SCIENCE FOR CONSERVATION 321

Health and wellbeing benefits of conservation in New Zealand

Paul Blaschke

newzealand.govt.nz

Department of Conservation
Te Papa Atawhai

Cover: Volunteers at community planting day, Ō Tū Wharekai Wetland restoration project, Lake Heron, Canterbury, September 2009. *Photo: George Iles.*

Science for Conservation is a scientific monograph series presenting research funded by New Zealand Department of Conservation (DOC). Manuscripts are internally and externally peer-reviewed; resulting publications are considered part of the formal international scientific literature.

This report is available from the departmental website in pdf form. Titles are listed in our catalogue on the website, refer www.doc.govt.nz under *Publications*, then *Science & technical*.

ISSN 1177–9241 (web PDF)
ISBN 978–0–478–14990–6 (web PDF)

This report was prepared for publication by the Publishing Team; editing by Amanda Todd and layout by Lynette Clelland. Publication was approved by the Deputy Director-General, Science and Capability Group, Department of Conservation, Wellington, New Zealand.

Published by Publishing Team, Department of Conservation, PO Box 10420, The Terrace, Wellington 6143, New Zealand.

In the interest of forest conservation, we support paperless electronic publishing.

CONTENTS

Health and wellbeing benefits of conservation in New Zealand

Paul Blaschke[1, 2]

[1] Blaschke and Rutherford Environmental Consultants, 34 Pearce St, Wellington 6021, New Zealand. Email: paul.blaschke@xtra.co.nz

[2] Department of Public Health, University of Otago, PO Box 7343, Newtown, Wellington 6242, New Zealand

Abstract

Despite a long-held popular belief that nature is 'healthy' for people, exactly how or even whether this is true has only recently been subject to scientific scrutiny. This report reviews key literature relevant to the relationship between conservation and health and wellbeing (HWB) benefits, with a particular focus on public conservation areas (PCAs) managed by the New Zealand Department of Conservation (DOC). The review takes a broad approach both to the types of natural environments that may offer HWB benefits and to the scope of HWB. Overall, there is a large body of internationally relevant modern research that suggests that exposure to natural environments has direct positive effects on human HWB. However, much of this research was either anecdotal or descriptive. Of the relatively small number of experimental studies that have rigorously tested differences between natural and non-natural settings, many of the positive effects were not statistically significant or related to very small sample groups. Therefore, further investigation of activities undertaken in PCAs and their HWB outcomes is required to better understand conservation/human HWB relationships in New Zealand. The report identifies sources of data and expertise that are required to further analyse the relationships between conservation investment and human health, discusses the value of conservation investment as measured by health outcomes, and describes measures that would improve the alignment between conservation management and potential HWB benefits in New Zealand. Recommendations focus on requirements for research relevant to New Zealand natural areas, and the need for an integrated approach between DOC, other managers of public natural areas, and managers and stakeholders in the health and volunteering sectors.

Keywords: human health, wellbeing, New Zealand, public conservation area, wilderness, green space, natural area, recreation, environmental volunteering

Blaschke, P. 2013: Health and wellbeing benefits of conservation in New Zealand. *Science for Conservation 321*. Department of Conservation, Wellington. 37 p.

1. Introduction

1.1 The provision of services from natural ecosystems

Natural ecosystems, including most public conservation areas (PCAs) in New Zealand, provide a wide range of ecosystem services that sustain human populations, the fundamental importance of which is being increasingly recognised Millennium Ecosystem Assessment 2005; WHO 2011).

In a recent review, McAlpine & Wotton (2007) detailed the range of provisioning, regulating and supporting ecosystem services that are provided by PCAs. Many of these services are also fundamental to human health through the provision of food, clean air and water, soil, the disposal of biological waste products etc. However, these types of direct health benefits are not covered in the present review. Rather, the emphasis here is on a range of indirect ecosystem services that are delivered through people spending time in and being directly exposed to natural settings, for purposes such as recreation, refreshment, education or contributing to conservation[1] efforts. In this report, these types of benefits (which would be classified as 'cultural benefits' in the Millennium Ecosystem Assessment (2005)) are called 'benefits to human health and wellbeing (HWB)'.

1.2 Concepts of health and nature

A commonly used definition of health, which was adopted by the World Health Organization in 1946, is 'a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity'. All aspects of health are essential for the wellbeing and functioning of individuals and communities. According to this definition, the word 'wellbeing' is redundant in the term 'health and wellbeing'; however, I have used the full phrase in this review because many, if not most, people still view health as being synonymous only with the absence of physical disease. Indeed, even within the health sector, previous research on both physical and mental health has tended to focus on the identification and prevention of illness. However, there is growing recognition that health is about more than the absence of illness; for example, mental health requires the presence of positive thoughts and functioning (discussed further below). The implication of this for policy makers is that eliminating illness will not in itself guarantee a healthy society; positive aspects of health also need to be increased (Keyes 2007).

An innate belief in the 'healthiness' of nature for people is an ancient human paradigm, stemming back at least to Greek philosophers, and more recently reasserted by the eminent naturalist Edward Wilson, who articulated the 'biophilia' hypothesis (Kellert & Wilson 1993). This hypothesis suggests that there is an instinctive bond between human beings and other living systems. In accordance with this hypothesis, general mechanisms postulated to explain relationships between green space and health, wellbeing and social capital are shown in Fig. 1. These assumed relationships have been critical to the development and management of parks and other types of natural areas. However, despite this long-held popular belief, exactly how or even whether the provision of nature and natural areas to humans directly relates to human health has only recently been subject to scientific scrutiny. Therefore, this review seeks to examine evidence for this relationship in more detail, particularly in relation to the potential HWB benefits provided by PCAs managed by the Department of Conservation (DOC) in New Zealand.

1. Throughout this review 'conservation' is equated to 'nature conservation', consistent with the definition of conservation in the Conservation Act.

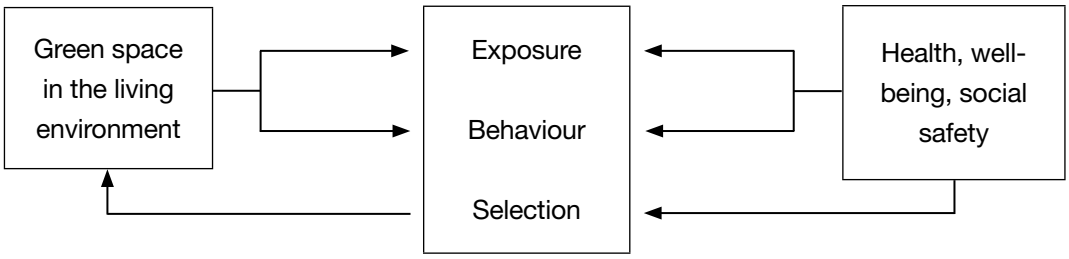

Figure 1. General mechanisms postulated to explain the relationships between green space and health, wellbeing and social capital (termed 'social safety' in this figure). Based on figure in Groenewegen et al. (2006).

Potential applications of understanding of this relationship may be useful both in conservation management and for therapeutic use. Ecopsychology studies the relationship between human beings and the natural environment through both ecological and psychological principles. Ecopsychology seeks to develop and understand ways of expanding the emotional connection between individuals and the natural environment, thereby assisting individuals with developing sustainable lifestyles and remedying alienation from nature (e.g. Buzzell & Chalquist 2009; Milfont 2012). A related area of social and mental health research experiencing recent rapid growth is that of positive psychology, a psychology of positive human functioning, which aims to 'achieve a scientific understanding and effective interventions to build thriving individuals, families, and communities' (Seligman & Csikszentmihalyi 2000). Considerable research on positive emotions from this field shows the significant benefits of positive emotions to HWB, as discussed, for example, by Martin Seligman and Barbara Fredrickson. According to Fredrickson (2001), the capacity to experience positive emotions may be a fundamental human strength central to human flourishing. Discrete positive emotions—including joy, interest, contentment, pride, and love—share the ability to broaden people's momentary thought-action repertoires and build their enduring personal resources (which range from physical and intellectual resources to social and psychological resources).

People go to PCAs, and other parks and natural areas, on a regular basis. It seems obvious that they do this to experience positive emotions—they would not go if they experienced negative emotions. Visiting natural areas would commonly be associated with several positive emotions such as awe, serenity, joy and happiness.

1.3 Background to this review

In the last couple of decades, the relationships between health and nature have been the focus of considerable international interest, both from a scientific perspective and in terms of how these relationships should be reflected in the management of natural areas by government agencies and communities. Public parks, green spaces and natural areas of all types, through their provision of various types of services to human communities, may be seen as key areas that mediate between natural and social capital. In simple terms, parks bring people and nature together in areas where most people live, work and recreate (Maas et al. 2009).

Programmes investigating the relationships between health and nature and, more recently, implementing the outcomes of this research have been developed in several countries or states, including Victoria (Australia), British Columbia (Canada), the United Kingdom and the Netherlands. The Secretariats of the Convention on Biological Diversity and the World Health Organization have also played a significant role in developing understanding and providing liaison between these programmes (see for example WHO (2011) for a recent review).

In New Zealand, DOC has a role in advocating for the conservation of natural and historic resources generally, and promoting the benefits of various kinds of conservation to present and future generations. DOC is also responsible for fostering the use of natural and historic resources

for recreation, and allowing their use for tourism (to the extent that such use is not inconsistent with conservation of the resource). The Conservation Act 1987 defines conservation as 'the preservation and protection of natural and historic resources for the purpose of maintaining their intrinsic values, providing for their appreciation and recreational enjoyment by the public, and safeguarding the options of future generations'. Although this definition does not include direct reference to ecosystem services, the inclusion of the undefined term 'intrinsic values' could arguably imply or include the conservation, protection or preservation of ecosystem services, providing a statutory background to this project.

This review is part of DOC's Conservation and Prosperity Programme (CAPP), which has been established to improve understanding of society's dependence on biodiversity and its fundamental role in New Zealand's social and economic wellbeing. This programme thus directly contributes to DOC's overall outcome:

> *New Zealanders gain environmental, social and economic benefits from healthy functioning ecosystems, from recreation opportunities, and from living our history* (DOC 2012: 10).

The CAPP includes a range of components, including understanding and documenting the ecosystem service benefits of conservation management. The programme assesses the links between biodiversity management and ecosystem services in New Zealand, and studies the effects of conservation management on services such as carbon storage, soil formation and retention, and water supply and quality, along with intrinsic benefits to biodiversity, and cultural and societal benefits. Human health benefits accrue through some types of ecosystem services, such as purifying and regulating services, and human HWB benefits are among the societal benefits to be assessed.

Most of the literature considered in this review does not include explicit discussion of the nature of 'nature' as a concept related to HWB, or definitions of terms used about nature and the natural environment. For this review, I generally equate 'nature' with the 'natural environment' (or different types of natural environments), often called the 'natural world', encompassing all living and non-living things occurring naturally on Earth or some part of the Earth, e.g. New Zealand. The natural environment is often contrasted with the built environment, which has been defined as 'the human-made space in which people live, work, and recreate on a day-to-day basis' (Roof & Oleru 2008).

The natural environment is often considered to be unaffected by humans, but humans as a species are, of course, also part of nature, and by the twenty-first century have influenced and modified almost all parts of the natural environment to some degree. The natural environment in which humans as a species evolved has never been static either. This review does not attempt further discussion of the complex relationships between humans and the natural environment, involving many sociological, ethical and other aspects as well as biophysical relationships. Instead, for the purposes of this review I take a more prosaic approach of roughly equating the natural environment with those natural resources managed by DOC. Natural resources are defined in the Conservation Act as:

> (a) plants and animals of all kinds; and
>
> (b) the air, water, and soil in or on which any plant or animal lives or may live; and
>
> (c) landscape and landform; and
>
> (d) geological features; and
>
> (e) systems of interacting living organisms, and their environment;—
>
> and includes any interest in a natural resource.

Within 'natural resources', green and blue spaces (see below) refer to the actual areas of land or water within which natural resources are located. Further discussion of the continuum of green spaces is provided in section 3.1.

General references to 'nature' almost always clearly include rivers, streams, and other freshwater bodies within land areas, and often also refer to coastal and marine areas. In the Conservation Act, the definitions of conservation and references to DOC's functions clearly include responsibilities for the management of freshwater, coastal and marine areas and ecosystems in as far as they form part of 'natural resources'. Thus the scope of this review includes freshwater, coastal and marine areas, often referred as 'blue space' in contrast to the 'green space' of land areas. However, the majority of the studies reviewed and conclusions reached refer to green rather than blue space, a reflection of the relative research effort directed at relationships between HWB and contact with blue and green space respectively.

1.4 Objectives

This review aimed to:

1. Assess the key literature relevant to the relationship between conservation resources and management (including the biodiversity and recreation responsibilities of DOC) and HWB benefits (including both mental and physical health), with a particular focus on New Zealand.
2. Identify and document the main sources of data and expertise required to further analyse the relationship between conservation investment and human HWB in New Zealand.
3. Carry out a preliminary analysis of the value of conservation investment as measured by health outcomes in New Zealand, including a broad national dollar value if possible.
4. Make recommendations on how to progress knowledge and monitor the relationship between conservation investment and HWB outcomes in New Zealand and, if appropriate, to improve the alignment between conservation management and potential HWB benefits.

