. If, as Tam (2013a) demonstrated, these scales measure an underlying core construct of connectedness to nature, one would expect the scales to demonstrate a consistent association with PEB. The multidimensional scales with a moderate number of items, and dimensions that included affective and behavioural or affective, behavioural, and cognitive items, had the strongest association with PEB. The Disposition to Connect with Nature, Nature Relatedness and Environmental Identity scales incorporated these qualities. The single-item, cognitive scale (Inclusion of Nature in Self) had one of the lowest associations with PEB. My findings support Tam's (2013a) suggestion that the distinction between cognitive and non-cognitive scales may be important. Furthermore, multidimensional scales may capture more of what it means to be connected to nature and, therefore, better predict PEB. Multi-dimensional scales also allow a detailed analysis of how their various dimensions relate to PEB and how they are affected by interventions aimed to increase connection to nature. My results indicated cognition, affect and behaviour were important components of connection to nature in its relationship with PEB. Addressing

participant environmental knowledge alongside building an emotional and experiential connection to nature may be required in interventions that aim to motivate greater engagement PEB.

The way PEB was operationalized was also a significant moderator of the relationship. The multidimensional scales that measured general PEB and covered several domains of behaviour had the strongest association with connection to nature. There was a fairly consistent relationship with connection to nature across these multi-dimensional scales. Means fell within the 95% confidence interval of the scales with the highest association with connection to nature, 0.39 - 0.61 (i.e., scales based on Whitmarsh & O'Neill, 2010). Multi-dimensional scales can reduce measurement error and produce generalizable results (Epstein, 1983; Kirkpatrick, 2003). People may not consistently engage with a wide range of PEBs, and some behaviours (e.g., recycling) generally require less effort than others (e.g., political activism or using public transport). Aggregating PEBs across several dimensions can capture a more realistic picture of a person's general PEB than measuring a single behaviour.

The demographics I tested were not significant moderators of the relationship between connection to nature and PEB. The age group or mean age in years of participants and the percentage of females did not affect the strength of the relationship. This was unexpected because generally being older and female is associated with greater engagement in PEB (Kollmuss & Agyeman, 2002). Undergraduates are often used as a convenient population in research. There are some concerns that, as a population, undergraduates may not be representative of the general adult population and study results may therefore not be generalizable. I found no significant difference in results for students and adults, indicating these concerns may be unwarranted in this area of research. The lack of geographic location as a moderator contradicted cross-cultural studies that report that the way individuals relate to the natural environment is culturally patterned (Milfont & Schultz, 2016). This might be because the existing research centres on urban populations in western countries. Nature connectedness needs to be investigated in non-western cultures.

This meta-analysis has focussed on the relationship between people's connection to nature and their engagement in PEB. However, an individual's relationship with nature and

their engagement in PEB develops within a social context. The perceived expectations and behaviours of other people, who are important to the individual, influence the development of a person's social norms (Abrahamse, 2019; Steg et al., 2013). Social norms are informal rules that govern attitudes and behaviour (such as connection to nature and PEB) in a particular group of people or society (Cialdini , 1998). Although the social context of connection to nature and PEB development is beyond the scope of the meta-analysis, it is worth briefly examining the extent to which researchers have investigated these social influences.

In the current meta-analysis four researchers considered the social context in their work. Collado, Evans et al. (2015) reported that the level of parents' engagement in PEB had a negative association with their children's PEB (aged 6 -12 years), and had no significant association with their connection to nature. Belonging to an environmental group, participating in a community planting scheme and being in nature with other adults were all associated with a stronger connection to nature (Nisbet et al., 2009, Sanguinetti 2014, Whitburn et al., 2018). The effect of social norms on people's connection to nature, environmental attitude and PEB has been somewhat overlooked in the studies in the current meta-analysis. The failure to account for social context may, for example, help explain inconsistences in the relationship between environmental attitudes and engagement in PEB (Olli et al., 2001). Understanding the social context in which connection to nature and PEB develop is an area that could benefit from more research.

My study has some limitations. The correlation I found does not mean causation. A stronger connection to nature may indeed motivate greater PEB. Conversely, individuals who participate in more PEB may develop a stronger connection to nature, or other variables may be involved. However, my findings do consolidate existing research and provide a solid grounding to justify future longitudinal research into increasing PEB by strengthening individuals' connection to nature (Schultz, 2011).

Further, differences in the strength of the relationship between connection to nature and engagement in PEB may also be attributable to items in the scales that indirectly measure PEB, which could result in a stronger correlation. For example, several scales include an item that described how a person's actions affect the environment (Nature

Relatedness, Environmental Identity, and Commitment to Nature, and Connectedness to Nature scales). These scales did correlate more strongly with PEB than the scales without such items.

Connection to nature and PEB are measured by self-report. Reliance on self-reports threatens construct validity (i.e., metrics used may not measure what they are intended to) and can lead to inflated associations between variables measured via the same method due to shared method variance. However, observing actual PEB is difficult because most actions are not carried out in public and observing a single behaviour is not a valid measure of an individual's general PEB (Frantz & Mayer, 2014).

I focused on the direct relationship between connection to nature and PEB. However, the relationship may be indirect. For example, the relationship between connection to nature and PEB is partially mediated by environmental attitudes, the use of nature for psychological restoration (Whitburn et al., 2018) and environmental values (Pereira & Forster, 2015), and fully mediated by biospheric concerns (Gosling & Williams, 2010). It is useful to identify mediators that facilitate the relationship between connection to nature and PEB to determine types of interventions that may motivate greater PEB.

Conservation science has successfully identified the biological values and processes affected by anthropogenic activity and has successfully mitigated some human impacts (Schultz, 2011). However, conservation efforts are continually undermined by human behaviour (Mascia et al., 2003). Conservation actions are human behaviours (Schultz, 2011; Verissimo, 2013); therefore, it is vital to understand how social and psychological factors influence such behaviours (Bennett et al., 2017; Fox et al., 2006; Mascia et al., 2003). My findings support Schultz's (2011) suggestion that promoting stronger connections to nature could increase individuals' pro-environmental and conservation behaviours. My results showed that people with a stronger connection to nature are more likely to engage with a range of PEBs, including conservation of energy and water, anti-consumerism, pro-environmental political activism and financial support for environmental organisations.

Future longitudinal studies (ideally randomised experiments) could provide evidence of a causative relationship between connection to nature and PEB. A recent longitudinal study demonstrated the amount of time spent in nature as a 6-year-old is related to

environmental attitudes and behaviour as a young adult (Evans et al., 2018). Although time in nature is not connection to nature, it may be indicative of the relationship one might expect if connection to nature is causative of PEB. The usefulness of existing interventions, such as environmental education, aimed at strengthening connection to nature as a way to motivate greater engagement in PEB, needs evaluation.

2.6 Conclusion

This is the first meta-analysis to investigate the relationship between connection to nature and PEB. I demonstrated that the relationship between connection to nature and PEB is positive and of moderate strength. This finding complements recent meta-analyses (Capaldi et al., 2014; Pritchard et al., 2019) that showed a small positive relationship between connection to nature and human wellbeing. Together, these studies suggest that a deep relationship or connection to nature benefits both environmental and human wellbeing.

The way connection to nature and PEB are measured affects the strength of the relationship between the two variables. Multi-dimensional scales that incorporate items that measure feelings toward nature had the strongest association with self-reported engagement in PEB. It may be preferable to use these scales in the future.

My study supports the hypothesis that promoting people's connection to nature could also increase their conservation and PEBs (Schultz, 2011). My findings only demonstrate a correlational relationship. Future experiments with repeat measures (and ideally randomised) are required to demonstrate that strengthening connection to nature causes an increase in PEB.

Chapter 3: Children's connection to nature and their psychological wellbeing

3.1 Abstract

Exposure to nature can benefit many aspects of human health, including psychological wellbeing. It can also strengthen children's connection to nature and be psychologically restorative. This research investigated drivers of children's psychological wellbeing associated with their relationship with nature, primarily their connection to nature, and also their use of nature for psychological restoration. I examined how these psychological factors are related to one another and to aspects of children's psychological wellbeing: vitality and life satisfaction.

Data was collected via a self-administered questionnaire from children attending environmental education programmes in Wellington, New Zealand (*N* = 324). I tested whether children's connection to nature and their use of nature for psychological restoration were associated with their vitality and life satisfaction. I also tested whether socio-demographic factors could improve on the modelled relationships. Structural equation modelling, followed by Information Theoretic model selection and inference was used to identify the best model.

Connection to nature had a direct, positive relationship with children's vitality, but not their life satisfaction. The children's use of nature for psychological restoration had a direct, positive association with their vitality and their life satisfaction. There was also a strong positive relationship between children's connection to nature and their use of nature for psychological restoration. The model explained 28% of the variance in vitality, and 5% of the variance in life satisfaction. Models that contained socio-demographic variables were not well supported.

Reduced opportunities for children to interact with nature in urban environments may adversely impact their psychological wellbeing. Therefore, providing access to natural, psychologically restorative environments near to where children live, and encouraging

children to use them, may be an effective intervention to improve children's wellbeing, irrespective of their socio-economic circumstances.

3.2 Introduction

The majority of the earth's human population lives in cities. In developed countries, such as New Zealand, this proportion rises to over 90% (United Nations, 2012). Increasing urbanisation is associated with a shift in the burden of illness from acute infections to increases in non-communicable physical and mental illnesses. Illnesses such as cardiovascular disease, high blood pressure, obesity (Dye, 2008) and depression, anxiety and stress (Sundquist, Frank, & Sundquist, 2004) are increasingly common.

Urban nature provides eco-system services important to human health by, for example, lowering air pollution and moderating its temperature (Chen, 2017; Roberts, 2015; World Health Organisation, 2005). In addition, a growing body of evidence reports physical, psychological and social wellbeing benefits of spending time in nature, even urban nature (for reviews, see Bowler et al., 2010; Chawla, 2015; Gill, 2014; Hartig et al., 2014; Keniger et al., 2013; Matsuoka & Kaplan, 2008; McMahan & Estes, 2015). The natural environment has, in particular, been associated with mental health benefits (Barton & Pretty, 2010; Cox et al., 2017; Dillen, De Vries, Groenewegen, & Spreeuwenberg, 2012; Korpela, Borodulin, Neuvonen, Paronen, & Tyrvainen, 2014; Tillman, Tobin, Avison, & Gilliland, 2018; van den Berg et al., 2015).

Urban children, however, spend less time outdoors compared to their predecessors (Natural England, 2009; Ward et al., 2016; Wheeler et al., 2010). Children are having fewer direct experiences with nature (Soga, 2018); instead, they are spending more time in sedentary activities, such as those that involve digital devices and media (Rideout, Foehr, & Roberts, 2010). This may lead to a physical and psychological disconnection from nature (Pyle, 2003) and, in turn, negatively impact children's wellbeing and their wellbeing as adults (Engemann et al., 2019; Pensini, Horn & Caltabiano, 2016; Preuß et al., 2019).

Connection to nature is thought to develop by spending time in nature (Braun & Dierkes, 2017; Liefländer et al., 2013; Mayer et al., 2009; Nisbet & Zelenski, 2011; Richardson & Sheffield, 2017). It is positively related to psychological wellbeing in adults, including their life satisfaction and vitality (Capaldi et al., 2014; Mayer & Frantz, 2004; Nisbet et al., 2011; Pritchard et al., 2019; Tam, 2013a). A few researchers have demonstrated that children's connection to nature is related to aspects of their

psychological wellbeing such as life satisfaction, self-satisfaction and pro-social behaviours (Richardson et al., 2015; Whitten et al., 2018). My research adds to this small body of knowledge.

Children also find exposure to natural environments psychologically restorative (Bagot et al., 2015; Berto et al., 2015; Collado & Staats, 2016). Psychologically restorative experiences in nature have seen improvements in children's cognitive function (measured as their ability to concentrate) and development (e.g., Dadvand et al., 2015; Dadvand et al., 2017; Faber Taylor et al., 2002; Wells, 2000), positive affect and social activity (Bagot et al., 2015), and reductions in their level of stress (Corraliza et al., 2012; Kelz et al., 2015; Wells & Evans, 2003). The use of nature for psychological restoration may also be positively associated with other aspects of children's psychological wellbeing such as vitality and/or life satisfaction, as it is in adults (Korpela, Ylen, Tyrvainen, & Silvennoinen, 2008; Ojala, Korpela, Tyrväinen, Tiittanen, & Lanki, 2019; Whitburn, 2014). How children's use of nature for psychological restoration relates to their connection to nature is as yet unknown.

Children's connection to nature and their restorative experiences in nature may be inter-related mechanisms that facilitate the beneficial effects of spending time in nature (Whitburn, 2014; Wyles et al., 2019). A child who feels drawn to spend time in nature may avail themselves of nature's restorative benefits, with or without conscious thought. Such experiences of psychological restoration in nature may lead to feelings of closeness, appreciation and greater connection to the natural world. The direction of causation between connection to nature and the use of nature for psychological restoration is unclear. The increase in connection to nature seen after short walks in urban nature was mediated by gains in psychological restoration for 80 Canadian university students (Nisbet & Zelenski, 2011). The reverse relationship was demonstrated in a similar experiment where connection to nature mediated the relationship between exposure to nature and increased restoration (Mayer et al., 2009). Understanding the mechanisms by which exposure to nature affects human wellbeing is key to predicting health outcomes and identifying what interventions are possible (Bell et al., 2014; Cleary et al., 2017).

Participation in pro-environmental behaviour (PEB) is generally associated with caring for the environment, but it has also has been associated with greater levels of

personal happiness. Subjective wellbeing or happiness was higher in adults (Bechtel & Corral Verdugo, 2010; Brown & Kasser, 2005) and adolescents (Brown & Kasser, 2005) who reported greater engagement in ecologically responsible behaviour compared to adults and adolescents who reported lower levels of engagement. This relationship between PEB and psychological wellbeing is consistent with other research into the benefits of participating in ecological restoration schemes or community gardening initiatives (Kingsley, Townsend, & Henderson-Wilson, 2009; Miles, Sullivan, & Kuo, 1998). It is not yet known, however, whether engaging in PEB is also associated with greater wellbeing in younger children. This research aims to fill that gap.

In this chapter I investigate the hypothesised relationships (Figure 3.1) between two of the drivers of children's wellbeing associated with their experiences in nature: children's connection to nature and their use of nature for psychological restoration. In particular, I wanted to examine how children's connection to nature related to their use of nature for psychological restoration and two wellbeing measures that are known benefits of spending time in nature: vitality and life satisfaction. Vitality, as an example of eudaemonic wellbeing, is defined as having physical and mental energy and comes with a sense of aliveness, enthusiasm and energy available for the tasks of life compared to being exhausted and tired (Ryan & Frederick, 1997). In contrast, life satisfaction, as an example of hedonic wellbeing, measures a person's satisfaction with their life as a whole, compared to that which they judge is an appropriate standard (Diener et al., 1999; Huebner, 1991; Rees, Goswami, & Bradshaw, 2010).

I also wanted to determine how much of the unexplained variance in the model was explained by socio-demographic factors. This is because socio-economic status is associated with health inequalities (Diener et al., 1999; Mitchell & Popham, 2008; New Zealand Government, 2018) and access to urban nature (Freeman et al., 2015; Mitchell & Popham, 2008; Shanahan et al., 2014). In addition, socio-demographic factors such as gender, age and ethnicity are associated with children's connection to nature (Bruni & Schultz, 2010; Department of Conservation, 2016; RSPB, 2013).

Based on the literature reviewed above and elaborated in Chapter 1, I expected children's connection to nature and their use of nature for psychological restoration to be

positively correlated (Mayer et al., 2009; Nisbet & Zelenski, 2011; Whitburn et al., 2018; Wyles et al., 2019) and to have a positive relationship with their vitality and life satisfaction (e.g., Capaldi et al., 2014; Richardson et al., 2015; Tam, 2013a; Wolsko & Lindberg, 2013; Zelenski & Nisbet, 2012). In addition, I expected children's connection to nature and their use of nature for psychological restoration to be more strongly associated with their wellbeing than the socio-demographic indicators. The literature is unclear whether a greater use of nature for psychological restoration leads to a stronger connection to nature or whether the relationship is reversed (Mayer et al., 2009; Nisbet & Zelenski, 2011; Whitburn et al., 2018; Wyles et al., 2019). Therefore, I developed models to test both scenarios (Figure 3.1). Finally, I expected that children's engagement in PEB would be positively associated with their wellbeing (Brown & Kasser, 2005).

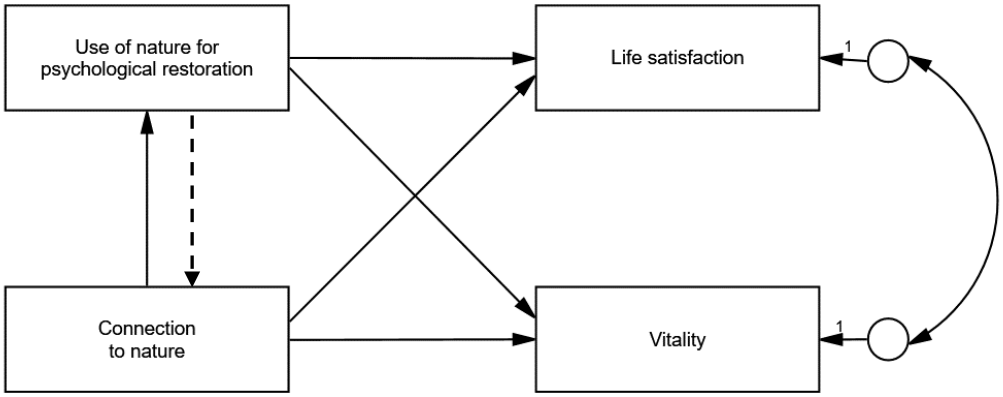


Figure 3.1 Theoretical model explaining the relationship between children's connection to nature and their psychological wellbeing (life satisfaction and vitality), mediated by their use of nature for psychological restoration.

3.3 Methods

3.3.1 Design and procedure

This study used a quasi-experimental, non-equivalent design, because children were already in established groups (classes). Classes, who had booked to attend environmental education field trips in Wellington, New Zealand, were referred to me by the education providers (Zealandia Eco-sanctuary, Wellington Zoo, Mountains to Sea Wellington). A convenience sample of schools was selected which resulted in a fairly representative sample of Wellington children based on their age, geographical location (urban, suburban, and rural) and socio-economic diversity.

I used a self-administered questionnaire (Appendix 1) to collect data from 31 October 2017 to 15 August 2018. All questionnaires were confidential. Information sheets and consent forms were distributed to the parents or guardians of all students (Appendix 2). I administered the survey after parental consent was obtained and children affirmed their willingness to participate. Surveying took place in the children's school classroom in the days before the environmental education intervention. I introduced myself, and the research and the survey, and explained what was required of the children. All children were offered a small thank-you gift (a toy, badge or branded pencil) after completing the survey.

Initially there was a poor return-rate for the parental consent forms, even after adding an electronic consent option. This is a common problem for teachers (Coyne, 2010). The teachers involved in the research thought it was probably because of the large amount of information going between school and home, rather than parents not wanting their children to be involved. I moved to a passive consent system, which has been shown to result in a 93-100% participation rate (Loveridge, 2010; Tigges, 2003). This required the parents to return a non-consent form (either in hard copy or on-line) only if they did not want their child to participate in the research. If the parents did consent they did not need to do anything further, and their child was included in the study. The passive consent process resulted in only one non-consent form being returned and one child choosing not to participate.

3.3.2 Participants

Children in school years 5 - 8 (aged 7 - 13 years) were recruited from seventeen classes in eight primary (elementary) schools in the greater Wellington region, New Zealand (Appendix 6). Three hundred and seventy-nine children completed the survey. One school withdrew from the study (*N* = 53). Two children's surveys were discarded as one was over 90% incomplete and the other answered every item with a 5, even negatively scored items. The 324 usable surveys were an adequate sample for the structural equation models, mixed-design ANOVAs and regression analyses (Field, 2013; Kline, 2005).

The 324 survey respondents were 39.8% female, with a mean age of 10.6 ± 1.42 (SD) years. The children identified their ethnicity as New Zealand European (60.8%), Māori (27.2%), Pacific Peoples (24.1%), Asian (11.4%) and Middle Eastern, Latin America or African (4.6%). The sum percentage of ethnicities is over 100 because children could select as many ethnicities as they considered appropriate. The children were more likely to be male ($\chi^2_{(1)}$ = 11.06, $p < 0.001$) and identify as Māori ($\chi^2_{(1)} = 20.06$, $p < 0.001$), Pacific Island ($\chi^2_{(1)} = 54.37$, $p < 0.001$) or Middle Eastern, Latin American and African ($\chi^2_{(1)} = 19.63$, $p < 0.001$) than the population of children in the Wellington region (Statistics New Zealand, 2017).

3.3.3 Self-report measures

The self-report questionnaire included latent variables to measure socio-psychological constructs, species' identification and socio-demographic questions (Appendix 1). The socio-psychological constructs were rated on a five-point Likert-type scale ranging from 1 (strongly disagree) to 5 (strongly agree). There were from one to four reverse-scored questions in each construct to encourage evaluation of each question and avoid acquiescence bias.

'Nature' was not specifically defined in the survey or when I administered the survey in classrooms because such definitions "sometimes resists or confounds our constructions" (Chawla, 2001, p. 456). This allowed the term to be interpreted by children in its most inclusive sense; allowing the children to draw on their own experiences and understanding of nature.

3.3.3.1 Connection to nature, 16 items

I used the 16-item children's Connection to Nature Index (Cheng & Monroe, 2012) to measure children's connection to nature or their "affective attitude toward the natural environment" (Cheng & Monroe, 2012, p. 31). The Connection to Nature Index was specifically designed and validated for use with children in my chosen age group. Other researchers have found it to be reliable with a Cronbach's alpha ranging from 0.82 - 0.86 (Bragg et al., 2013; Department of Conservation, 2016; Ernst & Theimer, 2011; Richardson et al., 2015). Bragg et al.'s (2013) comparative analysis of three scales found that the Connection to Nature Index was the easiest for children to complete and understand. The scale provides an overall connection to nature score and is made up of four sub-factors or dimensions. Cheng and Monroe (2012) suggest the scale has four dimensions: enjoyment of nature, empathy for creatures, sense of oneness with nature and sense of responsibility for nature. There has been some variation in the dimensionality reported by other researchers. For example, in Bragg et al.'s (2013) study, the dimension capturing a sense of oneness with nature did not show an acceptable internal consistency.

I adapted some items to make them more suitable to the Wellington, New Zealand, context with reference to Stuart-Currier (2016) who previously used the Connection to Nature Index with children in Wellington. For example, "I like to see animals living in a clean environment" (Cheng & Monroe, 2010, p. 41) was changed to "I like seeing native eels, fish and birds living in a clean environment" and "I like to see wild flowers in nature" was changed to "I enjoy looking at birds, bugs, lizards and plants". I also made changes to balance the number of items in each dimension. Cheng and Monroe's original scale contained: enjoyment, 7 items; empathy, 4; oneness, 2; sense of responsibility, 3. My adaptations resulted in enjoyment, 5 items; empathy, 4 items; oneness, 4 items and responsibility, 3 items. I also reworded some items to be in the first rather than third person. 'People' became I, me or my. I did this to encourage the children to reflect on their personal response to the questions rather than what they thought others should do. My version of the scale included one reverse scored item.

3.3.3.2 Use of nature for psychological restoration

The use of nature for psychological restoration measured the children's awareness of their experiences of psychological restoration and emotional self-regulation in natural

areas. The scale consisted of eight items designed to measure different aspects of psychological restoration associated with Attention Restoration Theory (Kaplan & Kaplan, 1989) and emotional regulation (Ulrich et al., 1991): being away (e.g., “When I spend time in nature I feel free”), compatibility (e.g., “I can do things I like in nature”) and emotional self-regulation (e.g., “When I’m angry or upset, being surrounded by nature helps me calm down”). The items were developed with reference to other scales developed for adults (Hartig et al., 2007; Whitburn et al., 2018) and children (Bagot, Kuo, & Allen, 2007; Korpela, Kytta, & Hartig, 2002). There were two reverse scored items.

3.3.3.3 Environmental attitude

Environmental attitude was measured with the 10-item New Ecological Paradigm (NEP) scale for children. The NEP was originally developed for adults (Dunlap et al., 2000) and revised for the use in adolescents (Manoli et al., 2007) and children (Corraliza et al., 2013). The dimensionality reported for the children’s NEP scale has varied. Manoli et al. (2007), for example, report a three dimensional scale. The dimensions include: rights of nature (e.g., “Plants and animals have as much right as people to live”), eco-crisis (e.g., “If things don’t change, we will have a big disaster in the environment soon”) and human exemptionalism (e.g., “People are clever enough to keep from ruining the earth”). The children’s NEP scale has four reverse scored items.

3.3.3.4 Pro-environmental behaviour

I developed a 12-item scale to measure every-day pro-environmental behaviour (PEB). The selection of items was informed by previous scales measuring PEB in children (such as Collado et al., 2013; Evans, Brauchle, et al., 2007; Richardson et al., 2015), and contained actions children could reasonably perform on their own. The PEB scale incorporates three different domains of behaviour: Daily conservation actions in the areas of water and energy conservation and recycling (e.g., “I try to use less water when I have a shower or brush my teeth”); environmental citizenship/social behaviours which involve influencing others within the children’s sphere of influence (e.g., “I remind friends to pick up trash if they drop it on the ground”) and pro-nature behaviours which encompass actions that have direct impact on plants or animals (e.g., “I put water outside for the birds”). The PEB scale contained two reversed scored items.

3.3.3.5 Students' Life Satisfaction scale

I used the Students' Life Satisfaction Scale (Huebner, 1991), revised by Rees et al. (2010), to obtain an overall evaluation of the child's satisfaction with their life. The 5-item scale includes items such as "I have a good life" and has one reverse scored item. It has been used previously with children in New Zealand (Ward et al., 2016).

3.3.3.6 Vitality

I used a scale developed by Ryan and Frederick (1997) to measure vitality. This 7-item scale was originally developed for adults. I removed two items and simplified some of the language to make it appropriate for children. The scale includes items such as "I feel alive and active most days". The vitality scale has one reverse scored item.

3.3.3.7 Socio-demographics

I collected data on the age, gender and ethnicity of the children. Children could select as many ethnic groups as were relevant to them. The categories of ethnicity reflected those in the New Zealand Government census (Statistics New Zealand, 2013). They included: New Zealand European; Māori; Pacific People; Asian; Middle Eastern, Latin American and African.

I used the decile rating system for New Zealand schools to obtain a measure of socio-economic status for each school. The decile system is a socio-economic ranking of schools, based on the number of students who live in low socio-economic communities. The decile system is used to target funding to help overcome barriers to learning associated with lower socio-economic circumstances (Ministry of Education, 2018). Decile 1 schools are the 10% of schools with the highest proportion of students from low socio-economic communities, whereas decile 10 schools are the 10% of schools with the lowest proportion of these students. As schools are made up of students from a variety of socio-economic backgrounds it can mean schools of a similar decile rating vary in the overall socio-economic composition, especially in the middle decile rankings. The decile system has been used as an indicator for socio-economic selection by other researchers in New Zealand (e.g., Freeman et al., 2015).

The survey was piloted on 26 June 2017 using two classes of primary (elementary) school children in years 4 - 6. The pilot study was to ensure the directions and questions were clear and to find out how long the survey would take to complete. The survey took

children 20 - 30 minutes to complete. Observations from the pilot and comments from the class teachers were used to improve the layout, question clarity, instructions and language. The pilot survey originally included a 15-item scale to measure children's engagement in outdoor activities, and a drawing activity to capture the amount of nature around children's homes. These two elements were removed from the final survey as they distracted from the main focus of my research. Removing these sections brought the survey completion time to less than 20 minutes, which the teachers deemed acceptable.

3.3.4 Statistical analyses and data preparation

3.3.4.1 Preliminary analyses

Raw data from the completed surveys was entered into a SPSS data sheet (IBM SPSS Statistics for Windows, Version 24.0). 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.

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 was assessed by box plots and standardised scores (*z*). The Shapiro-Wilk Test was significant for all variables, indicating non-normal distribution. This is common in larger samples such as found in my study (Pallant, 2013). However, the shape of the histograms and scores for each variable indicates that they are approximately normally distributed. This is also supported by inspecting the normal probability plots (Q-Q plots). Most of the variables were negatively skewed, but the magnitude of kurtosis was acceptable (Tabachnick & Fidell, 2013). One variable connection to nature, item 6, had seven cases with the standardised (z) score above the recommended 3.29. This indicates possible outliers. Item 6 was "I feel sad when animals are hurt". One would expect most children to agree with this. It is not surprising that only a few children disagreed. These cases were retained in the dataset because the scores on other items of the connection to nature construct were not classified as outliers (that is, $z < 3.29$).

3.3.4.2 Missing data analysis

Surveys can contain a number of unanswered questions and, therefore, missing data. Cohen and Cohen (1983) suggest that levels of missing data up to 10% are unlikely to affect 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 (2016) recommends imputing missing data to maximise the information available in AMOS (IBM SPSS AMOS version 24), which I used for the Structural equation models. 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 or missing in a more systematic way (Not Missing at Random).

The total percentage of unanswered questions was low (3.04%). The majority of variables (individual survey items) had less than 5% missing values. Twelve variables (out of 59) had more than 5% missing values. In particular, ten of the PEB variables and two of the life satisfaction variables had more than 5% missing values. Sixteen children failed to answer any questions in the PEB section. This may be because the PEB questions were on a facing page after a section with a different layout. The children could have easily turned straight to the final page of the survey without seeing the PEB section. This only occurred after the surveys were printed on both sides of the page. The two life satisfaction variables were of a personal nature (i.e., "I have a good life" or "I have what I want in life"), so it is not surprising these were not answered by children more than other questions. Separate Variance t-Tests in SPSS showed that the variables with 5% or more of missing data were significantly correlated with other variables in the dataset and could, therefore, be predicted from these variables. Little's MCAR test for the pre-intervention dataset was not statistically significant and indicates the missing values in this dataset can be considered MCAR ($\chi^2_{5146} = 513.77$, $p > 0.05$) (Tabachnick & Fidell, 2013). I therefore imputed missing values to the dataset using the expectation-maximisation algorithm in SPSS (Cunningham, 2016).

3.3.4.3 Factor analysis

An exploratory factor analysis (EFA) was conducted, followed by a confirmatory factor analysis (CFA) to clarify the latent factors in each construct. First, I undertook an EFA

in SPSS to identify the underlying factors among each set of observed variables gathered in the survey (Fabrigar, Wegener, MacCallum, & Strahan, 1999). Kaiser-Meyer-Olkin values of over 0.6 suggested the patterns of item correlations were relatively compact and an EFA should produce distinct and reliable factors (Cunningham, 2016; Field, 2013; Tabachnick & Fidell, 2013). Statistically significant results ($p < 0.05$) for Bartlett's Test of Sphericity indicate there are enough inter-correlations between variables to merit factor analysis (Cunningham, 2016).

Once I determined the constructs were suitable for EFA, each construct was submitted to an unconstrained Maximum Likelihood extraction followed by Oblimin rotation with Kaiser Normalisation, as earlier tests revealed acceptable normal data distributions. Oblimin rotation was chosen because earlier zero-order, bivariate correlations revealed positive correlations between variables (Cunningham, 2016) (Appendix 3).

Following Dunlap (2000), the dimensionality of the constructs were 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 are acceptable (Tabachnick and Fidell, 2013).
- Corrected item-total correlations over 0.3 are acceptable (Field, 2012).
- Cronbach's alpha is a measure of internal consistency and indicates how well a set of variables fit together as a group. Values > 0 .70 for a set of variables in a construct are considered acceptable (Cunningham, 2010; Kline, 2005).

For constructs with less than 10 items I also examined the corrected item-total correlations (0.3 - 0.7 are acceptable, Field, 2013) and inter-item correlations (0.2 - 0.4 are acceptable, Pallant, 2013). I also considered whether the variables loading on the same factor were conceptually similar and whether variables loading on different factors measured something conceptually different.

Confirmatory factor analysis (CFA) is the preferred approach to testing measurement models because, unlike EFA, it is theoretically rather than purely statistically driven. In CFA, the number of factors and relationship between the items and factors is specified *a priori*, and are based on theory. I undertook a CFA in AMOS (IBM SPSS AMOS version 24) using a Maximum Likelihood estimation. I examined the standardised residual matrices to check for miss-specifications (values should be < 2, Cunningham, 2016).

Several absolute indices were used to indicate an acceptable level of model fit for each latent construct:

- X^2/df - a 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 and models with *N* > 200 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 & Bentler, 1999).
- Tucker Lewis Index (TLI). 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): A value of 0.08 is acceptable and less than 0.05 indicates a good fit (Hu & Bentler, 1999).

EFA may not place the same items on the same factors, or even with the same number of factors as a CFA. This is because an EFA seeks to identify the smallest number of latent variables that reproduce the original correlations and covariances associated with the larger set of measured variables. In contrast, a CFA is based on a pre-stipulated theoretical model of dimensions within a construct and measures how well the overall model fits the data.

3.3.5 Results of the factor analyses for the constructs

Kaiser-Meyer-Olkin Measure of Sampling Adequacy and Bartlett's Test of Sphericity determined the constructs were suitable for factor analysis. The number of factors in each

construct was supported by the scree plots. The factor loadings were in the acceptable range and the inter-item and item-total correlations were acceptable for scales with less than ten items. The results of the exploratory factor and confirmatory factor analyses are presented in Table 3.1 and summarised below.

3.3.5.1 Connection to nature, 16 items (CFA graphic, see Appendix 4)

The EFA revealed four factors and explained 56.6% of the variance (Table 3.1). However, factor 1 had only a single item; therefore it was deleted, leaving a three-factor model. These three factors could be called: enjoyment, empathy, and oneness. One item, "I can help keep my local neighbourhood, parks and beaches clean", was deleted from enjoyment because it was conceptually different from the other items in enjoyment. Another item, "I enjoy touching animals and plants", was theoretically considered part of the empathy dimension, but loaded on enjoyment. This item was retained in enjoyment because it was conceptually similar to the other items. Cronbach's alpha for this eleven-item construct was acceptable ($\alpha = 0.87$). Cronbach's alphas for each of the three factors reflecting the latent variable connection to nature were also acceptable: enjoyment ($\alpha = 0.75$), empathy ($\alpha = 0.73$) and oneness ($\alpha = 0.81$). A CFA of the three-factor model was an acceptable fit to the data: $\chi^2/df = 2.59$; CFI = 0.95; TLI = 0.93; RMSEA = 0.070 [0.054 - 0.087]; SRMR = 0.048; $N = 324$. TLI is slightly below acceptable range of 0.95, but other model fit indices indicate the model is a good fit to the data.

I conducted a CFA for the hypothetical four-factor model (as developed by the authors of the Connection to Nature Index, Cheng & Monroe, 2012) which included a fourth factor - responsibility. The four-factor model did not fit the data as well as the three-factor model: $\chi^2/df = 2.70$; CFI = 0.92; TLI = 0.90; RMSEA = 0.073 [0.060 - 0.085]; SRMR = 0.051; $N = 324$. Cronbach's alpha for this construct was an acceptable at 0.88. Cronbach's alphas were also acceptable for three factors (as in the three-factor model), however, Cronbach's alpha was unacceptable for the factor, responsibility ($\alpha = 0.61$). It is worth noting that the factor 'responsibility' is more focused on behaviour, rather than an affective connection to nature. Therefore, this factor may be conceptually different from the other factors. In addition, it conceptually overlaps with my measure of PEB. Therefore, I selected the three-factor model to represent connection to nature in the subsequent analyses.

3.3.5.2 Use of nature for psychological restoration (CFA graphic, see Appendix 4)

The EFA revealed two factors and explained 60.0% of the variance (Table 3.1). However, the two items in factor 2 (which were reverse scored) did not make theoretical sense as a separate factor and, therefore, factor 2 was discarded. Cronbach's alpha for the resulting one-dimensional, six-item construct was acceptable ($\alpha = 0.84$). A CFA showed the one-factor model was an acceptable fit to the data: $\chi^2/df = 2.97$; CFI = 0.97; TLI = 0.96; RMSEA = 0.078 [0.045 - 0.113]; SRMR = 0.034; *N* = 324. Therefore, the one-factor construct was chosen to represent the use of nature for psychological restoration in the subsequent analyses.

Table 3.1 Results from the Exploratory Factor Analyses used to confirm the usefulness of all constructs. Kaiser-Meyer-Olkin Measure of Sampling Adequacy (KMO) and Bartlett's Test of Sphericity (Bartlett's) were used to assess the suitability of the data for factor analysis. *, $p < 0.001$; NI = number of items, either the total number or the number of items retained after exploratory factor analysis; α = Cronbach's alpha; $N = 324$.

				Exploratory factor analysis				
Construct	KMO	Bartlett's	NI	Factors	Variance (%)	α	Inter-item correlation	Item–total correlation
Connection to nature	0.88	$\chi^2_{(120)} = 1644.98$*	16	4	56.6	0.88		
			11	3		0.87		
Psychological restoration	0.83	$\chi^2_{(28)} = 748.31$*	6	2	60.0	0.84	0.36 - 0.57	0.55 - 0.69
Environmental attitude	0.69	$\chi^2_{(45)} = 60.17$**	10	3	50.1	0.55		
			5	2		0.70	0.20 - 0.40	0.34 - 0.46
PEB	0.87	$\chi^2_{(66)} = 1033.95$*	12	2	55.4	0.85		
			9	3		0.84	0.32 – 0.40	0.48 – 0.61
Vitality	0.73	$\chi^2_{(10)} = 238.00$*	4	1	43.7	0.71	0.28 - 0.46	0.44 - 0.53
Life satisfaction	0.70	$\chi^2_{(10)} = 267.13$*	5	2	65.8			
			4	1		0.70	0.20 - 0.54	0.34 - 0.56

3.3.5.3 Environmental attitude (CFA graphic, see Appendix 4)

The EFA revealed three factors and explained 50.1% of the variance (Table 3.1). The factors could be named eco-crisis, human exemptionalism (humans are dominant over nature and exempt from the rules of nature) and rights of nature. However, Cronbach's alpha was unacceptable (α = 0.55) for the construct and was between 0.54 and 0.58 for each of the factors. A CFA of the three-factor model, as suggested by the initial EFA, revealed there was no significant correlation between the factor human exemptionalism and the other two factors. Human exemptionalism was, therefore, removed from the model. The resulting two-factor model was a good fit to the data:; χ^2/df = 1.08; CFI = 0.99; TLI = 0.99; RMSEA = 0.015 [0.000 - 0.087]; SRMR = 0.021; *N* = 324. Cronbach's alpha for the two-factor construct was a acceptable (α = 0.70), but was below the acceptable level for the individual factors: Rights of Nature (α = 0.58) and eco-crisis (α = 0.57). The inter-item and item-total correlations were within the acceptable ranges. The two-factor model was selected to represent environmental attitude in the subsequent analyses.

3.3.5.4 Pro-environmental behaviour (CFA graphic, see Appendix 4)

The EFA revealed two factors and explained 55.4% of the variance (Table 3.1). Factor 1 had only one item so was discarded. Cronbach's alpha was acceptable for the two-factor model (α = 0.85) and for factors 2 and 3, α = 0.78 and 0.76, respectively. A CFA showed the two-factor model was a good fit to the data: χ^2/df = 1.92; CFI = 0.97; TLI = 0.96; RMSEA = 0.053 [0.035 - 0.073]; SRMR = 0.039; *N* = 324. These factors could be called personal PEBs and conservation behaviours.

A CFA for the hypothetical three-factor PEB model showed the model was a good fit to the data: χ^2/df = 2.48; CFI = 0.95; TLI = 0.93; RMSEA = 0.068 [0.049 - 0.087]; SRMR = 0.046; *N* = 324. Only the TLI is a bit low. These factors could be called personal PEBs, citizenship PEBs and pro-nature PEBs. The standardised residual covariance for two items in the citizenship factor was > 2 which suggests a misfit between my model and the data (Cunningham, 2016). I removed the item "I am a member of a wildlife or nature group" because the item "I remind friends to pick up trash if they drop it" was more highly correlated with citizenship. This resulted in an excellent model fit: χ^2/df = 1.64; CFI = 0.98; TLI = 0.97; RMSEA = 0.046 [0.019 - 0.07]; SRMR = 0.036; *N* = 324. Cronbach's alpha for the three-factor model was acceptable (α = 0.84) as were the alphas for the three factors reflecting the latent variable PEB: personal PEB (α = 0.64); citizenship PEB (α = 0.70) and

pro-nature PEB (α = 0.71). The inter-item and item-total correlations were within the acceptable ranges. Both the two-factor and three-factor models fitted the data well. The three-factor model made more theoretical sense and was, therefore, selected to represent PEB in the subsequent analyses.

3.3.5.5 Vitality (CFA graphic, see Appendix 4)

The EFA revealed a single factor which explained 43.7% of the variance (Table 3.1). The factor loading of one item was unacceptable (0.18), so this item was discarded. Cronbach's alpha for the single factor was acceptable (α = 0.71). A CFA found that model fit was a reasonable fit for the data: $\chi^2/df = 4.7$; CFI = 0.97; TLI = 0.90; RMSEA = 0.108 [0.046 - 0.181]; SRMR = 0.035; *N* = 324. The four-item model was retained to represent vitality in the subsequent analyses because it performed adequately in the EFA, Cronbach's alpha and item-item and item-total correlations.

