Public Health Devon

Devon County Council

Devon Local Nature Partnership
Health & Access Group

Review of the literature concerning the benefits to health of engagement with the natural environment

1. Introduction

Background

1.1 The idea that there are health benefits to be gained from promoting a "re-connection" with nature has generated considerable interest in recent years. This has been reflected in a body of research which has rapidly increased in both quality and quantity over the last half-decade. This literature review appraises this existing research with a view to establishing a more complete understanding of the relationship between health and the natural environment.

1.2 This literature review is undertaken by Public Health Devon on behalf of the Health and Access Group of the Devon Local Nature Partnership (LNP). The Devon LNP was established in 2012 and is one of 48 strategic LNPs formed in England following publication of the 2011 Natural Environment White Paper. The partnership will provide vision, strategic leadership and a strong championing voice for Devon's superb natural environment. The high level priorities of the Devon LNP are:

- Protect and improve Devon's natural environment
- Grow Devon's green economy
- Reconnect Devon's people and nature.

1.3 The Health and Access Group seeks to address the third priority: '*reconnect Devon's people and nature'*. This literature review is a key part of informing this agenda and seeks to relate the evidence base for promoting engagement with the natural environment to the context of public health in Devon.

Engagement with the Natural Environment

1.4 Since the launch of the Monitor of Engagement with the Natural Environment (MENE) survey in 2009, a wealth of data has been collected on how people use, enjoy and are motivated to protect the natural environment.

1.5 Between March 2012 and February 2013, an average of 41 percent of the English adult population visited the natural environment during the previous 7 days. In total, 47 per cent of visits to the natural environment were taken to the countryside, 43 per cent were to green spaces within towns and cities while 10 per cent were taken in coastal locations. 66 per cent of all visits were taken within 2 miles of home.

1.6 Overall, levels of participation in visits over the previous 7 days were significantly higher amongst people aged 25 to 64, those in employment, those living in rural areas and those in the AB socio-economic groups. Conversely, overall levels of participation were significantly lower amongst those aged 65 and over, members of the Black and Minority Ethnic (BAME) population, those living in urban areas and members of the DE socio-economic groups. Whilst in total 43 per cent of visits were taken to green spaces within towns and cities, for certain groups this type of place was more important. 82 per cent of visits taken by the BAME population were to this type of place, as were 66 per cent of the visits taken by those living in the most deprived neighbourhoods.

Evidence Overview

1.7 This literature review asks the question: 'what are the health benefits of engagement with the natural environment?' The search strategy identified a total of 63 studies which addressed this topic. Studies identified were predominantly from the UK but also from the United States, Canada, the Netherlands, Australia, Japan and Sweden.

1.8 Observational studies, including cohort, cross-sectional and ecological studies, dominate the literature. The search strategy identified only a small number of experimental studies, in addition to 2 systematic reviews. Where relevant, qualitative and ethnographic studies were also included, in addition to a small number of large-scale, peer-reviewed programme evaluations.

1.9 Taken overall, the evidence suggests an association between the natural environment and health, with the majority of the studies in the review finding a positive relationship. The evidence indicates that contact with the natural environment may offer considerable benefit to health and have a positive effect on communities, including:

- improved mental health and wellbeing
- improved population health
- reduced health inequalities
- increased levels of physical activity
- improved levels of social cohesion.

1.10 Whilst the available evidence is sufficient to suggest that there may be a major trend at work, it is also clear that the evidence base is still evolving and there is a definite need for further rigorous research in this area. The current evidence is dominated by observational studies with only a small number of low-level RCTs. As such, the evidence available at present may be subject to confounding and is unable to demonstrate a causal relationship.

1.11 **SUMMARY:** the evidence suggests that engagement with the natural environment may offer considerable benefits to health. However, it is also clear that the evidence base is still evolving and there is a clear need for further rigorous research in this area.

2. Methodology

2.1 This literature review explores the question 'what are the health benefits of engagement with the natural environment'? This question is considered through an appraisal of the existing literature, identified through a search strategy, and discussed thematically in the following review.

2.2 PICO is a method of designing a search strategy to help frame a research question. The question can be broken down in PICO format as follows:

Population: general population
Intervention: engagement with the natural environment
Comparison: health and wellbeing
Outcomes: health benefits, advantages and improvement, or adverse outcomes, disadvantages and barriers.

2.3 Based on this format, the search strategy used the following search terms:

Population: outdoor, natural, environment, countryside, seaside, green, space, nature, park
Intervention: engagement, access, physical, activity, recreation, recreation therapies, ecotherapy, exercise
Comparison: health, wellbeing, wellness
Outcomes: benefits, advantages, disadvantages, barriers, restrictions, contraindications, improvement.

2.4 The following databases were used to conduct this search: TRIP, NHS Evidence, Google Scholar, Pubmed and Google NHS/Ac/Uk and HDAS (Medline from PubMed, AMED, BNI, CINAHL, EMBASE, Health Business Elite, HMIC and PsycINFO). In addition, the reference lists of identified papers and other review papers were searched for relevant sources.