2. Methodology

Electronic databases currently hold more than 20 000 articles on various aspects of the relationships between the natural environment and HWB (Bowler et al. 2010). However, it was not possible or desirable to systemically review even a fraction of this large number here. Instead, I have taken two approaches: first I provide an overview and analysis of the range of research in this field, and then I present a focused analysis of international and New Zealand research that pertains to the kinds of green spaces that are of most relevance to DOC.

Through these approaches, I aim to answer five key questions:

1. How does exposure to natural environments influence HWB?
2. What HWB benefits can be attributed to exposure to natural environments?
3. How strong is the evidence of a link between nature and HWB?
4. What are the limitations of current research regarding the relationship between nature and HWB?
5. How applicable to New Zealand are international findings in this area?

The results of the literature review (Objective 1) are presented in three main sections:

1. A summary and commentary on four major international reviews of the topic published between 2004 and 2010 (section 3.2):
   - 'Nature and Health' (Health Council of the Netherlands & RMNO 2004)
   - 'Healthy parks, healthy people: the health benefits of contact with nature in a park context' (Maller et al. 2008—for Parks Victoria, Australia)
   - 'Parks and other green environments: essential components of a healthy human habitat health' (Kuo 2010—for National Recreation and Park Association, USA)
   - 'Systematic review of evidence for the added benefits to health of exposure to natural environments' (Bowler et al. 2010—not commissioned)

   These four reviews were identified through discussions with DOC staff and prior personal literature review. The first three were substantial, wide-ranging and relatively recent studies that were commissioned by government or park agencies. The final review (Bowler et al 2010) is one of a small number of uncommissioned recent systematic reviews in this area, and was selected for comprehensive review because, of these systematic reviews, it includes the greatest number of individual studies. My commentary covers the whole spectrum of work covered in the reviews, including their context as well as their recommendations for further research and for application of the findings.
2. A critical review of the evidence base for a relationship between direct contact with green spaces and human HWB (section 3.3). This review concentrates on English language research that has investigated nature settings equivalent to DOC-administered PCAs and research that has been conducted in New Zealand (regarding any kind of public green space, natural or constructed).
3. A brief review of New Zealand research relevant to the topic, including consideration of the applicability of international research to New Zealand (sections 3.4 and 3.5).

The results of the above three review elements are presented and discussed in section 3, while section 4 addresses Objectives 2–4.

3. Literature review

3.1 Types of green space

As mentioned in the introduction, this review focuses on research that pertains to the kinds of green or blue space or conservation area that are most relevant to DOC. These types may generally be seen as areas of the 'natural environment' rather than 'domestic nature' such as private gardens or 'built nature' such as urban parks or green streetscapes (see Fig. 2). In this review, those parts of the continuum that are managed by DOC are called Public Conservation Areas (PCAs), and the types of green spaces and other types of natural resources (as defined in the Conservation Act) typically found in PCAs are called 'PCA-type nature'. Other public natural areas that are managed by other agencies (principally parks and reserves managed by local government agencies) are called public natural areas. PCAs do include many natural areas within or near urban limits, as well as many places managed for purposes other than nature conservation, e.g. historic reserves.

Note that:

1. The built environment defined in section 1.3 includes public and private green spaces such as gardens and parks.
2. Figure 2 relates specifically to land areas (green space) rather than to marine conservation areas or other types of blue space.

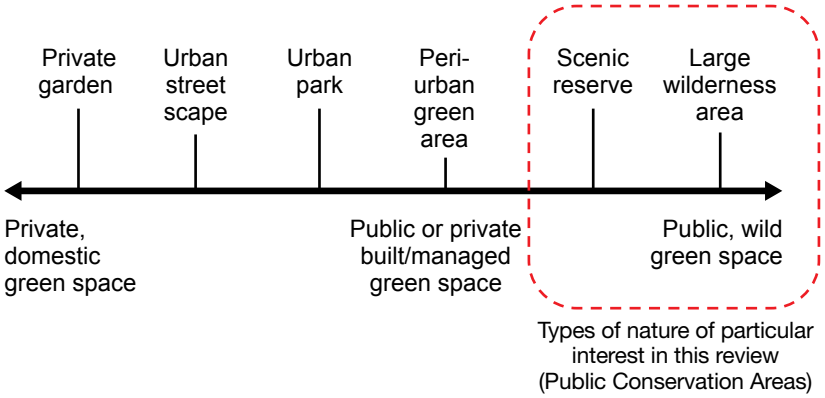

Figure 2. Proposed continuum of types of natural or green space.

3.2 Four major international reviews on the relationship between nature and health

Four international reviews have investigated the relationship between nature and health. In the following sections, I briefly outline and comment on the main findings of these reviews and discuss how this research has developed through time. Further details of each of these reviews can be found in Appendix 1.

3.2.1 Nature and health (Health Council of the Netherlands & RMNO 2004)

This review was commissioned by government ministers of the Netherlands. It thoroughly investigated and assessed the international scientific literature on a possibly beneficial influence of nature on HWB. The research available at that time appeared to be dominated by European work, with a few studies from North America and Japan. Most material related to relatively green urban environments rather than PCA-type nature. The review highlighted several areas where

there were promising indications of possible positive effects between exposure to nature and different types of HWB. However, with the exception of positive effects of nature on recovery from stress and attention fatigue, the studies yielded very little empirical evidence and very few proven effects. Even for the effects on recovery from stress and attention fatigue, the review found there was no information on what dose of nature would be required to prevent stress-related illness in the long term. Consequently, the conclusions and recommendations of this review were heavily dominated by recommendations for further research in all of the categories of possible HWB effects discussed.

3.2.2 Healthy parks, healthy people (Maller et al. 2008)

This review was undertaken for Parks Victoria, the Austalian state of Victoria's state parks management agency. It aimed to provide key information for a range of stakeholders with an interest in HWB benefits arising from interactions with nature, including in park settings. The review revealed a considerable amount and range of new research activity since the time of the previously mentioned review; however, most of this was not specifically relevant to the questions that guided the earlier review.

The review concluded that contact with 'green nature' (ibid) had a range of important benefits for HWB. The range of natural environments reviewed was greater than in the Dutch review, and the assessment was specifically geared towards the park setting, in line with the mission of Parks Victoria. However, the review included a number of nature-related activities that could be considered peripheral or even irrelevant to PCA-type nature, including, for example, the benefits of pet ownership, gardening or viewing somewhat green but nevertheless artificial urban settings (compared with totally built urban settings). Thus, the review could be considered uncritical if it were to be applied directly to the topic of the current review, even though it was very thorough.

The review's conclusions were very positive, covering a wide range of claimed benefits; however, it presented a combined analysis of sound empirical studies with works that were essentially descriptive or produced for advocacy purposes, and many of the statements included were suppositional. Furthermore, although many of the conclusions were framed in terms of park settings, many of the studies from which the conclusions were reached dealt with urban residents and settings, and thus may be of limited applicability to PCAs. The review concluded that because parks and other natural environments are a fundamental health resource, urban planning should ensure that communities have adequate access to nature. However, its recommendations for further work, including the application of the findings to urban design, were relatively generalised.

3.2.3 Parks and other green environments (Kuo 2010)

This report was commissioned by the National Recreation and Park Association—a non-government organisation working to advance parks, recreation and environmental conservation efforts in the USA. It covered a similarly wide range of natural environments and activities to the 'Healthy parks, healthy people' review (Maller et al. 2008), and reached similar conclusions, but with greater certainty. This very articulate and succinct review of actively developing research areas covered social, psychological and physical indicators of HWB among people of different socioeconomic status, and considered both the strengths and variety of research before reaching the overall conclusion that the case for the benefits of exposure to nature on HWB was now proven. In particular, the author considered that:

> … *scientists are routinely taking into account income and other differences in their studies. The question is no longer, do people living in greener neighborhoods have better health outcomes? (They do.) Rather, the question has become,* do people living in greener neighborhoods have better health outcomes **when we take income and other advantages associated with greener neighborhoods into account?** (Kuo 2010: 3–4)

According to the review, the answer to this question is yes:

> *Yes, the benefits of nature that have been intuited and written about through the ages have withstood rigorous scientific scrutiny … In the face of the tremendously diverse and rigorous tests to which the nature-human health hypothesis has been subjected, the strength, consistency, and convergence of the findings are remarkable.* (Kuo 2010: 4)

The review then made useful and relatively specific recommendations based on the findings for creating healthier human (mainly urban) habitats, with relevant examples. These recommendations were largely based around the conclusion that green environments must be experienced (i.e. time must be spent in them) to yield HWB benefits. However although this conclusion is intuitively attractive, it was not particularly well justified in the review.

There was a strong focus on green urban environments and no clear discrimination between different types of natural environments. The review was also essentially negative in its focus: urban equals lack of green, stress and unwellness; and increasing urbanisation means decreasing greenness. Both these assumptions may not hold true in New Zealand or some other parts of the world (see sections 3.4.2 and 3.5). As in the Victorian review (Maller et al. 2008), there was insufficient distinction made between evidence from the different levels and types of material reviewed—for example, empirical studies were compared with descriptive studies, and studies based on small sample sizes were compared with those with large samples.

3.2.4 Systematic review of evidence for the added benefits to health of exposure to natural environments (Bowler et al. 2010).

This review was not commissioned. It took a very different approach to that of the previous three, carrying out a statistical analysis of the 'added benefit' of exposure to nature compared with non-natural settings. It used rigorous inclusion criteria and requirements for comparative environments for all studies, with only 25 studies, based on a narrow range of environments, meeting these criteria. Because of these strict requirements, the degree of greenness or naturalness in some studies was questionable, as acknowledged by the authors.

The authors were very cautionary in their conclusions:

> *Public health decision-makers might … use the review to justify a demand for more rigorous and objective evaluation of interventions which aim to use the natural environment for health promotion. Further research is necessary to investigate whether comparable effects are observed in different populations, environments and social contexts, and the longer-term significance of repeated exposure on health. Policy makers should therefore be wary of translating the findings of studies which have been conducted only in specific settings, for defined indicators and subjects, into generalised statements of universal benefits.* (Bowler et al. 2010)

However, this review did find that, overall, the findings of the studies suggested that natural environments may have direct and positive impacts on wellbeing, particularly for short-term indicators of positive emotions. To this extent, the conclusions were similar to all the other reviews, but had strongest similarities to those of the Health Council of the Netherlands & RMNO (2004) from nearly a decade earlier, which had been based on much more limited evidence and made on a more tentative basis.

3.3 The benefits of direct exposure to public conservation area-type (PCA-type) nature

In this part of the review I focus on international research on the type of nature of most relevance to DOC: generally non-urban, relatively natural PCAs.

3.3.1 How does contact with nature affect health and wellbeing?

There are three main postulated mechanisms by which contact with natural environments might influence health (Health Council of the Netherlands & RMNO 2004; Richardson et al. 2010):

1. **Physical activity**: Green space provides opportunities to partake in physical activity (Humpel et al. 2002); regular physical activity is strongly associated with better physical and mental health outcomes, and can play a role in both preventing and managing chronic disease (Bauman 2004).
2. **Social capital**: Green space may facilitate the development of social capital by providing places to interact with other members of the public and undertake activities with groups, and by strengthening people's sense of attachment to their living environment (Maas et al. 2009). There is a well-established link between social capital and improved physical and mental health (Islam et al. 2006).
3. **Direct effects**: It has been proposed that nature has direct effects on health and wellbeing. Attention has largely been focused on so-called 'restoration' effects—recovery from stress and attention fatigue, enabling people to reflect on issues beyond their routine thoughts and activities (Kaplan 1995). However, new laboratory-based research also suggests that forests might directly affect physical health in other ways; thus, the effects of various sensory stimuli that forests offer (such as visual stimulation, odours, tactile sensations) are currently being studied separately (Tsunetsugu et al. 2010).

These ways in which nature might affect HWB are not mutually exclusive. For example, a group physical activity in a natural setting may confer health benefits via all three of the mechanisms described above.

3.3.2 What are the health and wellbeing benefits of contact with nature?

Research investigating the links between contact with nature and HWB falls into three main categories: contact with 'natural' or 'wild' nature, which is of most relevance to PCAs in New Zealand; contact with green space within the areas in which people live, either at the neighbourhood or city level; and viewing nature from an inside space, either through a window or by looking at images. Research opportunities around this last strand are being expanded by advancing technology, which is enabling realistic virtual environments to be created that include sensory stimuli beyond visual (Depledge et al. 2011). Such research may help us to understand which components of real green environments are the most important for HWB, and may have application for people with mobility and other difficulties. However, the focus of this section is on the first strand—direct contact with PCA-type nature.

Over the last 10 years, there has been an increase in the quality of studies investigating the effects of direct contact with PCA-type nature on HWB, owing largely to well-designed research programmes based in Japan and Korea that have focused on the popular practice of 'Shinrin-yoku' ('forest bathing' or 'leisurely visit to a forest'). Many of the studies in this area now use controlled—and usually crossover—experimental designs, in which participants typically carry out a relatively short period of activity (walking and/or sitting down and 'taking in the scenery') in a forest environment (generally reasonably comparable to a forested New Zealand PCA), and then perform the same activity or activities in an urban environment, as a control. By comparing the same activity in both natural and urban environments, these studies are able to elucidate whether exposure to nature provides any added benefits (i.e. attributable to the direct effects of nature).