3.3.5.6 Students' Life Satisfaction scale (CFA graphic, see Appendix 4)

The EFA revealed two factors and explained 65.8% of the variance (Table 3.1). One item loaded moderately on both factors. Separating the five items into two factors did not make theoretical sense. I undertook a second EFA, constraining the items to a single factor. Four items loaded onto a single factor with satisfactory loadings over 0.32. Cronbach's alpha for this factor was acceptable (α = 0.70). A CFA of the 4-item model found that the data was an acceptable fit to the data: : $\chi^2/df = 0.80$; CFI = 1.00; TLI = 1.00; RMSEA = 0.00 [0.00 - 0.103]; SRMR = 0.017; *N* = 324. The inter-item and item-total correlations were within the acceptable ranges. The four-item, one dimensional model was used to represent satisfaction with life in the subsequent analyses.

The final score for each construct was calculated as the sum of the scores of all the items in the construct and divided by the number of items (Table 3.2). The distributions of all constructs were assessed for normality by measuring skewness and kurtosis, using Bar graphs, Q-Q plots and the Shaprio-Wilk test in SPSS. The presence of outliers or influential observations was detected by box plots and standardised scores (*z*). The Shapiro-Wilk Test was significant for all variables, indicating non-normal distribution. This is common in larger samples, such as this one (Pallant, 2013). However, the actual shapes of the histograms indicate the data is normally distributed. This is also supported by inspecting the normal probability plots (Q-Q plots). The constructs all were negatively skewed with means above

the scale mid-point. However, none of the constructs had standardised (z) scores above the recommended 3.29.

Therefore, I treated the constructs as though normally distributed for further analyses.

Table 3.2 Descriptive statistics for the socio-psychological constructs. SD = Standard deviation, α = Cronbach's alpha, SE = standard error,* = Significant skewness, *N* = 324.

Construct	Mean ± SD	α	Skewness ± SE	Kurtosis ± SE
Connection to nature	3.81 ± 0.71	0.88	-0.59 ± 0.14*	-0.15 ± 0.27
Use of nature for psychological restoration	3.72 ± 0.86	0.84	-0.56 ± 0.14*	0.09 ± 0.27
Pro-environmental behaviour	3.29 ± 0.87	0.71	-0.35 ± 0.14	-0.33 ± 0.27
Life satisfaction	4.03 ± 0.75	0.70	-0.52 ± 0.14*	-0.18 ± 0.27
Vitality	3.72 ± 0.85	0.84	-0.56 ± 0.14*	0.16 ± 0.27

3.3.6 Structure of the random variables

The children recruited for this research were from 17 individual classes and eight schools. One might expect individuals within the same grouping to be more similar to each other than individuals from other groups because of their unique experiences within their particular group - be it a class or school. This means that the data is likely to be correlated for individuals in a particular group which violates the assumption of independency of observations for statistical methods such as multiple regression and structural equation modelling. Correlated residuals can erroneously deflate the standard errors and, therefore, increase the likelihood of a Type 1 error when using multiple regression. That is, one may find an effect where there is actually not one. Multi-level linear models do not assume independence of observations and can be used to account for the effect of nesting (Field, 2013).

I used multi-level mixed modelling in SPSS to determine whether the nested nature of the dataset had a significant effect on the relationships between the explanatory variables and the dependent variable, vitality. Then I used Akaike's Information Criterion (AIC) to compare the resulting candidate models to choose the simplest model that was the best fit for the data. I used a top-down strategy (West, Welch, & Galecki, 2014) to build a 'beyond optimal' model for vitality using the pre-intervention data, following Zuur et al. (2009).

The 'beyond optimal' model consisted of fixed and random effects. The fixed effects consisted of all the explanatory variables and the interactions between them, which were selected based on the hypotheses I was testing (e.g., connection to nature, socio-demographics). The random effects were the grouping variables - school and class. The fixed effects were held constant and the random effects allowed to vary to identify the nested structure of the dataset (Zuur et al., 2009). The four candidate models, with varying random effects, included: no random effect, school, class and class within school. Class within school represents an interaction effect (where the effect of class may depend upon the school). In mixed models, Restricted Maximum Likelihood (REML) or Maximum Likelihood (ML) estimation can be used, but there is no real consensus of the best estimation procedure (Twisk, 2006). It is argued that REML can provide better estimates of random effects when testing mixed models that hold the fixed effects constant but, in many situations, the choice of REML or ML can only make a small difference of the parameter estimates (Field, 2013). Because I wanted to compare the four candidate models using Akaike's Information Criterion, ML estimation was selected as the only viable estimator (Burnham & Anderson, 2002). I checked the effect of using ML rather than REML by rerunning the data using REML. This had the same outcome as using ML estimation. The candidate models were compared using second order Akaike's Information Criterion (AICc), which is recommended when $n/k < 40$ (n = the number in the sample, and k = the number of parameters) (Anderson & Burnham, 2002; Anderson, Burnham, & Thompson, 2000). In my analyses, $n/k = 9.2$ for the most highly parameterised model.

Competing models were ranked in order of AICc. Relative support was calculated by the difference between each model's AICc and the minimum value from all the models (ΔAICc). A score of $\Delta AICc \leq 2$ 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) were also calculated to assess the relative probability of each model being the best model (Burnham and Anderson, 2002).

Model 1 (No random effect) had substantial support, with ΔAIC ≤ 2 (Table 3.3) and the majority of Akaike weights were attributed to it (ω_i = 0.81). The other candidate models had considerably less support with ΔAIC > 2.0 each and small Akaike weights. This indicates that model 1 is 11.5 times more likely to be the preferred model than models 2 - 4. In addition, the Intra-class Correlation Coefficients, which measures the proportion of the total variance in the outcome variables attributable to nested structure of the data, were zero for both school and class. Thus, none of the variance in vitality is attributed to differences between schools or classes. Therefore, the possibility of the grouping influencing the relationship between the covariates and vitality is not high enough to warrant including school or class as random effects in further analyses.

Table 3.3 Second order Akaike's Information Criterion (AICc) for the four candidate models testing random effects of the nested sample on the dependent variable, vitality. Models are listed from lowest to highest ΔAIC. *k* = number of parameters, ω_i is the Akaike weight. *N* = 324.

Model	*k*	AIC	AICc	ΔAIC	ω_i
1. No random effect	52	701.47	721.81	0.00	0.81
2. School	53	705.47	726.67	4.86	0.07
3. Class	53	705.47	726.67	4.86	0.07
4. Class + School	54	705.47	727.55	5.74	0.05

3.3.7 Structural equation models

Structural equation modelling 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 &

Lomax, 2010) and extends multivariate statistical analyses in two important ways. First, structural equation modelling 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, structural equation modelling also produces goodness-of-fit indices that assess how well the sample data represent the specified hypothetical model.

I set up a full structural equation model based on the *a priori* theoretical model and carried out a confirmatory factor analysis using the statistical software AMOS (IBM SPSS AMOS Version 24) with Maximum Likelihood estimation procedures. I performed bootstrapping for each model with 1000 bootstrap iterations. Bootstrapping, a method for resampling the data, yields a more robust estimate of indirect effects than standard testing (Zhao, Lynch, & Chen, 2010), and makes the distributional requirements of AMOS less important (Byrne, 2010; Cunningham, 2016; Jose, 2013a).

I estimated the covariance between the independent variables, among the mediators and among the outcome variables as I expected them to significantly related. I retained all statistically significant pathways and covariances (where $CR > \pm 1.96$, $p \leq 0.5$). I examined the standardised residual matrices to check for miss-specifications (values should be < 2, Cunningham, 2016). I obtained estimates of the direct, indirect and total effects and bias-corrected confidence intervals. The same indices were used to evaluate the model fit as laid out above: X^2/df, CFI, TLI, RMSEA and SRMR.

Once candidate models were defined and supported by the model fit indices, an Information Theoretic approach was used to rank the models and 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 & Hilborn, 2006). Null hypothesis testing 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). Second order Akaike's Information Criterion (AICc) was used as the Information Theoretic Statistic because the $n/k < 40$ (Anderson & Burnham, 2002; Anderson et al., 2000).

3.3.7.1 Theoretical models

The *a priori* model was set up as shown in Figure 3.1. The independent variable was connection to nature, the mediator variable was the use of nature for psychological restoration (or vice versa) and the dependent variables were life satisfaction and vitality (Figure 3.1). Socio-demographic variables (age, gender, ethnicity and school decile) were added as independent variables to construct the candidate models for AIC comparisons. Pro-environmental behaviour was also added as a mediator once the final wellbeing model was confirmed.

3.3.8 Ethics and inclusivity

Human ethics approval for the research was obtained from the Human Ethics Committee of Victoria University of Wellington (approved: 12 October 2016 and amended 17 November 2016; Reference number: 23405) (Appendix 5).

I consulted with local Māori in October 2016 about the research in general and questionnaire in particular. The Environmental and Cultural Services Manager for the Port Nicholson Block Settlement Trust thought she could not "add any value". I approached Terese McLeod, of Te Kawa a Māui, School of Māori Studies, Victoria University of Wellington, who is involved in conservation and environmental education in Wellington City. Terese was very encouraging of the research and asked her colleagues for comment. I did not receive any comments on the survey or research strategy. A good representation of Māori children completed the survey population, which suggests that the survey is inclusive.

3.4 Results

*3.4.1 Wellbeing m*odel

The *Wellbeing* model, with the use of nature for psychological restoration as the independent variable, had a good fit to the data: χ2/df = 2.66; CFI = 0.98; TLI = 0.96; RMSEA = 0.072 [0.033, 0.11]; SRMR = 0.028; *N* = 374 (Figure 3.2). The children's use of nature for psychological restoration had a similar sized direct, positive relationship with both life satisfaction and vitality. But the relationship between their use of nature for psychological restoration and vitality was stronger when partially mediated by connection to nature, principally because there was a strong relationship between connection to nature and the use of nature for psychological restoration (β = 0.83, $p < 0.001$). Connection to nature was not, however, associated with life satisfaction, although the two wellbeing variables do co-vary (β = 0.28, $p < 0.001$). Thus, the *Wellbeing* model was a partial mediation model. The model explained 28% of the variance in children's vitality and 5% of the variance in their life satisfaction. The strength of the relationships between use of nature for psychological restoration and connection to nature and vitality were of a similar magnitude: $\beta_{Total} = 0.49$, 95% CI [0.40, 0.58], $p < 0.01$ and $\beta_{Total} = 0.35$, 95% CI [0.17, 0.56], $p < 0.01$, respectively. The total association between the use of nature for psychological restoration and life satisfaction was smaller: $\beta_{Total} = 0.22$, 95% CI [0.14, 0.31], $p < 0.01$. According to this model, a greater endorsement of the use of nature for psychological restoration and a stronger connection to nature are associated with greater vitality. A greater endorsement of the use of nature for psychological restoration is also associated with greater life satisfaction.

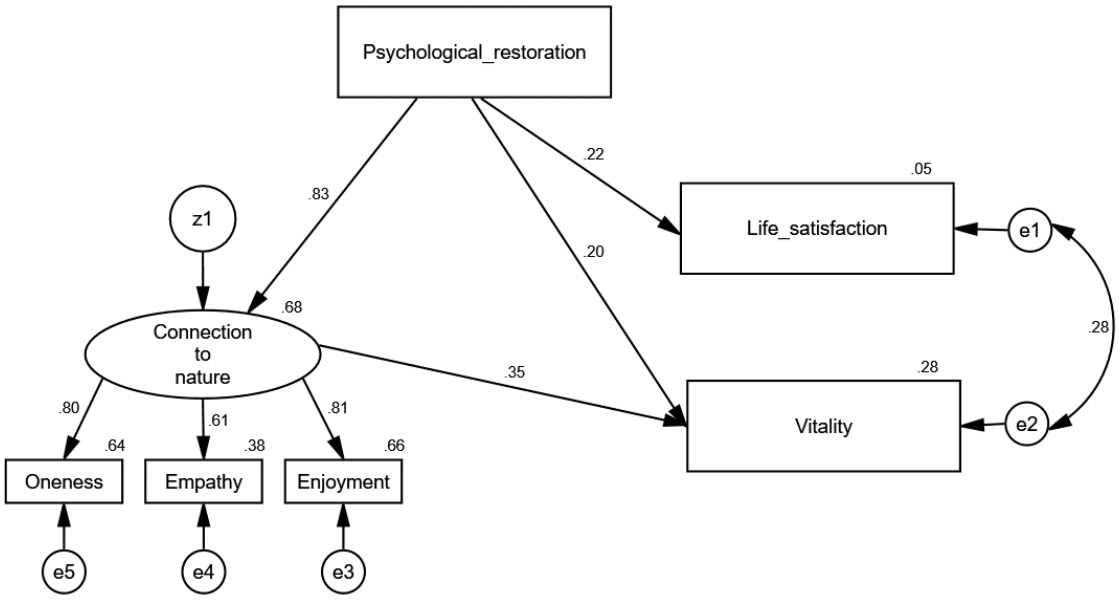


Figure 3.2 *Wellbeing* model demonstating the relationships between children's use of nature for psychological restoration and connection to nature with their vitality and life satsifaction, *N* = 324. Oneness, empathy and enjoyment are dimensions of the Connection to Nature Index.

An alternate model, with connection to nature as the independent variable and the use of nature for psychological restoration as a mediating variable, was tested (Figure 3.3). This model had the same strength of association between variables, explained the same amount of variation in wellbeing, and had the same model fit as the previous *Wellbeing* model: $\chi 2/df = 2.78$; CFI = 0.98; TLI = 0.96; RMSEA = 0.074 [0.038, 0.11]; SRMR = 0.028, *N* = 374. The difference was that this model demonstrated that connection to nature was associated with vitality both directly and indirectly, through the use of nature for psychological restoration ($\beta_{Total} = 0.52$, 95% CI [0.39, 0.63], $p < 0.01$). Connection to nature was also indirectly associated with life satisfaction through the use of nature for psychological restoration ($\beta_{Total} = 0.18$, 95% CI [0.10, 0.27], $p < 0.01$). According to this model a stronger connection to nature and a greater endorsement of the use of nature for psychological restoration are associated with greater vitality and greater life satisfaction.

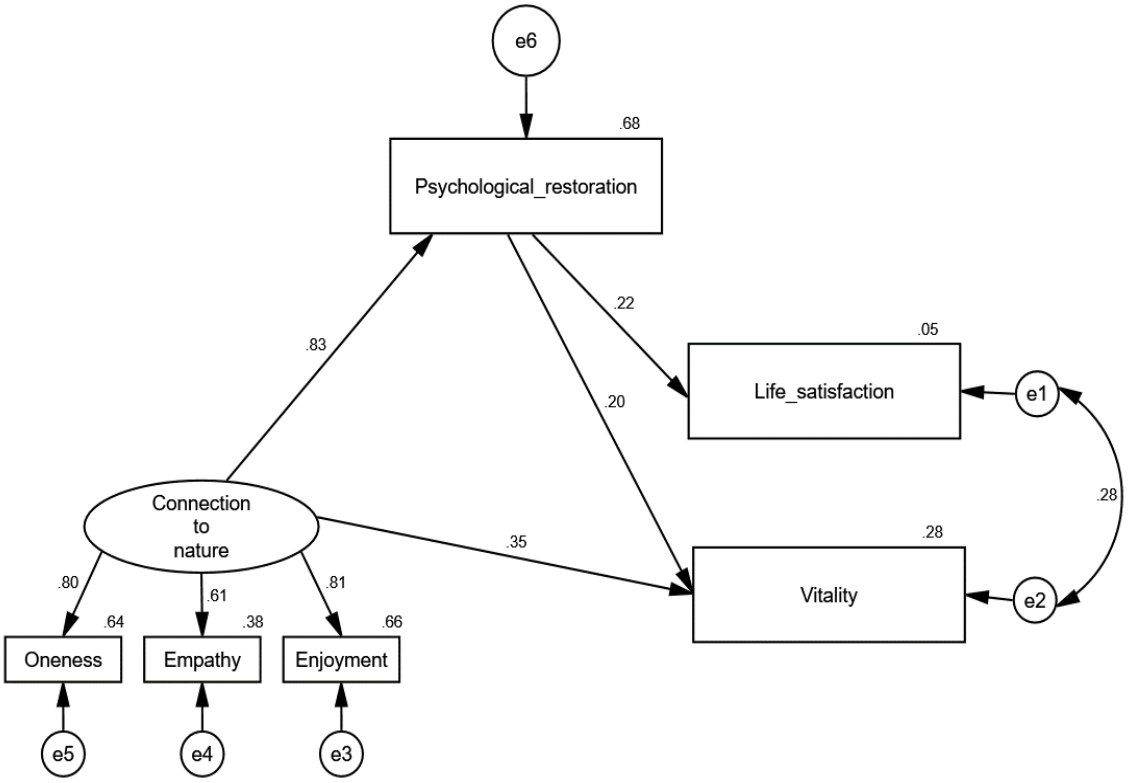


Figure 3.3 Alternate *Wellbeing* model, *N* = 324. Oneness, empathy and enjoyment are dimensions of the Connection to Nature Index.

The *Wellbeing* model, with psychological restoration as the independent variable (Figure 3.2), was chosen for the purposes of further analyses. This decision was made because (Nisbet & Zelenski, 2011) demonstrated that connection to nature was a mechanism through which nature could be psychologically restorative, and was also informed by the relationship of the variables in the *Pro-environmental Behaviour* model, presented in Chapter 4 of this thesis.

The socio-demographic variables were then individually added as independent variables to the *Wellbeing* model to determine whether they could improve on the modelled relationships. The socio-demographic variables included age, gender, ethnicity and school decile rating (as a measure of socio-economic status).

The age of the children was negatively related to both wellbeing measures: vitality (β = -0.22, 95% CI [-0.29, -0.16], $p < 0.01$) and life satisfaction (β = -0.08, 95% CI [-0.12, -0.04], *p*

< 0.01). That is, older children reported lower levels of wellbeing, particularly vitality. The negative relationships with life satisfaction and vitality were mediated by lower levels of connection to nature and use of nature for psychological restoration in older children. The model was a good fit to the data: χ^2 /df = 2.8; CFI = 0.97; TLI = 0.95; RMSEA = 0.074 [0.045, 0.105], SRMR = 0.035. The model explained an additional 2% of the variance in children's vitality but 1% less of the variance in their life satisfaction.

The older, pre-adolescent children (years 7 - 8), had a significantly lower mean connection to nature of than the younger children (years 5 – 6): 3.56 ± 0.80 (*n* = 159) and 4.04 ± 0.63 (*n* = 165) respectively (t (322) = 6.44, *p* < 0.05). But this varied from 2 – 5 (on the five-point scale) for individual children. Further, there was a positive correlation between connection to nature and the use of nature for psychological restoration (*r* = 0.72, *p* < 0.001) and vitality (*r* = 0.31, *p* < 0.001) in older children. That is, older children with a stronger connection to nature reported greater use of nature for psychological restoration and greater vitality than older children with a weaker connection to nature.

School decile rating had an indirect, negative relationship with both wellbeing measures: vitality (β = -0.22, 95% CI [-0.29, -0.15], *p* < 0.01) and life satisfaction (β = -0.08, 95% CI [-0.13, -0.04], *p* < 0.01). That is children from higher decile (wealthier) schools reported lower levels of wellbeing, particularly vitality, compared to children from lower decile schools. This negative relationship with wellbeing was mediated by lower levels of connection to nature and use of nature for psychological restoration in children from higher decile schools. The model was a good fit to the data: χ^2 /df = 2.8; CFI =0.98; TLI = 0.95; RMSEA = 0.070 [0.04, 0.1], SRMR = 0.037, but explained no additional variance in the children's vitality or life satisfaction.

Gender was not significantly associated with either vitality (β = 0.09, 95% CI [-0.08, 0.10], *p* > 0.05) or life satisfaction (β = -0.07, 95% CI [-0.16, 0.03], *p* > 0.05), and the model was a poor fit to the data: χ^2 /df = 93.26; CFI = 0.51; TLI = 0.20; RMSEA = 0.53 [0.51, 0.56], SRMR = 0.05. The model did not explain any additional variance in children's vitality or life satisfaction. This model was not supported by the model fit indices, therefore, it was not included in the model comparison.

The ethnicity of the children also had no direct relationship with their wellbeing, but two ethnic groups showed a small indirect association. Children who reported some New

Zealand European heritage had lower levels of vitality (β = -0.07, 95% CI [-0.12, -0.02], p < 0.05) and life satisfaction (β = -0.03, 95% CI [-0.06, -0.01], p < 0.05) compared with non-New Zealand European children. In addition, children who reported some Pacific Island heritage reported higher levels of both wellbeing measures than children with no Pacific Island heritage: vitality (β = 0.09, 95% CI [0.04, 0.13], p < 0.01) and life satisfaction (β = 0.03, 95% CI [0.02, 0.06], p < 0.01). The relationships with ethnicity were mediated through their use of nature for psychological restoration and connection to nature. The model was a reasonable fit to the data: χ^2 /df = 3.7; CFI = 0.93; TLI = 0.90; RMSEA = 0.09 [0.07, 0.12], SRMR = 0.07 but only explained an additional 1% of the variance in children's vitality, and 1% less of the variance in their life satisfaction.

In summary, being older, of New Zealand European heritage and attending a school with a higher socio-economic status was associated with lower levels of both vitality and life satisfaction. However, being younger, of Pacific Island heritage and attending a school with lower to medium socio-economic status was associated with higher levels of vitality and life satisfaction. These differences were associated with individual differences in children's connection to nature and their use of nature for psychological restoration.

There were four candidate models representing wellbeing: the *Wellbeing* model, *Wellbeing* plus age, Wellbeing plus decile and *Wellbeing* plus ethnicity (Table 3.4). The most parsimonious *Wellbeing* model is the only model that had substantial support (ΔAIC ≤ 2). Model 1, the *Wellbeing* model, assumed all (100%) of the candidate model set's Akaike weight. All other competing models had comparatively trivial Akaike weights (<0.001) and were implausible (ΔAIC > 10). The *Wellbeing* model is thus the preferred and most parsimonious of the candidate models. Although some socio-demographics are significantly correlated with the wellbeing measures, they do not improve on the *Wellbeing* model.

Table 3.4 Akaike's Information Criteria model comparisons, using second order Akaike's Information Criterion (AICc) for the four candidate wellbeing models. Models are listed in order from lowest to highest ΔAIC. *k* = number of parameters, ω_i = Akaike weight. *N* = 324.

Model	*k*	AIC	AICc	ΔAIC	ω_i
1. *Wellbeing*	21	46.62	49.68	0.00	1.00
2. *Wellbeing* + decile	25	63.81	68.17	18.49	0.00
3. *Wellbeing* + age	24	65.26	69.27	19.59	0.00
4. *Wellbeing* + ethnicity	25	104.30	108.66	58.98	0.00

3.4.2 Wellbeing model with pro-environmental behaviour

Individual differences in engagement in pro-environmental behaviour have been associated with differences in wellbeing in adults (e.g., Whitburn et al., 2018). To test if this is the same with children I added pro-environmental behaviour to the preferred *Wellbeing* model (Figure 3.4). The position of these additional variables was informed by theory and also by the *Pro-environmental behaviour* model in Chapter 4 of this thesis.

The model was a good fit to the data: χ^2 /df = 1.69; CFI = 0.99; TLI = 0.98; RMSEA = 0.046 [0.019, 0.071], SRMR = 0.025. Self-reported engagement in PEB was directly associated with greater vitality (β = 0.35, 95% CI [0.19, 0.41], $p < 0.01$) and, contrary to expectations, lower life satisfaction (β = -0.23, 95% CI [-0.39, -0.09], $p < 0.05$). That is, children who reported greater engagement in PEB also reported higher levels of vitality but lower levels of life satisfaction. This model explained 2% more of the variance in vitality and 3% more of the variance in life satisfaction than the *Wellbeing* model, but at the cost of parsimony.

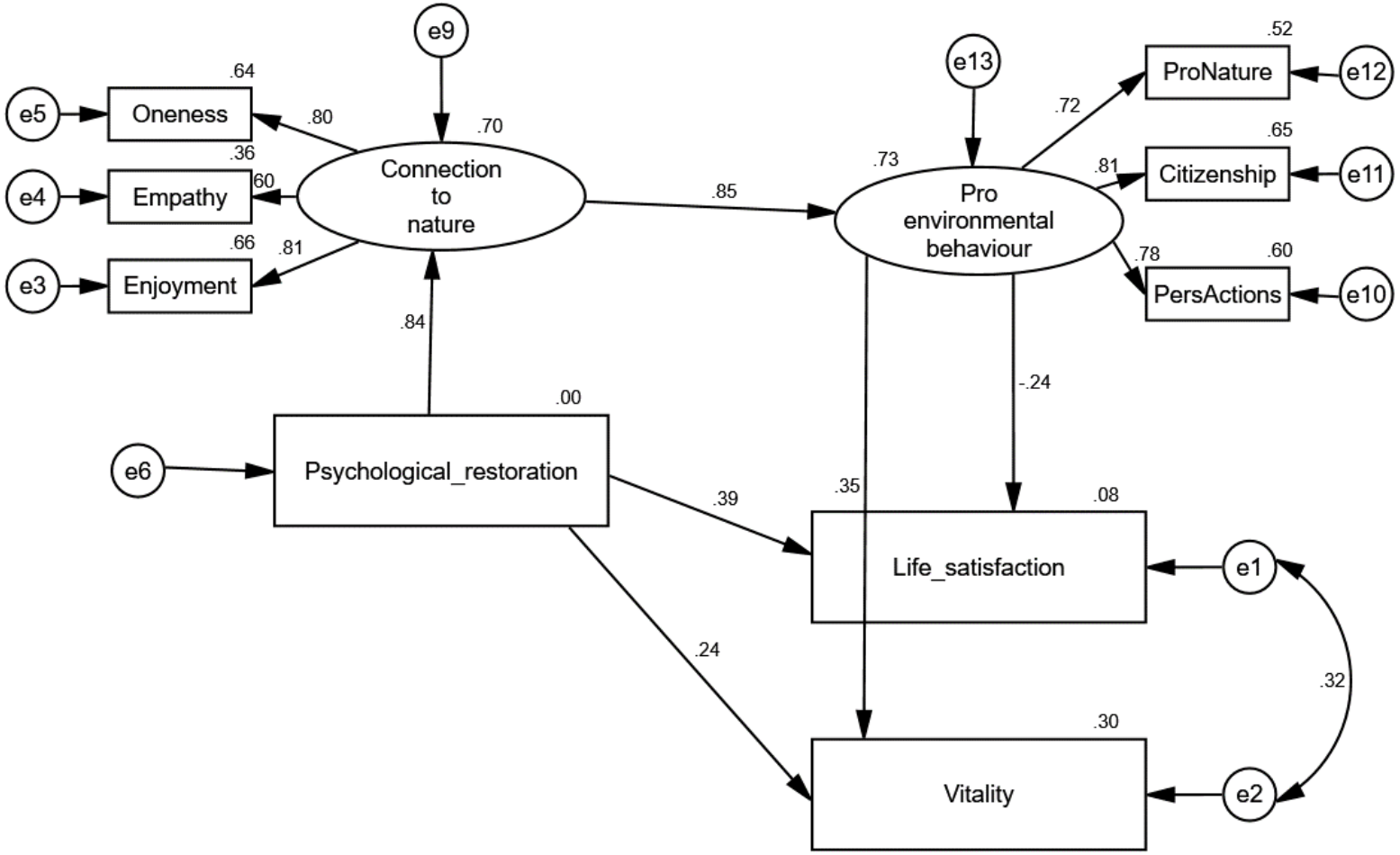


Figure 3.4 *Wellbeing* model with pro-environmental behaviour, *N* = 324. Oneness, empathy and enjoyment are dimensions of the Connection to Nature Index and PersActions, Citizenship and ProNature are dimensions of the pro-environmental behaviour construct.

3.5 Discussion

Children's contact with nature can support their psychological wellbeing. The existing literature has measured the relationship between nature exposure and some aspects of children's wellbeing, but has overlooked the mechanisms by which this occurs (Corraliza et al., 2012; Wells, 2000; Wells & Evans, 2003). My research fills this gap by examining the relationships between two such mediators, children's connection to nature and their use of nature for psychological restoration, and two measures of their psychological wellbeing. The *Wellbeing* model presented in this chapter, demonstrates that children's connection to nature has a direct positive association with their vitality, but not their life satisfaction. In addition, children's use of nature for psychological restoration has a direct positive association with both their vitality and life satisfaction. The relationship between the use of nature for psychological restoration and vitality is also partially mediated by connection to nature. That is, the strength of the relationship depends, in part, on a child's connection to nature.

My finding, that connection to nature is positively associated with vitality, is largely in line with research in adults (Capaldi et al., 2014; Mayer & Frantz, 2004; Nisbet et al., 2011; Wolsko & Lindberg, 2013). But this relationship has not been examined in children before. The lack of a significant relationship between connection to nature with life satisfaction contrasts with Richardson et al.'s (2015) study. They reported a weak, but significant, positive association between connection to nature and life satisfaction in English children. Children's use of nature for psychological restoration was positively associated with their life satisfaction. Similarly, the perceived restorativeness of school playgrounds has been associated positively associated with positive affect (Bagot et al., 2015).

Connection to nature appears to relate to different aspects of wellbeing in different ways and may be more strongly associated with optimal psychological functioning rather than happiness (Pritchard et al., 2019). Vitality can come from finding meaning in life (Ryan & Deci, 2001). Having a connection to nature can meet a psychological need for belonging (Bragg, 1996; Ryan & Deci, 2001) and further elicit a sense of meaning by connecting someone to something larger than one's self (Howell, Passmore, & Buro, 2013; McMahan, 2018). Thus, connection to nature could increase vitality through providing a sense of meaning (Howell et al., 2013). In contrast, life satisfaction, which involves a child's

evaluation of their life as a whole compared to that which they judge is an appropriate standard (Diener et al., 1999; Huebner, 1991; Rees, Goswami, & Bradshaw, 2010), does not appear to be as strongly associated with connection to nature as vitality. Or perhaps children may not yet understand how their experience of nature adds to the quality of their life when they are asked to evaluate it (Nisbet & Zelenski, 2011). Alternatively, the relationship between connection to nature and life satisfaction may be mediated by other variables (Basu et al., 2019).

My finding that connection to nature and the use of nature for psychological restoration are positively associated with children's vitality has potentially important implications. Vitality is an important part of both physical and mental health and motivation (Plante, Cage, Clements, & Stover, 2006; Ryan & Deci, 2008). People with an adequate level of vitality are more active and productive, cope better with stress and challenges, report greater mental health and are more resilient to physical and viral stresses (Ryan & Deci, 2008). Vitality is also associated with positive affect (emotions) and feeling calm and is distinct from happiness and life satisfaction.

An adequate level of life satisfaction is a pre-requisite for positive psychological wellbeing (Suldo & Huebner, 2004) and is positively associated with optimal mental health, including academic success, attachment to parents and peers and positive self-esteem (Suldo & Huebner, 2004) in children. Whereas low levels of life satisfaction are related to more adverse outcomes in adolescents such as anti-social behaviours, difficulty at school and low self-esteem (Martin, Huebner, & Valois, 2008; Suldo & Huebner, 2004).

Providing opportunities in nature for children to strengthen their connection to nature and for psychological restoration could be an effective low-cost intervention to improve children's mental health. Promoting sound mental health in childhood is a protective factor for mental health into adolescence and adulthood (Bingley & Milligan, 2004). Promoting childhood experiences of connection to nature is of additional importance because adults who have spent less time in nature are more likely to express fear, anxiety and uncertainty about nature which may limit their ability to experience nature's restorative benefits (Bell et al., 2014).

The strength of the relationships between connection to nature and the use of nature for psychological restoration with life satisfaction and vitality may appear small, but

they are similar to the size of the gains in wellbeing attributed to being married (Haring-Hidore, Stock, Okun, & Witter, 1985), and the gains in the variation of income or level of education within countries (Biedenweg, Scott, & Scott, 2017; Diener et al., 1999). Around 32,000 New Zealand children suffer from emotional and behavioural problems, including anxiety disorder, attention deficit disorders and depression (Ministry of Health, 2015). The cumulative effect of low-cost interventions that improve children's psychological health, such as contact with nature, could make a huge contribution to public health. For example, an Australian study demonstrated that depression in the adult population could be reduced by 7% if individuals spent at least 30 minutes a week in outdoor green space. This would amount to savings of just under one billion Australian dollars in public health costs (Shanahan et al., 2016).

3.5.1 Biophilia

Connection to nature and the use of nature for psychological restoration are generally examined as independent phenomena in the literature. It is evident from the *Wellbeing* model presented here that the extent to which individual children use nature for psychological restoration is strongly related to their connection to nature. A psycho-evolutionary perspective of restoration, on which, attention restoration (Kaplan & Kaplan, 1989) and physiological regulation theory (Ulrich et al., 1991) rely, may provide a framework for understanding this relationship. Theoretically, the benefit of psychological restoration gained from spending time in nature originates in a biophilic tendency in humans (Wilson, 1984). This tendency entails an "…unlearned predisposition to pay attention and respond…" to natural ecosystems that are favourable to human survival (Ulrich et al., 1991, p. 205). The ability to receive restoration may, therefore, be fundamentally an involuntary, psychological and physiological process activated by exposure to restorative environments. Although humans may be drawn to connect with nature, connection to nature itself is formed through contact with the attitudinal object – nature (Eagly & Chaiken, 1993), and is thought to develop through repeated experiences in nature (e.g., Schultz & Tabanico, 2007).

The *Wellbeing* model demonstrates connection to nature as a mediator of the relationship between psychologically restorative experiences in nature and children's vitality. Gaining from restorative experiences in nature could strengthen a child's feelings of appreciation, and closeness to the natural environment, which in turn provides more vital

energy for the tasks of life. This relationship could also work in the opposite direction. I tested the reverse model with connection to nature as the independent variable and psychological restoration as the mediator. Both models are feasible, theoretically and statistically. The existing research also provides support for both models in adults (Mayer et al., 2009; Nisbet & Zelenski, 2011; Wyles et al., 2019). However, my results cannot determine which model best represents the true situation and support Wyles et al.'s (2019) conclusion that there may be a bi-directional, mutually reinforcing relationship between psychologically restorative experiences in nature and individual's connection to nature. From an evolutionary perspective, however, the first model is more likely. Psychologically restorative experiences in nature, which can come automatically upon exposure to natural settings, precede and can strengthen children's connection to nature (Berto, Barbiero, Barbiero, & Senes, 2018; Braun & Dierkes, 2017). Biophilia is the antecedent to nature's role in psychological restoration, not the other way around.

3.5.2 Pro-environmental behaviour's variable association with wellbeing

Children's self-reported engagement in PEB was positively related to their vitality but, contrary to my hypothesis, was negatively associated with their life satisfaction. The negative association with life satisfaction contrasts with Brown & Kasser's (2005) finding that happiness was higher in teenagers who also reported greater engagement in PEB. Engagement in PEB may or may not support children's wellbeing, depending on what is being measured (Venhoeven, Bolderdijk, & Steg, 2013). Vitality is associated with finding meaning in life (Ryan & Deci, 2001) and engaging in PEB can be a meaningful activity. The association between vitality and greater engagement in PEB suggests that children who engage in actions that conserve resources and protect the environment may feel they are making a difference in the world, and this can be a source of meaning in their life which contributes to their vitality. The negative association with life satisfaction seems to contradict this.

Engaging in PEB can demand a cost in terms of resources, such as time or energy, which may detract from one's evaluation of their life. Alternatively, children who choose to engage in more PEB may be more aware of environmental issues and/or have a stronger sense of responsibility towards taking action. This may be associated with feelings of despair, helplessness and anxiety (Beer, Cook, & Kantor, 2018).

Adults with strong environmental attitudes can also suffer from anxiety and feelings of helplessness (Dean et al., 2018; Doherty & Clayton, 2011) or chronic grief (Hobbs, 2013) in the face of environmental degradation. If this is the case for the children in my study, they could feel afraid and helpless, in spite of engaging in PEB. These negative feelings could negatively impact their evaluation of their lives. Hope can mitigate helplessness and reduce anxiety (Li & Monroe, 2017). Therefore, it is important to nurture realistic hope in children.

Hope develops when children believe their choices and actions can make a difference (Li & Monroe, 2017). This requires a sense of self-efficacy (the belief one can perform a particular behaviour) (Swaisgood & Sheppard, 2010), and the expectation that those actions can make a difference to mitigating environmental problems (Collado & Evans, 2019; Li & Monroe, 2017). Environmental educators, for example, could nurture hope through empowering children to effectively engage in PEB by demonstrating effective actions they could take, developing their skills to successfully engage in these actions and deepening their understanding of the impact of these actions toward local or global environmental goals. In doing this, educators can build children's sense of self-efficacy and outcome expectancy, and in turn, inspire hope. Environmental education that focuses on communicating the magnitude and severity of environmental problems may be counterproductive (Sobel, 1996).

3.5.3 Socio-demographics and wellbeing

The demographic indicators generally provided no meaningful improvement in the *Wellbeing* model for children's vitality or life satisfaction; that is, they explained < 1% of additional variance. There was, however, one exception. Older children (years 7 - 8) reported lower levels of vitality than younger children (years 5 - 6). This was associated, with lower levels of connection to nature and psychological restoration in nature in older children.

Adolescence is a formative yet vulnerable time where children seek greater autonomy, explore their identity and experience peer pressure (Berk, 2004). Maintaining practices that support their mental health can help protect adolescents from developing serious mental illnesses. This research suggests that pre-adolescent children are not using nature as a resource to support their wellbeing to the same extent as younger children. This might, at least partially, be contributing to the lower level of vitality they have reported. This

being said, there were variations in pre-adolescents' connection to nature and their use of nature for psychological restoration. Correlations revealed that pre-adolescents with a stronger connection to nature also reported more use of nature for restoration and higher vitality than pre-adolescents with a weaker connection to nature. Where adolescents do connect more strongly with nature they have greater wellbeing, at least with respect to vitality. Thus, it suggests encouraging pre-adolescent children to spend time in nature, in ways that help develop a close connection to nature or that are psychologically restorative, could improve their wellbeing and build resilience. Doing so may mitigate some of the age-related differences in wellbeing.

3.5.4 Interventions to enhance children's connection to nature and wellbeing

My research shows that children's connection to nature and their use of nature for psychological restoration, may protect against, or support recovery from, poor mental health. Therefore, it may be useful to provide opportunities for children to have easy access to nature near to where they live or go to school and motivate their use of them. Nature does not have to be remote or relatively devoid of human interference to promote connection to nature and provide psychologically restorative opportunities (Keniger et al., 2013; Wells, 2000; Wells & Evans, 2003; White, Pahl, Ashbullby, Herbert, & Depledge, 2013). The incidental nature children are exposed to daily in urban landscapes can provide short micro-restorative experiences that accumulate over time (Joye & Van Den Berg, 2013; Kaplan, 2001; van den Berg, Maas, Verheij, & Groenewegen, 2010) and support their connection to nature (Freeman et al., 2015). Urban nature, which can build children's connection to nature and offer restorative benefits, may be as commonplace as tree-lined streets, suburban gardens, uncultivated vacant lots and urban parks (Aguirre-Bielschowsky, Freeman, & Vass, 2012; Chawla, 2015; Hand et al., 2017; Pyle, 2002; van Heezik, Freeman, Porter, & Dickinson, 2013), or as innovative as green-walls in school classrooms (van den Berg, Wesselius, Maas, & Tanja-Dijkstra, 2017). As far as children are concerned, more greenery around their school or home is positively associated with cognitive restoration, stress reduction and perceived restorativeness (e.g., Bagot et al., 2015; Faber Taylor et al., 2002; Wells & Evans, 2003). It may take only small changes in the amount of greenery to improve an environment's restorative potential (e.g., Kelz et al., 2015; Wells & Evans, 2003).

3.5.5 Limitations

There are some limitations in my research. My data is based on self-reports. Self-report can create a threat to construct validity (i.e., the measures used might not access what they are intended to measure) and lead to mono-method bias (i.e., associations between variables measured via the same method are inflated due to shared method variance). However, self-report is widely used in environmental psychology research as a reliable mechanism for assessing the relationships between psychological factors, such as attitudes or behaviour which cannot readily be observed. In addition, a written survey is appropriate for children in years 5-8 because they generally have the language and reading skills required to understand and answer the written questions (Borgers, de Leeuw, & Hox, 2000).

Children can be vulnerable to social desirability bias and provide socially acceptable answers. Younger children can display a stronger bias than older children (Miller et al., 2015), especially in the presence of influential adults or peers. It is possible a social desirability bias was present in this study. To minimise this type of bias, the questions were carefully worded. In addition, I told the children before they completed each survey that there were no correct answers and I wanted to know what they personally thought about each question.

The relationship between the variables in the *Wellbeing* model suggests a causative relationship between variables. However, my results are correlational and as such cannot speak to causation. Therefore, the relationships could be reversed: having greater vitality, for example, may mean a child has more energy to seek out experiences in nature which can strengthen their connection to nature and provide opportunities for psychological restoration.