2.5 Abstracts were reviewed to determine relevance to the clinical question and PICO and against the following exclusion criteria:

- Study not available in English language
- Study taken place in a developing country
- Relationship between the natural environment and health not the primary focus of the study
- Study uses visual representation of the natural environment as opposed to 'being' in the natural environment.

2.6 From this search, 63 studies were identified. The majority of studies were observational, including cohort, cross-sectional and ecological study designs. In addition, 2 systematic reviews were identified, a small number of experimental studies and, where relevant, qualitative and ethnographic studies and large-scale, peer-reviewed programme evaluations. Studies are predominantly from the UK, but also from the United States, Canada, the Netherlands, Australia, Japan and Sweden.

3. Evidence

3.1 The hypothesis that there are added benefits to be gained from performing physical activity or just 'being' in the natural environment[1] has generated considerable interest in recent years. This literature review explores the viability of this hypothesis through an appraisal of the existing literature.

3.2 The evidence identified by this review consists of 63 studies. The appraisal is structured thematically in the following sections, with each section including a summary of the evidence followed by a more detailed overview of each study:

- The Natural Environment and Mental Health
    - Green Space, Mental Health and Physical Activity
    - Mental Health and Access to Green Space
    - Children, Mental Health and Green Space
- The Natural Environment and Population Health
- The Natural Environment and Health Inequalities
- The Natural Environment and Physical Activity
- The Natural Environment, Obesity and Overweight
- The Social Value of the Natural Environment

[1] The term 'green space' has become a popular term referring to the natural environment. In this literature review, the terms green space and natural environment and green space are used interchangeably, reflecting the language use of the studies reviewed.

The Natural Environment and Mental Health

3.3 The literature review identified 27 studies exploring the relationship between the natural environment and mental health. This represents the most numerous and robust area of enquiry, including 2 systematic reviews and a large proportion of experimental studies. These studies explore 3 broad relationships: (1) the natural environment, mental health and physical activity; (2) access to the natural environment and mental health; (3) and the benefits of the natural environment to children's mental health.

3.4 This area of research is also supported by a range of theoretical stances which seek to explain the postulated 'restorative' and 'rejuvenative' qualities of the natural environment. Indeed, much of the literature in this review seeks to scrutinise these theories. In 1983, Ulrich proposed that natural environments promote recovery from stress by triggering positive emotional and physiological responses as a consequence of psycho-evolutionary processes. Similarly, Wilson's (1984) theory 'Biophilia', asserts that human beings subconsciously seek contact with nature through a pre-determined biological need developed through the evolutionary process. Building on these previous theories, in 1989 Kaplan and Kaplan proposed 'Attention Restoration Theory' (ART) which suggested that nature primarily assists with recovery from attention fatigue, as the natural environment allows individuals to distance themselves from routine activities and thoughts because they attract the attention without requiring concentration or effort.

- Green Space, Mental Health and Physical Activity

3.5 The literature review identified 15 studies investigating the relationship between the natural environment, physical activity and mental health. These included 2 systematic reviews (Thompson-Coon et al., 2011; Bowler et al., 2010), 1 'multi-study analysis' (Barton and Pretty, 2010), 7 randomised controlled trials (RCTs) (Park et al., 2010; Li et al., 2011; Park et al., 2007; Gladwell, 2012; Ulrich, 1981; Laumann 2003; Van de Berg and Custers, 2011), 2 quasi-experimental studies (Barton et al., 2012; Mackay and Neil, 2010), 2 cross-sectional studies (Mitchell, 2012; Astell-Burt et al., 2013), and 1 large-scale, peer-reviewed evaluation of green exercise programmes (Pretty et al., 2006).

3.6 Overall, the systematic reviews (Thompson-Coon et al., 2011; and Bowler et al., 2010) conclude that physical activity in natural environments is associated with improved mental health and wellbeing in comparison with synthetic environments. Further support for these conclusions is found in single studies where improvements in self-esteem (Barton et al., 2012; Barton and Pretty 2010; Pretty et al., 2006), positive mood (Barton et al., 2012; Van den Berg and Custers, 2011; Pretty et al., 2006), anxiety levels (Mackay and Neill, 2010), and a lower risk of poor mental health and psychological distress (Mitchell 2012; Astell-Burt et al., 2013) have been observed. However, both systematic reviews highlight poor methodological quality of the studies reviewed, small sample sizes, contextual specificity and a significant heterogeneity in study designs and outcome measures used.

3.7 In addition to the above studies, a small number of individual RCTs have investigated the relationship between physiological health markers and exposure to the natural environment (in comparison to synthetic environments). These studies have observed positive changes, including decreased heart rate (Park et al., 2010), decreased blood pressure (Park et al., 2010; Li et al., 2011), reduced adrenaline (Park et al., 2010), noradrenaline (Li et al., 2010), and cortisol (Park et al., 2010; Park et al., 2007; Van de Berg and Custers, 2011) as well as enhanced autonomic control (Park et al., 2010). The physiological changes that are noted are all suggestive of potential systemic relaxation. However, taken overall these studies do not amount to a body of rigorous research (Thompson-Coon et al., 2011). Thus, the impact of environment on physiological markers needs to be explored further using controlled environments and outcome measures relevant to physical and mental health.