'Forest bathing' scholars have investigated a number of HWB outcomes in both the field and the laboratory. In the following sections, I concentrate on the findings from field studies.

3.3.3 Benefits to mental health and wellbeing

Research to date has mainly focused on the mental health outcomes of contact with PCA-type nature. Many recent crossover experiments that have been conducted in Japan have examined the effects of spending time in nature on stress relief and mood, and have yielded similar positive findings (Hartig et al. 2003; Yamaguchi et al. 2006; Park et al. 2007, 2008, 2010; Tsunetsugu et al. 2007; Lee et al. 2011). Park et al. (2010) conducted the largest such study to date, involving 280 participants and 24 sites across Japan. This study found that sitting down observing nature (14 minutes) followed by walking in nature (16 minutes) resulted in a significant reduction in stress (as measured by biochemical and cardiovascular indicators) as well as improved mood and vigour, compared with similar activities in an urban setting.

Many earlier studies also investigated the effect of contact with wild nature on recovery from stress, how people feel and how people perform cognitively, although these studies were often methodologically weak. One exception was a randomised controlled study conducted in Southern California in 1991 (Hartig et al. 1991), in which groups of students were assigned to one of three groups: 40 minutes walking in a regional park; 40 minutes walking in an urban area; or 40 minutes reading magazines indoors. Before commencing the walk or magazine reading, subjects undertook 40 minutes of a standardised task to induce mental fatigue. It was found that the nature walk led to significant improvements in mood, reduced anger and aggression, and better recovery from mental fatigue compared with walking in the urban setting or sedentary magazine reading.

More recently, Barton & Pretty (2010) performed a meta-analysis of ten studies conducted in the United Kingdom that measured changes in self-esteem and mood after exercising in green and blue environments. They found that exercise in these environments was associated with improvements in self-esteem and mood directly after the activity. The greatest improvements were seen following very short doses of exercise (5 minutes), low-intensity exercise and exercise on or close to water. Their finding that short, low-intensity doses of 'green/blue' exercise may be the best dose for improving mental wellbeing may be encouraging for people with limited ability, time or motivation to exercise. However, it should be noted that the authors did not examine physical wellbeing, which would be expected to benefit from longer, more intense doses of activity. The findings of this study contrast with earlier research by the same authors (Barton et al. 2009), which found that longer durations of exercise were associated with greater improvements in mood; however, it should be noted that both studies suffered from quality issues (Depledge et al. 2011).

The value of nature as a therapeutic setting for various populations with behavioural or mental health problems has also been investigated. In a recent systematic review, Annerstedt & Währborg (2011) concluded that wilderness or adventure programmes are generally effective across a range of HWB outcomes, and that there is evidence that the longer the programme is, the more positive the result. An earlier review (Hine et al. 2009) that examined a range of quantitative and qualitative studies also reached broadly similar conclusions. Roe & Aspinall (2011) compared the effects of rural and urban guided walks for people with clinically diagnosed mental illness and for people with good mental health, and found that the rural walks led to a greater improvement in the mood and mindset of both groups, but to a larger degree among those with poorer mental health.

3.3.4 Benefits to physical health

Research into the effects of PCA-type nature on physical health is less developed, but has produced some interesting results. A number of laboratory studies have suggested that volatile substances in forests have beneficial effects on human immune function, although only some of these articles have been published in English (Li et al. 2006; Li et al. 2007). In field studies comparing forest and urban settings, it was found that forest bathing trips significantly increased natural killer cell activity in both male and female participants, signalling a potential role in

cancer prevention (Li et al. 2008a, b). Li et al. (2011) also conducted a field experiment in which 16 participants walked for 6 km in both a forest setting and an urban setting, and found that the forest walk resulted in significant increases in concentrations of the hormones adiponectin and DHEA-S, which may be protective against heart disease, obesity and diabetes.

The potential for nature to be used as a type of therapy for people with health problems has also been investigated. Ohtsuka et al. (1998) investigated the effect of forest walks on blood sugar control among older, non-insulin-dependent diabetics, and found that there was a greater average reduction in blood sugar level than previously found in other studies that have investigated the effect of exercising in non-natural environments. However, since there was no control group in this study, more research is needed to determine whether walking in nature really is better for diabetic control than walking elsewhere.

3.3.5 Environmental volunteering

The potential HWB benefits of environmental volunteering, as a group physical activity in a natural setting, were mentioned in section 3.3.1. A small number of studies have considered the relationship between environmental volunteering and HWB, building on a more substantial literature that links all kinds of volunteering to better HWB outcomes (Grimm et al. 2007). The most rigorous environmental volunteering study to date, to my knowledge, was by Pillemer et al. (2010) in California, who used data from the Alameda County Study, which followed a cohort of 6928 adults from 1965 to the present day, to examine whether a person who engaged in environmental volunteering or other types of volunteering in midlife would have better HWB outcomes 20 years later (data gathered in 1974 and 1994). They found that compared with other types of volunteering, environmental volunteering was more strongly associated with subsequent physical activity, as well as better self-reported health and fewer symptoms of depression. Although it is not possible to infer a causal link due to the study design, and the study was limited by a lack of detail on the type, duration or frequency of the environmental work, these findings support the need for further intervention studies in this area.

A number of largely qualitative studies on environmental volunteering have also been conducted by researchers at Deakin University in Victoria, Australia (Townsend 2006; Townsend & Ebden 2006). This team studied three types of environmental projects: groups involved in conserving certain local areas; a society focused on private land of high conservation value; and a project targeting people with mental health problems. Participants in all of these projects generally believed that their involvement brought physical, mental and social benefits.

3.3.6 Strengths and limitations of international research examined

Amongst the body of experimental and quasi-experimental research discussed above, it can be seen that there has been an increasing use of robust study designs, including control groups, objective and subjective outcome measures, and standardised instruments. There has also been an expansion in the outcomes being tested and groups of populations being studied (i.e. both 'healthy' and 'sick' populations).

However, many limitations still remain. Most currently available research does not clearly identify the characteristics or types of natural or green areas to which it pertains, often making its relevance to PCA-type nature difficult to assess. Also, most of the outcome measures have been short-term, e.g. reduction in stress or blood sugar shortly after a single nature experience, with later changes seldom being measured, and so these effects may have dissipated by the time people returned to their home, or even to the car park, resulting in no longer term effects on HWB. For example, in a Japanese study, Morita et al. (2011) found that although forest walking experiments often show short-term reductions in blood pressure, a cross-sectional analysis with a relatively large sample of people (n = 4666) attending a private preventative health clinic found no association between the frequency of forest walking and blood pressure or prevalence of hypertension. Although such cross-sectional research also has its limitations, this does indicate

that positive short-term effects cannot be assumed to translate into longer term HWB benefits. By contrast, Annerstedt & Währborg (2011) found that wilderness or adventure therapeutic programmes had lasting benefits a year later. Therefore, studies with larger cohorts and longer follow-up are required to elucidate whether short-term effects translate into reduced rates of illness and lasting improvements in wellbeing.

Unfortunately, the relative weakness of the evidence base is often insufficiently reflected in the claims and recommendations made by researchers or reviewers. For example, Barton & Pretty (2010) claimed that it is 'virtually certain [that] "Green exercise" … is associated with positive health outcomes, which exceed those experienced from exercising in environments lacking nature'. On the other hand, Bowler et al. (2010) urged wariness in translating the findings of the existing body of research 'into generalised statements of universal benefits', and Thompson Coon et al. (2011) were even more cautious in their assessment. As these latter authors pointed out, many of the studies have failed to: describe the randomisation and treatment allocation procedures; blind the assessors; provide evidence of sample size calculations; or test repeat sessions of activity and different weather conditions. There has also been limited variation in the types of green (or blue) space and types of activity investigated, and most studies have involved small samples of healthy university students or physically fit volunteers (Bowler et al. 2010; Thompson Coon et al. 2011). Furthermore, the HWB benefits of exposure to blue space needs further investigation both in its own right and in relation to exposure to green space and spaces containing both blue and green.

In a summary of the requirements for comprehensive evaluation, Thompson Coon et al. (2011: 1771) concluded that:

> *Large, well designed trials in which the effects of long-term physical activity interventions conducted indoors and out in nature on mental and physical wellbeing are compared in different groups of people are urgently needed … [including] measures to assess the adherence to different physical activity programs.* (Thompson Coon et al. 2011)

Bowler et al. (2010) discussed a simpler hypothesis in which natural settings simply promote health-enhancing behaviour rather than having specific and direct benefits. They provided as examples activities that occur specifically in a natural environment and that are particularly beneficial to health, or activities that are encouraged by a natural setting (e.g. jogging in a park). However, they also commented that their meta-analysis indicated beneficial effects of natural environments on some health measures even after controlling for the type of activity. Hartig (2008) also discussed an intertwining of mechanisms whereby the extent to which people are attracted to green spaces when taking physical activity is related to the restoration that they experience within them.

Much of the above discussion refers only to the enhancement of physical activity in natural settings. However, given that social capital and direct restorative effects have also been postulated as ways by which contact with natural environments might influence health, such intertwining of mechanisms as proposed by Hartig (2008) seems feasible. These considerations suggest that, even allowing for our far from complete knowledge of the types of HWB benefits that are enhanced by exposure to natural settings, let alone their mechanisms, the benefits are real.

3.4 New Zealand research on the relationship between nature and health and wellbeing

Very little research has been conducted in New Zealand that is of direct relevance to the theme of conservation and HWB benefits. However, there has been some recent research into the HWB benefits of involvement with community gardens or environmental restoration projects, as well as a few studies on access to urban green space. Much of this research has been carried out as student theses and projects.

3.4.1 Gardens and environmental restoration projects

There is a long history of gardening in New Zealand, both in private gardens and through different forms of communal gardening, amongst Māori and Pākeha (Dawson 2010; Earle 2011). Gardening was an integral part of Te Ao Māori (the Māori world) and gardening work was carried out communally. Various customary use practices of cultural harvest have continued to the present, although to a much more restricted extent than in earlier times. A recent Waitangi Tribunal report on how New Zealand law and policy have affected Māori culture and identity (the 'Wai 262' enquiry) documents the fundamental importance of taonga (treasured) plant and animal species to modern Māori in terms of their identity and kaitiakitanga (guardianship) (Waitangi Tribunal 2011). This particularly applies to plant species used in rongoā (traditional healing) and thus plays an important role in Māori concepts of HWB.

A recent study of gardens in the ecology and society of Dunedin City examined, among other things, the relationship of householders to their gardens, some of which included native biodiversity components (Van Heezink et al. 2012; Freeman et al. 2012). The authors documented the health and recreation benefits of gardens in Dunedin, largely through stress reduction. Social connections and capital were also enhanced through gardening, as was a sense of environmental stewardship.

In a summary of New Zealand research on community gardens, Earle (2011) documented how, in the last few years, the New Zealand health sector has begun to identify gardening as a possible public health intervention to help reduce the high prevalence of avoidable chronic health conditions among disadvantaged communities. The research involved interviewing 35 community garden coordinators and other stakeholders in Auckland and Wellington, who described a range of health benefits for the participating individuals, families/whānau and communities, including improved nutrition, increased physical activity, increased social capital, and enhanced mental and spiritual health. Earle (2011) noted that if community gardens foster an inclusive approach, they could also help to reduce inequalities by allowing people who may normally be excluded from community groups to become involved. Whether community gardening or environmental restoration groups are more inclusive than other groups does not appear to have been researched. However, a survey of farmers participating in restoration activities in the Maungatautari Mountain restoration project (Waikato) documented self-reported benefits of involvement, principally in terms of increased social connectivity (Roche & Rolley 2011).

In addition, two theses have documented ways in which community gardening and environmental restoration can contribute to increased environmental knowledge and understanding. Watson (2006) surveyed 14 community gardeners, and found that these gardens can be an ideal setting for children's learning in many domains of the curriculum. Cowie (2011) studied Kāpiti Coast dune restoration groups and found that two-thirds of respondents had learnt at least one skill or piece of knowledge, while the majority agreed that their new-found knowledge or skills had positively impacted on their attitude towards the environment.

A recent University of Otago student research project aimed to investigate the effects of participation in both community gardens and ecological restoration projects on wellbeing and social capital, and to explore whether community gardening could help to reduce the health disparities between Māori and non-Māori New Zealanders (Cleghorn et al. 2011). The researchers

undertook a qualitative survey involving semi-structured interviews with three community gardening and two restoration groups, and identified major benefits that included stress relief, a sense of achievement, improved social skills, increased community cohesion and a return to cultural roots—this last benefit had not previously received attention in the literature. The researchers concluded that both community gardening and ecological restoration involvement could bring multiple benefits, but that evidence suggested that community gardening brought the most benefits. Consequently, they suggested that community gardening could be prescribed as a therapy by General Practitioners through the 'Green Prescription' programme. A Green Prescription is a health professional's written advice to a patient to be physically active, as part of the patient's health management (see http://www.health.govt.nz/our-work/preventative-health-wellness/physical-activity/green-prescriptions).

3.4.2 Access to green space

Three cross-sectional spatial analyses have been carried out in recent years examining the relationship between neighbourhood access to green space and health in New Zealand (Witten et al. 2008; Richardson et al. 2010, 2013). Witten et al. (2008), who used health data from the nationally-representative New Zealand Health Survey and land use data from Land Information New Zealand and DOC, found no association between green space and Body Mass Index (BMI), sedentary behaviour or physical activity.