Another limitation is that the survey population was not representative of the population of children in the Wellington region. This may limit the generalizability of my findings. However, it did provide a relatively large number of children from non-New Zealand European ethnic groups.

3.5.6 Future work

The findings of this research strengthen the need for more research that investigates the specific elements of the environment and the types of interactions that promote children's connection to nature or provide psychologically restorative benefits. In most research, nature is unspecified or defined broadly. It would be useful for future researchers to investigate how qualities of the environment, such as the type of vegetation, level of biodiversity or duration of exposure, influence children's connection to nature and the benefits they gain from nature. Another avenue worthy of investigation is how benefits are shaped by social relationships such as the presence of adults. Influential adults, can be important in nurturing children's relationship with nature (Chawla, 1998; Collado, Evans, & Sorrel, 2017; Department of Conservation, 2016; Negev, Sagy, Garb, Salzberg, & Tal, 2008). My research is correlational; therefore, future, longitudinal studies (ideally randomised experiments) are required to determine whether the relationships presented in the *Wellbeing* model are causative.

3.6 Conclusion

This research extends the small literature that has examined the effect of children's relationship with nature on their wellbeing. In particular, children's connection to nature and their use of nature for psychological restoration were associated with their vitality and their use of nature for psychological restoration with their life satisfaction. There are many influences on children's psychological wellbeing (Holte et al., 2014). It is remarkable, therefore, that just two variables (children's connection to nature and their use of nature for psychological restoration), explained 28% of variance in vitality among children in this study. Nature is important for recovery from depleted states and supports and enhances children's wellbeing.

Children are spending less time outside in nature and more time in sedentary pursuits (Louv, 2008; Rideout et al., 2010). My results and those of other researchers suggest that reduced opportunities for children to interact with nature can adversely affect their psychological wellbeing. It becomes important, therefore, to consider providing restorative natural environments, especially in cities, and motivating children's use of them. Much, however, still needs to be understood about the qualities of these environments, the duration of exposure and the kind of experiences children require to increase their

connection to nature and improve their wellbeing. Moreover, the kinds of experiences will likely vary among children living in different social, biological, cultural and physical environments. This is work for the future that will draw on multiple disciplines - ecologists, urban designers, environmental psychologists and educators, for example – so that cities are better places for children to live.

Chapter 4: Children's connection to nature and their pro-environmental behaviour

4.1 Abstract

Researchers have shown that childhood experiences in nature are positively associated with adult pro-environmental attitudes and behaviour. There is, however, relatively little research on the relationship between children's experience in nature and their engagement in pro-environmental behaviour (PEB). This research investigates four drivers of children's PEB associated with their relationship with nature: primarily their connection to nature and also their environmental attitude and knowledge and use of nature for psychological restoration.

Data was collected via a self-administered questionnaire from children attending environmental education in Wellington, New Zealand (*N* = 324). I tested whether children's connection to nature, their environmental attitudes and knowledge and their use of nature for psychological restoration were associated with their self-reported engagement in PEB. I also tested whether socio-demographic factors could improve on the modelled relationships. structural equation modelling followed by Information Theoretic model selection and inference were used to identify the best model.

Connection to nature had a direct, positive relationship with PEB. Connection to nature also mediated the relationships between children's environmental attitude and their use of nature for psychological restoration and their engagement in PEB. This model explained 72% of the variance of children's PEB. Connection to nature was more strongly associated with engagement in PEB than the use of nature for psychological restoration and environmental attitudes. The relationship between environmental attitude and PEB varied with the age of the child. The significant association between environmental attitude and PEB found in older children did not hold for younger children. Models that contained socio-demographic variables were not well supported.

Strengthening children's emotional connection to nature is possibly the most important route to increasing their engagement in PEB, especially in younger children. These findings may be useful to inform interventions, such as environmental education

programmes, and inform local and national governmental policy aiming to encourage children's engagement in PEB.

4.2 Introduction

Environmental challenges are among the most daunting facing humanity today (IPCC, 2014; Kollmuss & Agyeman, 2002; Oskamp, 2000; Wilson, 2002; Zelezny & Schultz, 2000). People's individual choices and actions contribute to preventing or mitigating environmental degradation and moving towards more sustainable practices (Steg & Vlek, 2009). Pro-environmental behaviours are those "actions which contribute to environmental protection and/or conservation" (Axelrod, 1993, p. 153). It is, therefore, important to understand how and why people adopt pro-environmental behaviour (PEB) so that it can be encouraged and barriers to it removed (Kollmuss & Agyeman, 2002).

It is generally agreed that childhood experiences in nature are influential in developing pro-environmental attitudes and behaviours in adulthood (Chawla & Derr, 2012; Evans, Brauchle, et al., 2007; Kellert, 2002). Cross-sectional studies of children and teenagers in Spain and the United States observed that children who spent more time in nature also reported greater engagement in PEB (Collado, Corraliza, Staats, & Ruiz, 2015; Collado et al., 2013; Otto & Pensini, 2017), or had a greater interest in performing environmentally friendly behaviours (Cheng & Monroe, 2012; Müller et al., 2009; Richardson et al., 2015). A rare longitudinal study in New York demonstrated that the amount of time children spent in nature at six years of age was positively related to their PEB when they were 18 years old (N = 74) (Evans et al., 2018).

An individual's connection to nature is also positively associated with their engagement in a range of PEBs (Brügger et al., 2011; Mayer & Frantz, 2004; Nisbet et al., 2009; Whitburn et al., 2019). Children and adolescents (13 - 17 years of age) with a stronger connection to nature self-report greater engagement in PEBs (Collado, Evans, et al., 2015; Otto & Pensini, 2017; Roczen et al., 2014) and a greater intention or willingness to perform them (Cheng & Monroe, 2012; Müller et al., 2009; Richardson et al., 2015). Children's connection to nature and environmental attitude can mediate the positive relationship between the time they spend in nature and their PEB (Collado et al., 2013; Otto & Pensini, 2017). Conversely, a lack of connection to nature, especially in childhood, has been blamed for people's apathy towards environmental degradation and protection (Louv, 2008; Pyle, 2003; Soga & Gaston, 2016).

Three other aspects of an individual's relationship with nature are associated with their engagement in PEB: environmental attitude and knowledge and the use of nature for psychological restoration. Children's environmental attitudes generally have a positive association with their PEB (Collado, Evans, et al., 2015; Collado et al., 2013; Corraliza et al., 2013). This relationship between environmental attitude and PEB can vary with the age of the child. The small to medium-sized positive correlation between environmental attitude and PEB reported in older children (Collado, Corraliza, et al., 2015; Collado et al., 2013), is not evident in younger children (6 – 8 years) (Evans, Brauchle, et al., 2007; Evans, Juen, et al., 2007). The strength of the association between environmental attitude and PEB reported in older children can also vary with their ethnicity (Boeve-de Pauw & Van Petegem, 2011), and whether they live in rural or urban locations (Collado, Corraliza, et al., 2015).

People need a certain level of knowledge and understanding about the natural environment and of environmental issues to help them determine which actions will be effective in addressing the issues (Frick et al., 2004; Heimlich & Ardoin, 2008). Models that explain PEB usually consider knowledge to be an influential factor, especially in forming environmental attitudes (Gifford & Nilsson, 2014).

Lastly, nature can be psychologically restorative for children (Collado & Staats, 2016; Corraliza et al., 2012; Wells, 2000; Wells & Evans, 2003). Benefitting, therefore, from restorative experiences in nature may motivate children to care about nature and take action to protect it, in the same way as adults (Byrka et al., 2010; Hartig et al., 2007; Whitburn et al., 2018). Children who thought their school playground had more restorative qualities reported greater engagement in PEB than those children who regarded their playground as less restorative (Collado & Corraliza, 2015). However, to the best of my knowledge, the association between children's self-reported use of nature for psychological restoration and their engagement PEB has not been investigated.

It may be that, as in adults, motivators such as children's connection to nature, environmental attitude, knowledge and gaining from psychologically restorative experiences in nature facilitate the relationship between spending time in nature and engagement in PEB (Whitburn et al., 2018). However, the literature on this topic is small and particularly speculative.

Socio-demographics such as gender and age are associated with differences in children's connection to nature (Department of Conservation, 2016; Liefländer et al., 2013; Richardson et al., 2015), environmental attitudes (Collado, Evans, et al., 2015; Larson et al., 2010) and PEB (Collado, Evans, et al., 2015). Additionally, there are cultural differences in the way individuals relate to their environment and act on environmental issues (Boeve-de Pauw & Van Petegem, 2011; Evans, Juen, et al., 2007; Larson et al., 2010; Milfont & Schultz, 2016).

My research investigates the hypothetical relationships (Figure 4.1) between four of the drivers of children's PEB associated with their experiences in nature. In particular, I wanted to understand how children's connection to nature related to their engagement in PEB. I also wanted to investigate the roles that children's use of nature for psychological restoration, environmental attitude and knowledge plays in their PEB. Finally I wanted to assess the extent to which socio-demographics could explain children's engagement in PEB.

Based on the literature reviewed above and elaborated in Chapter 1, I hypothesised that children with a stronger connection to nature would also report greater engagement in PEB than children with a weaker connection to nature (e.g., Collado et al., 2013; Otto & Pensini, 2017). I also expected children who more strongly endorsed the use of nature for psychological restoration and held more eco-centric environmental attitudes to report greater engagement in PEB (Collado & Corraliza, 2015; Collado, Corraliza, et al., 2015; Collado et al., 2013). I predicted the relationship between connection to nature and PEB would be mediated by children's use of nature for psychological restoration and environmental attitude, based on the model presented by Whitburn et al. (2018). In addition, I expected knowledge to inform children's environmental attitude and indirectly their engagement in PEB (Lieflander & Bogner, 2018). Finally, I expected children's connection to nature, knowledge, their use of nature for psychological restoration and environmental attitude to be more strongly associated with their PEB than the socio-demographic indicators.

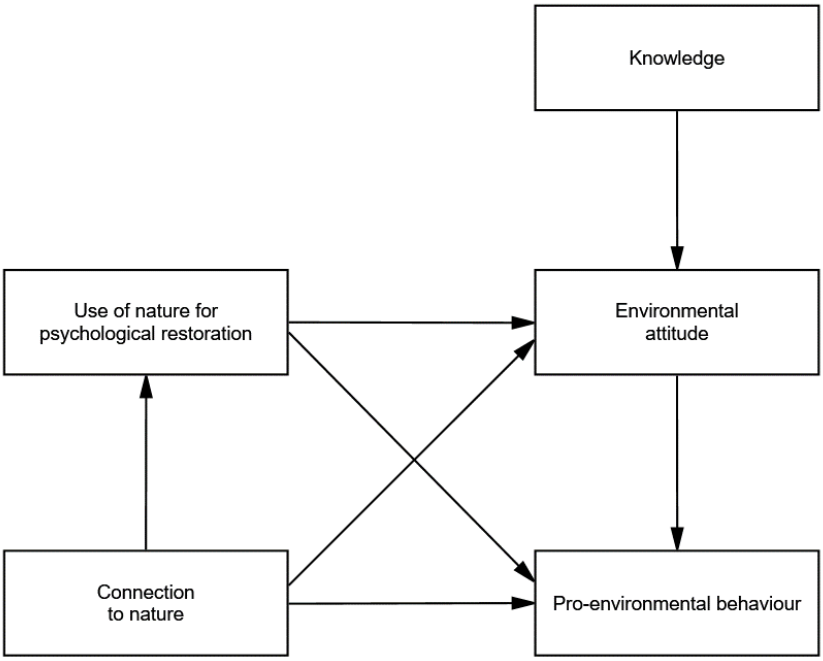


Figure 4.1 The theoretical model demonstrating the relationship between children's connection to nature and their engagement in pro-environmental behaviour.

4.3 Methods

4.3.1 Research design and analyses

This study used a quasi-experimental, non-equivalent design, because children were already in established groups (classes). Classes, who had booked to attend environmental education field trips in Wellington, New Zealand, were referred to me by the education providers (Zealandia Eco-sanctuary, Wellington Zoo, Mountains to Sea Wellington). A convenience sample of schools resulted in a fairly representative sample of Wellington children based on their age, geographical location (urban, suburban, and rural) and socio-economic diversity.

I used a self-administered questionnaire to collect data from 31 October 2017 to 15 August 2018 from children attending environmental education programmes in Wellington, New Zealand. Details of the survey content and how it was administered are described in the Methods of Chapter 3. The data from the pre-intervention survey, which was collected before children attended the environmental education programmes, was used for analyses in this chapter. The data-analyses pertaining to preliminary analyses, assessing and imputing missing values, and exploratory and confirmatory factor analyses of the constructs are described in detail in Chapter 3.

The constructs used for analyses in this chapter include connection to nature, use of nature for psychological restoration, environmental attitude and pro-environmental behaviour (Table 4.1). The socio-demographics sampled were children's age, gender and ethnicity, and the school decile rating (as an indicator of socio-economic status). I also assessed children's knowledge of the species that they might encounter during environmental education. Children were asked to identify seven terrestrial, coastal or aquatic species. The species varied with the environmental education programme. Children visiting Zealandia and Wellington Zoo were asked to identify mainly terrestrial species, whereas children participating in the Mountains to Sea programmes were asked to identify species they were likely to come across in the local marine and freshwater environment. Common names of species were accepted as a correct identification, in either English or te reo Māori. Species knowledge was scored out of seven.

Table 4.1 Descriptive statistics, for the socio-psychological constructs. SD = Standard deviation, α = Cronbach's alpha, SE = standard error, *N* = 324. * Significant skewness.

Construct	Mean ± SD	α	Skewness ± SE	Kurtosis ± SE
Connection to nature	3.81 ± 0.71	0.88	-0.59 ± 0.14*	-0.15 ± 0.27
Use of nature for psychological restoration	3.72 ± 0.86	0.84	-0.56 ± 0.14*	0.09 ± 0.27
Environmental attitude	3.95 ± 0.73	0.70	-0.86 ± 0.14*	0.83 ± 0.27
Pro-environmental behaviour	3.29 ± 0.87	0.71	-0.35 ± 0.14	-0.33 ± 0.27
Species' knowledge	2.47 ± 1.35		0.48 ± 0.14	1.11 ± 0.27

4.3.2 Participants

Children in school years 5 - 8 (aged 7 - 13 years) were recruited from seventeen classes in eight primary (elementary) schools in the greater Wellington region, New Zealand (see Appendix 6). Three hundred and twenty-four children completed a survey. Survey respondents were 39.8% female, with a mean age of 10.6 ± 1.42 (SD) years. The children identified their ethnicity as New Zealand European (60.8%), Māori (27.2%), Pacific Peoples (24.1%), Asian (11.4%) and Middle Eastern, Latin America or African (4.6%). The sum percentage of ethnicities is over 100 because children could select as many ethnicities as they considered appropriate. The children were more likely to be male ($\chi^2_{(1)} = 11.06$, $p < 0.001$) and identify as Māori ($\chi^2_{(1)} = 20.06$, $p < 0.001$), Pacific Island ($\chi^2_{(1)} = 54.37$, $p < 0.001$) or Middle Eastern, Latin American and African ($\chi^2_{(1)} = 19.63$, $p < 0.001$) than the population of children in the Wellington region (Statistics New Zealand, 2017).

4.3.3 Structure of the random variables

The children recruited for this research were from 17 individual classes and eight schools. I used multi-level mixed modelling in SPSS, following Zuur et al. (2009), to determine whether the nested nature of the dataset had a significant effect on the relationships between the explanatory variables and the dependent variable, PEB. Then I used Akaike's Information Criterion to compare the resulting candidate models to choose

the simplest model that was the best fit for the data. These analyses are described in more detail in Chapter 3.

The 'beyond optimal' model consisted of fixed and random effects. The fixed effects consisted of all the explanatory variables and the interactions between them, which were selected based on the hypotheses I was testing (e.g., connection to nature, socio-demographics). The random effects were the grouping variables - school and class. The fixed effects were held constant and the random effects allowed to vary to identify the nested structure of the dataset (Zuur et al., 2009). The four candidate models, with varying random effects, included no random effect, class, class within school and school. The model of class within school represents an interaction effect where the effect of class may depend on school.

Table 4.2 Second order Akaike's Information Criterion (AICc) for the four candidate models testing random effects on the dependent variable, pro-environmental behaviour. Models are listed from lowest to highest ΔAIC. *k* = number of parameters, ω_i is the Akaike weight, *N* = 324.

Model	*k*	AIC	AICc	ΔAIC	ω_i
1. School	35	711.09	719.84	0.00	0.41
2. No random effect	34	711.66	719.90	0.06	0.40
3. Class	35	714.61	723.36	3.52	0.07
4. Class + School	36	713.09	722.37	2.53	0.12

Model 1 (School) and Model 2 (No random effect) had substantial support, with ΔAIC ≤ 2 (Table 4.2) and the majority of Akaike weights were attributed to these two models (ω_i = 0.41 and 0.41 respectively). The other candidate models have considerably less support with ΔAIC > 2.0 each and small Akaike weights. This result indicates that Models 1 and 2 are nearly five times more likely to be the preferred model than Models 3 and 4. The Intra-class Correlation Coefficients, which measure the proportion of the total variance in the outcome

variables attributable to nested structure of the data, were: school, 5.0% and class, 4.1%. Thus, only 5.0% of the variance in PEB is attributed to differences between schools and 4.1% to differences between classes. These results indicate that the possibility of the grouping influencing the relationship between the covariates and vitality was not high enough to warrant including school or class as random effects in further analyses.

4.3.4 Structural equation models

I set up full structural equation models based on the *a priori* theoretical model (Figure 4.1) and carried out a Confirmatory Factor Analysis using the statistical software AMOS (IBM SPSS AMOS Version 24) with Maximum Likelihood estimation procedures as described in Chapter 3). Model fit to the data was evaluated using model fit indices: X^2/df, CFI, TLI, RMSEA and SRMR. Once candidate models were defined and supported by the model fit indices, an Information Theoretic approach, using Akaike's Information Criteria (AIC) was used to rank models and estimate the relative likelihood of each model (Anderson et al., 2000) (see also Chapter 3).

A priori models were designed to test my hypotheses based on the literature. All the models were mediation models. The independent variable was connection to nature, the mediator variables were the use of nature for psychological restoration and environmental attitude, the dependent variable was pro-environmental behaviour (Figure 4.1). Socio-demographic variables (age, gender, ethnicity, and school decile) were added as independent variables to construct the candidate models to investigate the relationships between the socio-demographic variables and children's PEB.

4.4 Results

4.4.1 Theoretical pro-environmental behaviour model

The *a priori* theoretical structural equation model designed to explain children's PEB was not supported by my data. Many of the expected relationships were not significant (Table 4.3). Connection to nature was the only variable that was directly associated with PEB. The use of nature for psychological restoration and environmental attitude were not directly related to PEB, and also not to each other (Table 4.3). Knowledge did not have a significant relationship with PEB. Connection to nature was associated with both the use of nature for psychological restoration and environmental attitude (Table 4.3). The resulting model (Figure 4.2), containing only connection to nature and PEB, is a good fit to the data: $\chi 2$/df = 2.76; CFI = 0.98; TLI = 0.97; RMSEA = 0.074 [0.038, 0.11]; SRMR = 0.029. Connection to nature explains 68% of the variance in the children's PEB and has a strong relationship with PEB ($\beta = 0.83$, $p < 0.001$). The strength of the relationships between constructs is stipulated based on Cohen's (1992) guidelines: < 0.30 = small; 0.30 – 0.49 = moderate; > 0.50 = strong effect.

Table 4.3 Relationships (standardised effects) between variables for the *a priori* theoretical pro-environmental behaviour model. PEB, pro-environmental behaviour. *, $p < 0.01$.

	Total effect		Indirect effect	
Relationships between constructs	β	95% CI	β	95% CI
Connection to nature – environmental attitude	0.77*	[0.56, 0.81]		
Connection to nature – psychological restoration	0.83*	[0.78, 0.88]		
Connection to nature – PEB	0.87*	[0.77, 0.89]	-0.04	[-0.41, 0.19]
Environmental attitude – PEB	-0.21	[-0.46, 0.01]		
Psychological restoration – PEB	0.11	[-0.08, 0.31]	0.06	[-0.03, 0.13]
Psychological restoration – environmental attitude			0.00	[0.00, 0.00]
Species' knowledge – environmental attitude	0.18*	[0.05, 0.15]		
Species' knowledge – PEB			0.00	[-0.1, 0.00]

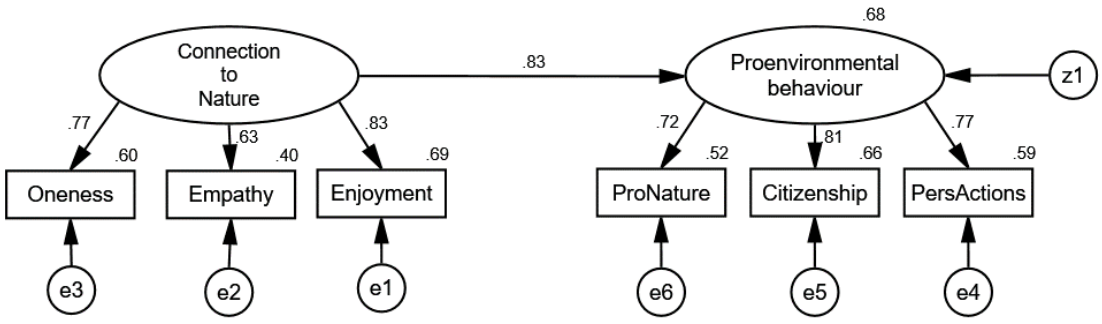


Figure 4.2 Reduced version of the *a priori* theoretical model explaining children's pro-environmental behaviour. Oneness, ProNature and PersActions etc. are the dimensions of each construct.

Although this reduced version of the *a priori* theoretical model (Figure 4.2) was a good fit to the data and explained 68% of the variance in children's PEB, it was based on cross-sectional research that cannot speak to causation. This means the direction of the relationships between the variables may not be as specified in the theoretical PEB model and this might explain why the expected relationships did not hold. For example, environmental attitude may be an antecedent of the use of nature for psychological restoration and connection to nature rather than the reverse as specified by my theoretical model. And psychological restoration may be an antecedent of connection to nature. Therefore, I tested these mediation relationships as well.

4.4.2 Triangular mediation testing of hypothetical relationships

I tested for mediation relationships between each triad of constructs, connection to nature, the use of nature for psychological restoration, environmental attitude and pro-environmental behaviour (as per Jose (2013a) and based on Baron and Kenny (1986)) to further understand the relationships between the variables and to re-specify the theoretical PEB model. Zero-order bivariate correlations were significant, except for the relationship between PEB and species' knowledge (Appendix 3). A significant mediation relationship is evidenced by the decrease in the strength of the relationship between each independent and dependent variable couple after the mediating variable ss added and by a significant Sobel test statistic (Table 4.4). The mediation tests of triads of constructs demonstrated that connection to nature fully mediated the relationship between environmental attitude and PEB. Connection to nature also fully mediated the relationship between the use of nature for psychological restoration and PEB. The use of nature for psychological restoration also fully mediated the relationship between environmental attitude and PEB. The model fit indices for each triad of constructs indicated an acceptable model fit (Table 4.4).

Based on the results of these mediation tests, the original theoretical model for PEB was re-specified. The order of the independent and mediating variables was the reverse of those in the theoretical model. Environmental attitude was re-positioned as the independent variable to the dependent variable, PEB. Connection to nature and the use of nature for psychological restoration were mediators. Knowledge was not included in the re-specified model because previous analyses determined it had no significant association with PEB. This is the *Pro-environmental behaviour* model.

Table 4.4 Mediation testing for triads of constructs. C is the direct path between the independent and dependent variable without a mediating variable. C' = is the same pathway after the mediating variable is added. *B,* unstandarised * = $p < 0.001$, $N = 374$.

Triad of constructs	C (*B*)	C' (*B*)	Sobel statistic	Model fit indices
Environmental attitude → Connection to nature → PEB	0.70*	-0.22	11.50*	$\chi 2$/df = 3.56; CFI = 0.95; TLI = 0.93; RMSEA = 0.08 [0.07, 0.11]; SRMR = 0.027
Environmental attitude → Psychological restoration → PEB	0.70*	0.14	4.50*	$\chi 2$/df = 1.74; CFI = 0.99; TLI = 0.98; RMSEA = 0.048 [0.00, 0.089]; SRMR = 0.038
Psychological restoration → Connection to nature → PEB	0.67*	0.14	9.96*	$\chi 2$/df = 1.74; CFI = 0.99; TLI = 0.98; RMSEA = 0.048 [0.00, 0.089]; SRMR = 0.038

4.4.3 *Pro-environmental behaviour* model

The re-specified *Pro-environmental Behaviour* model was a good fit to the data: $\chi 2/df = 2.61$; CFI = 0.97; TLI = 0.96; RMSEA = 0.07 [0.04, 0.93]; SRMR = 0.037; $N = 374$ (Figure 4.3). Neither environmental attitude nor the use of nature for psychological restoration were directly associated with PEB. The relationship between these variables and PEB was mediated by connection to nature. The relationship between environmental attitude and PEB was also mediated by the use of nature for psychological restoration. Thus, the *Pro-environmental Behaviour* model was a full mediation model. The model explained 72% of the variation in the children's PEB. Connection to nature had the strongest total relationship with PEB ($\beta = 0.85$, 95% CI [0.77, 0.91], $p < 0.01$), compared to environmental attitude and use of nature for psychological restoration ($\beta = 0.56$, 95% CI [0.42, 0.70], $p < 0.01$ and $\beta = 0.59$, 95% CI [0.44, 0.68], $p < 0.01$ respectively). According to this model, children with a stronger eco-centric environmental attitude also tend to have more personally gratifying experiences in nature (such as a closer connection to nature and use of nature for psychological restoration) and this is, in turn, associated with a greater engagement in PEB.

I chose to use the *Pro-environmental Behaviour* model (Figure 4.3) for further analyses, rather than the more parsimonious theoretical model (Figure 4.2), for several reasons. Both models had a good (and very similar) fit to the data, but the *Pro-environmental Behaviour* model explained an additional 4% of the variance in children's PEB and provided additional information. Although connection to nature had the strongest association with PEB ($\beta = 0.85$) in the *Pro-environmental Behaviour* model, environmental attitude and use of nature for psychological restoration also had a moderate positive association with children's PEB ($\beta = 0.56$ and 0.59 respectively). In addition, the *Pro-environmental Behaviour* model integrates existing research that reports environmental attitude, use of nature for psychological restoration and connection to nature are each positively associated with PEB. The model demonstrates how these three factors may be inter-related and together influence children's PEB. Further, The *Pro-environmental Behaviour* model also demonstrates that children's use of nature for psychological restoration and environmental attitude explained 76% of the variance in their connection to nature.

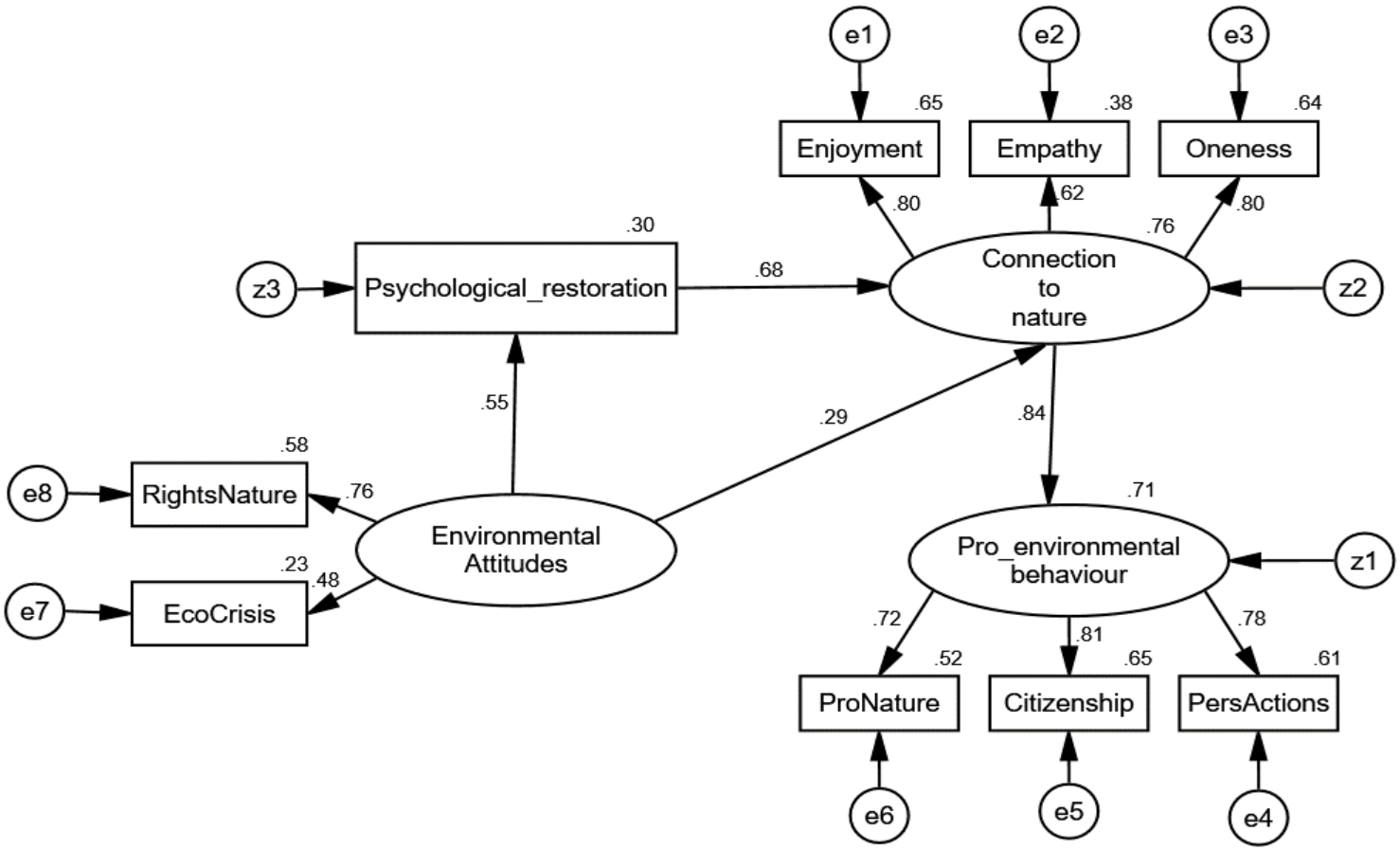


Figure 4.3 *Pro-environmental behaviour* model demonstrating the socio-psychological drivers and mediators of children's pro-environmental behaviour associated with their experiences in nature. RightsNature, Oneness, and ProNature etc. are the dimensions of each latent variable.

The socio-demographic variables were then added as independent variables to the *Pro-environmental behaviour* model to determine whether they could improve on the modelled relationships.

Children's age had a moderately-sized, negative association with their PEB (β_{Total} = -0.45, 95% CI [-0.53, -0.35], $p < 0.01$). That is, older children reported lower levels of PEB compared to younger children. This negative association with PEB was partially mediated by lower connection to nature and less use of nature for psychological restoration in older children. The total strength of the association between age and children's connection to nature and age and their use of nature for psychological restoration were (β = -0.38, 95% CI [-0.48, -0.27], $p < 0.01$) and (β = -0.36, 95% CI [-0.45, -0.27], $p < 0.01$), respectively. Age had no significant association with children's environmental attitude. The model was a good fit to the data: χ^2 /df = 2.39; CFI =0.97; TLI = 0.95; RMSEA = 0.066 [0.046, 0.086], SRMR = 0.038 and explained a further 1% of the variation in PEB compared with the *Pro-environmental behaviour* model.

Older, pre-adolescent children (years 7 - 8), had a significantly lower mean connection to nature than younger children (years 5 – 6): 3.56 ± 0.80 (n = 159) and 4.04 ± 0.63 (n = 165) for older and younger children respectively (t (322) = 6.44, $p < 0.001$). Further, there was a positive correlation between connection to nature and PEB (r = 0.68, $p < 0.001$) in older children. That is, older children with a stronger connection to nature reported greater engagement in PEB than older children with a weaker connection to nature.

The decile rating of the schools had a small, indirect, negative association with PEB (β = -0.28, 95% CI [-0.39, -0.20], $p < 0.01$). That is, children from higher decile schools reported lower levels of PEB compared to children from lower decile schools. This negative association with PEB was mediated by lower connection to nature and less use of nature for psychological restoration reported by children from higher decile schools. School decile rating was also negatively associated with children's environmental attitudes. The model was a good fit to the data: χ^2 /df = 2.45; CFI = 0.97; TLI = 0.95; RMSEA = 0.067 [0.047, 0.087], SRMR = 0.038, and explained a further 2% of the variation in PEB compared to the *Pro-environmental behaviour* model.

Gender had a small, indirect, positive association with PEB (β = 0.18, 95% CI [0.07, 0.31], $p < 0.01$). That is, girls reported greater engagement in PEB than boys. This association was mediated by greater endorsement for the use of nature for psychological restoration and stronger connection to nature reported by girls. The model was a good fit to the data in most model fit indices: χ^2 /df = 3.2; CFI = 0.95; TLI = 0.93; RMSEA = 0.08 [0.065, 0.010], SRMR = 0.05 and did not explain any further variation in PEB compared with the *Pro-environmental behaviour* model.

The ethnicity of the children had no direct association with their reported PEB, but two ethnic groups show a small, indirect association. New Zealand European children reported lower levels of PEB (β = -0.10 95% CI [-0.18, -0.03], $p < 0.01$) compared with non-New Zealand European children. In addition, children who reported some Pacific Island heritage reported higher levels of PEB compared with children who did not indicate Pacific Island heritage (β = 0.09 95% [0.04, 0.16], $p < 0.01$). The effects of ethnicity were mediated through use of nature for psychological restoration and connection to nature. The model was a reasonable fit to the data: χ^2 /df = 2.94; CFI = 0.94; TLI = 0.92; RMSEA = 0.08 [0.06, 0.09], SRMR = 0.06, but did not explain any more of the variance in PEB than the *Pro-environmental behaviour* model.

4.4.4 Model comparison using AICc

There were five candidate models representing PEB: the *Pro-environmental behaviour* model, *Pro-environmental behaviour* model plus gender, age, decile, and ethnicity. (Table 4.5). I used ΔAIC to compare the candidate models and select a preferred model (Anderson & Burnham, 2002; Anderson et al., 2000).

The most parsimonious *Pro-environmental behaviour* model (Model 1) was the only model that had substantial support (ΔAIC ≤ 2) (Table 4.5). The *Pro-environmental behaviour* model assumed all (100%) of the candidate model set's Akaike weight. All other competing models had comparatively trivial Akaike weights (<0.00) and were relatively implausible (ΔAIC > 10). The *Pro-environmental behaviour* model is thus the best and most parsimonious of the candidate models.

Table 4.5 Akaike's Information Criteria model comparison, using second order Akaike's Information Criterion (AICc), for the five candidate models. Models are listed in order from lowest to highest ΔAIC. *PEB* = *Pro-environmental behaviour* model, *k* = number of parameters, $\omega_{i\ =}$ Akaike weight, *N* = 324.

Model	*k*	AIC	AICc	ΔAIC	ω_i
1. PEB	36	104.28	113.56	0.00	1.00
2. PEB + gender	38	122.00	132.40	18.84	0.00
3. PEB + age	41	122.00	134.21	20.65	0.00
4. PEB + decile	40	122.96	134.55	20.99	0.00
5. PEB + ethnicity	40	169.66	181.25	67.69	0.00

4.4.5 Exploratory investigation of age group and PEB

I also undertook an exploratory investigation to further understand how the age-group of the children was associated with their PEB. I did this because age has been reported as an important variable in children's PEB (Collado, Evans, et al., 2015) and age had a moderate negative correlation with PEB when added to the *Pro-environmental behaviour* model. Age also had a moderate, negative correlation with the antecedents of PEB - connection to nature and the use of nature for psychological restoration. There were significant differences in the means of some of the constructs in relation to the age group of the children, as assessed by t-tests (Table 4.6).

Younger children had a significantly higher connection to nature and use of nature for psychological restoration and greater engagement in PEB than older children (differences are 0.48, 0.61, and 0.64 respectively) (Table 4.6). The size of Cohen's *d* indicates these differences are moderate (> 0.5) to large (> 0.8) in magnitude (Cohen, 1992). But there was no significant difference in environmental attitude between the two groups. The correlation between environmental attitude and the other variables was stronger for older children (Table 4.7).

Table 4.6 Means for each construct for both age groups of the children. t-tests determined whether the differences between age groups were significant. Where Levene's test was significant, denoting a violation of the assumption of homogeneity of variance, the t-tests are reported with equal variances not assumed. SD = standard deviation, *, $p < 0.05$; **, $p < 0.001$. Cohen's *d* = effect size. Degrees of freedom = 322.

	Mean ± SD				
Construct	Years 5 - 6 *N* = 165	Years 7 - 8 *N* = 159	Levene's F	t-test	Cohen's *d*
Connection to nature	4.04 ± 0.63	3.56 ± 0.72	4.61*	6.44**	0.71
Psychological restoration	4.02 ± 0.76	3.41 ± 0.85	1.28	6.73**	0.76
Environmental attitude	4.01 ± 0.72	3.90 ± 0.75	0.60	1.44	-
Pro-environmental behaviour	3.61 ± 0.76	2.97 ± 0.85	1.61	7.11**	0.82

Table 4.7 Zero-order bivariate correlations (*r*) between environmental attitude and the other constructs for younger (years 5 - 6) and older (years 7 - 8) children. All correlations are significant at $p < 0.001$. *N* = 165 for younger children and *N* = 159 for older children.

Bivariate correlations (*r*)	Years 5 - 6	Years 7 - 8
Environmental attitude → Connection to nature	0.26	0.61
Environmental attitude → Psychological restoration	0.22	0.54
Environmental attitude → PEB	0.17	0.50

I divided the dataset into younger (years 5 - 6) and older (years 7 - 8) children and tested the data with the preferred *Pro-environmental behaviour* model, thus producing two models (Figure 4.4). Both models were an acceptable fit to the data: χ^2 /df = 2.7; CFI = 0.98; TLI = 0.97; RMSEA = 0.07 [0.044, 0.102], SRMR = 0.029 and χ^2 /df = 2.11; CFI = 0.96; TLI =

0.95; RMSEA = 0.084 [0.05, 0.11], SRMR = 0.035, for younger and older children respectively.

There were differences between the two models explaining children's PEB (Figure 4.4). For older children, the structure of the relationships of the variables in the model is unchanged from the preferred *Pro-environmental behaviour* model (Figure 4.3). In contrast, for younger children, environmental attitude is not associated with connection to nature or the use of nature for psychological restoration, and therefore their engagement in PEB. The most notable difference between the models was that environmental attitude helped to explain the PEB of older children, but not the PEB of younger children.

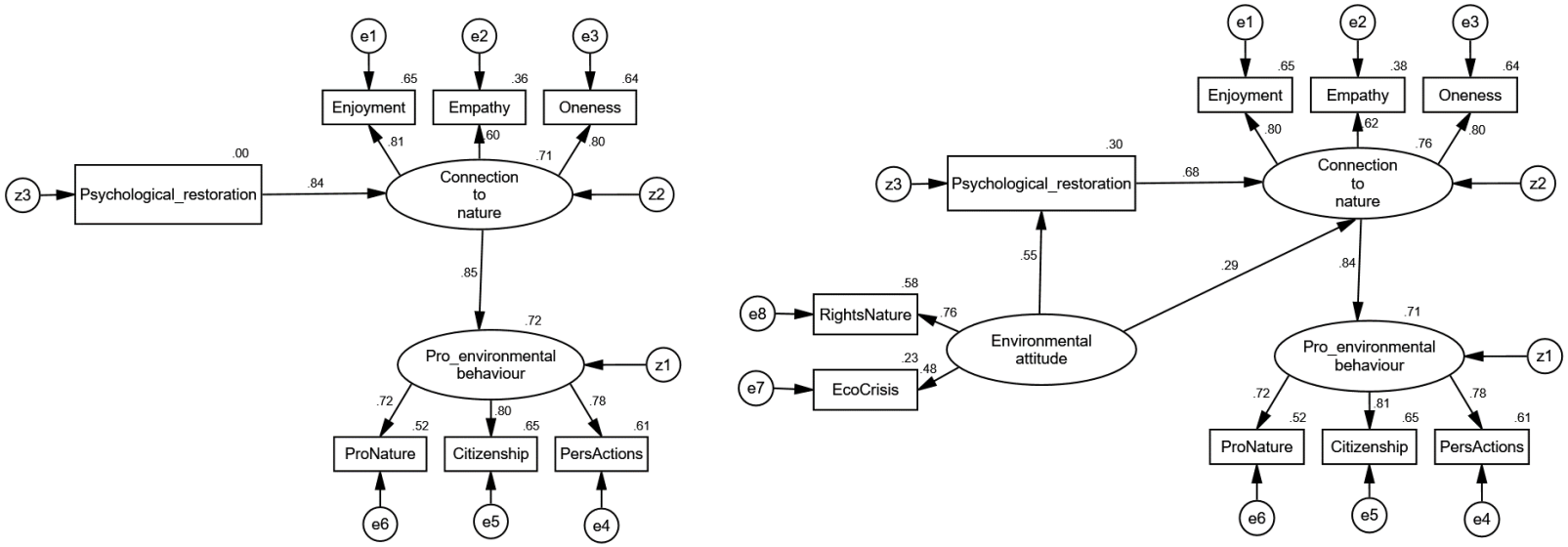


Figure 4.4 Structural equation models demonstrating the drivers of pro-environmental behaviour for younger children (years 5 – 6), on the left, and older children (years 7- 8), on the right. RightsNature, Oneness, and ProNature etc. are the dimensions of each latent variable.