3.8 **SUMMARY:** The evidence suggests that there may be considerable benefits to mental health to be gained from doing physical activity in natural environments as opposed to synthetic environments. Observed physiological changes are suggestive of potential systematic relaxation, in addition to improved self-esteem, positive mood and decreased anxiety levels. However, poor methodological quality hampers this research, and additional, rigorous research is required to quantify *which* aspects of mental health are benefited through contact with green space and to quantify *what* the physiological mechanisms are which cause this effect?

- Thompson-Coon et al., (2011) reviewed 11 trials including 833 adult participants, and found that compared with exercising indoors, exercising in natural environments was associated with greater feelings of revitalization and positive engagement, decreases in tension, confusion, anger, and depression, and increased energy. Participants reported greater enjoyment and satisfaction with outdoor activity and declared a greater intent to repeat the activity at a later date. However, the results suggest that feelings of calmness may be decreased following outdoor exercise.

- Bowler et al., (2010) reviewed 25 studies. A meta-analysis provided some evidence of positive benefits of a walk or run in a natural environment, including increased attention and focus, in comparison to a synthetic environment.

- The Barton and Pretty (2010) 'multi-study analysis', analysed 10 UK studies involving 1,252 participants. All studies found improvements to participant self-esteem and mood after exercise in green environments, with the presence of water in an environment having the greatest positive effect. A meta-analysis evidenced that dose responses for both intensity and duration showed large benefits from short engagements in green exercise, with diminishing but still positive returns. Those with poor mental health demonstrated the greatest improvements in self-esteem.

- The studies reviewed by Thompson-Coon et al., (2013) did not report on physiological variables, and Bowler et al., (2010) found only limited evidence for physiological changes. However, there are a small number of individual studies investigating exposure to nature that identify changes in physiological health markers, including decreased heart rate (Park et al.,

2010) and decreased systolic and diastolic blood pressure (Park et al., 2010; Li et al., 2011). Further, changes in endocrine markers such as reduced adrenaline (Park et al., 2010), noradrenaline (Li et al., 2010), and cortisol (Park et al., 2010; Park et al., 2007) as well as enhanced autonomic control (indirectly measured using heart rate variability) (Park et al., 2010) have also been reported. The physiological changes that are noted are all suggestive of potential systemic relaxation.

- Van de Berg and Custers (2011) tested the hypothesis that gardening has a stress-relieving effect. 30 allotment gardeners performed a stressful Stroop task and were then randomly assigned to 30 minutes of outdoor gardening or indoor reading on their own allotment plot. Salivary cortisol levels and self-reported mood were repeatedly measured. Gardening and reading each led to decreases in cortisol during the recovery period, but decreases were significantly stronger in the gardening group. Positive mood was fully restored after gardening, but further deteriorated during reading.

- Barton et al., (2012) used a clinical population (n=53) who were experiencing a range of mental health problems, to compare group-based health promotion initiatives including a social club, a swimming group, and a green exercise programme (weekly countryside and urban park walks). Results found that changes in self-esteem and mood were significantly greater in the green exercise group compared to the comparators.

- Mackay and Neill (2010) explored the short-term effects of “green exercise” on state anxiety and examined the influence of exercise type, intensity, duration, and degree of greenness. A quasi-experimental design involved participants in 8 pre-existing outdoor exercise groups (n= 101) who completed pre- and post-exercise questionnaires. Results indicated a significant reduction in participants' state of anxiety following green exercise.

- Mitchell (2012) used data from the Scottish Health Survey 2008, which described all environments in which respondents were physically active to draw associations between the use of each environment and the risk of poor mental health (measured by the General Health Questionnaire) and level of wellbeing (measured by the Warwick Edinburgh Mental health and Wellbeing Score). Results showed an independent association between regular use of natural environments and a lower risk of poor mental health, but not for activity in other types of environment.

- In an Australian study, Astell-Burt et al., (2013) used the Active Australia Survey to investigate the association between green space, physical activity and psychological stress among residents over 45years old living in New South Wales (n = 260,061). In comparison to residents of the least green areas, those in the greenest neighbourhoods were at a lower risk of psychological distress and were less sedentary.

- Pretty et al., (2006) conducted an evaluation of 10 green exercise programmes (including walking, cycling, horse-riding, fishing, canal-boating and conservation activities) in the UK including 263 participants. Even though these participants were generally an active and healthy group, it was found that green exercise led to a significant improvement in

self-esteem and total mood disturbance (with anger-hostility, confusion-bewilderment, depression-dejection and tension-anxiety all improving post-activity).