Similarly, Richardson et al. (2010), who used New Zealand-wide mortality data, also found no association between the amount of green space in the area in which people live (either useable space or total space) and mortality from either cardiovascular disease (e.g. heart attacks or strokes) or lung cancer. Whilst it is unlikely that lung cancer prevalence would be affected by green space (as the main risk factor is smoking), physical inactivity and stress are indicated in the causation of circulatory disease, so it might be expected that greener neighbourhoods would be associated with reduced cardiovascular disease mortality, as was found in England (Mitchell & Popham 2008). Thus, neither of these New Zealand studies found evidence of an association between greenness and selected health indicators at the neighbourhood level. The most recent New Zealand study of this type has confirmed that neighbourhood green space was related to some health outcomes but that although physical activity was higher in greener neighbourhoods, it did not fully explain the green space and health relationship (Richardson et al 2013).

3.5 Applicability of international research to New Zealand

As indicated in section 3.3.6, the questions of how much, how often and what type of nature is most beneficial for HWB require further research. Furthermore, international research in this area is not yet sufficient to assume that the findings can be generalised to New Zealand. Although it can be expected that spending time in PCAs would lead to improved mental health and wellbeing in the short term, it is not clear whether these effects would last, or whether the same level of effect might be gained from walking in an urban area, spending time in a private garden or visiting an urban park.

The issues around access to green spaces are of particular interest in applying international research to New Zealand. The findings of the New Zealand studies discussed in section 3.4.2 contrast with international research, which has shown that greener neighbourhoods are generally associated with reduced rates of mortality (Mitchell & Popham 2008), better self-rated health (de Vries et al. 2003; Maas et al. 2006; Mitchell & Popham 2007; Sugiyama et al. 2008), less illness (particularly mental illness) (Maas 2009), greater resilience to stress (van den Berg et al. 2010), and reduced rates of overweight and obesity (Ellaway et al. 2005; Nielsen & Hansen 2007). However, it should be noted that only a limited number of health measures have been examined so far in the New Zealand studies. The two earlier studies had further limitations, in that not only did they use land use / land cover data rather than data on the actual use of green environments

by individuals within the neighbourhoods, but there was also little differentiation between the types or qualities of green spaces. There are likely to be disparities in the quality of green spaces across different neighbourhoods in New Zealand (e.g. aesthetics and perception of safety), which are likely to influence the use of these areas.

Looking beyond the neighbourhood level, a recently published study (Richardson et al. 2012) investigated the relationship between greenness (at a city-level scale) and health by looking at the 49 largest cities in the USA, which had a combined population of 43 million people. Contrary to expectation, they found that at the city-level scale, the greener the city, the greater the risk of the residents dying, which contrasts markedly with findings at the neighbourhood level. This finding may reflect the fact that greener American cities tend to be more sprawling and so the residents are more car dependent; and there may also be a selection bias if healthier people tend to be attracted to bigger, denser, but less-green cities.

The Witten et al. (2008) and Richardson et al. (2010) studies drew attention to differences in green space and access to it across New Zealand. However, the contrast between urban and PCA-type natural areas in New Zealand is less pronounced than in countries with very large cities or conurbations, so the effects may not be the same or of the same magnitude. Urban areas in New Zealand are greener and private gardens tend to be larger than in many other parts of the world. Parks are also generally very accessible, with residents in three out of four neighbourhoods being estimated to be able to travel to a park by car within 2.4 minutes and 65% of the population living within 5 km of the sea (Witten et al. 2008). Thus, as implied above there is a need to exercise caution when applying international findings to New Zealand and a requirement for empirical research on the relationship between PCAs and HWB to be conducted here. The sometimes contrasting findings of the studies discussed above serve as a reminder that local access to green spaces is just one aspect of the relationship between nature and HWB, and that the relationship between green space, other aspects of urban and natural area planning and management and HWB is yet to be fully understood.

4. General discussion

In this section I address Objectives 2–4 of the research brief and discuss issues arising from the literature review, in terms of their conservation management implications.

4.1 Health and wellbeing and public conservation areas

4.1.1 What kinds of benefits where?

Although there has been some research on HWB benefits arising from PCA-type natural spaces, most of this has inadequately characterised the natural areas being assessed. In fact, as discussed in section 3.3.6, some of the studies reviewed refer to urban natural areas or even to areas that are highly modified, comprising introduced rather than native species, and merely 'green' in comparison to 'hard' (built) features such as houses or roads.

The findings of research to date on the effects of PCAs of different sizes and naturalness have been somewhat contradictory. Kuo (2010) suggested that extended, concentrated and immersive exposures may be particularly helpful, and that, all other things being equal, the greener the environment, the greater or more reliable the benefits. However, Barton & Pretty (2010) reported contradictory results, with the greatest benefits to self-esteem and mood measures resulting from short (5-minute) exposures; they were unclear about the benefits of repeated 5-minute exposures. Kuo (2011) also tentatively concluded that the benefits of 'being in nature' were greater than from merely 'seeing' nature, but did not comment on the benefits of 'doing things' in nature.

If it were true that potential HWB benefits come from **all** types of green space (however counterintuitive this may be), then to maximise HWB benefits there may be greater benefit from investing in areas such as urban parks (which are mainly managed by territorial local authorities) than in PCAs, as the former tend to be accessible to more people than most PCAs (managed in New Zealand by DOC). This could be true of recreation benefits from natural areas too. However, to fully assess the relative benefits of different types of natural areas, there is a need to more adequately characterise the natural areas being assessed for potential HWB benefits and the types of HWB benefits associated with these different kinds of natural areas, both in New Zealand and internationally. Furthermore, it is important to remember that any HWB benefits of PCAs are additional to all the other values of natural ecosystems, such as their biodiversity values, ecosystem service benefits and scenic values.

If it is found that all types of green areas are equally beneficial, there will be an opportunity for DOC to increase awareness of the potential HWB benefits from all of the land it manages, including the many PCAs that are located in and near urban areas. Some of these areas are relatively small and may have relatively low biodiversity values, but many are very important visitor destinations that receive large numbers of local as well as international visitors. Examples of such destinations are Long Bay Marine Reserve, North Head Historic Reserve, Leigh Recreation Reserve, Kauaeranga Road, Flagstaff Hill Walk, Rangitoto Island, Waikanae Estuary, Otaki Forks and the Ahuriri Estuary, all of which receive more than 30 000 visits annually. Some areas that are managed primarily for their historic heritage values may also fall into this category. I characterise this approach as 'bringing parks to people' (as opposed to the 'bringing people to parks' approach discussed in section 4.2.1).

4.1.2 Health and wellbeing benefits and national identity

For all New Zealanders, the sense of identity derived from their indigenous biota and natural areas is assumed to be important, at least symbolically, as stressed in the New Zealand Biodiversity Strategy (DOC & MfE 2000: 6):

> *New Zealand's biological world is the inspiration for our national icons – the kiwi, silver fern and koru. As New Zealanders, we are shaped by these symbols of our natural environment and our relationship to it – whether by cabbage trees or kahikatea forest, weta or whitebait. We would be impoverished kiwis indeed if our national icons went the way of the huia and the moa.*
>
> (DOC & MfE 2000)

This sentiment has also been widely exploited as both the inspiration and the marketing cachet of New Zealand's tourism industry and 'Brand New Zealand', with campaigns such as '100% Pure'. The stories associated with places are also important to New Zealanders' sense of identity, as expressed in many aspects of popular culture and many art forms. The significant number of PCAs that are managed primarily for their historic heritage values reinforces this importance.

A sense of identity is also known to have a positive influence on individuals' wellbeing, a relationship that forms an important component of the biophilia hypothesis (Kellert & Wilson 1993; Kellert 1997). Natural areas, especially those that include large 'wild' areas, may therefore be critical to HWB benefits associated with New Zealanders' sense of national or cultural identity. Although there is very little scientific research on this theme, there are some indications of the cultural importance of natural areas, particularly to Māori, as discussed in section 3.4.1. This importance was fully documented in the Waitangi Tribunal's 'Wai 262' enquiry (Waitangi Tribunal 2011), in which the Tribunal commented on the important place of taonga species and places in national identity, even outside Treaty relationship and obligations. The Tribunal found that the relationship between Māori and taonga species and places were vital to the ongoing expression of Māori culture and identity, and made several recommendations aimed at facilitating access to natural areas for Māori, to allow them to engage in cultural practices and to facilitate matauranga Māori, the system of Māori knowledge.

In terms of positive psychology and positive emotions (introduced in section 1.2), I note generally that psychological benefits of green spaces have been acknowledged in some articles cited in this review, but often in more clinical descriptions of mental health rather than a broader promotion of well-being approach. However, one important aspect of positive psychology directly relates to New Zealanders' sense of identity derived from their indigenous biota and natural areas. The unique aspects of New Zealand's indigenous ecosystems (largely under DOC's management) could provide a range of positive emotions relating to cultural identity and ancestral meaning for Maori, and increasingly for Pakeha in terms of a sense of place and belonging. I recommend that future survey work on identity issues for New Zealanders should include surveying New Zealanders' feelings about their indigenous flora and fauna, and natural areas, in relation to identity, and its impact on their positive emotions and wellbeing.

4.1.3 Health and wellbeing benefits from volunteering

Volunteers are likely to be a group of visitors that are of particular interest in aligning conservation management and potential HWB benefits. Grimm et al. (2007) reviewed the health benefits of volunteering in general for the Corporation for National and Community Service, USA, and some research has indicated that environmental volunteering leads to greater benefits than other types of volunteering (see section 3.3.5). In the environmental sector, volunteering activities often align all three mechanisms of potential HWB benefits (recreation, social capital and direct restorative effects), thereby possibly enhancing the potential HWB benefits for volunteers and the wider community in multiple ways. The large and increasing number of volunteers that are currently working in PCAs, as well as the range of activities they undertake and benefits they report, indicate the wide potential of these programmes.

DOC has recent survey information concerning the scale of volunteer conservation activity in PCAs (Hardie-Boys 2010; Helga Wientjes, DOC, pers. comm.). In 2010–2011 (the most recent year for which data are available), there were nearly 12000 volunteers contributing 32500 person-days of effort, i.e. 2.7 person-days per volunteer. In addition, there were 508 groups involving 19500 volunteers undertaking conservation activities in PCAs in partnership with DOC, who contributed more than 95000 person-days of effort, i.e. 4.9 person-days per volunteer. This number of person-days worked by individual volunteers and groups represented a 52% and 43% increase, respectively, over 2005–2006 levels, indicating that the interest in volunteering has increased significantly over recent years. Hardie-Boys (2010) also documented the wide range of activities undertaken by the volunteers, reported on the opinions of the volunteers on their efforts (including where they thought they were making the greatest contribution to conservation), and assessed the monetary and other values of the conservation effort.

One interesting finding from the Hardie-Boys (2010) survey was that although volunteers felt that they were making significant contributions to community involvement and public awareness, they were much less likely to report benefits to their own health and wellbeing. However, this finding is not consistent with the limited amount of international research that is available, and so requires further investigation in New Zealand. In the meantime, it is important not to 'oversell' the HWB benefits for volunteers (or for other groups), and to remember the many other benefits of volunteering programmes.

As well as providing many biodiversity and heritage protection benefits, volunteering programmes (both for individuals and all kinds of groups) also represent an important part of DOC's engagement goals. The fostering of volunteering programmes for a wide range of groups in New Zealand society may be an important mechanism for both the 'bringing parks to people' and 'bringing people to parks' approaches discussed in sections 4.1.3 and 4.2.1.

4.1.4 Health and wellbeing benefits from 'blue spaces'

There is very little information in the literature about HWB benefits associated with 'blue' rather than 'green' areas, i.e. PCAs based around water (lakes, rivers, coastal areas, etc.) rather than land (see section 1.3). Given the beneficial effect of natural scenes involving running water on the mood and psychological state of humans (Rohde & Kendel 1997; Barton & Pretty 2010), it is plausible that many of the potential HWB benefits from nature are likely to be at least as important, if not more so, for blue spaces than green. Furthermore, since 65% of the New Zealand population, across all types of neighbourhoods, live within 5 km of the sea (Witten et al. 2008), access to blue spaces may have even greater importance for HWB in New Zealand. Traditionally, coastal and river settings are seen as attractive to all New Zealanders, seemingly across all socio-economic, cultural and ethnic groups; however, New Zealand's changing cultural demographic mix may affect the relative importance of coastal and 'blue' zones. It should also be noted that many of the most-visited PCAs are coastal or marine areas and that New Zealanders have good access to and very highly value 'blue space'. For example, survey results confirm very high publicly-held values for coastal ecosystems in Auckland (Batstone & Sinner 2010).

4.2 Improving the alignment between conservation management and potential health and wellbeing benefits

4.2.1 Who receives potential health and wellbeing benefits from PCAs?

Although free entry to New Zealand PCAs is an established principle of conservation management in New Zealand, it is incorrect to assume that there are no barriers to people visiting PCAs. In fact, many of the PCAs, including many iconic national parks and scenic areas, are located a long distance from all of the main population centres. For example, there are only four national parks in the North Island, all of which are at least a 4-hour drive from Auckland. Therefore, while New Zealand PCAs generally have free entry, the travel and time costs of visiting them are often high (sometimes much higher than the entry fees charged in other countries for access to national parks, etc.), resulting in significant cost barriers (both absolute and relative) for many people in New Zealand. It is also likely that there are additional barriers to some New Zealanders, including those associated with culture, health or disability.