4.5 Discussion

This study examined the relationships between children's connection to nature, environmental attitude, knowledge and use of nature for psychological restoration and their engagement in self-reported PEB. This study fills an important gap in the literature by proposing and testing the mediating relationship between these variables. This will further our understanding of how to foster children's PEB.

The *Pro-environmental Behaviour* model I tested shows that children's connection to nature has a strong, positive association with their self-reported engagement in PEBs, such as water and energy conservation, caring for animals and participating in events to help nature. Children's environmental attitudes are indirectly associated with their PEB via their connection to nature and their use of nature for psychological restoration, in a double mediation pathway. That is, holding an eco-centric environmental attitude and gaining psychologically from nature relate to children's engagement in PEB only to the extent that a child also embraces a connection to nature. This is a novel contribution to the development of theoretical models in this field. The findings help to explain why some children behave more environmentally than others, even when they profess to have a strongly eco-centric worldview. This study provides the first evidence that connection to nature, environmental attitude and use of nature for psychological restoration are inter-related antecedents of children's PEB. These findings are important because childhood experiences in nature, which help form a strong bond with nature, may determine individual choices and actions in adulthood toward a more sustainable future on planet earth.

4.5.1 Connection to nature and use of nature for psychological restoration

In the *Pro-environmental Behaviour* model, children's connection to nature had the strongest total association with their PEB ($\beta = 0.84$), compared to their environmental attitude's ($\beta = 0.56$) and use of nature for psychological restoration ($\beta = 0.59$). Children's ability to correctly identify species had no relationship with their PEB. In addition, connection to nature explains most of the variance in the children's PEB (68%). Other researchers have also reported strong associations between connection to nature and PEB for children (Cheng & Monroe, 2012; Otto & Pensini, 2017; Richardson et al., 2015; Roczen et al., 2014; Whitburn et al., 2019). However, some have reported more moderate

associations between connection to nature and PEB (Collado, Evans, et al., 2015; Müller et al., 2009). The findings of my study support the notion that having a bond or connection to nature can motivate engagement in PEB.

Two other studies have proposed models that investigate the ability of children's connection to nature to explain their PEB. First, a competence model for environmental education (Otto & Pensini, 2017; Roczen et al., 2014) examined the relationships between German children's connection to nature and different types of environmental knowledge and their reported engagement in PEB. The connection to nature of children (Otto & Pensini, 2017) and early adolescents (Roczen et al., 2014) had a stronger association with their PEB than their environmental knowledge. Although I used a different measure of knowledge, I found that the children's connection to nature had a stronger relationship with their PEB than their species' knowledge. Environmental knowledge is a pre-requisite to environmental behaviour. Children need to understand environmental problems and know which actions they can take will be effective (Frick et al., 2004). But environmental knowledge alone only explains a small amount of the variance in children's PEB (2%, Otto & Pensini, 2017), or, as in my study, is not correlated with their PEB (Negev et al., 2008). Children's connection to nature explains a great deal more variance and has a stronger association with their PEB and, therefore, may be a more effective lever for behaviour change than improvements in children's knowledge (Abson et al., 2017).

In a second model, connection to nature (Emotional Affinity Toward Nature) and environmental attitude (New Ecological Paradigm) were investigated as independent antecedents of children's PEB (Collado, Evans, et al., 2015; Collado et al., 2013).This line of research suggests that children's connection to nature has a more moderate association with their self-reported PEB (Collado, Evans, et al., 2015), willingness to engage in conservation actions and environmental citizenship behaviour (Collado et al., 2013) compared with my *Pro-environmental Behaviour* model or the findings of Otto and Pensini (2017). The strength of the relationship between environmental attitude and PEB, however, was similar to my model. The main difference between my model and Collado et al.'s models is that they found children's environmental attitude to be directly associated with their PEB, whereas in my model connection to nature mediated the relationship between children's environmental attitudes and their PEB. Collado and her colleagues did not test

connection to nature as a mediator of the relationship between environmental attitude and PEB. My model confirms connection to nature is an important factor in motivating children's PEB.

Children's use of nature for psychological restoration was positively associated with their PEB in the *Pro-environmental Behaviour* model. This finding extends existing research, which has mostly examined the cognitive and emotional benefits of children spending time in nature. I demonstrate that benefitting from restorative experiences in nature may motivate children to engage in PEB. This has previously only been demonstrated in adults (Byrka et al., 2010; Hartig et al., 2007; Whitburn et al., 2018). My findings sit alongside those of Silvia Collado and her colleagues who have found that Spanish children's perceptions of the restorativeness of an environment are positively linked to their environmental attitude and PEB (Collado & Corraliza, 2011; Collado & Corraliza, 2015).

4.5.2 Age, environmental attitude and PEB

Children's age influenced the way in which their environmental attitude was associated with their engagement in PEB. Younger children's environmental attitude was not directly or indirectly related to their engagement in PEB. However, older children's environmental attitude was indirectly associated with their engagement in PEB (mediated by their connection to nature and, in turn, their use of nature for psychological restoration). Other researchers have also found a lack of correlation between young children's environmental attitude and their PEB across several different countries (Evans, Brauchle, et al., 2007; Evans, Juen, et al., 2007); or a lower positive correlation in 6th grade children compared to 12th grade adolescents (Negev et al., 2008). According to Piaget's stages of cognitive development, adolescent children are moving into the formal operational stage where they are increasingly capable of more abstract thought (Berk, 2004). This enables them to increasingly integrate their understanding with their actions, such as pro-environmental action (Kahn, 1999). My results suggest this may begin in pre-adolescence. The age of children has implications for understanding how environmental attitudes relate to PEB, and it may also be important to consider when developing interventions to motivate PEB in children. Younger children could be encouraged to love nature and elements of nature before they are educated about environmental issues and the expectation that they

can effectively respond to, or ameliorate, these issues (Chawla & Cushing, 2007; Sobel, 1996). In short, "let us allow them (children) to love the earth before we ask them to save it" (Sobel, 1996, p. 10).

My findings may also shed some light on why adolescents (aged 13 – 17 years), in western cultures, generally demonstrate less engagement in PEB than younger children or do not assume personal responsibility for PEB (Kaplan & Kaplan, 2002; Olsson & Gericke, 2016; Wray-Lake, Flanagan, & Osgood, 2010). It may depend on their connection to nature. In my study, a lower level of connection to nature in pre-adolescents facilitated their lower level of engagement in PEB. However, not all pre-adolescent children had a low connection to nature. Pre-adolescent children who had a stronger connection to nature reported greater engagement in PEB than pre-adolescents with a low connection to nature. This suggests that strengthening pre-adolescents' connection to nature may have beneficial effects on their engagement in PEB, which may persist into adolescence and beyond (Bruni & Schultz, 2010; Kaplan & Kaplan, 2002).

4.5.3 Socio-demographics and PEB

The demographic indicators generally explained less than 1% of additional variance in the *Pro-environmental Behaviour* model. There was however, an exception to this. Children who attended schools with a higher socio-economic status engaged in less PEB than children from schools with a lower socio-economic status. This was associated with lower levels of connection to nature and less use of nature for psychological restoration in children from the higher decile schools, which suggests the differences might be related to the amount of time they spend in nature.

Higher income can mean greater access to electronic devices and out-of-school activites (such as sport) which can displace time spent outdoors in nature (e.g., Clements, 2004; Skar, Wold, Gundersen, & O'Brien, 2016). In New Zealand, over 50% of children exceed the recommended two hours per day of screen time (Clinical Trials Research Unit, 2010). In addition, New Zealand children from less economically advantaged areas have fewer opportunites to play sport or participate in music, dance and drama than children from areas with higher incomes (South Island Alliance, 2011). Less access to screens and participation in fewer organised activities may actually allow more time for free-play,

exploration and engagement with nature in local neighbourhoods. Differences in engagement in PEB that are associated with economic factors may be mitigated by encouraging children to spend more time in nature and developing a strong connection to nature.

Gifford and Nilsson (2014), in their review of personal and social influences on pro-environmental concern and behaviour, suggest it is a priority to assess socio-demographic factors that influence pro-environmentalism. My research has shown that, compared to socio-psychological factors associated with nature, socio-demographics such as gender, age, economic status or ethnicity only explain at most 1% – 2% of the children's PEB. The relationship between these demographics and children's PEB was mediated in all cases by their connection to nature and use of nature for psychological restoration. That is, how age and gender relate to PEB depends on children's connection to nature. Socio-demographics, such as gender, ethnicity and economic status, generally can't be changed. I have demonstrated that it may be more fruitful to focus interventions on strengthening children's connection to nature – a malleable trait (Tseng & Wang, 2019), with a stronger relationship to behaviour.

4.5.4 Interventions to promote PEB

Interventions that aim to increase children's PEB could be more effective when they strengthen children's affective connection to nature or include psychologically restorative experiences in nature, alongside providing information or targeting cognitive environmental attitude (Pooley & O'Connor, 2000). Connection to nature may be strengthened through direct experiences with nature where there is physical contact with elements of nature, such as natural settings, plants or animals, rather than through indirect or vicarious experiences (Kellert, 2002; Mayer et al., 2009; Soga, Gaston, Yamaura, Kurisu, & Hanaki, 2016). Experiences in nature where a child can appreciate the natural environment and nature's beauty and engage in appreciative activities, such as walking, investigating, planting or mindfulness practices (Barbaro & Pickett, 2016; Department of Conservation, 2016; Wells & Lekies, 2006; Wolsko & Lindberg, 2013; Zhang, Howell, & Iyer, 2014), may more likely influence their connection to nature and provide the opportunity for restorative

experiences than activities where nature is more of a setting for the activity, such as mountain biking.

This study has shown that connection to nature has a strong correlation with PEB and it may be enhanced by psychologically restorative experiences in nature (also Chapter 3). In adults, connection to nature is stable over time and resistant to change (Kaiser et al 2014). It is therefore, all the more important to implement nature-based interventions in childhood, a time when connection to nature is still being formed and is more dynamic (Tseng & Wang, 2019).

4.5.5 Limitations

There are some limitations in my research. My data is based on self-reports. Self-report can create a threat to construct validity and lead to mono-method bias (also outlined in Chapter 3). However, self-report is widely used in environmental psychology research as a reliable mechanism for assessing the relationships between psychological factors, such as attitudes or behaviour, which cannot readily be observed. Further, a written survey is appropriate for children in years 5-8 because they generally have the language and reading skills required to understand and answer the written questions (Borgers et al., 2000).

Children can be vulnerable to social desirability bias and provide socially acceptable answers. Younger children can display a stronger bias than older children (Miller et al., 2015), especially in the presence of influential adults or peers. It is possible a social desirability bias was present in this study. To minimise this type of bias, the questions were carefully worded. In addition, I told the children before they completed each survey that there were no correct answers and I wanted to know what they personally thought about each question.

The relationships in the *Pro-environmental behaviour* model suggest a causative relationship between variables. However, my results are correlational and as such cannot speak to causation. Therefore, the reverse relationships are possible: greater engagement in PEB may strengthen children's connection to nature or their disposition to use nature for psychological restoration. Although this is possible, it seems that children's connection with nature and experience of psychological restoration are driven by engagement with nature.

This is in-line with what the theoretical and experimental work in this area suggests (Kaplan & Kaplan, 1989; Mayer & Frantz, 2004; Nisbet & Zelenski, 2011; Ulrich et al., 1991)

Another limitation is that the survey population was not representative of the population of children in the Wellington region. This may limit the generalizability of my findings. However, it did provide a relatively large number of children from non-New Zealand European ethnic groups.

4.5.6 Future work

Although the *Pro-environmental Behaviour* model explains over 70% of the variance in children's PEB, it leaves 30% unexplained. One area worthy of future investigation is social influence, particularly family members, on children's connection to nature, environmental attitudes and behaviour. Children's connection to nature, environmental attitude, values and PEB have been positively associated with their parents' (Cheng & Monroe, 2012; Collado et al., 2017; Department of Conservation, 2016; Evans et al., 2018); although there are exceptions (Collado, Evans, et al., 2015; Evans, Brauchle, et al., 2007). The support of people, parents, relatives or peers, who nurture children's relationship to nature can have a positive influence on children's environmental attitudes and behaviour (Chawla, 1998; Collado et al., 2017; Kals et al., 1999; Negev et al., 2008). The ways in which social relationships affect children's connection to nature, environmental attitude and PEB is worthy of further research.

Future work is also required to understand the differences in pre-adolescents' connection to nature compared with that of younger children and whether these differences might be able to explain the dip often found in adolescents' concern for the environment and their levels of engagement in PEB (Kaplan & Kaplan, 2002; Olsson & Gericke, 2016; Wray-Lake et al., 2010). Pre-adolescence may be a pivotal time to arrest or minimise these changes.

Although connection to nature shows promise as a lever for pro-environmental behaviour change, little is known about the specific characteristics of the natural environment or the type of interventions that can increase children's connection to nature. Further research is needed to identify these characteristics and to develop tools that could be used to strengthen children's connection to nature.

4.6 Conclusion

This research extends the current literature examining children's connection to nature and their PEB. In particular, this study has proposed a model that describes how children's connection to nature, their use of nature for psychological restoration and environmental attitude are related to their engagement in PEB. Children's environmental attitude and their use of nature for psychological restoration were only associated with their PEB to the extent that they embraced a connection to nature. This is one of the first studies to empirically establish the mediating relationships between these variables, and contributes to theoretical work in this area. There are many influences on PEB besides these three (Gifford & Nilsson, 2014; Steg & Vlek, 2009), and therefore it is remarkable the three variables explain 72% of the variance in children's PEB. What is more, children's connection to nature alone explains 68% of the variance. A personal connection to nature can be beneficial to an individual's wellbeing (Capaldi et al., 2014), but this research shows it also benefits the wellbeing of the natural environment.

Another novel contribution of my work is that it clearly shows that the positive relationship between environmental attitude and connection to nature, and in turn PEB, evident in pre-adolescent children is not seen in younger children. This has implications for interventions, such as environmental education, that seek to increase children's PEB. Interventions may be more effective in young children if they nurture the children's love of nature through exploration and free-play in nature, rather than to provide a lot of adult-generated information. This may allow a strong connection to nature to develop, which as I have shown is strongly related to children's engagement in PEB.

For connection to nature to become a useful tool in promoting PEB, research into the type of natural environments, length of exposure and type of engagement needs to be undertaken. This would require researchers and practitioners, such as environmental educators, to collaborate both on theory-driven research (Monroe, 2010) and on the development and assessment of effective interventions. Strengthening connection to nature in the population may provide an important lever for environmental behaviour change in response to the environmental challenges facing humanity (Abson et al., 2017; Ives et al., 2017).

Chapter 5: The effectiveness of environmental education in promoting children's connection to nature

5.1 Abstract

Environmental education is an important tool to enhance environmental literacy and equip children to effectively respond to environmental challenges. A personal relationship or connection with nature, which develops in childhood, is associated with greater engagement in pro-environmental behaviour (PEB). Therefore, nature-based environmental education could be an effective way to promote connection to nature and motivate conservation and every-day PEBs. Few researchers have studied this. In addition, research shows that exposure to nature is positively associated with greater psychological wellbeing. Therefore, environmental education in a natural environment has the potential to provide opportunities for psychological restoration and to improve psychological wellbeing. This has not yet been investigated in the environmental education literature.

I conducted a longitudinal, quasi-experiment (with control groups) with children aged 7 - 13 years from schools who attended environmental education in Wellington, New Zealand (*N* = 257). Data was collected via a self-administered questionnaire and a gifting (Token) experiment immediately before and four weeks after children attended environmental education interventions. The token experiment measured children's observed support for conservation. Mixed-design (repeated measures) ANOVAs were used to determine whether environmental education could have a positive effect on children's connection to nature, their self-reported PEB, observed conservation behaviour and other variables of interest.

The results indicate that environmental education had little effect on children's connection to nature, environmental attitude, their vitality, life satisfaction or use of nature for psychological restoration. However, there was an increase in children's PEB and species' knowledge as well as an increase in financial support for conservation after the environmental education session. Children's pre-existing levels of connection to nature moderated the effect of environmental education on their connection to nature after the

intervention. The field-trips only increased the connection to nature of children with the highest pre-existing level of connection to nature.

Based on these findings, environmental education programmes could incorporate direct, hands-on experiences with nature that evoke an emotional response in children to increase their connection to nature and in turn motivate engagement in every-day PEBs and conservation.

5.2 Introduction

Environmental education is thought to increase an individual's awareness, knowledge, attitudes and skills to enable them to participate in solving environmental problems and help manage the quality of the environment (Hungerford & Volk, 1990; Rickinson, 2001; Stern et al., 2014). Environmental education is, therefore, an important tool to maintain the health of the world's ecosystems (UNESCO, 1978). Environmental education programmes are ubiquitous, and have risen to prominence as part of formal and informal education since the 1970s (Carter & Simmons, 2010). However, four decades since the Tbilisi Declaration provided a framework for environmental education (UNESCO, 1978), humans continue to live unsustainable lifestyles (IPCC, 2014; Steffen et al., 2015; Zelezny, 1999).

It might be that environmental education is not as effective as it is assumed to be (Blumstein & Saylan, 2007). In particular, environmental education strategies may not be focused on the most effective psychological factors that motivate pro-environmental behaviour (PEB), referred to as levers of change by Abson et al. (2017). Alternatively, environmental education programmes might overlook those behaviours that have the most impact on mitigating environmental degradation (Stern, 2000). In response to this, researchers have been advocating for environmental education interventions to reconnect people to nature (Frantz & Mayer, 2014; Giusti et al., 2018; Ives et al., 2017; Zylstra et al., 2014), because these type of interventions might result in transformational, long-term behaviour change in individuals (Abson et al., 2017) (see also Chapters 3 and 4).

Uncertainties about the efficacy of environmental education are compounded by the lack of systematic evaluation, particularly in New Zealand. It is rare for programme outcomes to be articulated as programme objectives and then subsequently measured (Blumstein & Saylan, 2007; Carleton-Hug & Hug, 2010). In particular, evaluation tends to focus on environmental knowledge, attitudes and to a lesser extent self-reported PEB (Leeming, Dwywe, Porter, & Cobern, 1993; Rickinson, 2001; Stern et al., 2014; Zelezny, 1999). In addition, the focus is on immediate rather than longer term (1 – 3 months post-intervention) outcomes (Stern, Powell, & Ardoin, 2008). Other methodological weaknesses include a lack of control groups, the pre-intervention equivalence of groups and pre- and

post-intervention testing or poor construct reliability (Zelezny, 1999). Further, when behaviour change is measured, the measure relies almost exclusively on self-reports and rarely observed behaviours (Zelezny, 1999). More research is needed to investigate the psychological factors that lead to more effective environmental education (Neill & Roberts, 2008).

The idea that nature-based environmental education should reconnect children to nature in order to promote PEB arises because exposure to nature as a child is associated with stronger environmental attitudes and greater engagement in PEB (Chawla, 1998; Evans et al., 2018; Wells & Lekies, 2006), and a stronger relationship with nature (Berk, 2004; Chawla, 1998; Kellert, 2002) in adulthood. In addition, connection to nature is positively associated with engagement in PEB across all life stages (Brügger et al., 2011; Collado, Evans, et al., 2015; Mayer & Frantz, 2004; Otto & Pensini, 2017; Rosa et al., 2018; Whitburn et al., 2019). Connection to nature may even be the strongest predictor of PEB (Whitburn et al., 2018). It out-performs other variables, such as moral or social norms, and explains more of the variance in PEB than some multi-variable models (Otto & Pensini, 2017). Perhaps environmental education in the natural environment that is focused on strengthening children's connection to nature (alongside providing appropriate environmental knowledge) can provide a broad-based lever for behaviour change that persists into adulthood (Abson et al., 2017).

There is a small body of literature that examines whether environmental education can promote children's connection to nature. Some researchers have found increases in children's connection to nature that persisted for at least six weeks after the education programme had finished (Braun & Dierkes, 2017). Other researchers have found no increase in connection to nature (Ernst & Theimer, 2011, using the Connection to Nature Index). In some studies children's connection to nature increased initially, but decreased to pre-existing levels several weeks or months later (Sellmann & Bogner, 2013; Stern et al., 2008). In addition, increases in connection to nature could not necessarily be attributed to the environmental education programme *per se*; but were attributed to exposure to nature (Collado et al., 2013). Further, children's pre-exisiting connection to nature, can influence how they benefit from environmental education (Braun & Dierkes, 2017; Kossack & Bogner, 2012). My experimental study contributes to this small body of knowledge.

The evidence concerning the ability of environmental education programmes to impart knowledge, strengthen children's environmental attitude and motivate their engagement in PEB is mixed. Environmental education often has a strong focus on science education and is usually successful at imparting ecological knowledge (Rickinson, 2001; Stern et al., 2008; Stern et al., 2014). Reviews and experimental studies generally report that environmental education has a positive effect on children's environmental attitude (Collado et al., 2013; Evans, Juen, et al., 2007; Genc, Genc, & Rasgele, 2018; Johnson & Manoli, 2010; Liefländer & Bogner, 2014; Rickinson, 2001; Schmitz & da Rocha, 2018; Sellmann & Bogner, 2013; Zelezny, 1999). However, around a quarter of the studies in a recent review by Stern et al. (2014) reported no gains in environmental attitude after environmental education.

Promoting PEB is often the main aim of environmental education (UNESCO, 1978). Environmental education can promote increases in children's PEB, but there are exceptions to this (Stern et al., 2014; Zelezny, 1999). Some studies have found that children increased their willingness to engage in daily conservation or environmental citizenship actions after attending nature camps (Collado et al., 2013; Stern et al., 2008). But other researchers have reported no gains in PEB after environmental education in nature, despite increases in the children's environmental attitude (Burnett, Sills, Peterson, & DePerno, 2016; Evans, Brauchle, et al., 2007).

Further, environmental education providers do not generally investigate the effect of interventions on children's psychological wellbeing. However, children's experiences in nature are positively associated with psychological wellbeing benefits (Collado & Staats, 2016; Dadvand et al., 2015; Dadvand et al., 2017; Faber Taylor et al., 2002; Wells, 2000); therefore, nature-based environmental education has the potential to benefit children's psychological wellbeing.

The primary purpose of my research was to determine whether short duration, nature-based, environmental education programmes could increase children's affective connection to nature. I also wanted to know whether these programmes increased the outcomes traditionally assessed in environmental education research: environmental attitude, knowledge, engagement in PEB and support for conservation or whether they could enhance children's wellbeing. I also examined whether the effectiveness of

environmental education was dependent on children's level of connection to nature before they attended the programmes.

Based on the literature reviewed above, and elaborated in Chapter 1, I expected nature-based environmental education to have a positive effect on children's affective connection to nature (Collado et al., 2013; Stern et al., 2008). In addition, I expected that children with lower levels of baseline connection to nature would benefit more from nature-based environmental education than children with a higher baseline connection to nature (Braun & Dierkes, 2017; Kossack & Bogner, 2012). In addition, I expected children's knowledge, environmental attitude, PEB and support for conservation to increase after environmental education (Rickinson, 2001; Stern et al., 2014; Zelezny, 1999). Finally, I expected to see improvements in children's use of nature for psychological restoration, vitality and/or life satisfaction as a benefit of spending time in nature as part of environmental education (Capaldi et al., 2014; Mayer & Frantz, 2004; Nisbet et al., 2011).

5.3 Methods

5.3.1 Environmental education providers

I sampled classes attending the environmental education programmes of three providers: Zealandia (formerly Karori Wildlife Sanctuary), Wellington Zoo and Mountains to Sea Wellington. Zealandia is an eco-sanctuary with 225 hectares of regenerating forest and reintroduced biodiversity, some of which are not seen in the wider Wellington region. It is located just 4 km (2.5 miles) from Wellington City's central business district, within its suburban environment. Wellington Zoo is a small, city zoo, covering 13 hectares, in the green belt of Wellington City. Its enclosures house native and exotic wildlife, and a veterinary care facility is also on site. Lastly, Mountains to Sea Wellington (MTS) is an organisation that delivers freshwater and marine education programmes, including Experiencing Marine Reserves and Healthy Harbours, across the greater Wellington region. MTS programmes take place at local harbours, streams, coast and marine reserves around the Wellington region.

The education programmes provided by these organisations are presented by trained education staff and held outdoors, in line with Ministry of Education (2015) guidelines. All the programmes that were part of this study included a half-day, nature-based field-trips held outdoors. At Zealandia, the four classes (n = 45) participating in my research all attended experiences in the sanctuary. As the children were guided through the sanctuary, the education staff taught them about terrestrial and freshwater biodiversity. Three classes visited Wellington Zoo (n = 50). One class visiting the zoo participated in a half-day programme entitled "Animal Adaptations" where they learnt about, and observed first-hand, structural adaptations of animals to their environment from the education staff. The other two classes at Wellington Zoo participated in the Bush Builders environmental literacy programme. Bush Builders involved a half-day introductory session at Wellington Zoo where children participated in hands-on activities and visited a native-plant restoration project. The four classes (n = 50) participating in MTS Experiencing Marine Reserves learnt about marine biodiversity and the importance of marine reserves for the conservation of our oceans from the trained educators. They also compared marine reserve and non-marine reserve biodiversity via snorkelling fieldtrips. The four classes (n = 65) in the MTS Healthy Harbours programme explored the link between land and sea through the waterways in the

Porirua or Wellington City catchments and examined the biodiversity and tested water quality from freshwater streams and the harbours.

The New Zealand Ministry of Education has produced guidelines that state a balanced environmental education programme should be *in* the environment, *about* the environment and *for* the environment. These guidelines are underpinned by four concepts: interdependence, sustainability, biodiversity and personal and social responsibility in ways that embrace a Māori worldview (Ministry of Education, 2015). The extent to which the three environment education providers met these guidelines was not examined in my research. However, I observed that all providers aimed to incorporate the four concepts underlying the guidelines.

The programmes mainly focussed on ecological or systems knowledge about the natural processes within ecosystems and the human impact on these ecosystems (Frick, Kaiser, & Wilson, 2004). Educators also provided some action-related knowledge around the potential behaviours that can be changed and the relative effectiveness of these behavioural changes (Frick et al., 2004). The programmes in my research were not specifically designed to promote children's connection to nature, although they all stated they aimed to achieve this.

The programmes offered by Zealandia and Mountains to Sea are place-based. The content related directly to the natural environment in which they take place. In contrast, the animals at Wellington Zoo are not in their natural environment and the content of the education programmes are relevant to the wider New Zealand and international context.

The nature-based education experiences are usually followed up by a student-driven conservation action at the children's own school, related to the eco-system the children have experienced. The actions can include artwork or presentations to the wider school community with a conservation message, or projects such as planting trees, building lizard gardens and stream monitoring and clean-ups.

5.3.2 Research design and analyses

This study used a longitudinal quasi-experimental, non-equivalent, control group design. Classes, who had booked to attend environmental education, were referred to me by the education providers (Zealandia Eco-sanctuary, Wellington Zoo, Mountains to Sea

Wellington). These referrals made up the intervention group. In turn, teachers from this intervention group approached their colleagues to identify those who were willing for their class to act as a control group. Fourteen classes served as the intervention group and participated in environmental education programmes and three classes served as a control group and did not participate in any environmental education during the duration of my surveying. Children in the control group had a similar background in environmental education and were in the same age group as their school-mates from the intervention group. Children from the control or intervention group may have previously visited one or more of the environmental education providers either privately or as part of a school visit in previous years.

I used a self-administered questionnaire and a gifting experiment, henceforth called the Token experiment, to collect data from 31 October 2017 to 15 August 2018 from children attending environmental education in the Wellington region. Details of the survey content and how it was administered are described in Chapter 3.

The constructs used for analyses in this chapter include connection to nature, use of nature for psychological restoration, environmental attitude, pro-environmental behaviour, vitality and life satisfaction. I also assessed children's knowledge of the species the children might encounter during environmental education. Children were asked to identify seven terrestrial, coastal or aquatic species. The species varied with the environmental education programme. Children visiting Zealandia and Wellington Zoo were asked to identify mainly terrestrial species, whereas children participating in the Mountains to Sea programmes were asked to identify species they were likely to come across in the marine and freshwater environments. Common names of species were accepted as a correct identification, in either English or te reo Māori. Species' knowledge was scored out of 7. Socio-demographic information was also collected and included children's age, gender and ethnicity and the school decile rating (as an indicator of socio-economic status).

In addition to surveying children's connection to nature before and four weeks after the education intervention, their connection to nature was surveyed immediately on-site after the intervention. This was measured using an adapted version of the Connection to Nature Index, which was re-worded into the present tense to capture children's immediate

experience of nature, following Mayer et al. (2009). For example, “I often feel separate from nature” was changed to the more immediate “Right now I feel separate from nature”. There was one reverse scored item. One hundred and fifty-one children completed all three surveys of connection to nature.

The written survey and the token experiment were administered as close to the beginning of the environmental education intervention as possible and approximately four weeks after. The control group completed the survey and participated in the Token experiment in the same timeframe as the intervention group.

5.3.3 Token (gifting) experiment

I designed the Token experiment to collect observational data of children’s conservation behaviour to complement the self-report PEB in the survey (Figure 5.1). The children earnt a token, worth 50 New Zealand cents, for completing the pre- and post-intervention surveys. They were asked to spend that token by supporting one of three causes immediately after completing each survey. The children’s donations were subsequently donated to the pertinent cause. The causes represented support for conservation, domestic animal care (welfare) but not conservation, and the children’s own school. Support for conservation is represented by two different choices depending on the education provider. This was because the MTS education programmes had a different ecological focus to Zealandia and Wellington Zoo. First, children could support conservation by donating to building kākā (a forest parrot) nest-boxes at Zealandia (for children visiting Zealandia or Wellington Zoo) or cleaning-up local streams to provide a clean environment for animals such as the tuna (long-finned eel) (for children involved in the MTS programmes). Second, children could support the care of (largely) domestic animals by donating to the Wellington Society for the Prevention of Cruelty to Animals (SPCA), represented by a Labrador dog. Third, children could support their own school, represented by donating toward library books or playground equipment. I designed a ballot-box style booth so children could make their choice privately to minimise the effect of social desirability or peer to peer influence (Figure 5.1).

A.

B.

Figure 5.1 Voting booths where children could donate the token they had earnt by completing the survey. A, for the programmes at Zealandia and Wellington Zoo and B, for the Mountains to Sea programmes. The three categories represent support for conservation, the child's own school, or domestic animal care at the SPCA.

5.3.4 Participants

Children in school years 5 - 8 (aged 7 - 13 years) were recruited from 17 classes in 8 primary (elementary) schools in the greater Wellington region of New Zealand (Appendix 6). Two hundred and fifty seven children completed both the pre- and post-intervention surveys, with 20.7% attrition. There were no significant differences between children who dropped out of the study compared with children who completed both surveys with regard to their pre-intervention connection to nature or engagement in PEB: $t(322) = 1.16$, $p > 0.05$ and $t(322) = 0.84$, $p > 0.05$, respectively. Survey respondents, who completed both surveys,

were 38.1% female, with a mean age of 10.7 ± 1.4 (SD) years. The children identified their ethnicity as New Zealand European (61.9%), Māori (24.9%), Pacific Peoples (25.3%), Asian (11.7%) and Middle Eastern, Latin America or African (5.4%). The sum percentage of ethnicities is over 100 because children could select as many ethnicities as they considered appropriate. The children were more likely to be male ($\chi^2_{(1)} = 12.3$, $p < 0.001$) and identify as Māori ($\chi^2_{(1)} = 9.2$, $p < 0.01$), Pacific Island ($\chi^2_{(1)} = 51.7$, $p < 0.001$) or Middle Eastern, Latin American and African ($\chi^2_{(1)} = 25.0$, $p < 0.001$) than the population of children in the Wellington region (Statistics New Zealand, 2017). My sample consisted of two groups: an intervention group (14 classes, $n = 210$) that participated in environmental education and a control group that did not (3 classes, $n = 47$).

5.3.5 Data analyses

The preliminary analyses included, assessing and imputing missing values, exploratory and confirmatory factor analyses of the constructs and assessing the potential effect of nesting of children in classes or schools; these are described in detail in Chapter 3.

Several additional analyses are unique to this chapter:

1. Independent t-tests were used to determine if there were any differences between the intervention and control groups with respect to socio-demographic characteristics and the baseline level of the survey variables.

2. Mixed-design (repeated measures) ANOVAs, with time (pre-intervention and four-weeks post intervention) and environmental education versus control group, with Bonferroni corrected post-hoc tests, were used to investigate whether environmental education had a positive effect on children's mean connection to nature, use of nature for psychological restoration, environmental attitude, PEB, species' knowledge, life satisfaction and vitality. A mixed-design (the repeated measures) ANOVA examines differences between two or more independent groups over time. The mixed design entails a within-subjects factor (repeated measure) and a between-subjects factor (intervention vs control group) (Field, 2013).

3. The analyses that involved connection to nature, surveyed immediately after children participated in environmental education, were assessed using dependent samples t-tests rather than mixed-design ANOVAs. This was done because the control group did not

complete the connection to nature survey that the intervention group completed, on-site, immediately after participating in environmental education.

4. The effect of the environmental education intervention on the Token experiment was assessed using Chi-squared tests for categorical data (Field, 2013).

5. I also investigated whether the intervention had a differential effect on the test variables depending on children's baseline connection to nature. Moderation occurs when one independent variable affects the direction and/or strength of the relationship between another independent variable and a dependent variable (Baron & Kenny, 1986). Three- or four-step hierarchical regression analyses were used to examine the moderation effects (Jose, 2013a). Significant interactions are presented in a graphical format using ModGraph-I version 3 (Jose, 2013b).

5.4 Results

5.4.1 Environmental education's effect on variables

Before the intervention, there were no significant differences between the intervention and control groups with respect to age (Table 5.1). There were also no significant differences between the intervention and control group with respect to gender ($\chi^2_{(1)} = 0.59$, $p > 0.05$) or ethnicity (NZ European ($\chi^2_{(1)} = 0.59$, $p > 0.05$); Māori ($\chi^2_{(1)} = 0.29$, $p > 0.05$); Pacific Peoples ($\chi^2_{(1)} = 2.44$, $p > 0.05$); Asian ($\chi^2_{(1)} = 0.08$, $p > 0.05$); MELAA ($\chi^2_{(1)} = 0.12$, $p > 0.05$)). However, the intervention group had a higher mean school decile rating than the control group (Table 5.1). The intervention and control group scores for the socio-psychological variables (connection to nature, use of nature for psychological restoration, environmental attitude, species' knowledge, vitality and life satisfaction) were not significantly different before the interventions (Table 5.1).

Mixed-design (repeated measures) ANOVAs with time (pre-intervention and four weeks post intervention) and environmental education versus control group indicated that the interventions did not modify the mean score for most of the variables of interest: connection to nature ($F(1, 255) = 0.005$, $p > 0.05$), use of nature for psychological restoration ($F(1, 255) = 2.52$, $p > 0.05$), environmental attitude ($F(1, 255) = 1.69$, $p > 0.05$), vitality ($F(1, 255) = 0.26$, $p > 0.05$) or life satisfaction ($F(1, 255) = 2.79$, $p > 0.05$) (Figure 5.2, Table 5.2). However, there were increases in children's PEB ($F(1, 255) = 7.87$, $p < 0.05$) and species' knowledge ($F(1, 255) = 3.77$, $p < 0.05$) (Figure 5.2, Table 5.2).

The means for the 151 children who completed all three connection to nature surveys were: before intervention (3.86 ± 0.73 SD), immediately after the intervention (3.84 ± 0.97 SD) and at 4-week re-test (3.87 ± 0.94 SD). A paired-sample t-test showed there was no significant change in the children's connection to nature immediately after environmental education ($t(150) = 0.44$, $p > 0.05$), compared to before the intervention. There was also no significant difference at the 4-week re-test ($t(150) = -0.59$, $p > 0.05$), compared to immediately after the intervention.

Table 5.1 Means for age, school decile and socio-psychological variables before the environmental education intervention for the intervention and control groups. Independent t-tests assessed whether these means were significantly different between groups. Intervention group, $n = 210$; control group, $n = 47$; degrees of freedom = 255. *, $p < 0.05$.

Variable	Group	Mean ± SD	Independent t-test
Age	Intervention	10.70 ± 1.42	$t = 0.76$
	Control	10.53 ± 1.33	
School decile	Intervention	5.80 ± 3.53	$t = 2.61$*
	Control	4.34 ± 3.14	
Connection to nature	Intervention	3.79 ± 0.75	$t = -0.05$
	Control	3.80 ± 0.63	
Psychological restoration	Intervention	3.75 ± 0.87	$t = 1.61$
	Control	3.52 ± 0.86	
Environmental attitude	Intervention	3.94 ± 0.75	$t = -1.06$
	Control	4.06 ± 0.76	
Pro-environmental behaviour	Intervention	3.25 ± 0.92	$t = -0.92$
	Control	3.39 ± 0.74	
Species' knowledge	Intervention	2.44 ± 1.31	$t = 1.11$
	Control	2.21 ± 1.16	
Vitality	Intervention	3.76 ± 0.80	$t = -0.32$
	Control	3.80 ± 0.92	
Life satisfaction	Intervention	4.07 ± 0.73	$t = 1.00$
	Control	3.95 ± 0.84	

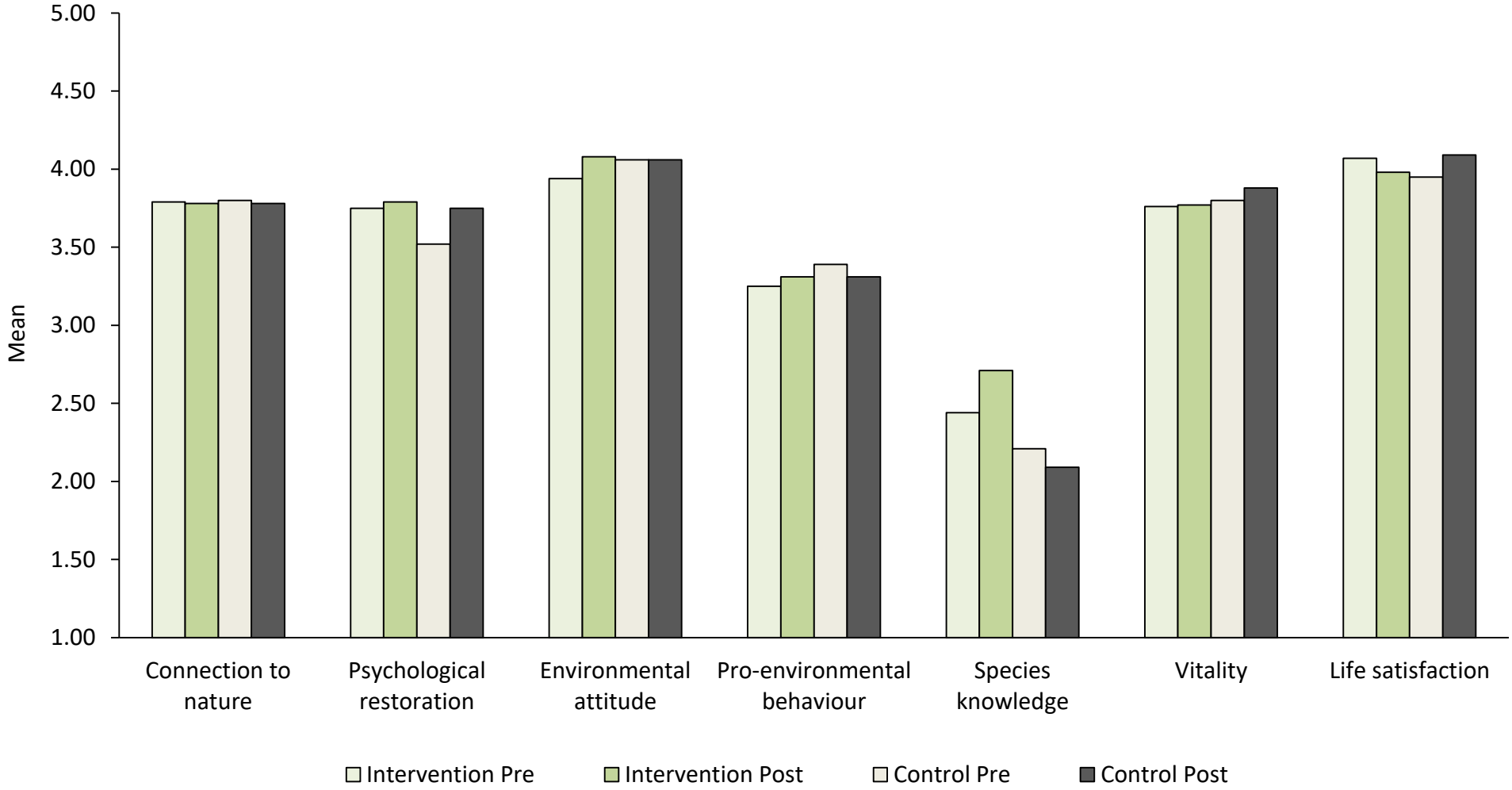


Figure 5.2 Means for the socio-psychological variables before (pre) and four weeks after (post) environmental education for the intervention and control groups. Intervention group, *n* = 210, control group, *n* = 47.