- Mental Health and Access to Green Space

3.9 Other studies relating to the mental health benefits of the natural environment explored the relationship between mental health and access to green space. The literature review identified 8 studies including 1 quasi-experimental study (Roe et al., 2013), 2 cohort studies (Annerstedt et al., 2012; White et al., 2013), 4 cross-sectional surveys (Grahn and Stigsdotter, 2003; Guite et al., 2006; Nielsen and Hansen, 2007; Maas et al., 2009), and 1 ecological study (Richardson et al., 2013).

3.10 Overall, the studies indicate a positive relationship between access to green space and improved mental health. Observed relationships include reduced stress (Roe et al., 2013; White et al., 2013) and better general mental health (Guite et al., 2006; Grahn and Stigsdotter, 2003) in those living in *urban areas* with higher levels of green space. *And* reduced stress (Nielsen and Hansen, 2007), better mental health (Annerstedt et al., 2012; Richardson et al., 2013), and reduced anxiety and depression (Maas et al., 2009) in those living in *both urban and rural areas* with green space near to the home.

3.11 However, this undoubtedly remains an area for further research. The mechanisms behind this effect remain un-researched as do variables such as quality and quantity or green space, differences between urban and rural contexts, and potential confounders such as socio-economic status, area deprivation, gender, age, ethnicity, disability and the importance of urban vs. rural contexts.

3.12 **SUMMARY:** The evidence suggests that there may be benefits to mental health from living in areas with good access to green space. Benefits may include reduced stress, anxiety and depression and better overall mental health and wellbeing. Additional research should focus on understanding the role of confounding factors in this relationship, and to quantify the type (quantity, quality etc.) of natural environment which is beneficial to mental health.

- Roe et al., (2013) measured salivary cortisol concentrations 3, 6 and 9 hours post awakening over 2 consecutive weekdays, together with measures of perceived stress. Participants (n=106) were men and women not in work aged between 35–55 years, resident in socially disadvantaged districts from the same Scottish, urban context. Results from linear regression analyses showed a significant and negative relationship between higher green space levels and stress levels, indicating living in areas with a higher percentage of green space is associated with lower stress. In summary, green space was associated with mental health benefits, but the mechanism behind this was not clear.

- White et al., (2013) used longitudinal panel data from over 10,000 individuals in the UK to explore the relation between urban green space and well-being (indexed by ratings of life satisfaction) and between urban green space and mental distress (indexed by General Health Questionnaire scores) for the same people over time. Controlling for

individual and regional covariates, it was found that, on average, individuals have both lower mental distress and higher well-being when living in urban areas with more green space.

- Annerstedt et al., (2012) undertook a cohort study in Sweden investigating the relationship between green space and mental health. They found that perceived neighbourhood greenness was more strongly associated with mental health than it was with physical health. The authors found that there was a significant relationship between green space, mental health, recreational walking and social coherence. However, the mental health/ green space relationship was not completely justified by these two additional factors, suggesting an additional restorative effect of green space on mental health.

- Grahn and Stigsdotter (2003) randomly selected almost 1,000 individuals in nine Swedish cities who answered questions about their health and the use of urban green spaces close to their homes. Significant statistical relationships were found between the use of urban green spaces and reported experience of stress regardless of age, gender and socio-economic status. Those people who visited urban green spaces more frequently reported fewer stress related illnesses. The study also showed that distance to urban green spaces is associated with amount of use.

- The survey by Guite *et al* (2006) of 1,000 adults conducted in a deprived inner city area in London (UK) supports these findings. A range of urban environmental variables were investigated along five domains (internal environment, design and maintenance, noise, density and escape, fear of crime and harassment, social participation), and linked to measures of mental health and well-being. Density, notably feeling overcrowded in the home and dissatisfied with local green spaces (which are important as escape mechanisms) were associated with poorer mental health.

- Nielsen and Hansen, 2007 in Denmark, investigated the links between access and use of green space and two health indicators – body mass index and experienced stress, using a postal survey of a randomly selected sample of 2,000 adults aged 18-80 (response rate 63%). Statistical analysis of the responses found that greater distance from home to green spaces was a better predictor of higher stress levels for all groups and obesity in younger respondents (aged 25 or below) than reported use of green spaces. This study also linked having access to a private garden or green area near the home as associated with reduced levels of stress and obesity.

- Maas et al., (2009) derived mortality data from 195 general practitioners in 96 Dutch practices, serving a population of 345,143 people and compared with data on percentage of green space within a 1 km and 3 km radius. After controlling for confounding factors, the results showed that the annual prevalence rate of 15 of the 24 disease clusters was lower in living environments with more green space in a 1 km radius. The relation was strongest for anxiety disorder and depression with people in less green spaces more likely to report feelings of loneliness and perceived shortage of social support. The relation was stronger for children and people with a lower socioeconomic status.

- Using data from the New Zealand Health Survey, Richardson et al., (2013) found that the greenest neighbourhoods had the lowest risks of poor mental health, independent of individual risk factors. Although physical activity was higher in greener neighbourhoods, it did not fully explain the green space and health relationship.

- Children, Mental Health and Green Space

3.13 There are a number of additional studies which focus specifically on children and the mental health benefits of contact with green space. The literature review identified 4 studies which explore this issue, including 2 RCTs (Faber-Taylor, 2009; Faber et al., 2002) and 2 cross-sectional studies (Faber et al., 2001; Well and Evans, 2003).