I am not aware of any New Zealand research on these barriers. However, DOC surveys showed that between 2008 and 2011, 33–39% of the New Zealand population aged over 15 years had visited a DOC-administered PCA in the previous 12 months; while in the same period, 18–25% of the New Zealand population aged over 15 years had visited a national park in the previous 12 months (DOC 2011). (By comparison, about 30% of international visitors to New Zealand each year visit a national park, and this figure has not varied greatly over the last couple of decades.) No similar information appears to be available on the proportion of **young** New Zealanders who have visited PCAs or national parks, nor the proportion of New Zealanders who have **ever**, or **never**, visited a PCA or national park. It is reasonably safe to assume, however, that given the cost barriers to visiting many PCAs and national parks, people in lower socio-economic groups are more likely to be among those who have not visited a national park or other PCA requiring significant travel, either in the last 12 months or ever. Whether this likelihood extends to visits to all public natural areas is unknown, but given the findings that all types of neighbourhoods in New Zealand have good access to green space (Witten et al. 2008; Richardson et al. 2010), it is reasonable to speculate that there is more equal accessibility to urban green space than to PCA-type green space across socio-economic groups in New Zealand.

This review has identified the potential HWB benefits associated with access to PCAs, including benefits that are possibly associated with wilderness or extensive natural areas such as national parks. However, there is currently widespread concern about the inequalities of health outcomes for some New Zealanders in low socio-economic groups (Tobias et al. 2009; Imlach Gunasekara et al. 2010), and that these inequalities are increasing in many areas (Baker et al 2012). Thus, there is a risk that if access to PCAs is not equitable, then the HWB benefits associated with natural areas are also not equitably shared, or even worse, exacerbate existing health inequalities if access becomes economically easier for some groups than others. To equitably increase any HWB benefits associated with PCAs there needs to be equal access to these areas across socio-economic groups, which is likely to require increased accessibility for groups who are not currently accessing them.

This potential problem also provides an opportunity for DOC to maximise access by all groups to PCAs, as well as to increase awareness of the potential HWB benefits of such access. This opportunity could be realised through specific awareness programmes, but could also require specific programmes to bring target groups of people into a range of PCAs including national parks and more remote natural areas. I characterise this approach as 'bringing people to parks' (as opposed to the 'bringing parks to people' approach discussed in section 4.1.3).

4.2.2 Health and wellbeing benefits in DOC's strategic planning

Current strategic planning within DOC appears to recognise potential HWB benefits reasonably well, particularly those associated with recreational benefits. The 2012–2017 Statement of Intent (DOC 2012), for example, refers to recent rises in obesity and states that encouraging people to engage in physical activity is a key platform for the Outdoor Recreation Strategy 2009–2015. DOC intends to help increase participation in recreation at conservation destinations, as shown through the Statement of Intent, which asserts that:

> *Everything we do to encourage more people to participate in outdoor recreation … is an investment in our future health, wellbeing and prosperity.* (DOC 2012)

However, the description of these benefits could be broadened to include the full range of potential HWB benefits, i.e. including those gained through the building of social capital and direct restorative effects.

4.2.3 DOC cannot achieve potential health and wellbeing benefits on its own

Regardless of the findings and increased understanding gained from further research into the benefits of exposure to different types of green space on HWB, it will be impossible for DOC to provide the full range of potential HWB benefits by itself, given the important range of public natural areas that is managed by local government, which tend to be more accessible to more people than most DOC-managed PCAs. An example of the limitations of access to DOC-managed PCAs is hinted at in the results of the MENE surveys in the United Kingdom (Stewart 2010, 2011) (see section 4.4.2), which showed the enormous extent of visits to the natural environment for the purpose of walking with dogs (see Maller et al. 2008 for an extensive review of HWB benefits associated with contact with companion animals). Anecdotal information suggests that dog walking is also a very important reason for many New Zealanders to visit natural areas. However, this activity is not permitted on several types of DOC-managed PCAs, including all national parks, and thus is generally more widely available to urban residents in local government-managed parks and natural areas.

Consequently, DOC needs to engage with local government, and preferably also other stakeholders in the health and volunteering sectors, to plan for integrated research and future implementation of policies to maximise HWB benefits associated with all kinds of green spaces. There is already significant collaboration between DOC and local government agencies in natural area planning and management, but such collaboration would necessarily need to be enlarged to achieve the range of potential HWB benefits from all types of public natural areas. Achieving these benefits would also require significantly more interaction between the conservation and health sectors than appears to have occurred in the past. A recent Axford Fellowship report highlighted the need for improved partnerships and integration to improve human, animal and ecosystem health in New Zealand (Harvey 2010). Although the focus of that study was on government arrangements for biosecurity and management of the impacts of zoonotic disease, the integrated approach that was recommended may reflect the sorts of collaborative initiatives that are needed to maximise HWB benefits from all kinds of natural areas.

Volunteer projects with a therapeutic aspect, sometimes targeting people with mental health problems (discussed in section 3.3.5), usually need to be carried out as a collaboration between conservation, health, and/or non-governmental agencies. A Victorian study (Townsend & Ebden 2006) provides useful insights into the challenges of implementing and sustaining programmes for people who, in theory, have the most to gain from exposure to nature. Key issues include governance and achieving buy-in from both funders and front-line workers, as well as more practical barriers to participation, such as lack of transport. Thus, while extending opportunities for experiencing nature to people who would not typically be motivated to volunteer is a laudable goal that may have significant HWB benefits, it is not without significant challenges that require careful management.

4.3 The value of conservation investment as measured by health outcomes in New Zealand

All potential HWB benefits may be associated with monetary benefits. In New Zealand as elsewhere, health costs form a very significant part of central government costs and the national economy generally, and so any treatment costs that could be avoided by the delivery of HWB benefits would have economic benefits. Such benefits may be in the form of avoidance of primary or secondary treatment by way of improved wellness of individuals or populations, or reduced costs of primary or secondary treatment by way of reduced recovery times or improved wellness after treatment. There are also other components to the economic values of improved HWB in addition to avoided costs, such as the avoidance of lost output in the economy as a result of fewer employee days spent off work, etc.

Most research that has attempted to estimate the economic value of HWB benefits has primarily considered the benefits from recreation, including the physical activity associated with recreation. In the United Kingdom, Natural England has commissioned a body of research on this topic over the last few years (see http://publications.naturalengland.org.uk/category/127020). This topic is also considered in a project examining the broader benefits of recreation associated with native biodiversity that is currently being carried out by the New Zealand Institute of Economic Research (NZIER) on behalf of DOC. As discussed in section 3, many of the HWB benefits associated with green spaces come from increased (mainly recreational) physical activity in these spaces.

I am not aware of any New Zealand research that has assessed the monetary value of any HWB benefits associated with natural areas. The most significant problem with any such research at present is that, as discussed in section 3.3.6, most of the currently available research on the relationship between nature and HWB is anecdotal or descriptive in nature, making it difficult to draw any conclusions. Furthermore, many of the positive effects found in the relatively small number of empirical studies that have rigorously tested the differences between green and non-green settings are not statistically significant or relate to very small sample groups. These issues make it virtually impossible to even estimate the 'added benefits' delivered by PCA-type natural settings to HWB benefits. Therefore, following discussion with DOC staff, I conclude that the available data are of insufficient quality to currently attempt to monetise the benefits of conservation investment on HWB in New Zealand.

However, even in the absence of the ability to monetise HWB benefits, it is still valid to assess the contribution of potential HWB benefits with key high-level health goals and objectives. On the basis of the relationships discussed in the review, the potential HWB benefits associated with natural areas may contribute directly to high-level health goals, especially in relation to increased levels of physical activity and improved mental health and wellbeing. Potential HWB benefits may also contribute less directly to the achievement of further high-level goals, including through the development of social capital.

In conclusion, as stated above, all potential HWB benefits may be associated with monetary benefits. However the current paucity of information on the 'added benefits' delivered by PCA-type natural settings to HWB benefits means that it is currently premature to attempt monetisation of such benefits. In the meantime it is, however, reasonable to conclude that potential HWB benefits associated with natural areas are likely to contribute to high-level health sector goals including, in particular, those aimed at increasing the levels of physical activity and improved mental HWB.

4.4 Advancing understanding of the relationship between conservation investment and human health in New Zealand

The literature review indicated that the evidence base for the relationship between direct exposure to PCA-type nature and human HWB is relatively limited, both in New Zealand and internationally. Therefore, this section considers how an understanding of this relationship in the New Zealand context could be advanced.

There are two key questions that first need to be investigated:

1. Which parts of PCAs are used and by whom?
2. What do visitors do in PCAs?

The first question is important because not all people access PCAs equally. To answer this question, the following information about visitors to PCAs would be useful:

- Age
- Gender
- Physical and mental health characteristics
- Ethnicity and cultural identification
- Socio-economic status
- Place of residence[2]
- Place(s) visited within the PCA—particularly the type of site where various types of activities take place

To answer the second question, which would provide information on the types and scale of activities undertaken that have potential HWB benefits, the following information would need to be collected:

- Activities undertaken
- Frequency, intensity and duration of these activities

4.4.1 Data currently available

The most detailed information about the use of PCAs and what visitors do in them is held within DOC's AMIS (Asset Management Information System) database, which contains the annual numbers of visitors to almost all managed destinations within PCAs, including the seasonal and monthly distribution of visitors (Ross Laurence, DOC, pers. comm.). For many destinations, visitor numbers are provided by calibrated data counters, while for other destinations the number is estimated by DOC staff based on a variety of information sources. Each site in the database also contains locational data and is classified into one of nine types of predominant visitor group according to DOC's visitor strategy (DOC 2003). Overall, DOC staff have a reasonable degree of confidence in the accuracy of the database, and because all destinations are geo-referenced, the number of visitors at a given destination has the potential to be linked to a specific type of facility, such as a length of track or road, or a visitor centre, hut, historic building or picnic spot. Information in this database shows that the estimated number of annual visits to a single destination varies from less than 10 to 807500 (as at September 2011), while the total number of visits to destinations within PCAs is approximately 25.3 million annually[3] (Ross Laurence, DOC, pers. comm. June 2012).

[2] Note that while potential HWB benefits are not confined to New Zealand visitors to PCAs (i.e. they may also be conferred on international visitors), the primary focus of this study is on New Zealanders.

[3] It should be noted that this total only includes visits to places that are regarded by DOC as specifically managed 'assets', i.e. it excludes visits such as those made by hunters or trampers accessing PCAs across farmland, visitors travelling by boat on rivers within PCAs, or visitors accessing PCAs for a short visit from a stretch of road or coastline with no facilities; it also excludes most visits by DOC staff.

Additional information is also available from studies on individual destinations or groups of visitors to PCAs, of which two bibliographies have been compiled (Booth & Mackay 2007; Lovelock et al. 2011). These studies often include surveys of the perceptions and experiences of visitors, and include demographic data about them. Some of these studies include detailed information that is relevant to the questions above; however, detailed study of these was beyond the scope of this review.

Studies that utilise sources other than DOC may also provide some useful information around these questions; for example, studies of participants in Outward Bound, multi-sport activities (e.g. the annual Coast to Coast event across the South Island) or wilderness therapy programmes, or assessments of such programmes. Although these programmes are not specifically located in PCAs, they often take place on PCAs administered by DOC or other public land comprising natural ecosystems. Box 1 gives an example of the types of information, from both DOC and non-DOC sources, that are available about one well-known PCA.

Further examples of studies of areas outside PCAs include those on regional parks managed by Auckland and Wellington Regional Councils, which contain a range of natural ecosystems, including relatively extensive 'backcountry' areas. The former Auckland Regional Council commissioned a number of surveys and studies of visitor profiles and experiences within the parks system (Auckland Regional Council 2006; Lovelock et al. 2011), and a detailed qualitative study of the experience of back-country anglers in various kinds of natural areas has also been carried out (Walrond 2001).

4.4.2 Additional information required

Although AMIS can provide substantial data on visitor types to PCAs, further information on visitors' motivation to visit PCAs and the benefits they obtain from these visits would be of great benefit. A good example of the type of information-gathering that needs to be carried out to answer these two questions is the Monitor of Engagement with the Natural Environment (MENE) survey in the United Kingdom, which has recently been initiated to collect detailed information on people's use and enjoyment of the natural environment. Results from the first and second years' surveys have recently been published (Stewart 2010, 2011), which provide very interesting examples of the sort of information about people's behaviour and motivation that helps to illustrate the linkages between people's activities in natural areas and the potential HWB benefits from them. A snapshot of the findings from the first survey, which are of relevance to the potential HWB benefits of nature (although they may not all be directly applicable to New Zealand), includes the following:

- The frequency of visits to the natural environment varied greatly across the English population—whilst half (54%) of the adult population normally visited the natural environment at least once per week, 10% of respondents stated that they had not taken a visit in the previous 12 months and 8% had made only one or two visits.
- The English adult population participated in an estimated 2.86 billion visits to the natural environment in the 12 months from March 2009 to February 2010. This equates to an average of 69 visits per adult.
- Levels of participation in visits to the natural environment were higher amongst people aged between 45 and 64, people in employment, and people in the ABC1 (relatively advantaged) socio-economic group.
- Levels of participation were significantly lower amongst the oldest age groups (aged 65 and over), the black and minority ethnic (BME) population, and members of the DE (relatively disadvantaged) socio-economic group.
- Just under half (48%) of visits to the natural environment were taken to the countryside, while 41% were to green spaces such as parks within towns and cities, 7% were to a green space in a seaside town or resort, and 4% were to another coastal location.
- Two-thirds (66%) of visits were taken within 2 miles of the starting point of the visit, highlighting the importance of accessible green space that is close to home.