Table 5.2 Means for the variables, before environmental education and at the 4-week re-test, for the intervention and control groups. And results for the mixed design (repeated measures) ANOVAs, with Bonferroni corrected post-hoc tests. $N = 257$. Degrees of freedom = (1, 255). Abbreviations: Pre-EE, before environmental education; Post-EE, 4-week re-test; * $p < 0.05$, **, $p < 0.01$.

Variable	Treatment	Pre-EE Mean ± SD	Post-EE Mean ± SD	ANOVA
Connection to nature	Intervention	3.79 ± 0.75	3.78 ± 0.84	$F = 0.01$
	Control	3.80 ± 0.63	3.78 ± 0.61	
Psychological restoration	Intervention	3.75 ± 0.87	3.79 ± 0.88	$F = 2.52$
	Control	3.52 ± 0.86	3.75 ± 0.80	
Environmental attitude	Intervention	3.94 ± 0.75	4.08 ± 0.73	$F = 1.69$
	Control	4.06 ± 0.76	4.06 ± 0.67	
Pro-environmental behaviour	Intervention	3.25 ± 0.92	3.31 ± 0.87	$F = 7.87$**
	Control	3.39 ± 0.74	3.31 ± 0.78	
Species' knowledge	Intervention	2.44 ± 1.31	2.71 ± 1.30	$F = 3.77$*
	Control	2.21 ± 1.16	2.09 ± 1.12	
Vitality	Intervention	3.76 ± 0.80	3.77 ± 0.84	$F = 0.26$
	Control	3.80 ± 0.92	3.88 ± 0.85	
Life satisfaction	Intervention	4.07 ± 0.73	3.98 ± 0.89	$F = 2.79$
	Control	3.95 ± 0.84	4.09 ± 0.77	

Pro-environmental behaviour: The results of the mixed-design ANOVA (Table 5.2) showed that the environmental education intervention resulted in a significant change in children's PEB (F (1, 255) = 7.87, $p < 0.01$). Pair-wise comparisons, using Bonferroni adjustments, confirm a small, but significant, increase in PEB for the intervention group ($\Delta = 0.06 \pm 0.02$, $p < 0.01$). But the decrease seen in the control group was not significant ($\Delta = -0.074 \pm 0.04$, $p > 0.05$). These findings support the notion that the environmental education interventions can have a positive effect on children's PEB.

Species' knowledge: The environmental education intervention resulted in a significant change in children's species' knowledge (F (1, 255) = 3.77, $p < 0.05$) (Table 5.2). Pair-wise comparisons, using Bonferroni adjustments, confirm a significant increase in species' knowledge for the intervention group ($\Delta = 0.27 \pm 0.09$, $p < 0.01$), but there was no significant change for the control group ($\Delta = -0.13 \pm 0.18$, $p > 0.05$). These findings support the notion that the environmental education interventions can have a positive effect on children's species' knowledge.

5.4.2 Environmental education increased support for conservation

For children who attended environmental education, there were significant post-intervention differences in the distribution of support for conservation, domestic animal care or the children's school ($\chi^2_{(2)} = 11.44$, $p < 0.01$) (Figure 5.3). Compared with the pre-intervention Token experiment, 18 more children supported conservation and 19 fewer children supported the SPCA. Children's support for conservation increased and their support for the SPCA decreased after attending environmental education. In contrast, the distribution of support was the same before and after the time of the environmental education intervention for the control group ($\chi^2_{(2)} = 1.91$, $p > 0.05$).

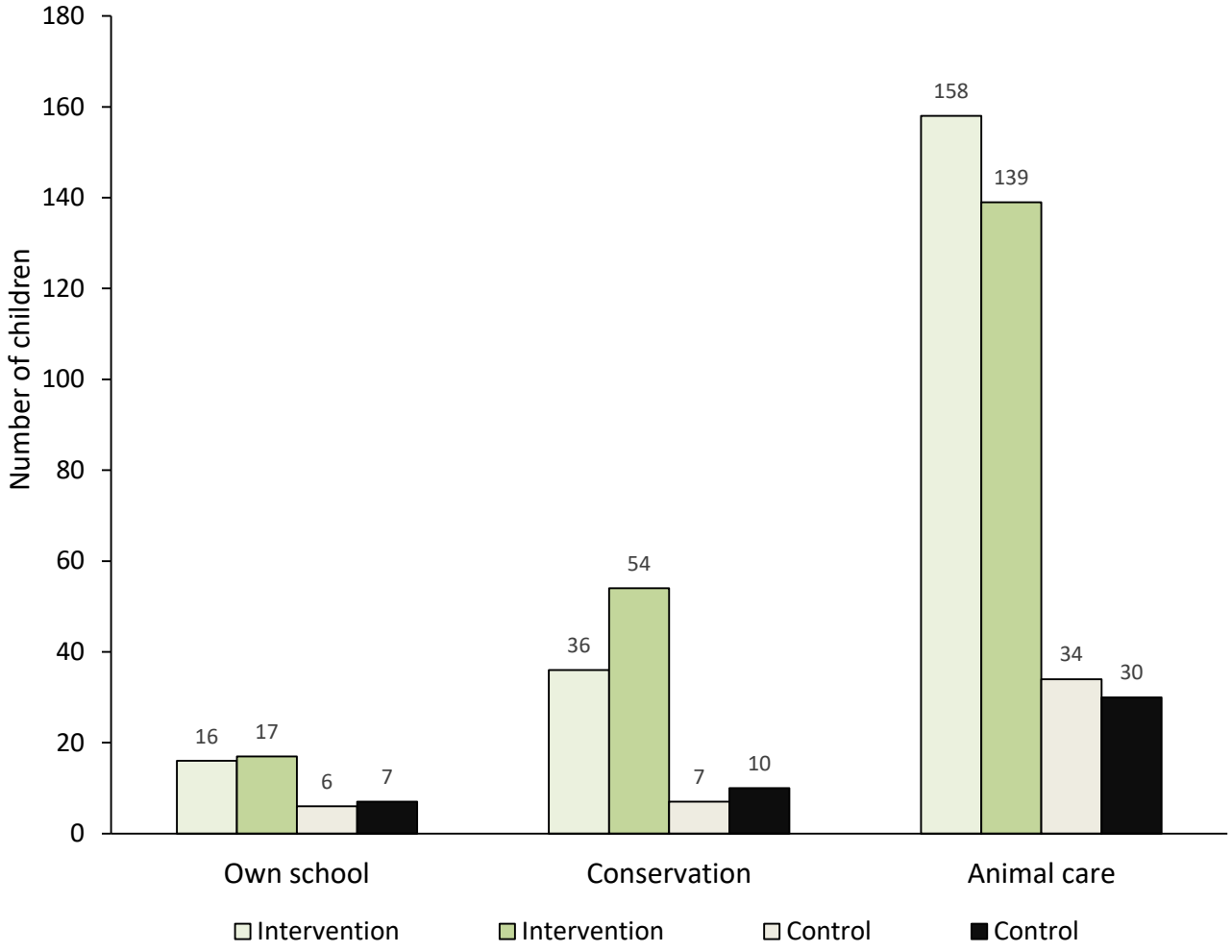


Figure 5.3 Results of the Token experiment showing support for the three causes before environmental education (pre) and at the 4-week re-test (post) for the intervention and control groups. The increased support for conservation and decreased support for animal care seen in the intervention group is statistically significant. Intervention group, *n* = 210; control group, *n* = 47.

The children who participated in environmental education reported greater engagement in PEB, compared with the control group, in behaviours such as water and energy conservation and caring for plants and animals. In addition, the intervention group also increased their financial support for conservation and the children could identify more species correctly.

5.4.3 The differential effect of environmental education

A moderation analysis was conducted to examine whether children's baseline connection to nature moderated the effect of the intervention on the variables of interest.

Children's baseline connection to nature did not moderate the effect of the intervention on the other variables of interest: use of nature for psychological restoration (β = 0.38, t = 1.24, p > 0.05), environmental attitude (β = 0.64, t = 1.91, p > 0.05), pro-environmental behaviour (β = -0.04, t = -0.30, p > 0.05), species' knowledge (β = -0.22, t = -0.64, p > 0.05), vitality (β = 0.40, t = 1.15, p > 0.05) or life satisfaction (β = 0.041, t = 0.03, p > 0.05).

However, children's baseline connection to nature did moderate the effect of the intervention on their connection to nature. Model 3 (Table 5.3) shows that children's connection to nature had a significant positive association with their post-intervention connection to nature (β = 0.53, p < 0.001), and that the intervention had a significant negative effect (β = -0.57, p < 0.05). This was qualified by a significant interaction between children's baseline connection to nature and participating in the environmental education (β = 0.63, p < 0.05) (Table 5.3), which is graphed in Figure 5.4.

The graph for the interaction effect (Figure 5.4) shows the slopes were statistically significant for both the intervention and control groups: β = 0.89 ± 0.12 SE, p < 0.01 and β = 0.58 ± 0.31 SE, p < 0.001, respectively. For the intervention group, the slope was steeper than for the control group; signifying that the change in connection to nature at the 4-week re-test was greater for the intervention group than the control group.

These results indicate that the impact of the intervention on children's connection to nature depended on the level of children's baseline connection to nature. Although significant, the interaction explained only an additional 1% of the variance in children's post-intervention connection to nature. Twenty three percent of children in the intervention group had a high baseline connection to nature (≥ 4.5/5), and 16.3% a low baseline connection to nature (≤3/5).

Table 5.3 Regression analysis testing whether baseline connection to nature (Connection 1) moderated the effect of environmental education on the dependent variable, children's connection to nature after environmental education. Abbreviations: IV = Independent variable, β = standardised regression coefficient. * $p < 0.05$; ** $p < 0.001$.

Model	IV	ΔR^2	β	*t*
1	Connection 1	0.59**	0.77	19.25**
2	Connection 1	0.00	0.77	19.21**
	Intervention or control		0.002	0.06
3	Connection 1	0.009*	0.53	4.89**
	Intervention or control		-0.57	-2.41*
	Connection 1 x Intervention or control		0.63	2.45*

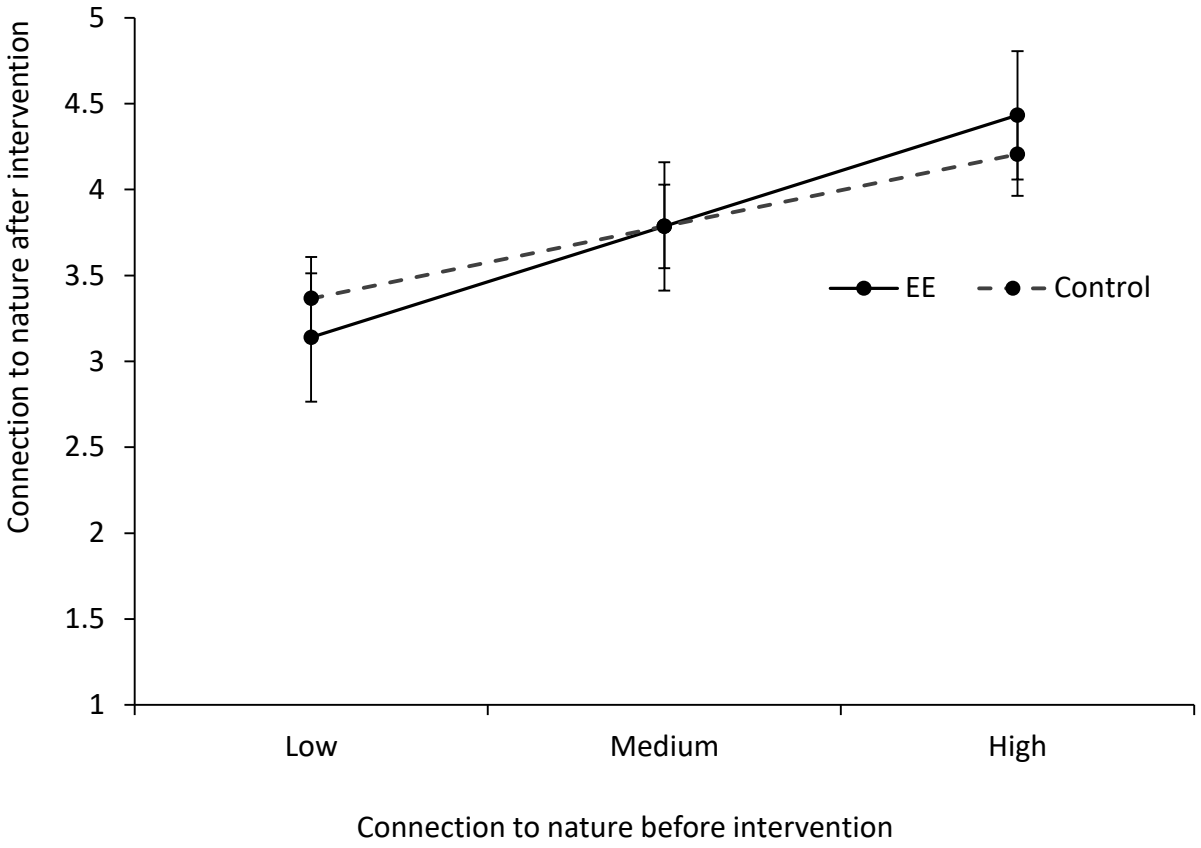


Figure 5.4 The differential effect of environmental education on children's connection to nature, depending on their baseline connection to nature. Error bars = ± 1 SE.

5.5 Discussion

Connecting children to nature is a critical outcome for nature-based environmental education because it can motivate their engagement in PEB (Frantz & Mayer, 2014; Giusti et al., 2018; Zylstra et al., 2014). Contrary to my hypothesis, based on the literature, I found that environmental education interventions had no significant effect on children's affective connection to nature either immediately after the intervention or at the 4-week re-test. However, this provides only part of the picture. The effect of environmental education depended on children's connection to nature before they attended the programme. The field-trips only increased the connection to nature of children with the highest pre-existing level of connection to nature. There was no significant change in children's environmental attitude, use of nature for psychological restoration, vitality or life satisfaction. However, as expected, there was an increase in children's self-reported PEB, observed support for conservation and species' knowledge after environmental education. Thus, environmental education programmes successfully promoted children's engagement in PEBs, and increased their knowledge, but had a limited influence on their affective connection to nature. This is of concern because connection to nature is positively associated with engagement in PEB and wellbeing (Capaldi et al., 2014; Whitburn et al., 2019), and these programmes stated that they increase children's connection to nature.

5.5.1 Environmental education and children's connection to nature

It would be remarkable if short-term interventions involving a single half-day event, such as those investigated in this research, could have a measurably positive impact on children's connection to nature. Although connection to nature is thought to be malleable in children (Chawla, 2007; Tseng & Wang, 2019; Wells & Lekies, 2006), repeated and long-term exposures may be required to achieve sustained improvements (Schultz & Tabanico, 2007; Stern et al., 2008). Nonetheless, some studies have observed increases in children's and teenagers' connection to nature after short-term interventions (Kossack & Bogner, 2012; Liefländer et al., 2013; Sellmann & Bogner, 2013). Programmes of longer duration have also found increases in children's connection to nature (Barthel, Belton, Raymond, & Giusti, 2018; Collado et al., 2013). These gains in connection to nature can persist for up to two years, but may be lost over shorter time frames (Stern et al., 2008).

In my research, children's affective connection to nature did not change immediately after environmental education, nor at the 4-week re-test. These findings are in line with some researchers and in contrast with others. Ernst and Theimer (2011) also used the Connection to Nature Index to measure connection to nature and found no measurable change over seven environmental education programmes. A qualitative study, that coded children's responses in line with the three dimensions of the Connection to Nature Index, reported increases in children's connection to nature both immediately after environmental education and two years later (Barthel et al., 2018). Collado and her colleagues (2013) reported an increase in children's affective connection to nature (measured as Emotional Affinity Toward Nature) immediately after environmental education, but they did not re-test the children to determine whether this increase was retained in the medium- to long-term. Researchers, who have used the cognitive Inclusion of Nature in Self scale, consistently report gains in connection to nature after environmental education (Braun & Dierkes, 2017; Kossack & Bogner, 2012; Liefländer et al., 2013; Sellmann & Bogner, 2013), whereas researchers using affective scales have produced inconsistent results.

This suggests that environmental education programmes may be more effective in influencing the way children think about their relationship with nature rather than influencing how they feel about it. Environmental education programmes are typically oriented towards cognitive learning (Eilam & Trop, 2012; Heimlich, 2010; Pooley & O'Connor, 2000; Rickinson, 2001), and the programmes in my study were expected to meet academic curriculum guidelines. Knowledge-based activities may not increase children's affective connection to nature (Lumber, Richardson, & Sheffield, 2017). Targeting children's cognitive rather than affective faculties may have important consequences for their engagement in PEB. Affective attitudes, such as connection to nature, which are formed through direct experiences, are thought to have a stronger attitude-behaviour consistency than cognitive attitudes (Millar & Millar, 1996). This is evident in connection to nature research. Affective, connection to nature scales have a stronger correlation with PEB than cognitive scales (Tam, 2013a; Whitburn et al., 2019).

One of the main objectives of most environmental programmes is to motivate children's PEB; therefore, promoting their affective connection to nature may be an effective lever to motivate PEB. The paucity of programmes purposefully designed to promote children's affective connection to nature might partially explain why there remains a gap between possessing

environmental knowledge and holding eco-centric environmental attitudes and actual engagement in PEB (Jurin & Fortner, 2002; Kollmuss & Agyeman, 2002) – people may not be emotionally invested enough to act.

The inconsistences, revealed by my work and that of other researchers, means we cannot be confident that environmental education field-trips, such as those investigated here, can promote children's connection to nature at this time. First, there are only a few studies. Second, researchers generally measure connection to nature immediately after an intervention (Collado et al., 2013; Ernst & Theimer, 2011). Therefore, we do not know whether these increases will persist. Third, researchers have used different scales to measure children's connection to nature, which can make it difficult to integrate the results of different studies (Tam, 2013a). For example, Bragg et al. (2013) showed the level of children's connection to nature varied, depending on the scale used to measure it. In addition, the presence or absence of significant effects from environmental education interventions can depend on the scale used to measure connection to nature (Ernst & Theimer, 2011). The current body of research raises doubts about the general efficacy of environmental education in strengthening children's connection to nature, especially their affective connection to nature, and makes it clear that much more evaluative research is needed.

I found that environmental education had a differential effect on children's connection to nature, depending on their connection to nature before they attended the programmes. This is an important finding because it has implications for who benefits from environmental education and it could inform the design of environmental education programmes. In contrast to other researchers (Braun & Dierkes, 2017; Kossack & Bogner, 2012), I found that when children's baseline connection to nature was relatively high, participation in environmental education was associated with an increase in their connection to nature. But when children's baseline connection to nature was relatively low, participation in environmental education resulted in a decrease in their connection to nature, compared with the control group.

The children in my study with a low baseline connection to nature, and presumably less experience in nature, may have found exploring forest tracks or snorkelling in the ocean a new experience. This may have aroused feelings of discomfort or anxiety that impacted their enjoyment and, in turn, may have negatively influenced their connection to nature (Kossack & Bogner, 2012). However, children with a strong connection to nature, who are more familiar with

the natural environment, may be more interested in and may more easily integrate, new nature experiences (Cheng & Monroe, 2012; Collado et al., 2013). The strength of a personal connection to nature shapes how opportunities, such as environmental education are perceived and experienced (Bell et al., 2014). Alternatively, a low baseline connection to nature may reflect a low level of interest in nature, as this does vary among children (Gill, 2014; Rickinson, 2001). This lack of interest in nature may manifest itself as a lack of interest in environmental education, which may help explain the outcomes in this study. Further research is necessary to clarify the nature of the differential effects of environmental education and how to take account of these differences when designing and implementing environmental education interventions.

It is possible the Connection to Nature Index was not able to detect increases in children's connection to nature because of a ceiling effect. Other researchers have cited this as a possible explanation for their inability to detect change in connection to nature after environmental education interventions (Ernst & Theimer, 2011; Kossack & Bogner, 2012). A ceiling effect occurs when scores cluster towards the high end of a scale, and the survey instrument is unable to distinguish change in individuals who score at the higher end of the scale (Garin, 2014). If 15 - 20% of respondents achieve the highest score, a ceiling effect is likely (Garin, 2014). In my study, the mean connection to nature score before the interventions was relatively high (3.81 ± 0.73), on a 5-point Likert scale, and 21.8% of the children had an intial connection to nature score of ≥ 4.5. Although this may indicate a ceiling effect according to Garin (2014), the Connection to Nature Index was able to detect increases in children with the highest baseline score. Therefore, I do not think the ceiling effect explains why I did not detect an increase in connection to nature scores across the whole sample.

5.5.2 PEB, support for conservation and knowledge

The environmental education interventions I investigated had a positive effect on children's PEB, including their support for conservation (as per the Token experiment). The 2.8 – 4.1% increase in every-day PEBs may appear small, but the observed support for conservation increased by 50%. These gains were achieved by just a half-day intervention and demonstrate that short-duration education programmes can increase children's PEB. My findings are generally in line with reviews which report environmental education can increase children's PEB (Leeming et al., 1993; Rickinson, 2001; Stern et al., 2014; Zelezny, 1999). Collado et al., (2013) reported larger

increases in children's willingness to engage in daily conservation or environmental citizenship actions after attending summer camps compared to the self-reported behaviour found in my research. The stronger effect could be because the summer camps were of a longer duration (one to two weeks) than the interventions I investigated. However, measuring a willingness or intention to engage in PEB is not the same as measuring self-reported PEB. Although intention (or willingness) is the immediate antecedent of behaviour in some models (Ajzen, 1991), there is only a moderate correlation between behavioural intentions and behaviour (Bamberg & Moser, 2007; Grimmer & Miles, 2017).

Children's initial species' knowledge was low (mean = 2.44 out of 7), but increased after environmental education. The children could correctly identify more animal species that they may have encountered during the interventions. This is in line with other researchers who generally report an increase in ecological or science knowledge after nature-based environmental education (Liefländer, Bogner, Kibbe, & Kaiser, 2015; Stern et al., 2008). Although this type of knowledge was not associated with PEB in Chapter 4, it can motivate the acquisition of action-related knowledge (Frick et al., 2004), and also build empathy (Kaiser, Roczen, & Bogner, 2008, in Roczen et al., 2014). Both of these concepts are associated with engagement in conservation and every-day PEBs (Collado & Evans, 2019; Liefländer et al., 2015; Roczen et al., 2014; Tam, 2013b).

It is unclear whether the gains in PEB and support for conservation found in this study will persist beyond the 4-week retest without the concurrent enhancement of children's connection to nature. In chapter 4, I found a strong correlation between children's connection to nature and their engagement in PEB. However, only children with a high baseline connection to nature increased in their connection to nature after environmental education. PEB can be influenced by a number of factors other than connection to nature, such as moral and social norms, problem awareness, knowing which actions can be effective (Steg & Vlek, 2009) and exposure to nature (Cheng & Monroe, 2012; Collado, Corraliza, et al., 2015). But the associations between these variables and engagement in PEB are much lower than the association I found between connection to nature and PEB. If a stronger connection to nature leads to greater engagement in PEB as correlational studies suggest (Whitburn et al., 2019), any gains in PEB and support for conservation may not last. But if having an adequate level of connection to nature establishes the

necessary condition for a favourable response to requests for PEB (Mayer & Frantz, 2004), the gains may persist.

5.5.3 Environmental attitude and wellbeing

There was no significant change in children's environmental attitude after environmental education. Reviews of the subject generally report that environmental education has a positive effect on children's environmental attitude (Leeming et al., 1993; Rickinson, 2001; Zelezny, 1999). My findings are also at odds with research that reports increases in children's environmental attitude after participating in nature-based environmental education (Collado et al., 2013; Evans, Juen, et al., 2007; Genc et al., 2018; Johnson & Manoli, 2010; Liefländer & Bogner, 2014; Schmitz & da Rocha, 2018; Sellmann & Bogner, 2013).

Intervention studies that reported increases in children's environmental attitude after environmental education were generally of a longer duration (three days to two weeks) than those I investigated. Although attitudes are open to change, they are generally stable over time (Eagly & Chaiken, 1993). Half-day interventions may not be long enough to promote a measurable change in children's environmental attitude. In addition, children's environmental attitudes and values can be influenced by parents, peers or other important people in their lives (Cheng & Monroe, 2012; Collado et al., 2017; Evans et al., 2018; Negev et al., 2008). A short, half-day intervention probably cannot offset the influence of parents and peers. How social relationships affect children's environmental attitudes and how this changes as they mature is worthy of further research.

Environmental education had no significant impact on children's use of nature for psychological restoration, vitality or life satisfaction. Environmental education programmes, similar to the ones I investigated, do not generally evaluate their impact on children's psychological wellbeing, although increased self-esteem has been a reported benefit (Dresner & Gill, 1994). Outdoor education or wilderness-type programmes have demonstrated improvements in children's self-concept, self-confidence or locus of control (Gustafsson, Szczepanski, Nelson, & Gustafsson, 2011; Neill & Richards, 1998). The inability to measure any increase in children's life satisfaction or vitality may be because children (like adults) do not realise the beneficial effect

nature has on their psychological wellbeing (Nisbet & Zelenski, 2011) or possibly the interventions were not long enough to have a measurable effect.

5.5.4 Fostering affective connection to nature

The environmental education programmes in my research had little success in promoting children's affective connection to nature. Strengthening connection to nature is important because of its strong positive association with PEB and wellbeing (Chapters 3 and 4). The affective domain has long been acknowledged as an important part of environmental education (Iozzi, 1989; Pooley & O'Connor, 2000; Sobel, 2012; Stern et al., 2014). However, connection to nature is largely absent from empirical studies and designs for environmental education programmes (Stern et al., 2014). If it is considered, promoting connection to nature is often presumed to be an outcome of simply being in nature. However, whether a nature experience positively influences a child's connection to nature is also related to the qualities and duration of the experience (Chawla & Cushing, 2007; Collado, Corraliza, et al., 2015).

Environmental education that aims to promote children's affective connection to nature could incorporate experiences that are firstly enjoyable and allow for free play and hands-on exploration (Gill, 2014; Giusti et al., 2018). They could also involve private experiences in nature such as sitting still in quietness (Braun & Dierkes, 2017), and appreciative activities that foster a love for nature (Chawla & Cushing, 2007; Sobel, 2008; Wells & Lekies, 2006). These direct experiences with nature should activate the senses (Giusti et al., 2018; Kellert, 2002) and evoke emotional responses such as awe, wonder, an appreciation of nature's beauty, joy or fascination (Bartlett, 2008; Braun & Dierkes, 2017; Zhang et al., 2014). Examples of these types of experiences include leading children barefooted and blindfolded through shallow water (Liefländer et al., 2013), climbing trees or sensory walks designed to stimulate their sense of sight, smell, hearing and touch.

These nature experiences can develop abilities related to children's connection to nature. Such abilities begin with feeling comfortable in nature, and with natural processes (such as rain, sun or mud) and build toward caring about and taking care of nature and ultimately feeling one with nature (Giusti et al., 2018). In contrast, environmental education that does not allow children to directly engage with elements of nature, perhaps by being told not to touch or keep on the

path, or that is unenjoyable, too information heavy or evokes negative emotions can increase children's alienation from nature and is unlikely to strengthen their connection to nature (Bergman, 2016; Kossack & Bogner, 2012; Larson, Whiting, & Green, 2011; Sobel, 2012).

5.5.5 Limitations

There are some limitations in my research. The bulk of my data is based on self-reports. Self-report can create a threat to construct validity and lead to mono-method bias. The token experiment measured an observed PEB. Measuring an observed behaviour alongside self-reported behaviour is a strength of my research. Both self-reported PEB and observed support for conservation increased after environmental education which suggests that (at least with respect to PEB) self-report is not inflating the results of environmental education.

My research avoided many of the other methodological weaknesses apparent in research evaluating environmental education programmes (Zelezny, 1999). I included a control group, established pre-intervention equivalence of groups, performed pre- and post-testing of variables, and had good construct reliability. In addition, I measured an observed behaviour alongside self-reported PEB and designed a booth to help minimise the effect of social desirability bias.

An aspect of longitudinal experiments that can affect the results is attrition. Attrition could be a problem if there were systematic differences between the children who dropped out of my study and those who did not (Abrahamse, 2016). This research had a 79.3% retention rate. There was some attrition from all but one class. However, a quarter of the children who did not complete the post-intervention survey came from one school and they attended a sport's day on the same day as the 4-week re-test. Although these children did not self-select to drop out of the survey, children who participated in playing sport could be systematically different from those who did not. They may enjoy the outdoors more and, therefore, may have enjoyed and benefitted more from environmental education than children who did not participate in sport. The levels of connection to nature and engagement in PEB did not differ significantly for children who dropped out of my study compared with children who completed both surveys. Therefore, the outcomes of this research may not have been very different had these children been retained.

The control group contained classes from only three of the eight schools which participated in my study. Ideally, I would have recruited classes from each school. One of biggest

challenges in this kind of research is getting participation by intervention and control groups (Bergman, 2016). Selection bias can occur in non-randomised experiments if the control and intervention groups have systematic differences in their baseline characteristics (Peacock & Peacock, 2011). In addition there could be systematic differences between schools that are not reflected in the control group. There were no significant baseline differences between the intervention and control groups with respect to most demographics and all the socio-psychological factors. In addition, less than 5.0% and 0% of the variance in outcome variables PEB and vitality respectively could be attributed to differences between schools. Therefore, the control group would allow a reasonable comparison with the intervention group.

5.5.6 Future work

There is a need to understand and evaluate the characteristics of environmental education programmes that drive positive outcomes in relation to children's affective connection to nature. These may include characteristics of the programmes, the educators or the environment in which they are held (Stern et al., 2014). In addition, tools that promote connection to nature need to be developed for teachers and environmental educators (Bergman, 2016).

In Wellington, primary school-aged children attend environmental education offered by non-government organisations only once or twice per year. Meanwhile, their connection to nature develops and progresses over time through a variety of nature experiences (Bergman, 2016; Giusti et al., 2018). It would be useful to establish continuity in interventions aimed to promote connection to nature over time and across environmental education providers. A proposed framework has been developed to assess where and how children connect with nature (Giusti et al., 2018) and it could be applied to environmental education interventions. Key qualities of the framework have been successfully employed in a creative nature-based play intervention (Beer et al., 2018). This framework could be strategically implemented and evaluated across environmental education providers in Wellington and in other regions nationally or internationally.

Broad implementation of such a framework would necessitate partnerships between environmental education practitioners and researchers. Partnerships are necessary because researchers are not always aware of the practical considerations facing practitioners, such as time

limitations and expectations from schools. In addition, practitioners may have limited access to primary research and limited time and perhaps the skills to integrate the findings into their programmes (Monroe, 2003). Networks such as Wellington Region Environmental Educators Forum or national organisations such as the New Zealand Association for Environmental Education are ideal places to promote such initiatives. Implementation of a regional framework to increase children's connection to nature as part of environmental education could benefit both the environment and perhaps children's psychological wellbeing.

5.6 Conclusion

This research extends the small body of literature that has examined the effect of environmental education on children's connection to nature. In particular, my work demonstrates that nature-based environmental education did not increase children's mean affective connection to nature. However, I did find that environmental education had a differential effect on children's connection to nature depending on their baseline level of connection to nature. The field-trips only increased the connection to nature of children with the highest pre-existing level of connection to nature. I have demonstrated that children's species' knowledge, engagement in PEB and support for conservation increased after environmental education. It is remarkable that such short-term interventions can have a measurable difference and my findings support the work environmental educators are doing. However, with respect to connection to nature, the positive effect of environmental education is not ubiquitous and education programmes may need to consider the needs of children with different baseline levels of connection to nature.

The existing body of research raises doubts about the ability of these type of environmental education interventions to promote children's affective connection to nature. Opportunities and activities that encourage the development of an emotional bond with nature may be missing from nature-based environmental education programmes. This matters because children's affective connection to nature has a strong positive association with their engagement in PEB. Direct experiences with nature that are enjoyable, allow free play and hands-on exploration and evoke a positive emotional response may facilitate the development of their connection to nature (Chawla & Cushing, 2007; Giusti et al., 2018). Future research could focus on

enhancing aspects of environmental education programmes, such as programmes design, characteristics of educators and aspects of the natural environment, which can strengthen children's connection to nature. My study also highlights the importance of rigorous assessment of environmental education interventions, because the outcomes are not always what providers might expect. This future work will require collaborations between environmental education practitioners and researchers to continue to develop children's environmental literacy and connection to nature, with the ultimate goal of achieving more sustainable lifestyles and support for conservation.

Chapter 6: General discussion

There is increasing interest in the human relationship with nature, in particular connection to nature. Connection to nature is positively associated with benefits to human health (Capaldi et al., 2014; Mayer & Frantz, 2004; Wolsko & Lindberg, 2013; Zelenski & Nisbet, 2012) and greater support for conservation and engagement in every-day pro-environmental behaviours (PEB) (Brügger et al., 2011; Mayer & Frantz, 2004; Nisbet & Zelenski, 2013; Tam, 2013a; Whitburn et al., 2019). However, there is little empirical research that investigates children's connection to nature and how it is related to their psychological wellbeing or engagement in PEB. There is also concern that children are becoming increasingly disconnected from nature (Louv, 2008; Pyle, 2003) and that this might have negative consequences for their physical and psychological wellbeing. Further, a disconnection from nature might cause children to care less for nature and natural environments (Louv, 2008; Pyle, 2003; Soga et al., 2018). Environmental education, that takes place in a natural environment is now being considered as a means to reconnect children to nature (Frantz & Mayer, 2014). However, a lack of evaluation studies makes it unclear whether environmental education can consistently promote children's connection to nature. This research was undertaken to address these specific knowledge gaps within the literature. It provides evidence about the central importance of connection to nature to children's wellbeing and as a motivator of PEB. My work contributes to the global literature on connection to nature, offers a methodological contribution and provides tests of theoretical models.

Each of the four data chapters is presented as a single study, but they form a cohesive narrative. This final chapter summarises the unique contributions this research makes to the existing body of knowledge in this area. First, I reviewed, via meta-analysis, the existing literature that had examined the relationship between connection to nature and PEB. I then investigated how children's relationship with nature, in particular their connection to nature, was associated with their psychological wellbeing and their engagement in PEB. Having demonstrated positive associations, I undertook a longitudinal field experiment to determine whether nature-based environmental education could promote children's connection to nature and their engagement in PEB. In this chapter I summarise my key findings and discuss their implications and the contributions of this thesis. Finally, I reflect on some aspects of my research and make key recommendations for environmental education and future research.

6.1 Summary of research

Study 1, Chapter 2. (Published as, Whitburn et al., 2019). This study reports the first quantitative summary of the existing research on the relationship between connection to nature and PEB. This meta-analysis showed there was a moderate-sized, positive association between an individual's connection to nature and their engagement in PEB, and that the relationship was ubiquitous. This supports the theory that a connection to nature is a crucial antecedent to engagement in PEB (Clayton, 2003; Mayer & Frantz, 2004; Roszak, 1995; Schultz, 2002). This meta-analysis provided a foundation for the subsequent investigation of this relationship in children and the evaluation of environmental education programmes. A second finding was that the scales used to measure both connection to nature and PEB moderated the strength of the relationship. In particular, scales that contain items measuring an affective connection to nature, and that had a moderate number of items, had a stronger relationship with PEB compared with scales with purely cognitive items. This study highlights the significance of affective connection to nature as a motivator for PEB.

Study 2, Chapter 3. The *Wellbeing* model, validated the theoretical stance that connection to nature is positively associated with human wellbeing. Although this is becoming well established in adults (Capaldi et al., 2014; Mayer & Frantz, 2004; Wolsko & Lindberg, 2013; Zelenski & Nisbet, 2012), only few have investigated this in children (Richardson et al., 2015; Whitten et al., 2018). A structural equation model demonstrated that children's connection to nature was positively associated with their vitality, but not their life satisfaction. This suggests that connection to nature may be more closely aligned with eudaemonic rather than hedonic wellbeing (Pritchard et al., 2019). The model also suggests that psychologically restorative experiences in nature, which come automatically upon exposure to natural settings, can strengthen children's connection to nature.

Experiences in nature that develop a strong connection to nature and are psychologically restorative may be protective factors that promote resilience, even for the most at risk children. Nurturing children's connection to nature through providing restorative natural environments, especially in cities, and motivating children's use of them may play a role in supporting their psychological functioning in a childhood that is increasingly technological, competitive and stressful.

Study 3, Chapter 4. In this study I tested the theory that children's connection to nature is positively associated with their engagement in PEB. A structural equation model showed that children's connection to nature explained nearly 70% of their reported greater engagement in PEBs, such as water and energy conservation, encouraging friends not to litter and caring for wildlife. This substantiated previous research (Cheng & Monroe, 2012; Collado, Corraliza, et al., 2015; Otto & Pensini, 2017). I extended previous research to demonstrate that children's affective connection to nature was more strongly related to their engagement in PEB than their use of nature for psychological restoration and environmental attitude. In addition, environmental attitude and gaining psychologically from nature are related to children's engagement in PEB, but only to the extent that a child also embraces an affective connection to nature. Individual differences in connection to nature may help explain why some children behave more pro-environmentally than others, even when they report strong environmental attitudes. These findings can inform the development of interventions to increase children's connection to nature, and (assuming the correlational relationship represents a causative one), in turn, their engagement in PEB.

I found that that environmental attitude was not associated with PEB in younger children. This supports the stance that experiencing and building an emotional connection to nature is most important for young children and is a pre-requisite to intellectual learning (Carson, 1965; Kellert, 2002). Younger children should be encouraged to love nature before they are educated about environmental issues and expected to respond to or mitigate these issues (Sobel, 1996).

Study 4, Chapter 5. Non-government environmental organisations play a key role in delivering environmental education to children and strengthening their connection to nature. This is especially important in New Zealand where there is considerable variation in the environmental education available in schools (Eames et al., 2008). My longitudinal, field experiment demonstrated that, contrary to expectations based on the literature, environmental education did not promote affective connection to nature in most children. Only children with a high baseline connection to nature increased their connection to nature after participating in environmental education. Participation in environmental education did, however, increase children's conservation and self-reported PEB and species' knowledge. This raises an important question: if the positive correlational relationship between connection to nature and PEB demonstrated in the

Chapter 4 is causative, how long will changes in the children's behaviour persist without any concomitant increase in their connection to nature? These findings complement the work of other researchers who have measured the effect of environmental education on children's cognitive connection to nature (Braun & Dierkes, 2017; Kossack & Bogner, 2012; Liefländer et al., 2013; Sellmann & Bogner, 2013). Environmental education appears to be more effective in promoting children's cognitive connection to nature than their affective connection to nature. The current research raises doubts about the general efficacy of environmental education in strengthening children's affective connection to nature, and makes it clear that much more evaluative research is needed.

My thesis supports the assertion that the wellbeing of humans is intimately tied to the health of planet earth (Diaz, Fargione, Chapin, & Tilman, 2006; Nelson, Prescott, Logan, & Bland, 2019). An adjustment in our relationship with nature is required that embraces "a fundamental redefinition of our human identity… [to remember] a sense of our primal at-one-ment with the created world" (Tacey, 2000 p. 163). This may help address the interconnected challenges of our time that include biodiversity loss and environmental degradation and the rise of life-style related illnesses prevalent in cities (Jordan, 2009; Nelson et al., 2019). Strengthening an individual's connection to nature may provide an enduring motivation for PEB and at the same time benefit aspects of human wellbeing.

My research will contribute to future programme development in environmental education that aims to promote children's connection to nature and their engagement in PEB. My research is relevant to mental health professionals, teachers and caregivers who desire to promote children's psychological wellbeing, in that nature can be used as a health resource. My findings have implications both in New Zealand and internationally for urban design and local and national government policies around greening urban areas. In particular, they are relevant for policies that integrate biodiversity protection and human wellbeing such as the New Zealand Biodiversity Action Plan (Department of Conservation, 2000), which is currently being revised to guide conservation for the next 50 years, Wellington City Council's Biodiversity Action Plan (Wellington City Council, 2007) and Zealandia's Living with Nature: Tiaki Taiao, Tiaki Tangata

Strategy (Zealandia, 2016). I have made a contribution to the broader field of environmental psychology. Although there has been significant research on connection to nature (Brügger et al., 2011; Mayer & Frantz, 2004; Nisbet & Zelenski, 2013; Tam, 2013a), very little of this work has involved children (Bragg et al., 2013; Cheng & Monroe, 2012; Collado et al., 2013; Otto & Pensini, 2017).

6.2 Reflections on the study design & analyses

In writing this final chapter and reflecting on my work several thoughts are worth noting.

6.2.1 Defining nature

If I were to repeat this research I would include an opportunity for children to give me their perspective on nature. 'Nature' was not specifically defined in the survey itself or when I administered the survey. I told the children that nature was whatever it meant to them, but I did not know what memories, images or understanding of nature they were drawing on. It could vary from what might be called pristine nature, such as a visiting national parks, or the nature they find in highly modifield urban environments around their own homes and schools where they regularly play. Whatever 'nature' represents to the children could impact their experience of environmental education because the nature they encounter when attending environmental education may be quite different from their pre-existing images.