3.14 Observed relationships in these studies include improved concentration and functioning in children with ADHD after exposure to natural environments through leisure activities (Faber-Taylor, 2009; Faber et al, 2001), improved concentration and self-discipline in girls living in inner city areas with 'near-home nature' (Faber et al., 2002), and reduced stress and improved self-worth in children living in rural areas with good access to green space (Wells and Evans, 2003).

3.15 Whilst these studies indicate a relationship between children's mental health and green space, the evidence is relatively sparse and limited, including significant heterogeneity of hypotheses investigated, study types and outcome measures employed, small sample sizes, and a lack of control over confounding factors, meaning that it would be difficult to draw conclusions based on this research.

3.16 **SUMMARY:** There is some, limited evidence to suggest that there may be a relationship between child mental health and access to green space. Potential benefits may include improved concentration and functioning in children with ADHD, improved concentration, self-discipline and self-worth and reduced stress. Considerable further, rigorous research needs to be conducted in this area before conclusions can be drawn.

- Faber-Taylor (2009) used a small RCT in the US to investigate the relationship between children with ADHD and green space. 17 children with ADHD experienced each of three treatments (environments) through a 20 minute guided walk in single blind controlled trials. Environments were experienced 1 week apart, with randomized assignment to treatment order. After each walk, concentration was measured using Digit Span Backwards. The results suggest that children with ADHD concentrated better after the walk in the park than after the downtown walk or the neighbourhood walk with substantial effect sizes and comparable to those reported for recent [2009] formulations of methylphenidate.

- Faber et al., (2002) investigated the relationship between near-home nature and self-discipline and concentration in 169 inner city girls and boys randomly assigned to 12 architecturally identical high-rise buildings in the US with varying levels of nearby nature. Parent ratings of the naturalness of the view from home were used to predict children's performance on tests of concentration, impulse inhibition, and delay of gratification. Regressions indicated that, on average, the more natural a

girl's view from home, the better her performance at each of these forms of self-discipline.

- Faber et al., (2001) examined the relationship between the attentional functioning of children with ADHD and their exposure to nature through leisure activities in the US. Parents were surveyed regarding their child's attentional functioning after activities in several settings. Results indicate that children function better than usual after activities in green settings and that the "greener" a child's play area, the less severe his or her attention deficit symptoms.

- Wells and Evans (2003) investigated whether vegetation near the residential environment might buffer or moderate the impact of stressful life events on children's psychological well-being. Data were collected from 337 rural children dependent variables included a standard parent-reported measure of children's psychological distress and children's own ratings of global self-worth. The study found that in a rural setting, levels of nearby nature moderate the impact of stressful life events on the psychological well-being of children. Specifically, the impact of life stress was lower among children with high levels of nearby nature than among those with little nearby nature.

The Natural Environment and Population Health

3.17 In this area, the search identified 6 studies including 1 cohort study (Takano *et al*, 2002), and 5 cross-sectional studies (De Vries *et al*, 2003; Maas *et al*, 2009; Mitchell and Popham, 2007; Sugiyama et al., 2008; Maas et al., 2006) that specifically investigate the role of green space with regard to general health.

3.18 Taken overall, the evidence suggests a positive relationship between green space and general health, irrespective of socioeconomic status. The studies identified indicate that green space may positively affect longevity (Takano et al., 2002), mental health (Maas et al., 2009), and perceived general health (De Vries et al., 2003; Mitchell and Popham, 2007; Maas et al., 2006; Sugiyama et al., 2008).

3.19 The large sample sizes employed in these studies present a compelling picture of the relationship between green space and population health. However, whilst it is questionable whether an RCT would be possible in this case, further cohort studies (with similar designs to Takano et al., 2002) would significantly add to the evidence base. In addition, further research exploring the mechanisms by which green space has a positive effect on population health and understanding the full role of potential confounders, such as socio-economic status, area deprivation, gender, age, disability and ethnicity, need to be fully explored and quantified through further research.

3.20 **SUMMARY:** The evidence suggests that there may be benefits to general health from living in areas with good access to green space. The literature indicates that green space may positively affect longevity, perceived overall physical and mental health and wellbeing and reduce the number of health problems experienced. However, further research is required before a full understanding of this relationship can be drawn. Additional research should focus on understanding the role of confounding factors in this relationship,

and quantifying the types (quantity, quality etc.) of natural environment which are most beneficial to population health.

- In Japan a longitudinal study by Takano et al., (2002) demonstrated that living in areas with walkable green space positively influenced the longevity of older people in an urban area (Tokyo), independent of age, sex, marital status, baseline function and socio-economic status. Interviews with a sample of Tokyo residents (n = 3,144) aged 70 years and over were conducted, and data collected on their neighbourhood of residence. These data were analysed at the individual level, and the mortality rate in the cohort was followed over a 5 year period, finding that the probability of 5 year survival was significant for residents with walkable green streets near their residence.