- Just under half (48%) of all visits involved walking with a dog. The majority of other visits involved walking without a dog, playing with children, eating out or visiting attractions. Other popular activities included running, informal games and wildlife watching.
- Exercising dogs, personal health and exercise, relaxing and unwinding, enjoying fresh air and pleasant weather, and enjoying scenery were the most frequently cited reasons for taking visits to the natural environment.
- Men were more likely than women to be motivated by health benefits, while women were more likely to want to spend time with family, or to take visits to entertain children or exercise their dog.

Results from the second survey (Stewart 2011) were generally consistent with those reported above, but with an overall decrease of 13% in the number of total visits to the natural environment in all activities and all months. This lower total number of visits was thought to represent external factors such as poor weather, and decreases were not even among seasons, activities, places visited or population groups. The 2011 survey also produced a spatial report showing an analysis of geographical factors such as distance travelled, etc.

The approach discussed above would provide considerable detail on activity patterns within PCAs (i.e. exposure to nature). However, it would not by itself test hypotheses or demonstrate the benefits added by exposure to PCAs. To do this, it would be necessary to undertake a more fundamental study of the type analysed in the reviews by Bowler et al. (2010) and Thompson Coon et al. (2011). Such a study would involve measurement of chosen parameters of physical or mental HWB before and after activities have been undertaken in a characterised area within a PCA, preferably conducted over a considerable period of time with repeat episodes of activity. Such a study should also include a control group performing the same activities in non-green settings. This type of information is critical for obtaining an evidence-based understanding of the relationship between conservation and human HWB in New Zealand. However, it has previously been found that high-quality studies of this type, even when based on self-reported health outcomes, are difficult and expensive to carry out, requiring skills in both study design and analysis, and involving significant ethical and confidentiality considerations. Therefore, I recommend that any such study should not be undertaken until a more detailed analysis of visitor and volunteer profiles, perceptions, activities and motivations in New Zealand has taken place, to enable the formation of robust hypotheses and study design concerning the potential HWB benefits associated with PCAs.

Returning to the question of potential monetary benefits associated with HWB benefits (section 4.3), since DOC's AMIS database contains good-quality data on the costs associated with managing all DOC destinations, it would also be possible to obtain a reasonable indication of at least the relative overall cost-benefit ratios associated with managing those destinations in terms of HWB benefits. This could be done by collecting detailed information on specific activities associated with specific DOC destinations and the potential HWB benefits associated with those activities, together with existing data on use levels. An example of how this could be done is provided in Box 1.

Box 1. Example of a health and well-being (HWB) analysis for a specific destination.

Walkers on the Tongariro Crossing: who receives what type of HWB benefits?

The Tongariro Alpine Crossing ('Tongariro Crossing') in the northern part of Tongariro National Park is one of New Zealand's most popular and spectacular day walks. It attracts visitors from all over New Zealand as well as many thousands of international travellers each year, and its use increased significantly between the mid-1990s and mid-2000s (Blaschke & Whitney 2007). Data from the AMIS database showed that the estimated number of visitors on parts of the track in the year ending September 2011 ranged from 72 500 passing by or stopping at the Ketetahi Hut to 82 500 at Mangetepopo Road. The number of walkers completing the actual Tongariro Crossing was estimated at 77 500, the mid-point of this range. All of these walkers had carried out several hours of active walking, and been exposed to the spectacular and popular natural setting of the Tongariro Crossing.

Several types of visitors are likely to undertake this walk. Most places on the track for which counts are available are classified in the AMIS database in the Day Visitor category (DOC 2003). This is one of the most variable visitor groups, with individuals using a wide range of settings but mostly those with high vehicle accessibility. Activities undertaken by Day Visitors can last from 1 hour to a full day. PCAs classified as predominantly visited by Day Visitors range from those where large numbers of visitors may do little or no physical activity (e.g. Long Bay Marine Reserve) to those such as the Tongariro Crossing, where a whole day's reasonably strenuous walking is required.

By contrast, some places on the track are classified in the Back Country Comfort Seekers category. Members of this visitor group seek an outdoor experience in a natural setting, often tramping for 2–5 days. PCAs that are classified as predominantly visited by Back Country Comfort Seekers range from those where comparatively large numbers of visitors share portions of well-used day walks, such as the Tongariro Circuit, to little-used tracks that are relatively remote and require strenuous activity to reach and traverse.

In reality, the Tongariro Crossing is mainly traversed by walkers who fall midway between these two seemingly distinct visitor groups. Several thousand visitors to the Mangetepopo or Ketetahi Road ends are short-stay visitors who do not venture far from the road ends and would be correctly identified as Short Stop Travellers. By contrast, a smaller number of visitors recorded on parts of the track are multi-day walkers on the Tongariro Circuit or other Tongariro National Park tracks, some of whom would be more accurately identified as Back Country Adventurers or Remoteness Seekers.

All of these groups of walkers are likely to receive some HWB benefits; however, more information than is available from the AMIS database is required to determine which benefits and to what degree. Some of this information would be available from a number of visitor surveys that have been undertaken for the Tongariro Crossing or Tongariro Circuit Track, at least two of which (Cessford 1997; Blaschke & Whitney 2007) have carried out sufficiently detailed surveys of visitors' demographics, experiences, perceptions and satisfaction to answer some parts of the two principal research questions discussed in the text.

5. Conclusions

5.1 Nature of health and wellbeing benefits

1. The beneficial effects of nature and green spaces on human HWB are part of the continuum of ecosystem services that are provided by nature.
2. Public parks and green spaces may best be seen as key areas that mediate between natural and social capital (i.e. between 'people and nature') in areas where most people live, work and recreate.
3. An innate belief in the 'healthiness' of nature is an ancient human paradigm, but how this relates to measurable parameters of HWB has only recently been subject to scientific scrutiny.

5.2 Positive effects

4. Overall, a large body of internationally relevant modern research suggests that exposure to natural environments has direct positive effects on HWB.
5. Green spaces seem to influence HWB in three main ways: by providing opportunities to partake in physical activity; by facilitating the development of social capital; and through direct restorative effects, including recovery from stress and 'mental recharging'.
6. There is some specific evidence that exposure to green spaces provides short-term mental (such as improved mood) and physical (such as reduced blood sugar levels in diabetics) health benefits.
7. HWB benefits associated with natural areas may contribute to high-level goals of the New Zealand health sector, particularly those aimed at increasing the levels of physical activity and improved mental HWB.

5.3 Confounders and caveats

8. Much of the research on potential HWB benefits is either anecdotal or descriptive, and of the relatively small number of experimental studies that have rigorously tested differences between green and non-green settings, many of the positive effects are not statistically significant or relate to very small or unrepresentative sample groups.
9. Most currently available research does not clearly distinguish between different types of natural areas. There is evidence that spending time in large, 'natural' green spaces that are most commonly associated with DOC-managed PCAs provides direct, short-term wellbeing benefits; however, it is not clear whether these effects last and have clinical relevance, whether such areas are more beneficial than other types of green space, which population groups might derive the most benefit, or what 'dose' of nature is required.
10. The findings from some international research that there is a relationship between increasing urbanisation and decreasing greenness may not hold true in New Zealand, as well as other parts of the world, particularly in areas where large proportions of the population enjoy good access to natural areas even when they are economically or socially deprived and/or living in relatively large urban centres.
11. All potential HWB benefits may be associated with monetary benefits. However the paucity of information on the 'added benefits' of nature in perceived HWB benefits means that it is currently not possible to attempt to quantify such benefits.

5.4 Research requirements

12. Further investigation into the activities that are undertaken in PCAs and their HWB outcomes would allow better understanding of the conservation/human HWB relationship in New Zealand.
13. The first priority is to obtain further information and carry out research that can better differentiate between the usage of different types of green spaces, more directly measure how and how often green space is used, and provide more detailed demographic information on visitors.

5.5 Improving the alignment between conservation management and potential health and wellbeing

14. It will be impossible for DOC to provide the full range of potential HWB benefits on its own, given the important range of public natural areas that are managed by local government, which also tend to be more accessible to more people than most DOC-managed PCAs.
15. DOC should engage with local government and other stakeholders in the health and volunteering sectors to plan for integrated research and future implantation of policies to maximise HWB benefits associated with PCAs.
16. Volunteering programmes in conservation areas may have particular and multiple benefits for HWB, although more research is required in this area. However, there are many challenges in implementing and sustaining programmes for those who may have the most to benefit from exposure to nature.
17. Public conservation areas include many 'blue spaces' that may also contribute significantly to HWB. However, these effects are even less well-researched than those associated with terrestrial areas.
18. Natural areas, especially those that include large 'wild' areas, may be critical to HWB benefits associated with New Zealanders' sense of national or cultural identity.
19. Current strategic planning in DOC appears to recognise potential HWB benefits reasonably well, particularly those associated with recreational benefits. However, the description of those benefits could be broadened to include the full range of HWB benefits.

6. Recommendations

To improve our understanding of the relationship between conservation and HWB, I recommend that there is:

1. More detailed analysis of the existing New Zealand literature on visitors to PCAs, to gain a more complete understanding of the two key background questions regarding the relationship between usage of PCAs and HWB benefits:
   a. Which parts of PCAs are used and by whom?
   b. What do visitors do in PCAs?
2. A more detailed analysis of the existing New Zealand literature on volunteering, particularly to gain an understanding of volunteers' profiles, motivations and perceived benefits.

3. Future survey work on identity issues for New Zealanders that includes surveying New Zealanders' feelings about their indigenous flora and fauna, and natural areas, in relation to identity, and its impact on their positive emotions and wellbeing.
4. Discussion between DOC and managers and stakeholders in the health and volunteering sectors, and local government managers of PCAs, to develop an integrated research project for rigorous assessment of the HWB benefits associated with PCAs in New Zealand and to implement future policies that recognise such benefits.

At this stage, I make no specific recommendations around implementation, beyond engagement with the health and volunteering sectors, as in recommendation 4 above, as I consider that further information and understanding is needed before committing to potentially costly intervention programmes in New Zealand. In the meantime, a watching brief should be kept on international research and, especially, implementation programmes involving collaboration between the conservation and health sectors. To my knowledge, these appear to be developing most successfully in Victoria, Australia, and British Columbia, Canada, with a helpful international liaison role being played by the Secretariat of the Convention on Biological Diversity. In Europe, the Positive Health Effects on the Natural Outdoor Environment in Typical Populations of Different Regions in Europe (PHENOTYPE) project, which intends to provide a better understanding of the potential mechanisms, and better integration of human health needs into land use planning and green space management, is to my knowledge the most thorough current programme relevant to the aims of my review. Further information on this programme is available on http://www.phenotype.eu/.

7. Acknowledgements

This research was funded by DOC (Investigation Number 4386). I would particularly like to thank Kate Amore, University of Otago Wellington Medical School, for her skilled assistance with all aspects of the literature review. I also thank all the following for their willing and helpful logistical support, information and comments: Ross Laurence (Conservation and Prosperity Project Manager, DOC), Dr Rod Hay and Helga Wientjes (DOC), Hugh Norriss (Mental Health Foundation), Marc Slade (WWF-NZ), Peter Clough (NZ Institute of Economic Research), Prof. Philippa Howden-Chapman (University of Otago Wellington Medical School), Bill Beckner (US National Recreation and Park Association), Dave Stone (Natural England) and Bec Hoskins (Parks British Columbia). Lynette Clelland (Publishing Team, DOC) and Amanda Todd (Editor) provided skilled assistance with editing, revision and production of the final report.

8. References

Annerstedt, M.; Währborg, P. 2011: Nature-assisted therapy: systematic review of controlled and observational studies. *Scandinavian Journal of Public Health 39(4)*: 371–388.

Auckland Regional Council 2006: Through visitors' eyes: an approach to research on regional parks. Auckland Regional Council, Auckland (unpublished). 5 p.

Baker, M.G.; Barnard L.T.; Kvalsvig, A.; Verrall, A.; Zhang, J.; Keall; M.; Wilson, N.; Wall, T.; Howden-Chapman, P. 2012: Increasing incidence of serious infectious diseases and inequalities in New Zealand: a national epidemiological study. *The Lancet 379*: 1112-9. doi: 10.1016/S0140-6736(11)61780-7

Barton, J.; Hine, R.; Pretty, J. 2009: The health benefits of walking in greenspaces of high natural and heritage value. *Journal of Integrative Environmental Sciences 6*: 261–278.

Barton, J.; Pretty, J. 2010: What is the best dose of nature and green exercise for improving mental health? A multi-study analysis. *Environmental Science & Technology 44(10)*: 3947–3955.

Batstone, C.; Sinner, J. 2010: Techniques for evaluating community preferences for managing coastal ecosystems. Auckland regional stormwater case study. ARC Technical Report 2010/12. 45 p.