As in my work, 'nature' is not generally defined in connection to nature research; rather it is broad and ambiguous (Ives et al., 2017). This may be partly because the defintion of nature is contested in the literature (Hartig et al., 2014; Vining, Merrick, & Price, 2008) and 'nature' can be culturally or personally defined both in adults and children (Bratman et al., 2012; Collado, Íñiguez-Rueda, & Corraliza, 2016). However, without defining the charateristcs of nature that children connect to, it is difficult to develop interventions and policies to promote their connection to nature (Buijs, 2009; Keulartz, van der Windt, & Swart, 2004).

6.2.2 Survey

There are of course some limitations around using self-report surveys in primary aged children. However, it is appropriate to survey children this age group because they generally have

acquired a standard language and reading skills required to understand and answer the written questions (Borgers et al., 2000). This being said, the questions need to be clear. The reverse scored items in my survey were a source of confusion for many children. When these items were subjected to factor analysis they did not load on the expected factors. This was particularly evident in the children's version of the New Ecological Paradigm scale which contained four reverse scored questions. The questions could be rephrased in future studies to improve the robustness of the construct. Using reverse scored items may not be advisable to use with this age group (Borgers et al., 2000).

I would make changes to the Token experiment. The children's response to the Token experiment was heavily skewed towards support for the SPCA, represented by the Labrador dog. The children voiced how much they loved animals, especially dogs, or talked about their own dog when they donated their token. Dogs are very much part of children's lives compared to other species in the Token experiment. I could have selected a less polarising choice. However, children's support for kākā (forest parrot) or tuna (long-finned eel) increased when they had face-to-face experiences with the animals and learnt about their ecology, vulnerability to predators and what actions they could help mitigate this risk as part of environmental education.

6.2.3 Review of methodology

The methods chosen for this research were driven by the research questions. These questions required a quantitative approach because I was interested in the strength of the relationships between variables and the amount of change achieved from the environmental education interventions (Steg et al., 2013). Quantitative methods are especially useful if the goal of the research is to predict outcomes or design interventions (Steg et al., 2013).

Quantitative research methods use controlled, objective testing, large samples and work to control bias in the research process. The results obtained using quantitative methods, such as the self-report survey or field experiment used in my research, are replicable and can be generalizable to the general population or sub-group of a population (Rhaman, 2016, Steg et al., 2013). In contrast, qualitative approaches, such face-to-face interviews or open-ended survey questions, provide insight into how people's reality is shaped and maintained, or how they interpret their actions (Blaikie, 2007). A qualitative approach could be used to provide additional insight into how

children interpret the survey questions and what they meant by their responses. For example, face-to-face interviews could be useful to inform a revision of the New Ecological Paradigm (NEP) scale, used to measure children's environmental attitude (Manoli et al., 2007).

The children's version of the NEP scale may not adequately measure the construct it is supposed to represent. When I subjected the items of this scale to factor analysis, they did not load on the expected factors. The factors of the NEP scale vary in different groups of children (Corraliza et al., 2013; Manoli et al., 2007; an Petegem & Blieck, 2006). This suggests children's understanding of the individual questions may also vary from group to group (Kopnina, 2011). Interviews with children could clarify how they interpreted the questions and what they meant by their answers and thus help to develop a more robust scale.

6.2.4 Advantages and challenges of working with schools

I recruited children for my research through class teachers, after a referral from the environmental education provider. The advantages of recruiting children through schools include (i) access to a large number of diverse participants from the target population (children in school years 5 – 8) (Alibali & Nathan, 2010; Mishna, Muskat, & Cook, 2012); (ii) a high retention of participants (Bartlett et al., 2017), because in my research the children completed the survey in their classroom during school time and (iii) providing legitimacy for my research which may have facilitated the parental consent process (Bruzzese, Gallagher, McCann-Doyle, Reiss, & Wuetunga, 2009).

Having said this, recruitment was probably the greatest challenge in my research. Recruitment is a common challenge in this area of research (Bergman, 2016). Recruiting classes to participate in this research was time-consuming and required the cultivation of positive relationships with environmental education organisations and their educators and school staff, especially the class teachers (Powers, 2007). However, once these relationships were established, the teachers often introduced me to the wider school community to share my research project, which increased the visibility of my research and helped in additional recruitment. I did achieve an acceptable sample size needed to obtain reasonable stability in the parameter estimates using structural equation models and the other statistical analyses (Field, 2013; Kline, 2005).

I had the most difficulty with getting control classes to complete the second connection to nature survey on the same day as the intervention classes attended environmental education. On reflection, I could have employed the help of an assistant to implement the survey in the control classes, while I was administering the survey with the intervention group. This, unfortunately, affected the usefulness of that part of my data. Even though the intervention class did not show increase in connection to nature immediately after the programmes, I did not know whether this was also the case for the children in the control group.

6.2.5 Methodological contributions

My research avoided many of the methodological weaknesses apparent in research evaluating environmental education programmes interventions (Zelezny, 1999). I included a control group, established pre-intervention equivalence of groups, used pre-post testing and had good construct reliability. I also included an observed PEB (Token experiment) alongside the self-report survey. In addition, I tested whether the nested nature of the dataset had a significant effect on the relationships between the explanatory and dependent variables used in my models (Chapter 3 and 4). The booth used in the Token experiment helped to minimise peer pressure, by providing privacy for children to spend their token, and thus helped reduce any social-desirability bias in that experiment.

Passive parental consent aided recruitment

When I first began data collection I used an active, or opt in, consent process which required parents to return the consent form regardless of whether they allowed their child to participate or not. I had a low return rate of consent forms using this method, which is a common obstacle working with schools (Coyne, 2010). A large percentage of parents do not return consent forms because they lack the time or motivation to respond and not because that they do not wish their child to participate (Tigges, 2003). The low rate of return could have resulted in threats to validity of the research because of an unrepresentative or biased sample (assuming there are differences in the characteristics of parents who do or do not give active consent). To remedy this, teachers kindly sent out reminders to parents and I trialled sending the survey and consent form out electronically (through the class teacher); this improved the return rate somewhat to between 44 – 50%. I was concerned about the additional work it required of the class teacher and thought it might discourage them from participating. I, therefore, moved to a passive, or opt out, consent

process. Passive consent requires that parents are still fully informed about the research, but do not need to respond unless they do not want their child to participate (Berry et al., 2011; Tigges, 2003). The passive consent process resulted in 99% participation going forward. The teachers were pleased not to have to chase up the consent forms. Passive consent could be useful tool for other researchers to consider. A passive consent process may result in more teacher buy-in to requests to participate in research, because it is less onerous for already busy teachers (Carleton-Hug & Hug, 2010).

Dealing with nested data

Many studies cited in this thesis recruit children in existing groups, such as class or school. This can mean the data is correlated for individuals in a particular group and violates the independency assumption of statistical methods such as multiple regression and structural equation modelling. I used multi-level mixed modelling in SPSS to determine whether the nested nature of the dataset had a significant effect on the relationships between the explanatory and the dependent variables. I found the nested nature of the data accounted for 0% and 5% of the variance in the dependent variables; below the level that might be expected by chance. Researchers who do not employ this technique do not know how the nested nature of their data might affect their results and it would be a useful addition in future research.

6.3 Key recommendations

6.3.1 Future research

Connection to nature is thought to be strengthened through exposure to nature. However, the evidence is largely based on cross-sectional studies (Cheng & Monroe, 2012; Collado et al., 2013; Kals et al., 1999; Nisbet et al., 2009; Otto & Pensini, 2017; Rosa et al., 2018; Tam, 2013a; Whitburn et al., 2018). Currently it is thought that direct experiences with nature that allow free play and exploration are likely to strengthen children's connection to nature (Gill, 2014; Giusti et al., 2018). Researchers are only beginning to investigate the characteristics of nature that children are connected to and the types and duration of experiences that strengthen connection to nature. This is perhaps the most needed avenue of research to move the field forward and enable the development of focused interventions to more deeply connect children to nature. It could involve

longitudinal empirical studies (ideally randomised experiments) and qualitative assessments that are based on sound theoretical foundations, using tools such as journaling and photography (Ardoin et al., 2014) or interviews (Barthel et al., 2018).

Future research could investigate how connection to nature develops throughout childhood. Age associated differences in connection to nature have been reported. Older children can have a weaker connection to nature than younger children, which reaches a low around 15 - 16 years of age (Hughes, Rogerson, Barton, & Bragg, 2019). Having a lower connection to nature was associated with negative outcomes in my research - lower vitality, less use of nature for psychological restoration and less engagement in PEB. However, I found not all older children had a low connection to nature. Understanding the ontogeny of these individual differences can inform interventions to promote connection to nature that consider the stage of development and other characteristics of the child. For example, younger children appear to benefit most from self-directed free play and exploration (Giusti et al., 2018; Kellert, 2002; Sobel, 2008). However, pre-adolescent children, for whom peer relationships are becoming increasingly important (Berk, 2004), may engage more fully with and benefit more from interventions that require them to work in groups.

I have not investigated differences in cultural perspectives in any depth in this research. However, the concept of the human/nature relationship and environmental engagement can vary between cultures (Kellert, 2002; Milfont, 2012) and particularly between indigenous and non-indigenous peoples (Nelson, 1989 in Kahn, 1997; Unsworth et al., 2012). I found differences in children's connection to nature associated with their ethnicity, although ethnicity explained very little of the variance in my models (Chapters 3 and 4). New Zealand European children had weaker connection to nature (and subsequently lower vitality and less engagement in PEB) than non-New Zealand European children. Children who indicated a Pacific ethnicity had a stronger connection to nature than non-Pacific children. But there were no difference in connection to nature between Māori (the indigenous people of New Zealand) and non-Māori children. Exploring cultural and societal differences in connection to nature and how it relates to wellbeing and environmental concern and action is worthy of more research.

Finally, the models presented in Chapters 3 and 4 demonstrate correlational relationships between children's connection to nature and aspects of their psychological wellbeing or PEB.

Therefore, longitudinal studies (ideally randomised experiments) are required to confirm if these models represent causative relationships**.**

6.3.2 Environmental education programmes

Although many environmental programmes aim to promote children's connection to nature, connection to nature is largely absent from empirical studies and designs for environmental education programmes (Stern et al., 2014), and only a few programmes are specifically designed to accomplish this (e.g., Barthel et al., 2018; Liefländer et al., 2013). My research has demonstrated that the environmental education programmes I investigated did not promote increases in most children's connection to nature by "just being in nature", as a by-product of the main education curriculum. If environmental educators aim to promote connection to nature in children they may need to consider adapting their programmes to incorporate experiences that are thought to strengthen connection to nature.

This is not an easy task because, as stated above, the research in this area is based on cross-sectional studies and does not provide much specific guidance as to the type or duration of experiences in nature that can increase children's connection to nature. Furthermore, children are not a homogenous group, but attend environmental education programmes with varied perceptions, experiences of and levels of concern about the natural environment (Rickinson, 2001). Characteristics of individual children, such as their age or pre-exisiting connection to nature, can influence how they benefit from environmental education (Braun & Dierkes, 2017; Kossack & Bogner, 2012). This presents an additional challenge when designing programmes. However, finding ways to accommodate these differences may be essential for education programmes to effectively promote connection to nature in most, instead of some, children.

An important area to consider is programme evaluation. Environmental education providers in Wellington, and throughout New Zealand, have not often used social science research to evaluate the effectiveness of their programmes. The evaluation of key outcomes, such as connection to nature or PEB, needs to be built into the design and implementation of environmental education programmes. Organisations invest a great deal of money, time and effort to implement interventions, while there remains little evidence of their effectiveness. Evaluations can help move the education programmes in line with organisation's education and

conservation goals (Heimlich, 2010), enable good stewardship of resources and support future applications for funding.

Although environmental educators may want to apply primary research, they do not always have access to it, or the resources to evaluate and implement it (Monroe, 2003). Collaborations between researchers and environmental education practitioners are beginning to happen internationally (Monroe, 2003), ideally these kind of initiatives will become more widespread.

6.3.3 Connection to nature as an assessment tool

Frantz and Mayer (2014) have recommended connection to nature be used as an assessment tool for evaluating environmental education programmes. Although strengthening children's connection to nature remains a critical goal for environmental programmes (Frantz & Mayer, 2014), its usefulness as an assessment tool may require some refinement. First, connection to nature appears to be relatively stable and may require repeated or long-term exposure to nature to change it (Berto et al., 2018; Schultz & Tabanico, 2007). Second, it is perhaps unrealistic for short-duration environmental education programmes to achieve the multiple goals of imparting knowledge, strengthening environmental attitude and motivating behaviour change as well as promoting children's connection to nature. This is especially important considering that children will come to environmental education with different levels of environmental literacy (Rickinson, 2001) and connection to nature (Kossack & Bogner, 2012). Perhaps intermediary outcomes that point to building a stronger connection to nature could be evaluated in place of measuring connection to nature itself; outcomes such as being comfortable in nature, and having an interest or curiosity about nature (Ardoin et al., 2014; Giusti et al., 2018). These intermediary outcomes could link to the long-term outcome of strengthening children's connection to nature and could indicate progress on the way to this goal (Ardoin et al., 2014).

6.3.3 Urban design

My research demonstrates that children's connection to nature and their use of nature for psychological restoration and are positively related with their vitality and life satisfaction. These findings support the careful design and development of biophilic cities, which integrate aspects of nature into their design and provide varied opportunities for residents to experience nature.

Alongside any gains to biodiversity or eco-system services, such as improvements in air quality and climate control (Chen, 2017; Roberts, 2015), biophilic cities provide daily access to urban nature that may promote children's connection to nature and psychological wellbeing.

However, urban planners do not always consider the needs of children (Carroll, Witten, Kearns, & Donovan, 2015). In New Zealand, children mainly play close to home, in domestic gardens, streets, local parks and school playgrounds, especially children with the lowest level of connection to nature (Freeman et al., 2015). Wellington, New Zealand, has an abundance of green and blue space compared to many other cities internationally (Carmona, De Magalhaes, Blum, & Hopkins, 2003). However, only 23% of children in my study had a high connection to nature. This suggests that even when urban nature is relatively abundant, it may be inaccessible to children. This can be because parental restraints and safety concerns, for example, fast moving traffic, can reduce children's home range (Carroll et al., 2015; Freeman et al., 2015; Oliver et al., 2015). To make cities more liveable for children, provision of natural areas in the neighbourhoods where children live and play needs to be an integral part of urban design and upheld in local government policy. An interconnected network of natural areas would also increase the walkability of urban neighbourhoods and support children's independent mobility (Garau & Annunziata, 2019). This is especially important as housing density increases and domestic gardens and unbuilt areas are squeezed out of inner-city and suburban neighbourhoods. This investment could make cities more liveable for children, strengthen their connection to nature and psychological wellbeing and also motivate their engagement in PEB.

6.4 Conclusion

This thesis advances previous work, first by providing a quantitative summary of the existing research to show there is a moderately-sized, positive association between an individual's connection to nature and their engagement in PEB. Second, by demonstrating that children's connection to nature is positively associated with their use of nature for psychological restoration and vitality. Third by showing children's connection to nature is positively associated with their engagement in PEB, and has a stronger association with PEB than their use of nature for psychological restoration or environmental attitude. Finally, by demonstrating empirically that environmental education did not promote affective connection to nature in most children.

However, environmental education did promote support for conservation, engagement in PEB and increased knowledge.

My thesis has filled gaps in the connection to nature literature, which to date has predominantly studied adults. It also provides insight into the development of children's PEB. It highlights the importance of providing restorative natural environments, where children can connect to nature, especially in cities, and motivating children's use of them to support their wellbeing. My research has significant implications for the design and evaluation of environmental education programmes. I show the importance of programme assessment, and highlight the need for future research to investigate how children's connection to nature develops. Children's affective connection to nature benefits their psychological wellbeing and it is the soil in which seeds of knowledge can develop into wise stewardship of the natural environment (Carson, 1965).

Literature Cited

Abrahamse, W. (2016). Research designs for measuring the effectiveness of interventions. In R. Gifford (Ed.), *Research methods for environmental psychology* (pp. 291-306). UK: John Wiley & Sons, Ltd.

Abrahamse, W. (2019). *Encouraging pro-environmental behaviour: What works, what doesn't and why*. UK: Academic Press.

Abson, D. J., Fischer, J., Leventon, J., Newig, J., Schomerus, T., Vilsmaier, U., . . . Lang, D. J. (2017). Leverage points for sustainability transformation. *Ambio, 46*(1), 30-39.

Aguirre-Bielschowsky, I., Freeman, C., & Vass, E. (2012). Influences on children's environmental cognition: A comparative analysis of New Zealand and Mexico. *Environmental Education Research, 18*(1), 91-115.

Ajzen, I. (1991). The theory of planned behavior. *Organizational Behavior and Human Decision Processes, 50*(2), 179-211.

Alibali, M. W., & Nathan, M. J. (2010). Conducting research in schools: A practical guide. *Journal of Cognition and Development, 11*(4), 397-407.

Anderson, D. R., & Burnham, K. P. (2002). Avoiding pitfalls when using Information-Theoretic methods. *The Journal of Wildlife Management, 66*, 912-918.

Anderson, D. R., Burnham, K. P., & Thompson, W. L. (2000). Null hypothesis testing: Problems, prevelance and an alternative. *The Journal of Wildlife Management, 64*, 912–923.

Ardoin, N. M., DiGiano, M., Bundy, J., Chang, S., Holthuis, N., & O'Connor, K. (2014). Using digital photography and journaling in evaluation of field-based environmental education programs. *Studies in Educational Evaluation, 41*, 68-76.

Aron, A., Aron, E. N., Tudor, M., & Nelson, G. (1991). Close relationships as including other in the self. *Journal of Personality and Social Psychology, 60*, 241-253.

Axelrod, L. J. (1993). Responding to environmental concern: What factors guide individual action? *Journal of Environmental Psychology, 13*, 149-159.

Bagot, K. L., Allen, F. C. L., & Toukhsati, S. (2015). Perceived restorativeness of children's school playground environments: Nature, playground features and play period experiences. *Journal of Environmental Psychology, 41*, 1-9.

Bagot, K. L., Kuo, F. E., & Allen, F. C. L. (2007). Amendments to the Perceived Restorative Components Scale for Children (PRCS-C II). *Children, Youth and Environments, 17*(4), 124-127.

Bamberg, S., & Möser, G. (2007). Twenty years after Hines, Hungerford, and Tomera: A new meta-analysis of psycho-social determinants of pro-environmental behaviour. *Journal of Environmental Psychology, 27*(1), 14-25.

Barbaro, N., & Pickett, S. M. (2016). Mindfully green: Examining the effect of connectedness to nature on the relationship between mindfulness and engagement in pro-environmental behavior. *Personality and Individual Differences, 93*, 137-142.

Baron, R. M., & Kenny, D. A. (1986). The moderator–mediator variable distinction in social psychological research: Conceptual, strategic, and statistical considerations. *Journal of Personality and Social Psychology, 51*, 1173-1182.

Barthel, S., Belton, S., Raymond, C. M., & Giusti, M. (2018). Fostering children's connection to nature through authentic situations: The case of saving salamanders at school. *Frontiers in Psychology, 9*(928).

Bartlett, P. F. (2008). Reason and reenchantment in cultural change: Sustainability in higher education. *Current Anthropology, 49*(6), 1077-1098.

Bartlett, R., Wright, T., Olarinde, T., Holmes, T., Beamon, E. R., & Wallace, D. (2017). Schools as sites for recruiting participants and implementing research. *Journal of Community Health Nursing, 34*(2), 80-88.

Barton, J., & Pretty, J. (2010). Urban ecology and human health. In K. J. Gaston (Ed.), *Urban ecology* (pp. 202-229): Cambridge University Press.

Basu, M., Hashimoto, S., & Dasgupta, R. (2019). The mediating role of place attachment between nature connectedness and human well-being: Perspectives from Japan. *Sustainability Science*. doi: 10.1007/s11625-019-00765-x.

Bechtel, R. B., & Corral Verdugo, C. (2010). Happiness and sustainable behavior. In C. Corral Verdugo, C. H. García Cadena, & M. Frías Armenta (Eds.), *Psychological approaches to sustainability: Current trends in theory, Research and applications, environmental science, engineering and technology series*. New York: Nova Science Publishers.

Beer, T., Cook, A., & Kantor, K. (2018). Running wild: engaging and empowering future custodians of place through creative nature-based play. *Journal of Public Pedagogies,, 3*, 5-19.

Beery, T. H., & Wolf-Watz, D. (2014). Nature to place: Rethinking the environmental connectedness perspective. *Journal of Environmental Psychology, 40*, 198-205.

Bell, S. L., Phoenix, C., Lovell, R., & Wheeler, B. W. (2014). Green space, health and wellbeing: Making space for individual agency. *Health & Place, 30*, 287-292.

Bennett, N. J., Roth, R., Klain, S. C., Chan, K., Christie, P., Clark, D. A., . . . Wyborn, C. (2017). Conservation social science: Understanding and integrating human dimensions to improve conservation. *Biological Conservation, 205*, 93-108.

Bento, G., & Dias, G. (2017). The importance of outdoor play for young children's healthy development. *Porto Biomedical Journal, 2*(5), 157-160.

Bergman, B. G. (2016). Assessing impacts of locally designed environmental education projects on students' environmental attitudes, awareness, and intention to act. *Environmental Education Research, 22*(4), 480-503.

Berk, L. A. (2004). *Development through the lifespan*. Boston, Mass: Allyn and Bacon.

Berry, J. G., Ryan, P., Braunack-Mayer, A. J., Duszynski, K. M., Xafis, V., & Gold, M. S. (2011). A randomised controlled trial to compare opt-in and opt-out parental consent for childhood vaccine safety surveillance using data linkage: study protocol. *Trials, 12*(1), 1-10.

Berto, R., Barbiero, G., Barbiero, P., & Senes, G. (2018). An individual's connection to nature can affect perceived restorativeness of natural environments. Some observations about biophilia. *Behavioral Sciences (Basel), 8*(3), doi: 10.3390/bs8030034.

Berto, R., Pasini, M., & Barbiero, G. (2015). How does psychological restoration work in children? An exploratory study. *Journal of Child & Adolescent Behavior, 3*(3), doi:10.4172/2375-4494.1000200.

Biedenweg, K., Scott, R. P., & Scott, T. A. (2017). How does engaging with nature relate to life satisfaction? Demonstrating the link between environment-specific social experiences and life satisfaction. *Journal of Environmental Psychology, 50*, 112-124.

Blaikie, N. (2007). *Approaches to social enquiry* (2nd ed.). Cambridge: Polity Press.

Blumstein, D., & Saylan, C. (2007). The failure of environmental education (and how we can fix it). *Plos Biology, 5*, e120.

Boeve-de Pauw, J., & Van Petegem, P. (2011). A cross-cultural study of environmental values and their effect on the environmental behavior of children. *Environment and Behavior, 45*(5), 551-583.

Borenstein, M. (2005). Software for publication bias. In H. R. Rothstein, A. J. Sutton, & M. Borenstein (Eds.), *Publication bias in meta-analysis – prevention, assessment and adjustments* (pp. 193-220). Chichester: Wiley.

Borenstein, M. (2014). Comprehensive Meta-Analysis Software, Version 3. Englewood, NJ.: Biostat.

Borenstein, M., Hedges, L., Higgins, J., & Rothstein, H. (2009). *Introduction to meta-analysis*. West Sussex, United Kingdom: Wiley.

Borgers, N., de Leeuw, E., & Hox, J. (2000). Children as respondents in survey research: Cognitve development and response quality. *Bulletin de Méthodologie Sociologique, 66*, 60-75.

Bowler, D. E., Buyung-Ali, L. M., Knight, T. M., & Pullin, A. S. (2010). A systematic review of evidence for the added benefits to health of exposure to natural environments. *B M C Public Health, 10*, 456-466.

Bragg, E. A. (1996). Towards ecological self: Deep ecology meets constructionist self-theory. *Journal of Environmental Psychology, 16*(2), 93-108.
Bragg, R., Wood, C., Barton, J., & Pretty, J. (2013). *Measuring connection to nature in children aged 8-12: A robust methodology for the RSPB*. Sandy, UK: Royal Society for the Protection of Birds.
Bratman, G. N., Hamilton, J. P., & Daily, G. C. (2012). The impacts of nature experience on human cognitive function and mental health. *Annals of the New York Academy of Sciences, 1249*, 118-136.
Braun, T., & Dierkes, P. (2017). Connecting students to nature - how intensity of nature experience and student age influence the success of outdoor education programs. *Environmental Education Research, 23*(7), 937-949.
Brown, K. W., & Kasser, T. (2005). Are psychological and ecological well-being compatible? The role of values, mindfulness, and lifestyle. *Social Indicators Research, 74*, 349-368.
Brügger, A., Kaiser, F. G., & Roczen, N. (2011). Connectedness to nature, inclusion of nature, environmental identity, and implicit association with nature. *European Psychologist, 16*, 324-333.
Bruni, C. M., & Schultz, P. W. (2010). Implicit beliefs about self and nature: Evidence from an IAT game. *Journal of Environmental Psychology, 30*(1), 95-102.
Bruzzese, J., Gallagher, R., McCann-Doyle, S., Reiss, P. T., & Wuetunga, N. A. (2009). Effective methods to improve recruitment and retention in school-based substance use prevention studies. *Journal of School Health, 79*, 400-407.
Buijs, A. (2009). Lay people's images of nature: Comprehensive frameworks of values, beliefs, and value orientations. *Society & Natural Resources, 22*(5), 417–432.
Burnett, E., Sills, E., Peterson, M. N., & DePerno, C. (2016). Impacts of the conservation education program in Serra Malagueta Natural Park, Cape Verde. *Environmental Education Research, 22*(4), 538-550.
Burnham, K. P., & Anderson, D. R. (2002). *Model selection and multimodel inference: A practical information-theoretic approach*. New York: Springer.
Byrka, K., Hartig, T., & Kaiser, F. G. (2010). Environmental attitude as a mediator of the relationship between psychological restoration in nature and self-reported ecological behavior. *Psychological Reports, 107*(3), 847-859.
Byrne, B. M. (2010). *Structural equation modeling with AMOS: Basic concepts, applications, and programming* (2nd ed.). New York: Routledge.
Capaldi, C. A., Dopko, R. L., & Zelenski, J. M. (2014). The relationship between nature connectedness and happiness: A meta-analysis. *Frontiers in Psychology, 5*, 15, doi: 10.3389/fpsyg.2014.00976.
Carleton-Hug, A., & Hug, J. W. (2010). Challenges and opportunities for evaluating environmental education programs. *Evaluation and Program Planning, 33*(2), 159-164.
Carmona, M., De Magalhaes, C., Blum, R., & Hopkins, J. (2003). *Is the grass greener? Learning from international innovations in urban green space management. London, CABE, Bartlett School of Planning*. Retrieved from http://webarchive.nationalarchives.gov.uk/20110118111326/http://www.cabe.org.uk/files/is-the-grass-greener-full.pd
Carroll, P. A., Witten, K., Kearns, R., & Donovan, P. (2015). Kids in the city: Children's use and experiences of urban neighbourhoods in Auckland, New Zealand. *Journal of Urban Design, 20*(4), 417-436.
Carson, R. (1965). *The sense of wonder*. London, UK: HarperCollins.
Carter, R. L., & Simmons, B. (2010). The history and philosophy of environmental education. In A. Bodzin, B. Shiner Kline, & S. Weaver (Eds.), *The inclusion of environmental education in science teacher education* (pp. 3-16). Netherlands: Springer.
Casey, P. J., & Scott, K. (2006). Environmental concern and behaviour in an Australian sample within an ecocentric – anthropocentric framework. *Australian Journal of Psychology, 58*(2), 57-67.
Cervinka, R., Röderer, K., & Hefler, E. (2011). Are nature lovers happy? On various indicators of well-being and connectedness with nature. *Journal of Health Psychology, 17*(3), 379-388.
Chawla, L. (1998). Significant life experiences revisited: A review of research on sources of environmental sensitivity. *The Journal of Environmental Education, 29*, 11-21.

Chawla, L. (2001). Significant life experiences revisited once again: Response to Vol. 5(4) 'Five critical commentaries on significant life experience research in environmental education'. *Environmental Education Research, 7*(4), 451-461.
Chawla, L. (2007). Childhood experiences associated with care for the natural world: A theoretical framework for empirical results. *Children, Youth and Environments, 17*(4), 144-170.
Chawla, L. (2014). Children's engagement with the natural world as a ground for healing. In K. G. Tidball & M. E. Krasny (Eds.), *Greening in the red zone: Disaster, resilience and community greening* (pp. 111-124). Dordrecht: Springer.
Chawla, L. (2015). Benefits of nature contact for children. *Journal of Planning Literature, 30*(4), 433-452.
Chawla, L., & Cushing, D. F. (2007). Education for strategic environmental behavior. *Environmental Education Research, 12*, 437-452.
Chawla, L., & Derr, V. (2012). The development of conservation behaviors in childhood and youth. In S. Clayton (Ed.), *The Oxford Handbook of Environmental and Conservation Psychology* (pp. doi: 10.1093/oxfordhb/9780199733026.9780199733013.9780199730028). New York: Oxford University Press.
Chawla, L., Keena, K., Pevec, I., & Stanley, E. (2014). Green schoolyards as havens from stress and resources for resilience in childhood and adolescence. *Health & Place, 28*, 1-13.
Chen, W. (2017). Urban Nature and Urban Ecosystem Services. In P. Tan, J. Yok, & Y. Chi (Eds.), *Greening cities: Forms and functions* (pp. 181-199). Singapore: Springer.
Cheng, J. C.-H., & Monroe, M. C. (2012). Connection to nature: Children's affective attitude toward nature. *Environment and Behavior, 44*(1), 31-49.
Cialdini, R., Brown, S., Lewis, B., Luce, C., & Neuberg, S. (1997). Reinterpreting the empathy–altruism relationship: When one into one equals oneness. *Journal of Personality and Social Psychology, 73*, 481-494.
Clayton, S. (2003). Environmental identity: A conceptual and operational definition. In S. Clayton & S. Opotow (Eds.), *Identity and the natural environment: The psychological significance of nature.* (pp. 45-65). Cambridge, Mass.: MIT Press.
Clayton, S. (2009). *Conservation psychology: understanding and promoting human care for nature.* Chichster, UK.: Wiley-Blackwell.
Clayton, S., & Opotow, S. (2003). *Identity and the natural environment: The psychological significance of nature.* Cambridge, MA.: MIT Press.
Cleary, A., Fielding, K. S., Bell, S. L., Murray, Z., & Roiko, A. (2017). Exploring potential mechanisms involved in the relationship between eudaimonic wellbeing and nature connection. *Landscape and Urban Planning, 158*(February), 119-128.
Clements, R. (2004). An investigation of the status of outdoor play. *Contemporary Issues in Early Childhood, 5*, 68-80.
Clinical Trials Research Unit. (2010). *A national survey of children and young people's physical activity and dietary behaviours in New Zealand: 2008/09*. Retrieved from University of Auckland, New Zealand: https://www.health.govt.nz/system/files/documents/publications/cyp-physical-activity-dietary-behaviours-08-09-keyfindgs.pdf
Cohen, J. (1992). A power primer. *Psychological Bulletin, 112*(1), 155-159.
Cohen, J., & Cohen, P. (1983). *Applied multiple regression/correlation analysis for the behavioral sciences* (2nd ed.). New Jersey: L. Erlbaum Associates.
Collado, S., & Corraliza, J. A. (2011). Children's perceived restoration and pro-environmental beliefs. *Journal of Asian Behavioural Studies, 1*(2), 1-12.
Collado, S., & Corraliza, J. A. (2012). *Perceived restoration and environmental orientation in a sample of Spanish children.* Paper presented at the Asia Pacific International Conference on Environment-Behaviour Studies, (264-274). Sarawak, Malaysia., Sarawak, Malaysia.
Collado, S., & Corraliza, J. A. (2015). Children's Restorative Experiences and Self-Reported Environmental Behaviors. *Environment and Behavior, 47*(1), 38-56.

Collado, S., Corraliza, J. A., Staats, H., & Ruiz, M. (2015). Effect of frequency and mode of contact with nature on children's self-reported ecological behaviors. *Journal of Environmental Psychology, 41*, 65-73.

Collado, S., & Evans, G. W. (2019). Outcome expectancy: A key factor to understanding childhood exposure to nature and children's pro-environmental behavior. *Journal of Environmental Psychology, 61*, 30-36.

Collado, S., Evans, G. W., Corraliza, J. A., & Sorrel, M. A. (2015). The role played by age on children's pro-ecological behaviors: An exploratory analysis. *Journal of Environmental Psychology, 44*, 85-94.

Collado, S., Evans, G. W., & Sorrel, M. A. (2017). The role of parents and best friends in children's pro-environmentalism: Differences according to age and gender. *Journal of Environmental Psychology, 54*, 27-37.

Collado, S., Íñiguez-Rueda, L., & Corraliza, J. A. (2016). Experiencing nature and children's conceptualizations of the natural world. *Children's Geographies, 14*(6), 716-730.

Collado, S., & Staats, H. (2016). Contact with nature and children's restorative experiences: An eye to the future. *Frontiers in Psychology, 7: 1885*. doi: 10.3389/fpsyg.2016.01885

Collado, S., Staats, H., & Corraliza, J. A. (2013). Experiencing nature in children's summer camps: Affective, cognitive and behavioural consequences. *Journal of Environmental Psychology, 33*, 37-44.

Colléony, A., White, R., & Shwartz, A. (2019). The influence of spending time outside on experience of nature and environmental attitudes. *Landscape and Urban Planning, 187*, 96-104.

Corral-Verdugo, V., Garcia, F. I., Tapia-Fonllem, C., & Fraijo-Sing, B. (2012). Sustainable behaviors and perceived psychological restoration. *Acta de Investigación Psicológica, 2*(2), 749-764.

Corraliza, J. A., Collado, S., & Bethelmy, L. (2012). *Nature as a moderator of stress in urban children.* Paper presented at the Asia Pacific International Conference on Environment-Behaviour Studies, Sarawak, Malaysia.

Corraliza, J. A., Collado, S., & Bethelmy, L. (2013). Spanish version of the New Ecological Paradigm scale for children. *Spanish Journal of Psychology, 16*, 1-8.

Cox, D. T. C., Shanahan, D. F., Hudson, H. L., Fuller, R. A., Anderson, K., Hancock, S., & Gaston, K. J. (2017). Doses of nearby nature simultaneously associated with multiple health benefits. *International journal of environmental research and public health, 14: 172*. doi: 10.3390/ijerph14020172

Coyne, I. (2010). Research with children and young people: The issue of parental (proxy) consent. *Children and Society, 24*(3), 227-237.

Cunningham, E. (2016). *Structural equation modelling using AMOS*. Melbourne, Australia: Statsline.

Dadvand, P., Nieuwenhuijsen, M. J., Esnaola, M., Forns, J., Basagana, X., Alvarez-Pedrerol, M., . . . Sunyer, J. (2015). Green spaces and cognitive development in primary schoolchildren. *Proceedings of the National Academy of Sciences of the United States of America, 112*(26), 7937-7942.

Dadvand, P., Tischer, C., Estarlich, M., Llop, S., Dalmau-Bueno, A., Lopez-Vicente, M., . . . Sunyer, J. (2017). Lifelong residential exposure to green space and attention: A population-based prospective study. *Environmental Health Perspectives, 125*(9).

Davis, J. L., Green, J. D., & Reed, A. (2009). Interdependence with the environment: Commitment, interconnectedness, and environmental behavior. *Journal of Environmental Psychology, 29*(2), 173-180.

Dean, J. H., Shanahan, D. E., Bush, R., Gaston, K. J., Lin, B. B., Barber, E., . . . Fuller, R. A. (2018). Is Nature Relatedness Associated with Better Mental and Physical Health? *International journal of environmental research and public health, 15*(7). doi: 10.3390/ijerph15071371.

Department of Conservation. (2000). *The New Zealand biodiversity strategy*. Retrieved from Wellington, New Zealand: https://www.doc.govt.nz/Documents/conservation/new-zealand-biodiversity-strategy-2000.pdf

Department of Conservation. (2016). *Benchmark survey of New Zealand children's connection to nature*. Retrieved from New Zealand Government, Wellington New Zealand:

Diaz, S., Fargione, J., Chapin, F. S., & Tilman, D. (2006). Biodiversity loss threatens human well-being. *Plos Biology, 4*(8), 1300-1305.

Diener, E., Emmons, R. A., Larsen, R. J., & Griffin, S. J. (1985). The Satisfaction with Life Scale. *Journal of Personality Assessment, 49*, 71-75.
Diener, E., Suh, E. M., Lucas, R. E., & Smith, H. L. (1999). Subjective wellbeing: Three decades of progress. *Psychological Bulletins, 125*(2), 276-302.
Dillen, S. M. E., De Vries, S., Groenewegen, P. P., & Spreeuwenberg, P. (2012). Greenspace in urban neighborhoods and residents' health: Adding quality to quantity. *Journal of Epidemiology and Community Health, 66*, doil: 10.1136/jech.2009.104695.
Doherty, T., & Clayton, S. (2011). The psychological impact of global climate change. *American Psychologist, 66*(4), 265-376.
Dresner, M., & Gill, M. (1994). Environmental education at summer nature camp. *Journal of Environmental Education, 25*(3), 35-41.
Dresner, M., Handelman, C., Braun, S., & Rollwagen-Bollens, G. (2015). Environmental identity, pro-environmental behaviors, and civic engagement of volunteer stewards in Portland area parks. *Environmental Education Research, 21*(7), 991-1010.
Dunlap, R. E. (2008). The New Environmental Paradigm scale: From marginality to worldwide use. *Journal of Environmental Education, 40*(1), 3-18.
Dunlap, R. E., Van Liere, K. D., Mertig, A. G., & Jones, R. E. (2000). Measuring endorsement of the new ecological paradigm: A revised NEP scale. *Journal of Social Issues, 56*(3), 425-442.
Dutcher, D. D., Finley, J. C., Luloff, A. E., & Johnson, J. B. (2007). Connectivity with nature as a measure of environmental values. *Environment and Behavior, 39*(4), 474-493.
Duval, S., & Tweedie, R. (2000). A nonparametric trim and fill method of accounting for publication bias in meta-analysis. *Journal of the American Statistical Association, 95*, 89-98.
Dye, C. (2008). Health and urban living. *Science, 319*(5864), 766-769.
Eagly, A. H., & Chaiken, S. (1993). *The psychology of attitudes*. Fort Worth, Texas: Harcourt Brace Jovanovich.
Eames, C., Cowie, B., & Bolstad, R. (2008). An evaluation of characteristics of environmental education practice in New Zealand schools. *Environmental Education Research, 14*(1), 35-51.
Egger, M., Smith, G., Schneider, M., & Minder, C. (1997). Bias in meta-analysis detected by a simple, graphical test. *British Medical Journal, 315*, 629-634.
Ehrlich, P. R., & Kennedy, D. (2005). Millennium assessment of human behavior. *Science, 309*, 562-563.
Eilam, E., & Trop, T. (2012). Environmental attitudes and environmental behavior - Which is the horse and which is the cart? *Sustainability, 4*, 2210-2246.
Engemann, K., Pedersen, C. B., Arge, L., Tsirogiannis, C., Mortensen, P. B., & Svenning, J.-C. (2019). Residential green space in childhood is associated with lower risk of psychiatric disorders from adolescence into adulthood. *Proceedings of the National Academy of Sciences, 116*(11), 5188-5193.
Epstein, S. (1983). Aggregation and beyond: Some basic issues on the prediction of behavior. *Journal of Personality, 51*, 360-392.
Ernst, J., & Theimer, S. (2011). Evaluating the effects of environmental education programming on connectedness to nature. *Environmental Education Research, 17*(5), 577-598.
Evans, G. W., Brauchle, G., Haq, A., Stecker, R., Wong, K., & Shapiro, E. (2007). Young children's environmental attitudes and behaviors. *Environment and Behavior, 39*(5), 635-659.
Evans, G. W., Juen, B., Corral-Verdugo, V., Corraliza, J. A., & Kaiser, F. G. (2007). Children's cross-cultural environmental attitudes and self-reported behaviors. *Children, Youth and Environments, 17*(4), 128-143.
Evans, G. W., Otto, S., & Kaiser, F. G. (2018). Childhood origins of young adult environmental behavior. *Psychological Science, 29*(5), 679-687.
Faber Taylor, A., & Kuo, F. E. (2009). Children with attention deficits concentrate better after walk in the park. *Journal of Attention Disorders, 12*(5), 402-409.
Faber Taylor, A., Kuo, F. E., & Sullivan, W. C. (2002). Views of nature and self-discipline: Evidence from inner city children. *Journal of Environmental Psychology, 22*(1-2), 49-63.