- Maas et al., (2009) derived mortality data from 195 GPs, serving a population of 345,143 people and compared with data on percentage of green space within a 1 km and 3 km radius. After controlling for confounding factors, the results showed that the annual prevalence rate of 15 of the 24 disease clusters was lower in living environments with more green space in a 1 km radius. The relation was strongest for anxiety disorder and depression, and for children and people with a lower socioeconomic status.

- De Vries et al., (2003) combined Dutch data on the self-reported health of 17,000 people with land use data on the amount of green space in their living environments. After controlling for confounding factors such as age, sex, and socio-economic status, the authors concluded that living in a greener environment was positively related to all 3 of the available health indicators (number of health problems experienced in the previous 14 days; perceived general health measured on a 5 point scale; and the score on the Dutch General Health Questionnaire). The association was most significant for housewives and older people.

- Researchers in England (Mitchell and Popham, 2007) conducted a similar study to Maas *et al.*, (2009) utilising data from the Generalised Land Use Database at lower level super output areas (LSOA) combined with responses to questions on health contained in the 2001 UK census. In general a greater proportion of green space was associated with better health; however the association varied according to the combination of area income deprivation and urbanity.

- A second Dutch study, Maas *et al* (2006) involved a large-scale study of people registered with a GP (n=250,782) who completed a questionnaire on socio-demographic status, background and perceived health. The percentage of green space within 1 and 3 km radius of the participant's postcode was calculated. Analysis was controlled for age, gender, and socio economic status. Results clearly showed perceived general health to be better in people living in greener environments.

- In Adelaide, Australia Sugiyama et al., (2008) undertook a mailed survey (n=1,895) which collected adult's physical and mental health scores, perceived neighbourhood greenness, walking for recreation,

transport, social interaction and sociodemographic variables. They found that after adjusting for socio-demographic variables, those who perceived their neighbourhood as highly green had higher odds of better physical and mental health. When walking for recreation and social factors were added to the regression models, the researchers found a significant relationship between recreational walking, social coherence and mental and physical health.

The Natural Environment and Health Inequalities

3.21 The literature review identified 12 studies relating to the relationship between green space and health inequalities. By far the most compelling evidence of this relationship is found in Mitchell and Popham's (2008) large-scale ecological study which used census data from the whole UK population, younger than retirement age. This study found that health inequalities (related to income deprivation) for all-cause mortality and circulatory disease were significantly lower in areas with high exposure to green space.

3.22 Other studies indirectly supported this finding. In a series of experimental studies conducted in an urban, public housing context in Chicago, US (Kuo and Sullivan, 2001; Kuo, 2001) found that higher levels of green space in residential areas could help to mediate the effects of poverty by reducing mental fatigue and aggression and helping residents to cope with stress.

3.23 However, the reviewed studies also suggest that both socio-economic status and childhood experience may be important confounders in this relationship. An ecological study conducted in Bristol, UK (Jones et al., 2009) found that whilst people from more deprived areas had better access, they also reported less use and had more negative perceptions of green space. In a series of 8 qualitative studies Bell et al., (2003; 2004); Bixler et al., (2003); Ewert et al, (2005); Chipeniuk, (1995); Kals et al., (2009); Lohr and Pearson-Mims, (2005); Wells and Lekies, (2006) found that there is a positive relationship between accessing the natural environment as a child and utilising the natural environment as a resource for physical and mental health and wellbeing as an adult.

3.24 While these studies represent an interesting picture relating the natural environment with inequalities in health, this is clearly an area where more research is required. Studies are multi-disciplinary with a wide range of study designs and outcome measures. The most relevant and compelling evidence is found in the Mitchell and Popham (2008) ecological study. Whilst this study is significant due to its large size, its non-inclusion of individual data means that it may be subject to ecological fallacy and is unable to demonstrate a causal relationship. Whilst the additional studies (Kuo and Sullivan, 2001; Kuo, 2001; Bell et al., 2003; 2004; Bixler et al., 2003; Ewert et al, 2005; Chipeniuk, 1995; Kals et al., 2009; Lohr and Pearson-Mims, 2005; Wells and Lekies, 2006; Jones et al., 2009) add depth to this area of research, they are contextually specific and further research is an important priority in assessing whether there findings are transferable to other contexts.

3.25 **SUMMARY:** There is some limited evidence to suggest that good access to green space may reduce health inequalities. However, this observation is taken from an ecological study design which may have methodological faults. This point is particularly relevant in light of further studies which suggest that

there may be other important confounders in this relationship such as childhood experience of accessing green space and area deprivation. As such, further research must be undertaken in this area before conclusions can be drawn.