Bauman, A.E. 2004: Updating the evidence that physical activity is good for health: an epidemiological review 2000–2003. *Journal of Science and Medicine in Sport 7(1 Supplement)*: 6–19.

Blaschke, P.M.; Whitney, P. 2007: Establishing integrative use limits on the Tongariro Crossing, Tongariro National Park. CRESA, Wellington. 97 p. available on http://www.tba.co.nz/kete/case_studies/pdf/tongariro_crossing_case_study.pdf

Booth, K.; Mackay, M. 2007: Tourism and recreation in New Zealand's natural environment: a bibliography and research synthesis. Report for Ministry of Tourism, Wellington (unpublished). 90 p.

Bowler, D.; Buyung-Ali, L.; Knight, T.; Pullin, A. 2010: A systematic review of evidence for the added benefits to health of exposure to natural environments. *BMC Public Health 10(1)*: 456.

Buzzell, L.; Chalquist, C. (Eds): Ecotherapy: healing with nature in mind. Sierra Club Books, San Francisco.

Cessford, G. 1997: Visitor satisfactions, impact perceptions and attitudes toward management options on the Tongariro Circuit Track. *Science for Conservation 65*. Department of Conservation, Wellington. 56 p.

Cleghorn, M.; Carter, S.; Logan, C.; Mathews, J.; Calman, R.; Ahmad, M.F.; Boo, M.; Ball, O.; Emmett, B.; Gonsalves, M.; Jobson, M.; Kain, M.; Kwang, S.; Mitchell, J.; Azmin, F.M. 2011: Growing individuals, growing communities: well-being outcomes of participating in ecological restoration and community gardening initiatives. University of Otago, Wellington (unpublished). 90 p.

Cowie, C. 2011: Volunteers matter: the geographies of community-based ecological restoration groups in the Wellington Region. Unpublished Master of Science thesis, Victoria University of Wellington, Wellington. 152 p.

Dawson, B. 2010: A history of gardening in New Zealand. Godwit, Auckland. 304 p.

Depledge, M.H.; Stone, R.J.; Bird, W.J. 2011: Can natural and virtual environments be used to promote improved human health and wellbeing? *Environmental Science & Technology 45(11)*: 4660–4665.

de Vries, S.; Verheij, R.A.; Groenewegen, P.P.; Spreeuwenberg, P. 2003: Natural environments—healthy environments? An exploratory analysis of the relationship between greenspace and health. *Environment and Planning A 35(10)*: 1717–1731.

DOC (Department of Conservation) 2003: Visitor strategy. Department of Conservation, Wellington. 60 p.

DOC (Department of Conservation) 2011: Annual Report for the year ended 30 June 2011. Department of Conservation, Wellington. 128 p.

DOC (Department of Conservation) 2012: Statement of Intent 2012–2017. Department of Conservation, Wellington. 52 p.

DOC (Department of Conservation); MfE (Ministry for the Environment) 2000: The New Zealand Biodiversity Strategy. Department of Conservation and Ministry for the Environment, Wellington. 144 p.

Earle, M. 2011: Cultivating health: community gardening as a public health intervention. Unpublished Master of Public Health thesis, University of Otago, Wellington. 204 p.

Ellaway, A.; Macintyre, S.; Bonnefoy, X. 2005: Graffiti, greenery, and obesity in adults: secondary analysis of European cross sectional survey. *British Medical Journal 331(7517)*: 611–612.

Fredrickson, B.P. 2001: The role of positive emotions in positive psychology: the broaden-and-build theory of positive emotions. *American Psychologist 56*: 218–226.

Freeman, C.; Dickinson, K.J.M.; Porter, S.; van Heezik,Y.M. 2012: "My garden is an expression of me": exploring householders' relationships with their gardens. *Journal of Environmental Psychology 32*: 135–143.

Grimm, R.; Spring, K.; Dietz, N. 2007: The health benefits of volunteering: a review of recent research. Corporation for National and Community Service, Washington, DC. 20 p.

Groenewegen, P.; van den Berg, A.; de Vries, S.; Verheij, R. 2006: Vitamin G: effects of green space on health, well-being, and social safety. *BMC Public Health 6*: 149.

Hardie-Boys, N. 2010: Valuing community group contributions to conservation. *Science for Conservation 299*. Department of Conservation, Wellington. 68 p.

Hartig, T. 2008: Green space, psychological restoration, and health inequalities. *The Lancet 372(9650)*: 1614–1615.

Hartig, T.; Evans, G.W.; Jamner, L.D.; Davis, D.S.; Gärling, T. 2003: Tracking restoration in natural and urban field settings. *Journal of Environmental Psychology 23(2)*: 109–123.

Hartig, T.; Mang, M.; Evans, G.W. 1991: Restorative effects of natural environment experiences. *Environment and Behaviour 23(1)*: 3–26.

Harvey, H. 2010: Building bridges to protect health: enhanced partnerships among animal, human, and ecosystem health sectors in New Zealand. Fulbright New Zealand, Wellington. 88 p.

Health Council of the Netherlands; RMNO (Advisory Council for Research on Spatial Planning, Nature and the Environment) 2004: Nature and health: the influence of nature on social, psychological and physical well-being. Health Council of the Netherlands and RMNO, The Hague. 112 p.

Hine, R.; Pretty, J.; Barton, J. 2009: Social, psychological and cultural benefits of large natural habitat & wilderness experience: a review of current literature for the Wilderness Foundation. University of Essex, Colchester. 34 p.

Humpel, N.; Owen, N.; Leslie, E. 2002: Environmental factors associated with adults' participation in physical activity: a review. *American Journal of Preventive Medicine 22(3)*: 188–199.

Imlach Gunasekara, F.; Carter, K.N.; Liu, I.; Richardson, K.; Blakely, T. 2012. The relationship between income and health using longitudinal data from New Zealand. *Journal of Epidemiology and Community Health 66*: doi:10.1136/jech.2010.125021

Islam, M.K.; Merlo, J.; Kawachi, I.; Lindstrom, M.; Gerdtham, U.-G. 2006: Social capital and health: does egalitarianism matter? A literature review. *International Journal for Equity in Health 5(1)*: 3.

Kaplan, S. 1995: The restorative benefits of nature: toward an integrative framework. *Journal of Environmental Psychology 15(3)*: 169–182.

Kellert, S. 1997: Kinship to mastery: biophilia in human evolution and development. Island Press, Washington, DC. 272 p.

Kellert, S.; Wilson, E.O. (Eds) 1993: The biophilia hypothesis. Island Press, Washington, DC. 484 p.

Keyes, C.L.M. 2007: Promoting and protecting mental health as flourishing: a complementary strategy for improving national mental health. *American Psychologist 62(2)*: 95–108.

Kuo, F.E. 2010: Parks and other green environments: essential components of a healthy human habitat. National Recreation and Park Association, Ashburn, VA. 45 p.

Lee, J.; Park, B.J.; Tsunetsugu, Y.; Ohira, T.; Kagawa, T.; Miyazaki, Y. 2011: Effect of forest bathing on physiological and psychological responses in young Japanese male subjects. *Public Health 125(2)*: 93–100.

Li, Q.; Morimoto, K.; Kobayashi, M.; Inagaki, H.; Katsumata, M.; Hirata, Y.; Hirata, K.; Shimizu, T.; Li, Y.J.; Wakayama, Y.; Kawada, T.; Ohira, T.; Takayama, N.; Kagawa, T.; Miyazaki, Y. 2008a: A forest bathing trip increases human natural killer activity and expression of anti-cancer proteins in female subjects. *Journal of Biological Regulators and Homeostatic Agents 22(1)*: 45–55.

Li, Q.; Morimoto, K.; Kobayashi, M.; Inagaki, H.; Katsumata, M.; Hirata, Y.; Hirata, K.; Suzuki, H.; Li, Y.J.; Wakayama, Y.; Kawada, T.; Park, B.J.; Ohira, T.; Matsui, N.; Kagawa, T.; Miyazaki, Y.; Krensky, A.M. 2008b: Visiting a forest, but not a city, increases human natural killer activity and expression of anti-cancer proteins. *International Journal of Immunopathology and Pharmacology 21(1)*: 117–127.

Li, Q.; Morimoto, K.; Nakadai, A.; Inagaki, H.; Katsumata, M.; Shimizu, T.; Hirata, Y.; Hirata, K.; Suzuki, H.; Miyazaki, Y.; Kagawa, T.; Koyama, Y.; Ohira, T.; Takayama, N.; Krensky, A.M.; Kawada, T. 2007: Forest bathing enhances human natural killer activity and expression of anti-cancer proteins. *International Journal of Immunopathology and Pharmacology 20(2)*: 3–8.

Li, Q.; Nakadai, A.; Matsushima, H.; Miyazaki, Y.; Krensky, A.M.; Kawada, T.; Morimoto, K. 2006: Phytoncides (wood essential oils) induce human natural killer cell activity. *Immunopharmacology and Immunotoxicology 28(2)*: 319–333.

Li, Q.; Otsuka, T.; Kobayashi, M.; Wakayama, Y.; Inagaki, H.; Katsumata, M.; Hirata, Y.; Li, Y.; Hirata, K.; Shimizu, T.; Suzuki, H.; Kawada, T.; Kagawa, T. 2011: Acute effects of walking in forest environments on cardiovascular and metabolic parameters. *European Journal of Applied Physiology 111(11)*: 2845–2853.

Lovelock, B.; Farminer, A.; Reis, A.C. 2011: A bibliography of research on visitors to public conservation areas in New Zealand 1995–2010. Department of Conservation, Wellington. 85 p.

Maas, J.; van Dillen, S.M.E.; Verheij, R.A.; Groenewegen, P.P. 2009: Social contacts as a possible mechanism behind the relation between green space and health. *Health and Place 15*: 586–595.

Maas, J.; Verheij, R.A.; Groenewegen, P.P.; de Vries, S.; Spreeuwenberg, P. 2006: Green space, urbanity, and health: how strong is the relation? *Journal of Epidemiology and Community Health 60*: 587–592.

Maller, C.; Townsend, M.; St Leger, L.; Henderson-Wilson, C.; Pryor, A.; Prosser, L.; Moore, M. 2008: Healthy parks, healthy people: the health benefits of contact with nature in a park context. Deakin University and Parks Victoria, Melbourne. 96 p.

McAlpine, K.G.; Wotton, D.M. 2007: Conservation and the delivery of ecosystem services: a literature review. *Science for Conservation 295*. Department of Conservation, Wellington. 81 p.

Milfont, T. L. 2012: The psychology of environmental attitudes: conceptual and empirical insights from New Zealand. *Ecopsychology 4(4)*: 269-276.

Millennium Ecosystem Assessment 2005: Ecosystems and human well-being: synthesis. Island Press, Washington, DC. 155 p.

Mitchell, R.; Popham, F. 2007: Greenspace, urbanity and health: relationships in England. *Journal of Epidemiology and Community Health 61(8)*: 681–683.

Mitchell, R.; Popham, F. 2008: Effect of exposure to natural environment on health inequalities: an observational population study. *Lancet 72(9650)*: 1655–1660.

Morita, E.; Naito, M.; Hishida, A.; Wakai, K.; Mori, A.; Asai, Y.; Okada, R.; Kawai, S.; Hamajima, N. 2011: No association between the frequency of forest walking and blood pressure levels or the prevalence of hypertension in a cross-sectional study of a Japanese population. *Environmental Health and Preventive Medicine 16(5)*: 299–306.

Nielsen, T.S.; Hansen, K.B. 2007: Do green areas affect health? Results from a Danish survey on the use of green areas and health indicators. *Health & Place 13(4)*: 839–850.

Ohtsuka, Y.; Yabunaka, N.; Takayama, S. 1998: Shinrin-yoku (forest-air bathing and walking) effectively decreases blood glucose levels in diabetic patients. *International Journal of Biometeorology 41(3)*: 125–127.

Park, B.-J.; Tsunetsugu, Y.; Ishii, H.; Furuhashi, S.; Hirano, H.; Kagawa, T.; Miyazaki, Y. 2008: Physiological effects of Shinrin-yoku (taking in the atmosphere of the forest) in a mixed forest in Shinano Town, Japan. *Scandinavian Journal of Forest Research 23(3)*: 278–283.

Park, B.-J.; Tsunetsugu, Y.; Kasetani, T.; Hirano, H.; Kagawa, T.; Sato, M.; Miyazaki, Y. 2007: Physiological effects of Shinrin-yoku (taking in the atmosphere of the forest) using salivary cortisol and cerebral activity as indicators. *Journal of Physiological Anthropology 26(2)*: 123–128.

Park, B.-J.; Tsunetsugu, Y.; Kasetani, T.; Kagawa, T.; Miyazaki, Y. 2010: The physiological effects of Shinrin-yoku (taking in the forest atmosphere or forest bathing): evidence from field experiments in 24 forests across Japan. *Environmental Health and Preventive Medicine 15(1)*: 18–26.

Pillemer, K.; Fuller-Rowell, T.E.; Reid, M.C.; Wells, N.M. 2010: Environmental volunteering and health outcomes over a 20-year period. *The Gerontologist 50(5)*: 594–602.

Richardson, E.; Pearce, J.; Mitchell, R.; Day, P.; Kingham, S. 2010: The association between green space and cause-specific mortality in urban New Zealand: an ecological analysis of green space utility. *BMC Public Health 10(1)*: 240.