Fabrigar, L. R., Wegener, D. T., MacCallum, R. C., & Strahan, E. J. (1999). Evaluating the use of exploratory factor analysis in psychological research. *Psychological Methods, 4*(3), 272-299.
Fazio, R. H., & Olson, M. A. (2003). Implicit measures in social cognition. research: Their meaning and use. *Annual Review of Psychology, 54*, 297-327.
Field, A. P. (2013). *Discovering statistics using SPSS statistics: And sex, drugs and rock 'n' roll*. London: Sage.
Flick, U. (2011). *Introducing research methodology: A beginner's guide to doing a research project*. London: Sage.
Forgeard, M. J. C., Jayawickreme, E., Kern, M. L., & Seligman, M. E. P. (2011). Doing the right thing: Measuring wellbeing for public policy. *International Journal of Wellbeing, 1*(1), 79-106.
Forstmann, M., & Sagioglou, C. (2017). Lifetime experience with (classic) psychedelics predicts pro-environmental behavior through an increase in nature relatedness. *Journal of Psychopharmacology, 31*(8), 975-988.
Fox, H. E., Christian, C., Nordby, J. C., Pergams, O. R. W., Peterson, G. D., & Pyke, C. R. (2006). Perceived barriers to integrating social science and conservation. *Conservation Biology, 20*(6), 1817-1820.
Frantz, C. M., & Mayer, F. S. (2014). The importance of connection to nature in assessing environmental education programs. *Studies in Educational Evaluation, 41*, 85-89.
Freeman, C., van Heezik, Y., Stein, A., & Hand, K. (2015). *Natural neighbourhoods for city children*. Dunedin New Zealand: University of Otago.
Frick, J., Kaiser, F. G., & Wilson, M. (2004). Environmental knowledge and conservation behavior: Exploring prevalence and structure in a representative sample. *Personality and Individual Differences, 37*(8), 1597-1613.
Fromm, E. (1964). *The heart of man, its genius for good and evil*. Riverdale, New York: Harper and Row.
Garau, C., & Annunziata, A. (2019). Smart city governance and children's agency: An assessment of the green infrastructure impact on children's activities in Cagliari (Italy) with the tool "Opportunities for children in urban spaces (OCUS)". *Sustainability, 11: 4848*. doi: 10.3390/su11184848
Garin, O. (2014). Ceiling effect. In A. C. Michalos (Ed.), *Encyclopedia of quality of life and well-being research*. Dordrecht: Springer.
Genc, M., Genc, T., & Rasgele, P. G. (2018). Effects of nature-based environmental education on the attitude of 7th grade students towards the environment and living organisms and affective tendency. *International Research in Geographical and Environmental Education, 27*(4), 326-340.
Geng, L. N., Xu, J. K., Ye, L. J., Zhou, W. J., & Zhou, K. X. (2015). Connections with nature and environmental behaviors. *PLoS ONE 10(5): e0127247, 10*(5).
Gifford, R., & Nilsson, A. (2014). Personal and social factors that influence pro-environmental concern and behaviour: A review. *International Journal of Psychology, 49*(3), 141-157.
Gifford, R., & Sussman, R. (2012). Environmental attitudes. In S. Clayton (Ed.), *The Oxford handbook for environmental and conservation psychology* (pp. 64-80). New York: Oxford University Press.
Gill, T. (2014). The benefits of children's engagement with nature: A systematic literature review. *Children, Youth and Environments, 24*(2), 10-34.
Giusti, M., Svane, U., Raymond, C. M., & Beery, T. H. (2018). A framework to assess where and how children connect to nature. *Frontiers in Psychology, 8*, 2283-2283.
Gosling, E., & Williams, K. J. H. (2010). Connectedness to nature, place attachment and conservation behaviour: Testing connectedness theory among farmers. *Journal of Environmental Psychology, 30*(3), 298-304.
Grimmer, M., & Miles, M. (2017). With the best of intentions: a large sample test of the intention-behaviour gap in pro-environmental consumer behaviour. *International Journal of Consumer Studies, 41*(1), 2-10.
Gullone, E. (2000). The biophilia hypothesis and life in the twenty first century: Increasing mental health or increasing pathology? *Journal of Happiness Studies, 1*, 293-321.
Gustafsson, P. E., Szczepanski, A., Nelson, N., & Gustafsson, A. (2011). Effects of an outdoor education intervention on the mental health of schoolchildren. *Journal of Adventure Education and Outdoor Learning, 12*(1), 63-79.

Hand, K. L., Freeman, C., Seddon, P. J., Recio, M. R., Stein, A., & van Heezik, Y. (2017). The importance of urban gardens in supporting children's biophilia. *Proceedings of the National Academy of Sciences, 114*(2), 274-279.

Hanson, R. K., & Bussière, M. T. (1998). Predicting relapse: A meta-analysis of sexual offender recidivism studies. *Journal of Consulting and Clinical Psychology, 66*(2), 348-362.

Haring-Hidore, M., Stock, W. A., Okun, M. A., & Witter, R. A. (1985). Marital status and subjective well-being: A research synthesis. Journal of Marriage and Family *Journal of Marriage and Family, 47*, 947–953.

Hartig, T., Kaiser, F. G., & Bowler, P. A. (2001). Psychological restoration in nature as a positive motivation for ecological behavior. *Environment and Behavior, 33*(4), 590-607.

Hartig, T., Kaiser, F. G., & Strumse, E. (2007). Psychological restoration in nature as a source of motivation for ecological behaviour. *Environmental Conservation, 34*, 291-299.

Hartig, T., Mitchell, R., de Vries, S., & Frumkin, H. (2014). Nature and health. *Annual Review of Public Health, 35*, 207-228.

Hawcroft, L. J., & Milfont, T. L. (2010). The use (and abuse) of the New Environmental Paradigm scale over the last 30 years: A meta-analysis. *Journal of Environmental Psychology, 30*(2), 143-158.

Hedges, L., & Olkin, J. (1985). *Statistical methods for meta-analysis*. San Diego, CA: Academic Press.

Hedges, L., & Vevea, J. L. (1998). Fixed- and random-effects models in meta-analysis. *Psychological Methods, 3*(4), 486-504.

Heimlich, J. E. (2010). Environmental education evaluation: Reinterpreting education as a strategy for meeting mission. *Evaluation and Program Planning, 33*(2), 180-185.

Heimlich, J. E., & Ardoin, N. M. (2008). Understanding behavior to understand behavior change: A literature review. *Environmental Education Research, 14*(3), 215-237.

Hinds, J., & Sparks, P. (2008). Engaging with the natural environment: The role of affective connection and identity. *Journal of Environmental Psychology, 28*, 109-120.

Hines, J. M., Hungerford, H., & Tomera, A. N. (1987). Analysis and synthesis of research on responsible environmental behaviour: A metaanalysis. *Journal of Environmental Education, 18*, 1-8.

Hini, D., Gendall, P., & Kearns, Z. (1995). The link between environmental attitudes and behaviour. *Marketing Bulletin, 6*, 22-31.

Hobbs, N. T., & Hilborn, R. (2006). Alternatives to statistical hypothesis testing in ecology: A guide to self teaching. *Contemporary Statistics and Ecology, 16*, 5-19.

Hobbs, R. J. (2013). Grieving for the past and hoping for the future: Balancing polarizing perspectives in conservation and restoration. *Restoration Ecology, 21*(2), 145-148.

Holte, A., Barry, M. M., Bekkhus, M., Borge, A. I. H., Bowes, L., Casas, F., . . . Zachrisson, H. D. (2014). Psychology of child well-being. In A. Ben-Arieh, F. Casas, I. Frønes, & J. E. Korbin (Eds.), *Handbook of child well-being: Theories, methods and policies in global perspective* (pp. 555-631). Dordrecht: Springer Netherlands.

Hoot, R. E., & Friedman, H. (2011). Connectedness and environmental behavior: Sense of interconnectedness and pro-environmental behavior. *International Journal of Transpersonal Studies, 30*(1-2), 89-100.

Howell, A. J., Dopko, R. L., Passmore, H., & Buro, K. (2011). Nature connectedness: Associations with well-being and mindfulness. *Personality and Individual Differences, 51*(2), 166-171.

Howell, A. J., Passmore, H. A., & Buro, K. (2013). Meaning in mature: Meaning in life as a mediator of the relationship between nature connectedness and well-being. *Journal of Happiness Studies, 14*(6), 1681-1696.

Hu, L.-T., & Bentler, P. M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equation Modeling: A Multidisciplinary Journal, 6*(1), 1-55.

Huebner, E. S. (1991). Initial development of the Student's Life Satisfaction Scale. *School Psychology International, 12*, 231-240.

Hughes, J., Rogerson, M., Barton, J., & Bragg, R. (2019). Age and connection to nature: when is engagement critical? *Frontiers in Ecology and the Environment, 17*(5), 265-269.

Hungerford, H., & Volk, T. (1990). Changing learner behavoir through environemtnal education. *The Journal of Environmental Education, 21*(3), 257-270.

Huta, V., & Ryan, R. M. (2010). Pursuing pleasure or virtue: The differential and overlapping well-being benefits of hedonic and eudaimonic motives. *Journal of Happiness Studies, 11*, 735-762.

Iozzi, L. A. (1989). What research says to the educator. *The Journal of Environmental Education, 20*(4), 3-9.

IPCC. (2014). *Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, R.K. Pachauri and L.A. Meyer (eds.)] IPCC, Geneva, Switzerland, 151 pp.* Retrieved from http://www.ipcc.ch/pdf/assessment-report/ar5/syr/SYR_AR5_FINAL_full_wcover.pdf 4.12.2017

Ives, C. D., Giusti, M., Fischer, J., Abson, D. J., Klaniecki, K., Dorninger, C., . . . von Wehrden, H. (2017). Human-nature connection: a multidisciplinary review. *Current Opinion in Environmental Sustainability, 26-27*, 106-113.

Jagers, S. C., Linde, S., Martinsson, J., & Matti, S. (2017). Testing the importance of individuals' motives for explaining environmentally significant behavior. *Social Science Quarterly, 98*(2), 644-658.

Johnson, B., & Manoli, C. C. (2010). The 2-MEV scale in the United States: A measure of children's environmental attitudes based on the theory of ecological attitude. *The Journal of Environmental Education, 42*(2), 84-97.

Jordan, M. (2009). Nature and self – an ambivalent attachment? *Ecopsychology, 1*(126-31).

Jose, P. E. (2013a). *Doing statistical mediation and moderation: Methodology in the social sciences*. New York: The Guilford Press.

Jose, P. E. (2013b). ModGraph-I: A programme to compute cell means for the graphical display of moderational analyses: The internet version, Version 3.0. Victoria University of Wellington, Wellington, New Zealand. Retrieved [14.11.2018] from https://psychology.victoria.ac.nz/modgraph/.

Joye, Y., & Van Den Berg, A. E. (2011). Is love for green in our genes? A critical analysis of evolutionary assumptions in restorative environments research. *Urban Forestry & Urban Greening, 10*, 261-268.

Joye, Y., & Van Den Berg, A. E. (2013). Restorative environments. In L. Steg, A. E. Van Den Berg, & J. I. M. de Groot (Eds.), *Environmental Psychology* (pp. 57-66). West Sussex, UK: Blackwell.

Jurin, R. R., & Fortner, R. W. (2002). Symbolic beliefs as barriers to responsible environmental behavior. *Environmental Education Research, 8*(4), 373-394.

Kahn, P. H. (1997). Developmental psychology and the biophilia hypothesis: Children's affiliation with nature. *Developmental Review, 17*, 1-16.

Kahn, P. H., & Kellert, S. R. (2002). *Children and nature: Psychological, sociocultural and evolutionary investigations.* Cambridge, Mass.: MIT Press.

Kahn, P. H. J. (1999). *The human relationship with nature: Development and culture.* Cambridge, MA: MIT Press.

Kaiser, F. G. (1998). A general measure of ecological behavior. *Journal of Applied Social Psychology, 28*(395-422).

Kaiser, F. G., Brügger, A., Hartig, T., Bogner, F. X., & Gutscher, H. (2014). Appreciation of nature and appreciation of environmental protection: How stable are these attitudes and which comes first? *Revue européenne de psychologie appliquée, 64*, 269-277.

Kaiser, F. G., Byrka, K., & Hartig, T. (2010). Reviving Campbell's paradigm for attitude research. *Personality and Social Psychology Review, 14*(4), 351-367.

Kaiser, F. G., Hartig, T., Brügger, A., & Duvier, C. (2011). Environmental protection and nature as distinct attitudinal objects: An application of the Campbell Paradigm. *Environment and Behavior, 45*(3), 369-398.

Kaiser, F. G., Roczen, N., & Bogner, F. X. (2008). Competence formation in environmental education: Advancing ecology-specific rather than general abilities. *Umweltpsychologie, 12*(2), 56-70.

Kaiser, F. G., & Wilson, M. (2004). Goal-directed conservation behavior: The specific composition of a general performance. *Personality and Individual Differences, 36*(7), 1531-1544.
Kals, E., Schumacher, D., & Montada, L. (1999). Emotional affinity toward nature as a motivational basis to protect nature. *Environment and Behavior, 31*, 178-202.
Kaplan, R. (2001). The nature of the view from home psychological benefits. *Environment and Behavior, 33*, 507-542.
Kaplan, R., & Kaplan, S. (1989). *The experience of nature: A psychological perspective.* New York: Cambridge University Press.
Kaplan, R., & Kaplan, S. (2002). Adolescents and the natural environment: A time out? In P. H. Kahn & S. R. Kellert (Eds.), *Children and nature: Psychological, sociocultural and evolutionary investigations* (pp. 228-257). London: MIT Press.
Kellert, S. R. (1997). *Kinship to mastery: Biophilia in human evolution and development*. Washington DC: Island Press.
Kellert, S. R. (2002). Experiencing nature: Affective, cognitive, and evaluative development in children. In P. H. Kahn & S. R. Kellert (Eds.), *Children and nature: Psychological, sociocultural, and evolutionary investigations.* Cambridge, Mass.: MIT Press.
Kellert, S. R., & Wilson, E. O. (1993). *The biophilia hypothesis.* Washington, D. C.: Island Press.
Kelz, C., Evans, G. W., & Roderer, K. (2015). The restorative effects of redesigning the schoolyard: A multi-methodological, quasi-experimental study in rural Austrian middle schools. *Environment and Behavior, 47*(2), 119-139.
Keniger, L. E., Gaston, K. J., Irvine, K. N., & Fuller, R. A. (2013). What are the benefits of interacting with nature? *International Journal of Environmental Research and Public Health, 10*, 913-935.
Kennedy, E. H., Beckley, T. M., McFarlane, B. L., & Nadeau, S. (2009). Why we don't 'walk the talk': Understanding the environmental values/behaviour gap in Canada. *Human Ecology Review, 16*, 151-160.
Keulartz, J., van der Windt, H., & Swart, J. (2004). Concepts of nature as communicative devices: The case of Dutch Nature Policy. *Environmental Values, 13*, 81-99.
Kingsley, J. Y., Townsend, M., & Henderson-Wilson, C. (2009). Cultivating health and wellbeing: members' perceptions of the health benefits of a Port Melbourne community garden. *Leisure Studies, 28*, 207-219.
Kirkpatrick, L. A. (2003). Effects of multiple determinancy and measurement error on trait–behavior and behavior–behavior relations: An integrated conceptual mode. *Personality and Social Psychology Bulletin, 23*, 199-209.
Kline, R. B. (2005). *Principles and practice of structural equation modeling: Methodology in the social sciences.* (2nd ed.). New York: Guilford Press.
Kollmuss, A., & Agyeman, J. (2002). Mind the gap: Why do people act environmentally and what are the barriers to pro-environmental behavior? *Environmental Education Research,, 8*(3), 239-260.
Kopnina, H. (2011). Qualitative revision of the New Ecological Paradigm (NEP) scale for children. *International Journal of Environmental Research, 5*(4), 1025-1034.
Korpela, K., Borodulin, K., Neuvonen, M., Paronen, O., & Tyrvainen, L. (2014). Analyzing the mediators between nature-based outdoor recreation and emotional well-being. *Journal of Environmental Psychology, 37*, 1-7.
Korpela, K., Kytta, M., & Hartig, T. (2002). Restorative experience, self-regulation, and children's place preferences. *Journal of Environmental Psychology, 22*(4), 387-398.
Korpela, K. M., Ylen, M., Tyrvainen, L., & Silvennoinen, H. (2008). Determinants of restorative experiences in everyday favorite places. *Health & Place, 14*(4), 636-652.
Kos, M., Jerman, J., Anžlovar, U., & Torkar, G. (2016). Preschool children's understanding of pro-environmental behaviours: Is it too hard for them?. *International Journal of Environmental and Science Education,, 11*(12), 5554-5571.
Kossack, A., & Bogner, F. X. (2012). How does a one-day environmental education programme support individual connectedness with nature? *Journal of Biological Education, 46*(3), 180-187.

Larson, L. R., Castleberry, S. B., & Green, G. T. (2010). Effects of an environmental education program on the environmental orientations of children from different gender, age, and ethnic groups. *Journal of Park and Recreation Administration, 28*(3), 95-113.

Larson, L. R., Green, G. T., & Castleberry, S. B. (2011). Construction and validation of an instrument to measure environmental orientations in a diverse group of children. *Environment and Behavior, 43*(1), 72-89.

Larson, L. R., Whiting, J. W., & Green, G. T. (2011). Exploring the influence of outdoor recreation participation on proenvironmental behaviour in a demographically diverse population. *Local Environment: The International Journal of Justice and Sustainability, 16*(1), 67-86.

Leary, M. R., Tipsfors, J. M., & Tate, E. B. (2008). Allo-inclusive identity: Incorporating the social and natural worlds into one's sense of self. In H. A. Wayment & J. J. Bauer (Eds.), *Transcending self-interest: Psychological explorations of the quiet ego* (pp. 137-147). Washington: APA.

Leeming, F. C., Dwywe, W. O., Porter, B. E., & Cobern, M. K. (1993). Outcome research in environmental education: A critical review. *Journal of Environmental Education, 24*(4), 8-21.

Leopold, A. (1970). *A Sand County almanac: With essays on conservation from Round River*. New York: Ballantine Books.

Li, C. J., & Monroe, M. C. (2017). Exploring the essential psychological factors in fostering hope concerning climate change. *Environmental Education Research*, 1-19.

Lieflander, A. K., & Bogner, F. X. (2018). Educational impact on the relationship of environmental knowledge and attitudes. *Environmental Education Research, 24*(4), 611-624.

Liefländer, A. K., & Bogner, F. X. (2014). The effects of children's age and sex on acquiring pro-environmental attitudes through environmental education. *Journal of Environmental Education, 45*(2), 105-117.

Liefländer, A. K., Bogner, F. X., Kibbe, A., & Kaiser, F. G. (2015). Evaluating environmental knowledge dimension convergence to assess educational programme effectiveness. *International Journal of Science Education, 37*(4), 684-702.

Liefländer, A. K., Fröehlich, G., Bogner, F. X., & Schultz, P. W. (2013). Promoting connectedness with nature through environmental education. *Environmental Education Research, 19*(3), 370-384.

Lin, B. B., Fuller, R. A., Bush, R., Gaston, K. J., & Shanahan, D. F. (2014). Opportunity or orientation? Who uses urban parks and why. *Plos One, 9*, art. e87422. doi: 10.1371/journal.pone.0087422

Louv, R. (2008). *Last child in the woods: Saving our children from nature-deficit disorder*. Chapel Hill, N. C.: Algonquin Books of Chapel Hill.

Loveridge, J. (2010). *Involving children and young people in research in educational settings, Chapter 1 Introduction*. Retrieved from Wellington: https://www.educationcounts.govt.nz/publications/schooling/80440/Chapter_1

Lumber, R., Richardson, M., & Sheffield, D. (2017). Beyond knowing nature: Contact, emotion, compassion, meaning, and beauty are pathways to nature connection. *Plos One, 12*(5), e0177186. doi: 10.1371/journal.pone.0177186

Lyubomirsky, S., & Lepper, H. S. (1999). A measure of subjective happiness: Preliminary reliability and construct vaildation. *Social Indicators Research, 46*, 137-155.

MacKinnon, D. P. (2008). *Introduction to statistical mediation analysis: Multivariate applications*. New York: Lawrence Erlbaum Associates.

Manfredo, M. J., Teel, T. L., & Bright, A. D. (2003). Why are public values toward wildlife changing? *Human Dimensions of Wildlife, 8*, 287-306.

Manoli, C. C., Johnson, B., & Dunlap, R. E. (2007). Assessing children's environmental worldviews: Modifying and validating the New Ecological Paradigm scale for use with children. *Journal of Environmental Education, 38*(4), 3-13.

Markle, G. L. (2013). Pro-environmental behavior: Does it matter how it's measured? Development and validation of the pro-environmental behavior scale (PEBS). *Human Ecology, 41*(6), 905-914.

Martin, C., & Czellar, S. (2016). The extended Inclusion of Nature in Self scale. *Journal of Environmental Psychology, 47*, 181-194.

Martin, K., Huebner, E. S., & Valois, R. F. (2008). Does life satisfaction predict victimization experiences in adolescence? (pp. 705-714): John Wiley & Sons.
Mascia, M. B., Brosius, J. P., Dobson, T. A., Forbes, B. C., Horowitz, L., McKean, M. A., & Turner, N. J. (2003). Conservation and the social sciences. *Conservation Biology, 17*(3), 649-650.
Matsuoka, R. H., & Kaplan, R. (2008). People needs in the urban landscape: Analysis of landscape and urban planning contributions. *Landscape and Urban Planning, 84*, 7-19.
Mayer, F. S., & Frantz, C. M. (2004). The connectedness to nature scale: A measure of individuals' feeling in community with nature. *Journal of Environmental Psychology, 24*, 503-515.
Mayer, F. S., Frantz, C. M., Bruehlman-Senecal, E., & Dolliver, K. (2009). Why is nature beneficial? The role of connectedness to nature. *Environment and Behavior, 41*(5), 607-643.
McMahan, E. A. (2018). Happiness comes naturally: Engagement with nature as a route to positive subjective well-being. In E. Diener, S. Oishi, & L. Tay (Eds.), *Handbook of well-being* (pp. 1-63). Salt Lake City, Utah: DEF Publishers.
McMahan, E. A., & Estes, D. (2015). The effect of contact with natural environments on positive and negative affect: A meta-analysis. *Journal of Positive Psychology, 10*(6), 507-519.
Miles, I., Sullivan, W. C., & Kuo, F. E. (1998). Ecological restoration volunteers: The benefits of participation. *Urban Ecosystems, 2*, 27-41.
Milfont, T. L. (2007). *Psychology of environmental attitudes: A cross-cultural study of their content and structure.* (PhD), University of Auckland, Auckland, New Zealand.
Milfont, T. L. (2012). Cultural differences in environmental engagement. In S. Clayton (Ed.), *The Oxford handbook of environmental and conservation psychology* (pp. 181-200). The Oxford handbook of environmental and conservation psychology: Oxford University Press.
Milfont, T. L., & Duckitt, J. (2010). The environmental attitudes inventory: A valid and reliable measure to assess the structure of environmental attitudes. *Journal of Environmental Psychology, 30*(1), 80-94.
Milfont, T. L., & Schultz, P. W. (2016). Culture and the natural environment. *Current Opinion in Psychology, 8*, 194-199.
Millar, M. G., & Millar, K. U. (1996). The effects of direct and indirect experience on affective and cognitive responses and the attitude-behavior relation. *Journal of Experimental Social Psychology, 32*(6), 561-579.
Miller, P. H., Baxter, S. D., Royer, J. A., Hitchcock, D. B., Smith, A. F., Collins, K. L., . . . Finney, C. J. (2015). Children's social desirability: Effects of test assessment mode. *Personality and Individual Differences, 83*, 85-90.
Ministry of Education. (2015). *The New Zealand Curriculum: Guidelines for environmental education in New Zealand Schools*. Wellington, New Zealand Retrieved from http://nzcurriculum.tki.org.nz/Curriculum-resources/Education-for-sustainability/Tools-and-resources/Guidelines-for-Environmental-Education-in-New-Zealand-Schools.
Ministry of Education. (2018). School deciles. Retrieved from https://www.education.govt.nz/school/running-a-school/resourcing/operational-funding/school-decile-ratings/
Ministry of Health. (2015). *Annual update of key results 2014/15: New Zealand health survey*. Wellington New Zealand: New Zealand Ministry of Health.
Mishna, F., Muskat, B., & Cook, C. (2012). Anticipating challenges: School-based social work intervention research. *Children and Schools, 34*(3), 135-144.
Mitchell, R., & Popham, F. (2008). Effect of exposure to natural environment on health inequalities: An observational population study. *Lancet, 372*, 1655-1660.
Monroe, M. C. (2003). Two avenues for encouraging conservation behaviors. *Human Ecology Review, 10*(2), 113-125.
Monroe, M. C. (2010). Challenges for environmental education evaluation. *Evaluation and Program Planning, 33*(2), 194-196.
Müller, M. A., Kals, E., & Pansa, R. (2009). Adolescents' emotional affinity toward nature: A cross-societal study. *The Journal of Developmental Processes, 4*(1), 59-69.

Naess, A. (1973). The shallow and the deep, long-range ecology movement. A summary. *Inquiry, 16*, 95-100.
Natural England, U. K. (2009). *Childhood and nature: A survey on changing relationships with nature across generations*. Retrieved from publications.naturalengland.org.uk/file/5495287317528576
Negev, M., Sagy, G., Garb, Y., Salzberg, A., & Tal, A. (2008). Evaluating the environmental literacy of Israeli elementary and high school students. *Journal of Environmental Education, 39*, 3-20.
Neill, J. T., & Richards, G. E. (1998). Does outdoor education really work? A summary of recent meta-analyses. *Journal of Outdoor and Environmental Education, 3*(1), 2-9.
Nelson, D. H., Prescott, S. L., Logan, A. C., & Bland, J. S. (2019). Clinical ecology—Transforming 21st-century medicine with planetary health in mind. *Challenges, 10*, doi: 10.3390/challe10010015.
New Zealand Department of Conservation. (2015). Statement of Intent 2015–2019. Retrieved from https://www.doc.govt.nz/Documents/about-doc/role/publications/statement-of-intent-2015-2019.pdf
New Zealand Government. (2018). *He ara oranga : Report of the government inquiry into mental health and addiction* Retrieved from Wellington, New Zealand:
Nisbet, E. K., & Zelenski, J. M. (2011). Underestimating nearby nature: affective forecasting errors obscure the happy path to sustainability. *Psychological Science, 22*(9), 1101-1106.
Nisbet, E. K., & Zelenski, J. M. (2013). The NR-6: A new brief measure of Nature Relatedness. *Frontiers in Psychology, 4*, doi: 10.3389/fpsyg.2013.00813.
Nisbet, E. K., Zelenski, J. M., & Murphy, S. A. (2009). The Nature Relatedness scale: Linking individuals' connection with nature to environmental concern and behavior. *Environment and Behavior, 41*(5), 715-740.
Nisbet, E. K., Zelenski, J. M., & Murphy, S. A. (2011). Happiness is in our nature: Exploring Nature Relatedness as a contributor to subjective well-being. *Journal of Happiness Studies, 12*, 303-322.
Ojala, A., Korpela, K., Tyrväinen, L., Tiittanen, P., & Lanki, T. (2019). Restorative effects of urban green environments and the role of urban-nature orientedness and noise sensitivity: A field experiment. *Health & Place, 55*, 59-70.
Oliver, M., Mavoa, S., Badland, H., Parker, K., Donovan, P., Kearns, R. A., . . . Witten, K. (2015). Associations between the neighbourhood built environment and out of school physical activity and active travel: An examination from the Kids in the City study. *Health & Place, 36*, 57-64.
Olli, E., Grendstad, G., & Wollebaek, D. (2001). Correlates of environmental behaviors: Bringing back social context. *Environment and Behavior, 33*(2), 181-208.
Olsson, D., & Gericke, N. (2016). The adolescent dip in students' sustainability consciousness—Implications for education for sustainable development. *The Journal of Environmental Education, 47*(1), 35-51.
Orwin, R. G. (1983). A fail-safe N for effect size in meta-analysis. *Journal of Educational Statistics, 8*(2), 157-159.
Oskamp, S. (2000). Psychological contributions to achieving an ecologically sustainable future for humanity. *Journal of Social Issues, 56*(3), 373-390.
Otto, S., & Pensini, P. (2017). Nature-based environmental education of children: Environmental knowledge and connectedness to nature, together, are related to ecological behaviour. *Global Environmental Change, 47*, 88-94.
Pallant, J. F. (2013). *SPSS survival manual: A step by step guide to data analysis using SPSS for Windows* (5th ed.). Crows Nest, N.S.W: Allen & Unwin.
Peacock, J. L., & Peacock, P. J. (2011). *Oxford handbook of medical statistics*. New York, NY: Oxford University Press.
Pensini, P., Horn, E., & Caltabiano, N. J. (2016). An exploration of the relationships between adults' childhood and current nature exposure and their mental well-being. *Children, Youth and Environments, 26*(1), 125-147.
Pereira, M., & Forster, P. M. (2015). The relationship between connectedness to nature, environmental values, and pro-environmental behaviours. *Reinvention: an International Journal of Undergraduate Research, 8*(2).

Perkins, H. E. (2010). Measuring love and care for nature. *Journal of Environmental Psychology, 30*(4), 455-463.

Phenice, L. A., & Griffore, R. J. (2003). Young children and the natural world. *Contemporary Issues in Early Childhood, 4*(2), 167-171.

Plante, T. G., Cage, C., Clements, S., & Stover, A. (2006). Psychological benefits of exercise paired with virtual reality: outdoor exercise energizes while indoor virtual exercise relaxes. *International Journal of Stress Management, 13*, 108-117.

Pooley, J. A., & O'Connor, M. (2000). Environmental education and attitudes - Emotions and beliefs are what is needed. *Environment and Behavior, 32*(5), 711-723.

Powers, J. D. (2007). Successful entry and collaboration in school-based research: Tips from a school administrator. *Children and Schools, 29*, 247-250.

Preuß, M., Nieuwenhuijsen, M. J., Marquez, S., Cirach, M., Dadvand, P., Triguero-Mas, M., . . . Zijlema, W. (2019). Low Childhood Nature Exposure is Associated with Worse Mental Health in Adulthood. *International Journal of Environmental Research and Public Health*.doi:10.3390/ijerph16101809

Pritchard, A., Richardson, M., Sheffield, D., & McEwan, K. (2019). The relationship between nature connectedness and eudaimonic well-being: A meta-analysis. *Journal of Happiness Studie.* doi: 10.1007/s10902-019-00118-6.

Pyle, R. M. (2002). Eden is a vacant lot: Special places. species and kids in the neighborhood of life. In P. H. Kahn & S. R. Kellert (Eds.), *Children and nature: Psychological, sociocultural and evolutionary investigations*. Cambridge, Massachusetts: MIT Press.

Pyle, R. M. (2003). Nature matrix: Reconnecting people and nature. *Oryx, 37*, 206-214.

Rahman, M. S. (2016). The advantages and disadvantages of using qualitative and quantitative approaches and methods in language “testing and assessment” research: A literature review. *Journal of Education and Learning, 6*, 102-112.

Raudsepp, M. (2005). *Emotional connection to nature: Its socio-psychological correlates and associations with pro-environmental attitudes and behavior*. Cambridge, MA: Hogrefe & Huber Publishers.

Rees, G., Goswami, H., & Bradshaw, J. (2010). *Developing an index of children’s subjective well-being in England*. Retrieved from London: https://www.childrenssociety.org.uk/sites/default/files/tcs/research_docs/Developing%20an%20Index%20of%20Children's%20Subjective%20Well-being%20in%20England.pdf

Richardson, M., & Sheffield, D. (2017). Three good things in nature: noticing nearby nature brings sustained increases in connection with nature. *Bilingual Journal of Environmental Psychology, 8*(1), 1-32.

Richardson, M., Sheffield, D., Harvey, C., & Petronzi, D. (2015). *The impact of children’s connection to nature. A report for the Royal Society for the Protection of Birds (RSPB)*. Retrieved from http://www.rspb.org.uk/Images/impact_of_children%E2%80%99s_connection_to_nature_tcm9-414472.pdf 23.9.2016

Rickinson, M. (2001). Learners and learning in environmental education: A critical review of the evidence. *Environmental Education Research, 7*(3), 201-320.

Rideout, V. J., Foehr, U. G., & Roberts, D. F. (2010). *Generation M2: Media in the lives of 8- to 18-year-olds*. Retrieved from https://kaiserfamilyfoundation.files.wordpress.com/2013/04/8010.pdf

Roberts, L. (2015). *The nature of wellbeing: How nature’s ecosystems services contribute to the wellbeing of New Zealand and New Zealanders*. Retrieved from Wellington, New Zealand: https://www.doc.govt.nz/Documents/science-and-technical/sap258entire.pdf

Roczen, N., Kaiser, F. G., Bogner, F. X., & Wilson, M. (2014). A competence model for environmental education. *Environment and Behavior, 46*(8), 972-992.

Rosa, C. D., Profice, C. C., & Collado, S. (2018). Nature experiences and adults' self-reported pro-environmental behavoirs: The role of connectedness to nature and childhood nature experiences. *Frontiers in Psychology, 9*, 1-10.

Rosenthal, R. (1991). *Meta-analytic procedures for social research (Rev. Ed.)*. Newbury Park, California: Sage.

Roszak, T. (1995). Where psyche meet Gaia. In T. Roszak, M. E. Gomes, & A. D. Kanner (Eds.), *Ecopsychology: Restoring the earth, healing the mind.* San Francisco: Sierra Club.

RSPB. (2013). *Connecting with nature: Finding out how connected to nature the UK's children are*. Retrieved from http://www.rspb.org.uk/connectionmeasure

Ryan, R. M., & Deci, E. L. (2001). On happiness and human potentials: A review of research on hedonic and eudaimonic well-being. *Annual Review of Psychology, 52*, 141-166.

Ryan, R. M., & Deci, E. L. (2008). From ego-depletion to vitality: Theory and findings concerning the facilitation of energy available to the self. *Social and Personality Psychology Compass, 2*, 707-717.

Ryan, R. M., & Frederick, C. (1997). On energy, personality, and health: Subjective vitality as a dynamic reflection of well-being. *Journal of Personality, 65*(3), 529-565.

Ryff, C. D., & Keyes, L. M. (1995). The structure of psychological well-being revisited. *Journal of Personality and Social Psychology, 69*(4), 719-727.

Sanguinetti, A. (2014). Transformational practices in cohousing: Enhancing residents' connection to community and nature. *Journal of Environmental Psychology, 40*, 86-96.

Saunders, C. D. (2003). The emerging field of conservation psychology. *Human Ecology Review, 10*(2), 137-149.

Schmitz, G. L., & da Rocha, J. B. T. (2018). Environmental education program as a tool to improve children's environmental attitudes and knowledge. *Education, 8*(2), 15-20.

Schultz, P. W. (2000). Empathizing with nature: The effects of perspective taking on concern for environmental issues. *Journal of Social Issues, 56*(3), 391-406.

Schultz, P. W. (2002). Inclusion with nature: The psychology of human-nature relations. In P. Schmuck, Schultz, W. P. (Ed.), *Psychology of sustainable development* (pp. 61-78). Boston: Kluwer Academic.

Schultz, P. W. (2011). Conservation means behavior. *Conservation Biology, 25*(6), 1080-1083.

Schultz, P. W., Shriver, C., Tabanico, J. J., & Khazian, A. M. (2004). Implicit connections with nature. *Journal of Environmental Psychology, 24*(1), 31-42.

Schultz, P. W., & Tabanico, J. (2007). Self, identity, and the natural environment: Exploring implicit connections with nature. *Journal of Applied Social Psychology, 37*(6), 1219-1247.

Schultz, P. W., & Zelezny, L. (1998). Values and proenvironmental behavior: A five-country survey. *Journal of Cross-Cultural Psychology, 29*, 540-558.

Schumacker, R. E., & Lomax, R. G. (2010). *A beginner's guide to structural equation modeling* (3rd ed.). New York: Routledge.

Sellmann, D., & Bogner, F. X. (2013). Effects of a 1-day environmental education intervention on environmental attitudes and connectedness with nature. *European Journal of Psychology of Education, 28*(3), 1077-1086.

Shanahan, D. F., Bush, R., Gaston, K. J., Lin, B. B., Dean, J., Barber, E., & Fuller, R. A. (2016). Health benefits from nature experiences depend on dose. *Scientific Reports, 6, 28551*. doi: 10.1038/srep28551.

Shanahan, D. F., Lin, B. B., Gaston, K. J., Bush, R., & Fuller, R. A. (2014). Socio-economic inequalities in access to nature on public and private lands: A case study from Brisbane, Australia. *Landscape and Urban Planning, 130*, 14-23.

Skar, M., Wold, L. C., Gundersen, V., & O'Brien, L. (2016). Why do children not play in nearby nature? Results from a Norwegian survey. *Journal of Adventure Education and Outdoor Learning, 16*(3), 239-255.

Sobel, D. (1996). *Beyond ecophobia: Reclaiming the heart in nature education. Nature Literacy Series*. Barrington, MA: The Orion Society.

Sobel, D. (2008). *Childhood and nature: Design principles for educators*. Portland, Maine: Stenhouse Publishers.

Sobel, D. (2012). *Look, don't touch: The problem with environmental education*. Retrieved from https://orionmagazine.org/article/look-dont-touch1/

Soga, M., & Gaston, K. J. (2016). Extinction of experience: the loss of human-nature interactions. *Frontiers in Ecology and the Environment, 14*(2), 94-101.

Soga, M., Gaston, K. J., Yamaura, Y., Kurisu, K., & Hanaki, K. (2016). Both direct and vicarious experiences of nature affect children's willingness to conserve biodiversity. *International journal of environmental research and public health, 13*(6). doi: 10.3390/ijerph13060529.

Soga, M., Yamanoi, T., Tsuchiya, K., Koyanagi, T. F., & Kanai, T. (2018). What are the drivers of and barriers to children's direct experiences of nature? *Landscape and Urban Planning, 180*, 114-120.

Soliman, M., Peetz, J., & Davydenko, M. (2017). The impact of immersive technology on Nature Relatedness and pro-environmental behavior. *Journal of Media Psychology-Theories Methods and Applications, 29*(1), 8-17.

South Island Alliance. (2011). *The children's social health monitor: Introduction*. Retrieved from https://www.sialliance.health.nz/UserFiles/SouthIslandAlliance/File/PDFs/Child%20Health%20Status/South%20Island%20Childrens%20Social%20Health%20Monitor%20Introduction%20an.pdf

Statistics New Zealand. (2013). 2013 Census ethnic group profiles. Retrieved from http://archive.stats.govt.nz/Census/2013-census/profile-and-summary-reports/ethnic-profiles.aspx, October 2016

Statistics New Zealand. (2017). *Subnational population estimates by age*. Retrieved from http://nzdotstat.stats.govt.nz/wbos/Index.aspx?DataSetCode=TABLECODE7501#, retreived 1.2.2017

Steffen, W., Richardson, K., Rockström, J., Cornell, S. E., Fetzer, I., Bennett, E. M., . . . Sörlin, S. (2015). Planetary boundaries: Guiding human development on a changing planet. *Science, 347*(736), 1259855.

Steg, L., van Den Berg, A. E., & De Groot, J. I. M. (2013). *Environmental psychology*. West Sussex, UK: BPS Blackwell.

Steg, L., & Vlek, C. (2009). Encouraging pro-environmental behaviour: An integrative review and research agenda. *Journal of Environmental Psychology, 29*(3), 309-317.

Stern, M. J., Powell, R. B., & Ardoin, N. M. (2008). What difference does it make? Assessing outcomes From participation in a residential environmental education program. *Journal of Environmental Education, 39*(4), 31-43.

Stern, M. J., Powell, R. B., & Hill, D. (2014). Environmental education program evaluation in the new millennium: what do we measure and what have we learned? *Environmental Education Research, 20*(5), 581-611.

Stern, P. C. (2000). Toward a coherent theory of environmentally significant behavior. *Journal of Social Issues, 56*(3), 407-424.

Stevenson, M. P., Dewhurst, R., Schilhab, T., & Bentsen, P. (2019). Cognitive restoration in children following exposure to nature: Evidence from the attention network task and mobile eye tracking. *Frontiers in Psychology, 10*(42), 10.3389/fpsyg.2019.00042.

Stuart-Currier, S. A. (2016). *An exploration of children's connection to nature: Aotearoa New Zealand.* (Master of Science in Environmental Studies), Victoria University of Wellington.

Suldo, S. M., & Huebner, E. S. (2004). Does life satisfaction moderate the effects of stressful life events on psychopathological behavior during adolescence? *School Psychology Quarterly, 19*(2), 93-105.

Sundquist, K., Frank, G., & Sundquist, J. (2004). Urbanisation and incidence of psychosis and depression: Follow-up study of 4.4 million women and men in Sweden. *The British Journal of Psychiatry, 184*(293-298).

Swaisgood, R. R., & Sheppard, J. K. (2010). The culture of conservation biologists: Show me the hope! *Bioscience, 60*(8), 626-630.

Tabachnick, B. G., & Fidell, L. S. (2013). *Using multivariate statistics, 6th ed.* Boston: Pearson Education.

Tacey, D. (2000). *Re-enchantment: The new Australian spirituality*. New York: HarperCollins.

Tam, K.-P. (2013a). Concepts and measures related to connection to nature: Similarities and differences. *Journal of Environmental Psychology, 34*, 64-78.