- Mitchell and Popham (2008) used UK census data to classify the whole population of England at younger than retirement age (n=40,813,236) into groups on the basis of income deprivation and exposure to green space and obtained individual mortality records (n=366,348) to establish whether there was an association between income deprivation, all-cause mortality, and cause-specific mortality (circulatory disease, lung cancer, and intentional self-harm) in 2001-05, with control for potential confounding factors. The results showed that the association between income deprivation and mortality differed significantly across the groups of exposure to green space for mortality from all causes and circulatory disease, but not from lung cancer or intentional self-harm. Health inequalities related to income deprivation in all-cause mortality and mortality from circulatory diseases were lower in populations living in the greenest areas. There was no effect for causes of death unlikely to be affected by green space, such as lung cancer and intentional self-harm. They concluded that populations that are exposed to the greenest environments also have lowest levels of health inequality related to income deprivation.

- In a series of studies in an urban public housing setting in the US, Kou (2001) finds that presence of green spaces contributed to an increased ability among poor single parent mothers to cope with major life issues and stress. Green space seemed to make life more manageable, and contributed to reductions in aggression indicators and mental fatigue (Kuo and Sullivan, 2001). Overall, the series of studies presents a strong case for access to green space improving resident's psychological resources for coping with poverty.

- However, Jones et al., (2009), used the 2005 Bristol 'Quality of Life in your Neighbourhood Survey' (n=6,821), combined with objective measures of access to green spaces. They found that although respondents in more deprived areas lived closer to green spaces, they reported poorer perceived accessibility, poorer safety, and less frequent use. As such, relationships between physical activity and perceived accessibility, safety, and visit frequency were moderated by deprivation. The accessibility of green spaces was better in more deprived areas but those residents had more negative perceptions and were less likely to use the green spaces.

- In addition, there is evidence to suggest that engagement with the natural environment in adulthood is linked to access as a child. A Scottish study, (Bell et al., 2003) and a study in the East Midlands (UK) (Bell et al., 2004) found that those who visited woodlands frequently as a child are more likely to visit woodlands or walk on their own in adulthood and use them as a resource for their physical and mental health. Those who thought of green spaces as magical places were also those who stated that they visited such places frequently as children, while those who did not visit green spaces as children strongly disagreed. Young adults in the study who had very little parental anxiety as children (in regards to the natural environment) were most relaxed in woodland. However, those who had to

play in sight of adults or only visited woods accompanied by adults had mixed feelings. Furthermore, the sense of freedom gained through this kind of early experience of unstructured play, was seen in the study, as a source of independence and inner strength which could be drawn upon in subsequent challenging and stressful situations in later life.

- Bixler et al., (2002) interviewed 1800 adolescents and found that those who had played in the wilderness as younger children had more positive perceptions of natural environment, outdoor recreation activities and future outdoor occupational environments.

- Another study (Ewert, et al., 2005) examined the relation between outdoor experience in early life and environmental attitudes in early adulthood. It found that time outdoors appreciating nature, hunting and fishing, and exposure to books and nature programmes during youth were predictive of later positive environmental beliefs.

- Chipeniuk (1995) found that immigrant children in the US who as young children foraged for berries, fish, acorns etc had a much deeper understanding of biodiversity as teenagers than their suburban middle-class counterparts.

- Kals et al., (1999) studied German adults, some belonging to environmental organisations and some with no specific interest in the environment. Participants were interviewed about their contact with nature as a child. The results showed that time spent in nature between the ages of 7 and 12yrs was associated with the adult feeling of "indignation about insufficient nature protection."

- A similar study (Lohr and Pearson-Mims, 2005) looked at the relationship between childhood contact with nature and adult's attitudes towards plants. It indicated that children who looked after plants and planted trees were most likely as adults to believe that "trees are calming" and "trees have personal meaning".

- Wells and Lekies, (2006) looked at this relationship by interviewing 2,000 adults in the US. The results are consistent with the other research, demonstrating that contact with nature (particularly wild nature) before the age of 11yrs predicted a lifelong positive environmental behaviour.

The Natural Environment and Physical Activity

3.26 The literature review identified 7 studies that investigated the role of green space in promoting physical activity. The studies included 1 cross-sectional survey, combined with ethnographic research (Cohen et al., 2007), and 6 cross-sectional surveys (Giles-Corti et al., 2005; Hillsdon et al., 2006; Coombes et al., Astell-Burt et al., 2013; Richardson, 2013; Jones et al., 2009).

3.27 5 of the studies (Cohen et al., 2007; Giles-Corti et al., 2005; Coombes et al., Astell-Burt et al., 2013; Richardson, 2013) support a positive association between green space and physical activity, with residents living closest to green space being more likely to participate in physical activity than those

living further away. For instance, Cohen et al., (2007) found that those most likely to use public parks were young, male and living within 1 mile of the park, indicating that variables such as age and gender may also be important in this relationship.

3.28 However, both Hillsdon et al., (2006) and Jones et al., (2009) found that there was a negative association between green space and physical activity in studies in Norwich and Bristol. The Hillsdon et al., (2006) study found that in Norwich those with best access to green space reported lower levels of physical activity than those with poorest access, even after controlling for area deprivation. In Bristol, Jones et al., (2009) found that although respondents in more deprived areas lived closer to green spaces, they reported poorer perceived accessibility, poorer safety, and less frequent use of green space, suggesting that socio-economic status is an important variable. As such, confounders such as socioeconomic status and area deprivation remain important areas for further research.