Richardson, E.A.; Mitchell, R.; Hartig, T.; de Vries, S.; Astell-Burt, T.; Frumkin, H. 2012: Green cities and health: a question of scale? *Journal of Epidemiology and Community Health 66(2)*: 160–165.

Richardson, E.A.; Pearce, J,; Mitchell, R.; & Kingham, S. 2013. Role of physical activity in the relationship between urban green space and health. *Public Health*: doi: 10.1016/j.puhe.2013.01.004

Roche, M.; Rolley, C. 2011: Workplace wellbeing on Maungatautari Mountain: the connection between ecological restoration and workplace happiness. *Journal of Applied Business Research 27(2)*: 115–146.

Roe, J.; Aspinall, P. 2011: The restorative benefits of walking in urban and rural settings in adults with good and poor mental health. *Health & Place 17(1)*: 103–113.

Rohde, C.L.; Kendel, A.D. 1997: Nature for people. Pp. 319–335 in Kendle, A.D.; Forbes, S. (Eds): Urban nature conservation—landscape management in the urban countryside. E & FN Spon, London.

Roof, K; Oleru N. 2008: Public Health: Seattle and King County's Push for the Built Environment. *Journal of Environmental Health 71*: 24–27.

Seligman, Martin E.P.; Csikszentmihalyi, M. 2000: Positive psychology: an introduction. *American Psychologist 55(1)*: 5–14.

Stewart, D. 2010: Monitor of Engagement with the Natural Environment: The national survey on people and the natural environment. Annual Report from the 2009–2010 survey. Natural England Commissioned Report NECR049. 62 p.

Stewart, D. 2011: Monitor of Engagement with the Natural Environment: The national survey on people and the natural environment. Annual Report from the 2010–11 survey. Natural England Commissioned Report NECR083. 87 p.

Sugiyama, T.; Leslie, E.; Giles-Corti, B.; Owen, N. 2008: Associations of neighbourhood greenness with physical and mental health: do walking, social coherence and local social interaction explain the relationships? *Journal of Epidemiology and Community Health 62(5)*: e9.

Thompson Coon, J.; Boddy, K.; Stein, K.; Whear, R.; Barton, J.; Depledge, M.H. 2011: Does participating in physical activity in outdoor natural environments have a greater effect on physical and mental wellbeing than physical activity indoors? A systematic review. *Environmental Science & Technology 45(5)*: 1761–1772.

Tobias, M.; Blakely, T. Matheson, D.; Rasanathan, K.; Atkinson, J. 2009: Changing trends in indigenous inequalities in mortality: lessons from New Zealand. *International Journal of Epidemiology 38(6)*: 1711–1722.

Townsend, M. 2006: Feel blue? Touch green! Participation in forest/woodland management as a treatment for depression. *Urban Forestry & Urban Greening 5(3)*: 111–120.

Townsend, M.; Ebden, M. 2006: Feel blue, touch green. Deakin University, Melbourne.

Tsunetsugu, Y.; Park, B.-J.; Ishii, H.; Hirano, H.; Kagawa, T.; Miyazaki, Y. 2007: Physiological effects of Shinrin-yoku (taking in the atmosphere of the forest) in an old-growth broadleaf forest in Yamagata Prefecture, Japan. *Journal of Physiological Anthropology 26(2)*: 135–142.

Tsunetsugu, Y.; Park, B.-J.; Miyazaki, Y. 2010: Trends in research related to "Shinrin-yoku" (taking in the forest atmosphere or forest bathing) in Japan. *Environmental Health and Preventive Medicine 15(1)*: 27–37.

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 Heezink Y.M.; Dickinson, K.J.M.; Freeman, C. 2012: Closing the gap: communicating to change gardening practices in support of native biodiversity in urban private gardens. *Ecology and Society 17*: 34–43.

Waitangi Tribunal 2011: Ko Aotearoa Tēnei: a report into claims concerning New Zealand law and policy affecting Māori culture and identity (WAI 262 report). Waitangi Tribunal, Wellington. 268 p.

Walrond, C. 2001: Encounter levels—a study of backcountry river trout anglers in Nelson-Marlborough and Otago. Thesis, Doctor of Philosophy, University of Otago, Dunedin (unpublished). 524 p.

Watson, C. 2006: Are community gardens a good use of land in New Zealand? Dissertation, Bachelor of Surveying with Honours, University of Otago, Dunedin (unpublished). 92 p.

WHO (World Health Organization) 2011: Human health and the Rio Conventions: biological diversity, climate change, and desertification. WHO, Geneva. 64 p.

Witten, K.; Hiscock, R.; Pearce, J.; Blakely, T. 2008: Neighbourhood access to open spaces and the physical activity of residents: a national study. *Preventative Medicine 47*: 299–303.

Yamaguchi, M.; Deguchi, M.; Miyazaki, Y. 2006: The effects of exercise in forest and urban environments on sympathetic nervous activity of normal young adults. *The Journal of International Medical Research 34(2)*: 152–159.

Appendix 1

Details of major reviews of the link between nature and HWB

1. Nature and Health (Health Council of the Netherlands & RMNO 2004)

Author and commissioning agency:

Authors were members of an expert committee that had been commissioned to review the subject by government ministers of the Netherlands through the Health Council of the Netherlands, and the Dutch Advisory Council for Research on Spatial Planning, Nature and the Environment.

Length and number of references:

93 pages; 208 references. Particularly thorough on European literature to 2003.

Purpose:

The central question examined was: 'What knowledge on a possibly beneficial influence of nature on our health and wellbeing has so far been obtained through scientific research?'

Type of analysis:

Narrative review.

Types of benefits reviewed:

Research was reviewed under the following topics: link between nature and health; recovery from stress and attention fatigue; encouragement to exercise; facilitating social contact; encouraging optimal development in children; and providing opportunities for personal development and a sense of purpose.

Other material:

Detailed recommendations about further research questions, particularly aimed at Dutch and western European environments. This review was not particularly concerned with the application of research.

Key conclusions:

- With two exceptions (epidemiological studies), no methodologically sound, empirical research has been carried out investigating the link between nature and (generic) health indicators. Therefore, more research is required to provide stronger scientific proof.
- Many studies using sound methodology have produced strong evidence of a positive effect of nature on recovery from stress and attention fatigue. This was the strongest nature/health link, but there are no data on the duration or frequency of exposure to nature that is required to prevent stress-related illness in the long term.
- There are many indications that the environment is an important determinant of exercise, but it is much less clear how green the environment needs to be to encourage people to exercise.
- There is very little systematic research on whether nature can facilitate social contact. A more extensive classification and survey of urban green facilities is required.
- There is little systematic empirical research into the influence of contact with the natural environment on the development of children, and the evidence that does exist is unconvincing.
- The available research on the influence of nature on personal development and sense of purpose suffers from methodological limitations.

2. Healthy parks, healthy people: the health benefits of contact with nature in a park context (Maller et al. 2008)

Author and commissioning agency:

At the time of writing, the authors were all staff of the School of Health and Social Development, Deakin University, Melbourne. This review was undertaken for Parks Victoria, the Victorian state parks management agency, and it updated and expanded on an earlier (2002) review.

Length and number of references:

96 pages; approximately 365 references.

Purpose:

This review aimed to provide key information for park and open space managers, health professionals, researchers, and others with an interest in HWB benefits arising from interactions with nature, including in park settings.

Type of analysis:

Descriptive. Examined a broad cross-section of published literature that relates to the potential and actual health benefits of contact with nature, particularly (but not exclusively) in a park context. All types of nature and activities were reviewed, including experiences with pets and wild animals.

Types of benefits reviewed:

Benefits were reviewed under the following categories: viewing nature; being in nature; observing plants and gardens or gardening; and observing or encountering animals.

Other material:

This review forms part of the scientific basis for Parks Victoria's 'Healthy parks, healthy people' message. It provides extensive background material on several topics, including the determinants of health, the nature of public health and human-nature relationships.

Recommendations were made around supporting further research; encouraging and facilitating the repositioning of parks; and developing ways to integrate parks and nature into public health.

Key conclusions:

- 'Green nature', such as parks, can reduce crime, foster psychological wellbeing, reduce stress, boost immunity, enhance productivity and promote healing.
- Viewing nature is positive for health in terms of recovering from stress, improving concentration and productivity, and improving psychological state.
- Being in a natural environment affects people positively, particularly in terms of mental health.
- Plants and nearby vegetation can have profound effects on individuals, small groups or even entire neighbourhoods.
- Although relationships between social capital and the biophysical environment are only now being explored, it seems likely that human contact with nature through parks may have significant capacity for building social capital.
- Contact with companion animals has multiple positive physiological and psychological effects on human health.
- Natural environments such as beaches are important in providing a setting for pet owners to interact both with their pet and with other pet owners and park users.
- Concludes that because parks and other natural environments are a fundamental health resource, urban planning should ensure that communities have adequate access to nature.

3. Parks and other green environments: essential components of a healthy human habitat health (Kuo 2010)

Author and commissioning agency:

Author was Dr Frances (Ming) Kuo, Landscape and Human Health Laboratory, University of Illinois. The review was commissioned by the National Recreation and Park Association—a non-government organisation working to advance parks, recreation and environmental conservation efforts in the USA.

Length and number of references:

34 pages; 120 references.

Purpose:

To provide an overview of what scientists have discovered about the relationship between nature and human health, focusing on the most compelling findings.

Type of analysis:

Descriptive. The review discussed a sample of what was described as the most surprising, interesting and compelling evidence on 'nature deficit disorder' in order to document the quality and variety of evidence. The sample of research was chosen to highlight the diversity of ways in which a lack of contact with nature leads to social, psychological and physical dysfunction, and the diversity of ways in which regular contact with the natural environment helps humans to thrive, enables people to be robust and resilient in the face of challenges and perturbations, and promotes optimal functioning. All types of nature were reviewed, but the main focus was on various types of urban environments.

Types of benefits reviewed:

Social, psychological and physical indicators of HWB were reviewed.

Other material:

This review was presented in the context of the increasing amount of stress being placed on human populations through urbanisation, urban-related stress and a lack of greenness. The final chapter discusses the implications of the findings for creating healthier human habitats, in terms of providing as much nature, in as many forms, as possible; bringing nature to people; and bringing people to nature.

Key conclusions:

Summarised the benefits of a healthy human habitat (equated with 'greenness'). Concluded that green environments must be experienced (i.e. time must be spent in them) to yield HWB benefits.

- **Social indicators**: In greener settings of all scales and types, people are more generous and more desirous of connections with others. There are stronger neighbourhood social ties and a greater sense of community, more mutual trust and willingness to help others, and evidence of healthier social functioning in neighbourhood common spaces.
- **Psychological indicators**: Greater access to green views and green environments leads to improved cognitive functioning, increased proactiveness, more effective patterns of life functioning, more self-discipline and impulse control, improved overall mental health, and greater resilience in response to stressful life events.
- **Physical indicators**: Greener environments enhance recovery from surgery, enable and support higher levels of physical activity, improve immune system functioning, help diabetics to achieve healthier blood glucose levels, and improve functional health status and independent living skills among older adults.

- Across all these indicators, people of the same socio-economic status who have greater access to nature have better physical health outcomes.
- To promote a healthier, kinder, smarter, more effective, more resilient and more vital populace, communities should be designed to provide every individual with regular, diverse sources of 'Vitamin G', the colloquial term used to summarise the attributes of healthy human habitats.

4. Systematic review of evidence for the added benefits to health of exposure to natural environments (Bowler et al. 2010)

Author and commissioning agency:

At the time of publication, the authors were all affiliated to the Centre for Evidence-Based Conservation, School of Environment, Natural Resources and Geography, Bangor University, Wales. The study was not commissioned but was submitted to the journal *BMC Public Health* and peer reviewed as part of the journal's publication process.

Length and number of references:

10 pages; 57 references, of which 25 met the review inclusion criteria.

Purpose:

To collate and synthesise the evidence on whether there are added benefits of activities in natural environments over and above those in more synthetic environments.

Type of analysis:

Systematic review to collate and synthesise the findings of studies that compare measurements of health or wellbeing in natural and synthetic environments. Effect sizes of the differences between environments were calculated and a meta-analysis was carried out to synthesise data from studies measuring similar outcomes.

There were strict criteria for inclusion in the analysis, with only studies that collected data on a measure of health or wellbeing following direct exposure to a natural environment or exposure to a synthetic environment being chosen. Both observational and experimental studies were included. Most were crossover or controlled trials that investigated the effects of short-term exposure to each environment during a walk or run, and most were carried out within a narrow range of 'natural' environments (public parks and green university campuses) and comparison synthetic environments (indoor and outdoor built environments).

Types of benefits reviewed:

The most common outcome measures were self-reported emotions. A smaller number of studies examined biophysical indicators, including those pertaining to immune function.

Key conclusions:

- The review found some evidence of positive benefits of a walk or run in a natural environment compared with a synthetic environment.
- There was also some support for greater attention restoration following exposure to a natural environment (although this effect disappeared when effect sizes for pre-test differences were adjusted for).
- Meta-analysis of data on blood pressure and cortisol concentrations found no evidence of a consistent difference between environments across studies.
- Overall, the studies are suggestive that natural environments may have direct and positive impacts on wellbeing, but support the need for investment in further research on this question to understand the general significance for public health.