Tam, K.-P. (2013b). Dispositional empathy with nature. *Journal of Environmental Psychology, 35*, 92-104.

Thompson, S. C. G., & Barton, M. A. (1994). Ecocentric and anthropocentric atittudes towards the environment. *Journal of Environmental Psychology, 14*(2), 149-157.

Tigges, B. B. (2003). Parental consent and adolescent risk behavior research. *Journal of Nursing Scholarship, 35*(3), 283-289.

Tillman, S., Tobin, D., Avison, W., & Gilliland, J. (2018). Mental health benefits of interactions with nature in children and teenagers: a systematic review. *Journal of Epidemiology and Community Health, 72*, 958-966.

Tseng, Y.-C., & Wang, S.-M. (2019). Understanding Taiwanese adolescents' connections with nature: Rethinking conventional definitions and scales for environmental education. *Environmental Education Research*, 1-15.

Twisk, J. (2006). *Applied multilevel analysis : A practical guide*. Cambridge: Cambridge University Press.

Ulrich, R. S. (1983). Aesthetic and affective response to the natural environment. In I. Altman & J. F. Wohlwill (Eds.), *Human behavoir and environment: Behavior and the natural environment.* (Vol. 6, pp. 85-125). New York: Plenum Press.

Ulrich, R. S., Simons, R. F., Losito, B. D., Fiorito, E., Miles, M. A., & Zelson, M. (1991). Stress recovery during exposure to natural and urban environments. *Journal of Environmental Psychology, 11*, 201-230.

UNESCO. (1978). *Intergovernmental Conference on Environmental Education. Final Report.* Retrieved from Paris: https://unesdoc.unesco.org/ark:/48223/pf0000032763

United Nations. (2012). *World Urbanization Prospects, the 2011 Revision: Highlights.* Retrieved from New York:

Unsworth, S. J., Levin, W., Bang, M., Washinawatok, K., Waxman, S. R., & Medin, D. L. (2012). Cultural differences in children's ecological reasoning and psychological closeness to nature: evidence from Menominee and European American children. *Journal of Cognition and Culture, 12*, 17-29.

van den Berg, A. E., Maas, J., Verheij, R. A., & Groenewegen, P. P. (2010). Green space as a buffer between stressful life events and health. *Social Science & Medicine, 70*(8), 1203-1210.

van den Berg, A. E., & van den Berg, C. G. (2011). A comparison of children with ADHD in a natural and built setting. *Child: Care, Health and Development, 37*, 430-439.

van den Berg, A. E., Wesselius, J. E., Maas, J., & Tanja-Dijkstra, K. (2017). Green walls for a restorative classroom environment: A controlled evaluation study. *Environment and Behavior, 49*(7), 791-813.

van den Berg, M., Wendel-Vos, W., van Poppel, M., Kemper, H., van Mechelen, W., & Maas, J. (2015). Health benefits of green spaces in the living environment: A systematic review of epidemiological studies. *Urban Forestry & Urban Greening, 14*(4), 806-816.

van Heezik, Y., Freeman, C., Porter, S., & Dickinson, J. M. (2013). Garden size, householder knowledge, and socio-economic status influence plant and bird diversity at the scale of individual gardens. *Ecosystems, 16*(8), 1442-1454.

Van Petegem, P., & Blieck, A. (2006). The environmental worldview of children: a cross-cultural perspective. *Environmental Education Research, 12*(5), 625-635.

Venhoeven, L. A., Bolderdijk, J., & Steg, L. (2013). Explaining the paradox: How pro-environmental behaviour can both thwart and foster well-being. *Sustainability, 5*(4), 1372-1386.

Verissimo, D. (2013). Influencing human behaviour: an underutilised tool for biodiversity management. *Conservation Evidence*, 29-31.

Vining, J., Merrick, M. S., & Price, E. A. (2008). The distinction between humans and nature: Human perceptions of connectedness to nature and elements of the natural and unnatural. *Human Ecology Review, 15*(1), 1-11.

Ward, J. S., Duncan, J. S., Jarden, A., & Stewart, T. (2016). The impact of children's exposure to greenspace on physical activity, cognitive development, emotional wellbeing, and ability to appraise risk. *Health & Place, 40*, 44-50.

Watson, D., Clark, L. A., & Tellegen, A. (1988). Development and validation of brief measures of positive and negative affect: The PANAS scales. *Journal of Psychology, 54*(6), 1063-1070.

Wellington City Council. (2007). *Biodiversity action plan. Wellington, New Zealand: Wellington City Council.* Retrieved from https://wellington.govt.nz/~/media/your-council/plans-policies-and-bylaws/plans-and-policies/a-to-z/biodiversity/files/biodiversity.pdf

Wellington City Council. (2015). *Our natural capital: Wellington's biodiversity strategy and action plan*. Retrieved from https://wellington.govt.nz/your-council/plans-policies-and-bylaws/policies/biodiversity-strategy-and-action-plan

Wells, N. M. (2000). At home with nature - Effects of "greenness" on children's cognitive functioning. *Environment and Behavior, 32*(6), 775-795.

Wells, N. M., & Evans, G. W. (2003). Nearby nature - A buffer of life stress among rural children. *Environment and Behavior, 35*(3), 311-330.

Wells, N. M., & Lekies, K. S. (2006). Nature and the life course: Pathways from childhood nature experiences to adult environmentalism. *Children, Youth and Environments, 16*(1), 1 - 24.

West, B. T., Welch, K. B., & Galecki, A. T. (2014). *Linear mixed models: A practical guide using statistical software* (2nd ed.). New York: Chapman and Hall.

Wheeler, B. W., Cooper, A. R., Page, A. S., & Jago, R. (2010). Greenspace and children's physical activity: A GPS/GIS analysis of the PEACH project. *Preventive Medicine, 51*(2), 148-152.

Whitburn, J. (2014). *Urban vegetation, wellbeing and pro-environmental Behaviour: A socio-ecological experiment in Wellington City, New Zealand.* (MSc), Victoria University of Wellington, Wellington, New Zealand. Retrieved from http://hdl.handle.net/10063/3774

Whitburn, J., Abrahamse, W., & Linklater, W. L. (2019). Meta-analysis of human connection to nature and proenvironmental behavior. *Conservation Biology. 34(1), 180-193.*

Whitburn, J., Linklater, W. L., & Milfont, T. L. (2018). Exposure to urban nature and tree planting are related to pro-environmental behavior via connection to nature, the use of nature for psychological restoration, and environmental attitudes. *Environment and Behavior, 51*(7), 787-810.

White, M. P., Pahl, S., Ashbullby, K., Herbert, S., & Depledge, M. H. (2013). Feelings of restoration from recent nature visits. *Journal of Environmental Psychology, 35*, 40-51.

Whitmarsh, L., & O'Neill, S. (2010). Green identity, green living? The role of pro-environmental self-identity in determining consistency across diverse pro-environmental behaviours. *Environmental Psychology, 30*, 305-314.

Whitten, T., Stevens, R., Ructtinger, L., Tzoumakis, S., Green, M. J., Laurens, K. R., . . . Carr, V. J. (2018). Connection to the natural environment and well-being in middle childhood. *Ecopsychology, 10*(4), 270-279.

Wilson, E. O. (1984). *Biophilia*. Cambridge, Mass.: Harvard University Press.

Wilson, E. O. (2002). *The future of life*. New York: Alfred A. Knof.

Windhorst, E., & Williams, A. (2015). Growing up, naturally: The mental health legacy of early nature affiliation. *Ecopsychology, 7*(3), 115-126.

Wolsko, C., & Lindberg, K. (2013). Experiencing connection with nature: The matrix of psychological well-being, mindfulness, and outdoor recreation. *Ecopsychology, 5*(2), 80-91.

World Health Organisation. (2005). *Millennium ecosystem assessment: Ecosystems and human wellbeing.* Retrieved from Washington D.C.: Retreived from: https://www.millenniumassessment.org/documents/document.356.aspx.pdf.

Wray-Lake, L., Flanagan, C. A., & Osgood, D. W. (2010). Examining trends in adolescent environmental attitudes, beliefs, and behaviors across three decades. *Environment and Behavior, 42*(1), 61-85.

Wyles, K. J., White, M. P., Hattam, C., Pahl, S., King, H., & Austen, M. (2019). Are some natural environments more psychologically beneficial than others? The importance of type and quality on connectedness to nature and psychological restoration. *Environment and Behavior, 51*(2), 111-143.

Zealandia. (2016). Living with Nature: Tiaki taiao, tiaki tangata: Zealandia's strategy for 2016-2035. Retrieved from http://www.visitzealandia.com/livingwithnature

Zelenski, J. M., & Nisbet, E. K. (2012). Happiness and feeling connected: The distinct role of Nature Relatedness. *Environment and Behavior, 46*(1), 3-23.

Zelezny, L. (1999). Educational interventions that improve environmental behaviors: A meta-analysis. *The Journal of Environmental Education, 31*(1), 5-14.

Zelezny, L. C., & Schultz, P. W. (2000). Promoting environmentalism. *Journal of Social Issues, 56*(3), 365-371.

Zhang, J. W., Howell, R. T., & Iyer, R. (2014). Engagement with natural beauty moderates the positive relation between connectedness with nature and psychological well-being. *Journal of Environmental Psychology, 38*, 55-63.

Zhao, X. J., Lynch, J. G., & Chen, Q. (2010). Reconsidering Baron and Kenny: Myths and truths about mediation analysis. *Journal of Consumer Research, 37*, 197-206.

Zuur, A. F., Ieno, E. N., Walker, N., Saveliev, A. A., & Smith, G. M. (2009). *Mixed effects models and extensions in ecology with R*. New York: Springer-Verlag.

Zylstra, M. J., Knight, A. T., Esler, K. J., & Le Grange, L. L. L. (2014). Connectedness as a core conservation concern: An interdisciplinary review of theory and a call for practice. *Springer Science Reviews, 2*, 119-143.

Appendix 1: Survey

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

School:

Class:

This survey is to help environmental educators in Wellington, such as Zealandia and Wellington Zoo, do their work better and will be used for research. This is not a test; I just want to know what you think. Thank you for helping me with my survey.

I am happy to participate in this research as shown by completing this survey.

Can you please tell us a little bit about yourself?

What is your name? _____

How old are you? _____

Are you a boy or a girl? (Please circle your answer)

Boy *Girl*

Please tick which ethnic group you belong to (You can tick more than one):

New Zealand European	
NZ Māori	
Pacific Peoples (e.g., Samoan, Cook Island Māori, Niuean, Tongan)	
Asian	
Indian	
Middle Eastern, Latin American, African	
Other ethnic group	

	How much do you agree or disagree with each sentence below? (Circle one number for each question)	***Strongly Disagree***	***Disagree***	***Neutral***	***Agree***	***Strongly Agree***
1	*I like to hear different sounds in nature*	*1*	*2*	*3*	*4*	*5*
2	*I enjoy looking at birds, bugs, lizards & plants*	*1*	*2*	*3*	*4*	*5*
3	*I like to go outside even if it is cold and rainy*	*1*	*2*	*3*	*4*	*5*
4	*I like to garden and plant trees*	*1*	*2*	*3*	*4*	*5*
5	*Collecting rocks and shells is fun*	*1*	*2*	*3*	*4*	*5*
6	*I feel sad when animals are hurt*	*1*	*2*	*3*	*4*	*5*
7	*I like to see native birds, eels and fish living in a clean environment*	*1*	*2*	*3*	*4*	*5*
8	*I enjoy touching animals and plants*	*1*	*2*	*3*	*4*	*5*
9	*Taking care of animals is important to me*	*1*	*2*	*3*	*4*	*5*
10	*When I am outside I feel close to nature*	*1*	*2*	*3*	*4*	*5*
11	*I feel like I am part of the natural world*	*1*	*2*	*3*	*4*	*5*
12	*When I am in nature I feel like I belong there*	*1*	*2*	*3*	*4*	*5*
13	*I often feel separate from nature*	*1*	*2*	*3*	*4*	*5*
14	*My actions will make the natural world different*	*1*	*2*	*3*	*4*	*5*
15	*Picking up trash on the ground can help the environment*	*1*	*2*	*3*	*4*	*5*
16	*I can help keep my local neighbourhood, parks and beaches clean*	*1*	*2*	*3*	*4*	*5*

What do you think?

	How much do you agree or disagree with each sentence below? (Circle one number for each question)	***Strongly Disagree***	***Disagree***	***Neutral***	***Agree***	***Strongly Agree***
17	*When I spend time in nature I feel free*	*1*	*2*	*3*	*4*	*5*
18	*When I'm angry or upset, being surrounded by nature helps me calm down*	*1*	*2*	*3*	*4*	*5*
19	*I can do things I like when I'm in nature*	*1*	*2*	*3*	*4*	*5*
20	*Watching TV is the best way for me to relax*	*1*	*2*	*3*	*4*	*5*
21	*Being outdoors makes me happy*	*1*	*2*	*3*	*4*	*5*
22	*I can think better after being outside*	*1*	*2*	*3*	*4*	*5*
23	*Playing in nature helps me forget my worries*	*1*	*2*	*3*	*4*	*5*
24	*I feel uneasy whenever I spend time in nature*	*1*	*2*	*3*	*4*	*5*
25	*Plants and animals have as much right as people to live*	*1*	*2*	*3*	*4*	*5*
26	*There are too many (or almost too many) people on earth*	*1*	*2*	*3*	*4*	*5*
27	*People are clever enough to keep from ruining the earth*	*1*	*2*	*3*	*4*	*5*
28	*People must still obey the laws of nature*	*1*	*2*	*3*	*4*	*5*
29	*When people mess with nature it has bad results*	*1*	*2*	*3*	*4*	*5*
30	*Nature is strong enough to handle the bad effects of our modern lifestyle*	*1*	*2*	*3*	*4*	*5*
31	*People are supposed to rule over the rest of nature*	*1*	*2*	*3*	*4*	*5*
32	*People are treating nature badly*	*1*	*2*	*3*	*4*	*5*
33	*People will someday know enough about how nature works to be able to control it*	*1*	*2*	*3*	*4*	*5*
34	*If things don't change, we will have a big disaster in the environment soon*	*1*	*2*	*3*	*4*	*5*

Stretch your brain!

Here are some questions about animals you can find in Wellington. Please answer the question in the box beside it or circle the best answer for you. If you don't know an answer, that's OK. Remember, this is NOT a test.

What is this animal called?			
Is it endemic to New Zealand?	No	Unsure	Yes

What is this animal called?			
Is it endemic to New Zealand?	No	Unsure	Yes

What is this animal called?			
Is it endemic to New Zealand?	No	Unsure	Yes

What is this animal called?			
Is it endemic to New Zealand?	No	Unsure	Yes

What is this animal called?			
Is it endemic to New Zealand?	No	Unsure	Yes

What is this animal called?			
Is it endemic to New Zealand?	No	Unsure	Yes

What is this animal called?			
Is it endemic to New Zealand?	No	Unsure	Yes

	How much do you agree or disagree with each sentence below? (Circle one number for each question)	***Strongly Disagree***	***Disagree***	***Neutral***	***Agree***	***Strongly Agree***
35	*To save water, I try to use less water when I have a shower or brush my teeth*	*1*	*2*	*3*	*4*	*5*
36	*At home I put paper, plastic and glass in the rubbish bin*	*1*	*2*	*3*	*4*	*5*
37	*To save energy I switch off electrical appliance when I'm not using them (lights, TV, games)*	*1*	*2*	*3*	*4*	*5*
38	*I remind my family to take re-usable shopping bags*	*1*	*2*	*3*	*4*	*5*
39	*If I see a spider indoors I spray it with bug spray*	*1*	*2*	*3*	*4*	*5*
40	*I talk to my teachers or friends about protecting the environment (e.g., about recycling)*	*1*	*2*	*3*	*4*	*5*
41	*I remind friends to pick up trash if they drop it on the ground*	*1*	*2*	*3*	*4*	*5*
42	*I am a member of a wildlife or nature group (e.g., the Kiwi conservation club)*	*1*	*2*	*3*	*4*	*5*
43	*I take part in events to help nature (e.g., beach clean ups)*	*1*	*2*	*3*	*4*	*5*
44	*I put water outside for the birds*	*1*	*2*	*3*	*4*	*5*
45	*I make homes for wildlife (e.g., weta hotel, bird nest box or lizard home)*	*1*	*2*	*3*	*4*	*5*
46	*I have helped to plant plants that provide food for the birds, insects and bees (e.g., flowers or swan plants for monarch butterfly caterpillars)*	*1*	*2*	*3*	*4*	*5*

	How much do you agree or disagree with each sentence below? (Circle one number for each question)	***Strongly Disagree***	***Disagree***	***Neutral***	***Agree***	***Strongly Agree***
47	*My life is just right*	*1*	*2*	*3*	*4*	*5*
48	*I wish I had a different kind of life*	*1*	*2*	*3*	*4*	*5*
49	*I have a good life*	*1*	*2*	*3*	*4*	*5*
50	*I have what I want in life*	*1*	*2*	*3*	*4*	*5*
51	*My life is better than most kids*	*1*	*2*	*3*	*4*	*5*
52	*I feel alive and active most days*	*1*	*2*	*3*	*4*	*5*
53	*I mostly feel alert and awake*	*1*	*2*	*3*	*4*	*5*
54	*Sometimes I feel so alive I just want to burst*	*1*	*2*	*3*	*4*	*5*
55	*I feel tired a lot*	*1*	*2*	*3*	*4*	*5*
56	*I look forward to each new day*	*1*	*2*	*3*	*4*	*5*

Appendix 2: Information sheets and consent forms

Children's connection to nature and environmental education in Wellington, New Zealand

INFORMATION SHEET FOR PARENTS/LEGAL GUARDIANS

Your child's class is planning a visit to _____. I am conducting research on the environmental education programme run by various environmental education providers in the Wellington region, including _____. Please read this information before deciding whether or not your child may take part in this research. If you decide to participate, thank you. If you decide not to take part, thank you for considering my request. Your decision will not affect your child's participation in the class visit.

Consent

If you consent for your child to participate in the research you don't need to do anything further, your child will be included in the study. However, if you **DO NOT** wish your child to participate please return the form on last page to their class teacher or complete the online form here: https://goo.gl/forms/EpWkm3xAYX6Jfno12

Who am I?

My name is Julie Whitburn and I am a PhD student in the School of Biological Sciences at Victoria University of Wellington. This research project is work towards my research thesis.

What is the aim of the project?

The aim of this study is to investigate how the educational programmes in the Wellington region impact children's relationship with nature.

What is involved?

If you agree that your child can take part they will be asked to complete a questionnaire as part of a class exercise at school. Various scales will be used in the survey. These include:

- Children's Connection to Nature. This includes questions like, 'I like to hear different sounds in nature' and 'My actions will make the natural world different'.
- Children's Pro-environmental Behaviour. This scale includes questions like, 'To save water, I try to use less water when I have a shower or brush my teeth' and 'I talk to my teachers or friends about protecting the environment (e.g., about recycling)'.
- Two scales (of 5 questions each) will be used for children's wellbeing. The first is a children's Life Satisfaction Sale with questions like, 'My life is just right' and 'My life is better than most kids.' The second is a scale measuring Vitality and includes questions such as: 'I feel alive and active most days' and 'I feel tired a lot'.

Your child will be given a small thank you gift after they complete the survey (e.g., a branded pencil from Zealandia, a badge, stamp or small toy animal).

Participation and withdrawal

Participation in this study is voluntary.

Risks

Participation in this study will involve no special hazards or risks to your child.

What will happen to the information you give?

All data collected in this study will be confidential. Only my supervisors and I will have access to identified data. The data will be aggregated and analyzed and reported in such a way that responses will not be able to be linked to any individual. The data you provide will only be used for the specific research purposes of this study. I will not name you or your child in any reports, and I will not include any identifying information. All the surveys will be kept in a locked file and all electronic material will be password protected. Surveys will be destroyed five years after the conclusion of the research.

What will the project produce?

The information from my research will be used in my PhD thesis. I may also use the results of my research for conference presentations, academic journals and reports (e.g., to Zealandia, Wellington Zoo and Wellington City Council). I will not identify you or your child in my thesis or any presentation or report. Once the study is complete a report will be available on the university's website.

If you accept this invitation, what are your child's rights as a research participant?

You do not have to accept this invitation if you don't want to. If you do decide to participate, you and your child have the right to:

- choose not to answer any question
- ask any questions about the study at any time.

Human Ethics Committee information

This study has been approved by the Human Ethics Committee (HEC) at Victoria University of Wellington (Number: 23405). If you have any concerns about the ethical conduct of the research you may contact the Victoria University HEC Convener: Associate Professor Susan Corbett. Email: susan.corbett@vuw.ac.nz or telephone +64-4-463 5480.

If you have any questions or problems, who can you contact?

If you have any questions, either now or in the future, please feel free to contact either:

PhD Student:
Name: Julie Whitburn
School: Biological Sciences
Email: julie.whitburn@vuw.ac.nz

Supervisors:
Name: Wayne Linklater
School: Biological Sciences
Phone: 04 463 5233 **ext 8575**
Email: wayne.linklater@vuw.ac.nz

Name: Wokje Abrahamse
School: Geography, Environment & Earth Sciences
Phone: 04 463 5217
Email: wokje.abrahamse@vuw.ac.nz

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

Children's connection to nature and environmental education in Wellington, New Zealand

Researcher: Julie Whitburn, School of Biological Sciences, Victoria University of Wellington.

NON-CONSENT TO PARTICIPATE

Researcher: Julie Whitburn, School of Biological Sciences, Victoria University of Wellington.

Please return this form only if you **DO NOT** wish your child to participate in the research. Otherwise your child will be included if they are willing.

- I **DO NOT** give consent for my child_____ to participate in this research.
  (Name, Room)

Name of parent/guardian: _____

Signature of parent/guardian: _____

Date: _____

Children's connection to nature and environmental education

in Wellington, New Zealand

My name is Julie Whitburn and I am a Ph.D. student in the School of Biological Sciences at Victoria University of Wellington. I am conducting research on the environmental education programmes run by various providers in the Wellington region including_____. The aim of my study is to investigate how these educational programmes impact children's relationship or connection with nature and how a strong connection to nature might affect children's wellbeing, environmental attitudes and pro-environmental behaviour. Your school is booked to attend an education programme at _____ and I invite you to participate in my research. This study has been approved by the Human Ethics Committee at Victoria University of Wellington (# 23405).

A class survey is the foundation of this study. The survey needs to be completed twice - in the week prior to the class visit to _____ and then a second time about a month after the programme has finished. Ideally, I need two classes from each school - the class attending the education programme and a second class, which would act as a control group, which is not currently attending the programme. I will be present to implement the completion of the surveys in your classroom.

Any information the students provide will, of course, be kept strictly confidential. The data will be aggregated and then analyzed and reported in such a way that responses will not be able to be linked to any individual. Each child will be given a small thank-you gift after they complete the survey (e.g., a branded pen from Zealandia, a badge, eraser or small toy animal).

The information will be used in my Ph.D. thesis. I may also use the results of my research for conference presentations, academic journals and reports to the participating environmental education providers and Wellington City Council. This study has the potential to influence local and national government goals to connect New Zealanders to nature and inform the design, resourcing and implementation of the environmental education programmes both in New Zealand and internationally.

Thank you so much for considering my request. If you are willing to participate in my research please contact me directly. In addition, if you have any questions, either now or in the future, please feel free to contact either myself or my supervisors:

With kind regards,
Julie Whitburn

Ph.D. Student:
Julie Whitburn
Biological Sciences
Phone: 027 293 5941
julie.whitburn@vuw.ac.nz

Supervisors:
Wayne Linklater
Biological Sciences
Phone: 04 463 5233 **ext 8575**
wayne.linklater@vuw.ac.nz

Wokje Abrahamse
Geography, Environment & Earth Sciences
Phone: 04 463 5217
wokje.abrahamse@vuw.ac.nz

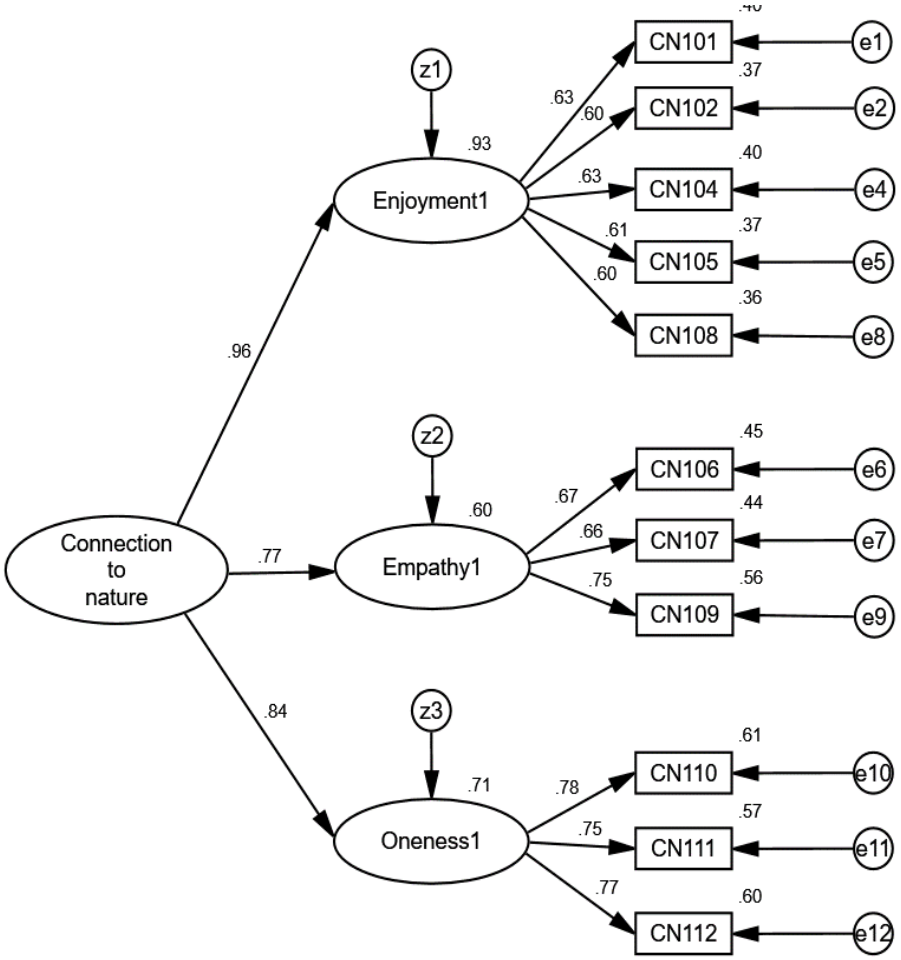
Appendix 3: Zero-order, bivariate correlations

Appendix 3 Zero-order bivariate correlations for all variables before the environmental education intervention. Correlations between ordinal[1] - ordinal or scale[2] - ordinal variables were measured by Pearson's Correlation Coefficient. Associations between dichotomous[3]- ordinal variables were measured by the point biserial correlation coefficient. PEB, pro-environmental behaviour, NZ, New Zealand, MELAA, Middle Eastern, Latin American and African, $N = 324$. *, $p < 0.05$; **, $p < 0.001$.

	Connection to nature	Psychological restoration	Environmental attitude	PEB	Knowledge	Life satisfaction	Vitality	Decile
Connection to nature[1]	1							
Psychological restoration[1]	0.73**	1						
Environmental attitude[1]	0.45**	0.39**	1					
PEB[1]	0.67**	0.66**	0.34**	1				
Knowledge[2]	0.08	0.07	0.17**	0.00	1			
Life satisfaction[1]	0.11	0.22**	0.05	0.05	0.04	1		
Vitality[1]	0.45**	0.50**	0.22**	0.47**	0.04	0.33**	1	
Age[2]	- 0.35**	- 0.38**	- 0.03	- 0.42**	0.23**	- 0.13*	- 0.24**	
Gender[3]	0.29**	0.20**	0.12*	0.23**	0.05	- 0.07	0.01	
Decile[2]	- 0.37**	- 0.38**	- 0.08	- 0.36**	0.18**	- 0.15**	- 0.20**	1
NZ European[3]	- 0.16**	- 0.21**	0.08	- 0.21**	0.21**	- 0.06	- 0.08	0.52**
NZ Māori[3]	0.06	0.05	0.05	- 0.01	- 0.04	0.02	- 0.02	- 0.28**
Pacific peoples[3]	0.16**	0.23**	- 0.01	0.15**	- 0.12*	- 0.01	0.11*	- 0.43**
Asian[3]	0.00	- 0.05	0.06	0.05	- 0.10	- 0.17**	- 0.06	0.10
MELAA[3]	- 0.09	- 0.03	- 0.10	0.03	- 0.04	- 0.02	- 0.00	0.07

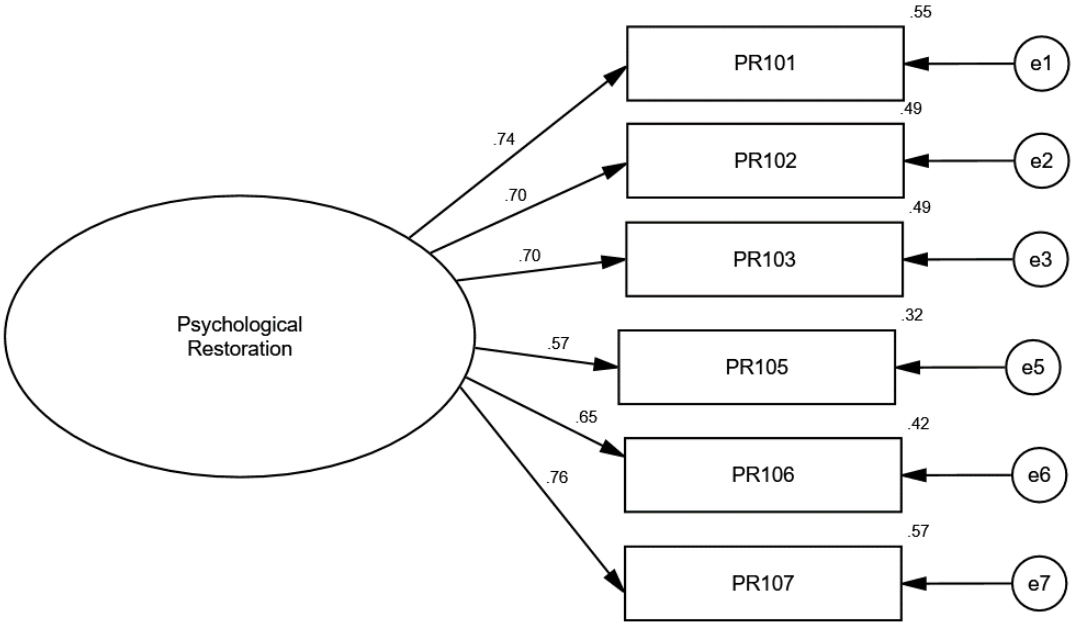
Appendix 4: Confirmatory factor analysis, graphics

Connection to Nature Index (Cheng & Monroe, 2012)



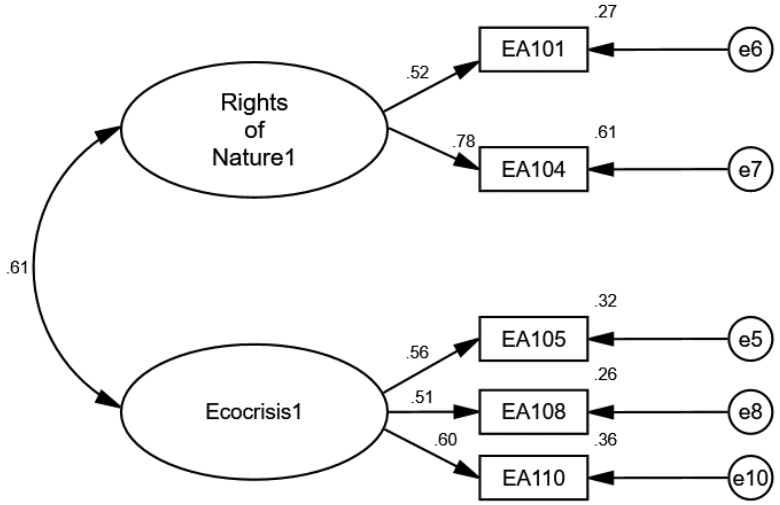
CMIN/DF = 2.59; CFI = 0.95; TLI = 0.93; RMSEA = 0.070 [0.054 - 0.087]; SRMR = 0.048

Use of nature for psychological restoration



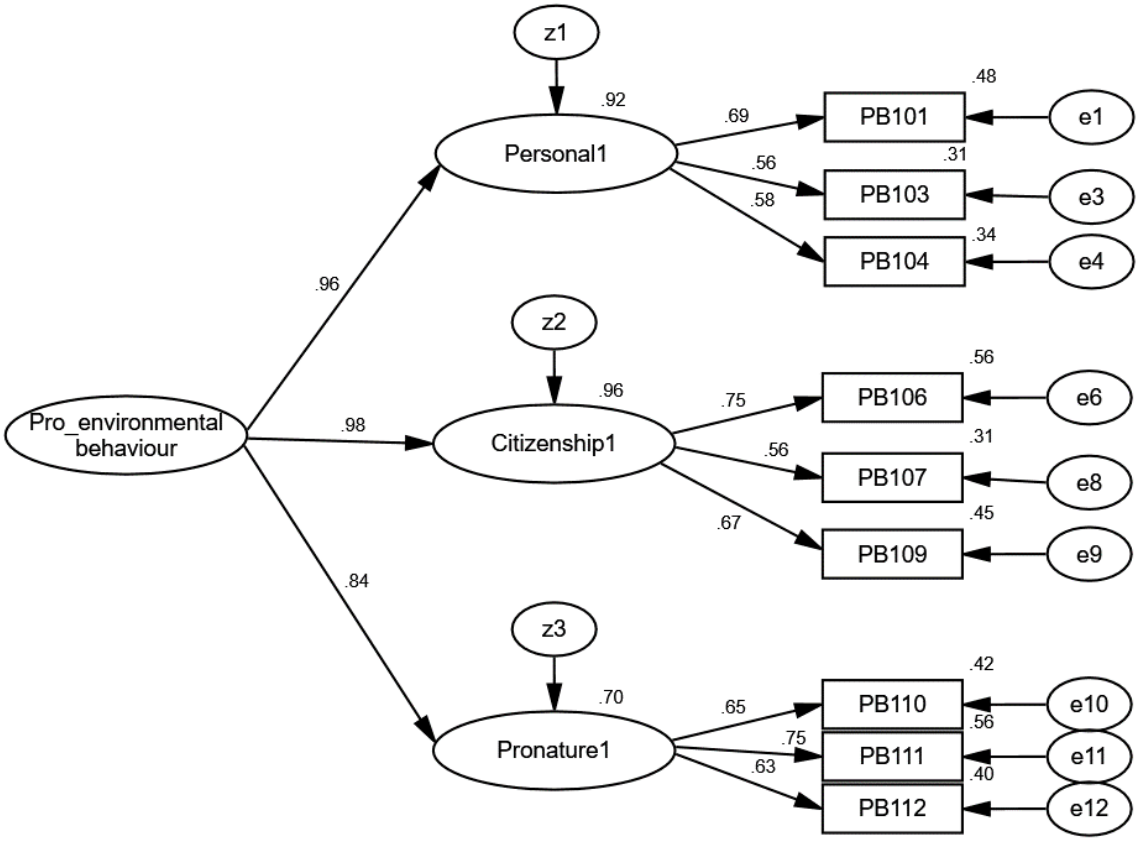
CMIN/DF = 2.97; CFI = 0.97; TLI = 0.96; RMSEA = 0.078 [0.045 - 0.113]; SRMR = 0.034

New Ecological Paradigm, for children & adolescents (Corraliza et al., 2013; Manoli et al., 2007)



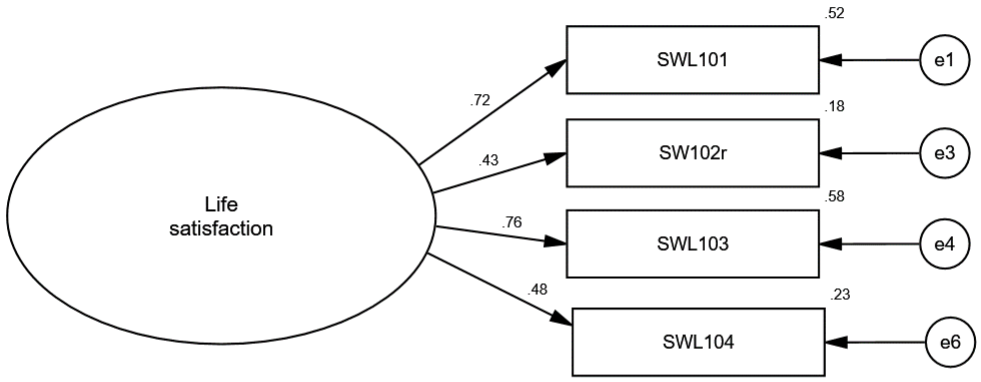
CMIN/DF = 1.08; CFI = 0.99; TLI = 0.99; RMSEA = 0.015 (0.00 - 0.087); SRMR = 0.021

Pro-environmental behaviour



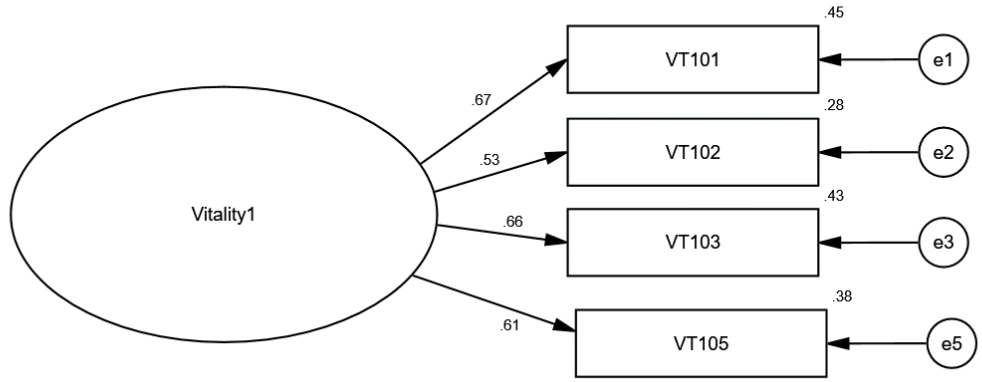
CMIN/DF = 1.68; CFI = 0.98; TLI = 0.97; RMSEA = 0.046 [0.019 - 0.070]; SRMR = 0.033

Students' Life satisfaction Scale (Huebner, 1991)



CMIN/DF = 0.80, CFI = 1.00; TLI = 1.00; RMSEA = 0.00 [0.00 - 0.103]; SRMR = 0.017

Vitality



CMIN/DF = 4.7; CFI = 0.97; TLI = 0.90; RMSEA = 0.108 [0.046 - 0.181]; SRMR = 0.035

Appendix 5: Human Ethics Approval memoranda

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

Phone 0-4-463 5480
Email susan.corbett@vuw.ac.nz

MEMORANDUM

TO	Julie Whitburn
COPY TO	Dr Wayne Linklater
FROM	AProf Susan Corbett, Convener, Human Ethics Committee
DATE	12 October 2016
PAGES	1
SUBJECT	**Ethics Approval: 23405** Connection to nature as the primary mediator for nature's beneficial effects on human wellbeing and engagement in 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 August 2019. 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.

Kind regards

Susan Corbett

Convener, Victoria University Human Ethics Committee

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

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MEMORANDUM

TO	Julie Whitburn
COPY TO	
FROM	AProf Susan Corbett, Convener, Human Ethics Committee
DATE	17 November 2016
PAGES	1
SUBJECT	**Ethics Approval: 23405** Connection to nature as the primary mediator for nature's beneficial effects on human wellbeing and engagement in pro-environmental behaviour

Thank you for your request to amend your ethics approval. This has now been considered and the request granted.

Your application has approval until 31 August 2019. 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.

Kind regards

Susan Corbett

Convener, Victoria University Human Ethics Committee

Appendix 6: Characteristics of classes and schools

School	Class	*n*	School year	Decile	Environmental education provider or control	Location
1	A	13	5 - 6	6	Zealandia	Semi-rural
	B	18	7 - 8	6	Zealandia	Semi-rural
2	A	12	5 - 6	5	Zealandia	Suburban
	B	9	7 – 8	5	Zealandia	Suburban
3	A	20	7 - 8	1	Control	Suburban
	B	19	5 - 6	1	MTS Healthy Harbours	Suburban
	C	23	5 - 6	1	MTS Healthy Harbours	Suburban
	D	14	5 - 6	1	MTS Healthy Harbours	Suburban
4	A	22	5 - 6	2	MTS Healthy Harbours	Suburban
5	A	23	5 - 6	3	MTS Marine Reserves	Suburban
	B	20	5 - 6	3	Control	Suburban
6	A	21	7- 8	10	MTS Marine Reserves	Suburban
	B	22	7 -8	10	MTS Marine Reserves	Suburban
7	A	21	7 – 8	8	Wellington Zoo	Suburban
	B	20	7 – 8	8	Wellington Zoo	Suburban
	C	22	7 – 8	8	Control	Suburban
8	A	25	7 - 8	10	Wellington Zoo	Urban

Abbreviations: MTS, Mountains to Sea