3.29 **SUMMARY:** There is some, limited evidence to suggest that there may be a positive association between green space and physical activity. However, evidence is largely contextually specific and it is clear that this relationship is complex with a range of other influencing factors which are not yet fully understood. As such this remains an important area for further research.

- In the US, Cohen et al (2007) interviewed and observed park users (n=713) in 8 public parks and interviewed a sample of people living near parks (n=605). People living nearer the park used the park more often: 43% of park users lived within 0.25 miles; 21% lived between 0.25 and 0.5 miles. Only 13% of park users lived more than one mile away. Age (being young), gender (being male) and distance (living within 1 mile of the park) were positively associated with park use. People who lived within 1 mile were 4 times more likely to visit the park once a week or more, and had 38% more exercise on average in a week than those living further away.

- Giles-Corti *et al* (2005) surveyed residents (n=1,803) in a metropolitan area of Perth (Australia). They found that regardless of the model used, overall use was positively associated with accessibility. However when size was taken into account, those with very good access to large attractive green space were more likely to use them suggesting that after distance is taken into account, size was more important than attractiveness in encouraging use. Those using green space were three times more likely to achieve recommended levels of physical activity.

- Hillsdon et al., (2006) measured access to green space and mapped these against the residences of a cohort of 4,732 middle aged (aged 47-74 years) people in Norwich (UK) who completed a physical activity questionnaire. Multiple regression models were used to determine the relationship between access to green space and levels of recreational physical activity. There was no evidence of clear relationship between recreational physical activity and access to green spaces. Those with the best access to high quality large green spaces actually reported lower levels of activity than those with the poorest access. The sample was stratified by deprivation, and again no relationships were observed between access to green space and those living in either the least or most deprived areas.

- The findings of this study are also supported by Jones et al., (2009), who used the 2005 Bristol 'Quality of Life in your Neighbourhood Survey' (n=6,821), combined with objective measures of access to green spaces. They found that although respondents in more deprived areas lived closer to green spaces, they reported poorer perceived accessibility, poorer safety, and less frequent use. As such, relationships between physical activity and perceived accessibility, safety, and visit frequency were moderated by deprivation. The accessibility of green spaces was better in more deprived areas but those residents had more negative perceptions and were less likely to use the green spaces.

- Astell-Burt et al., (2013) used data from the Active Australia Survey to investigate the association between green space and psychological distress among 260,061 Australians over 45years old living in New South Wales (2006-2009). In comparison to residents of the least green areas, those in the greenest neighbourhoods were at a lower risk of psychological distress and were less sedentary. An interaction was observed between physical activity and green space.

- Richardson et al., (2013) used data from the New Zealand Health Survey and linked it to neighbourhood-level green space (n= 8,157). The greenest neighbourhoods had the lowest risks of poor mental health and cardiovascular disease, independent of individual risk factors. Green space availability was not related to overweight or poor general health. Overall, levels of physical activity were higher in greener neighbourhoods, although it did not fully explain the green space and health relationship.

- In a study in Bristol, UK Coombes et al., (2010) used data from the Bristol Quality of Life in your Neighbourhood Survey' (n=6,821) to examine the association between objectively measured access to green space, frequency of green space use, physical activity, and the probability of being overweight or obese. Results showed that reported frequency of green space use declined with increasing distance, respondents living closest to green space were more likely to achieve the physical activity recommendation and less likely to be overweight or obese. However, the association with physical activity, but not with overweight or obesity, remained after adjustment for respondent characteristics, area deprivation, and a range of characteristics of the neighbourhood environment.

The Natural Environment, Overweight and Obesity

3.30 The literature review identified 6 studies related to green space and overweight and obesity. These included 1 cohort study (Bell et al, 2008), 4 cross-sectional studies (Nielsen and Hansen, 2007; Cummins and Fagg, 2012; Richardson, 2013; Coombes et al., 2010) and 1 ecological study (West et al., 2012).

3.31 3 of these studies reported a positive association between green space and a decreased likelihood of being overweight or obese (Bell et al., 2008; Nielsen and Hansen, 2007; West et al., 2012). However, 2 studies (Bell et al., 2008; Nielsen and Hansen, 2007) only report an association for children and young

people; and 1 study (West et al., 2012) only reports on the relationship between overweight/ obesity and parkland density in urban areas in the US.

3.32 2 studies (Cummins and Fagg, 2012; Richardson et al., 2013) report a negative association between green space and overweight/ obesity. Whilst 1 study undertaken in Bristol (Coombes et al., 2010) found that residents living close to green space were less likely to be overweight/ obese, this association did not remain after adjustment for confounding factors, such as area deprivation.

3.33 **SUMMARY:** From the available evidence, it is not possible to draw any conclusions concerning the relationship between access to the natural environment and the likelihood of being overweight or obese. Studies are contextually specific and it is clear that there are a range of complex factors also involved in this relationship. As such, this should be a priority for further research.

- In terms of overweight and obesity in children and the relationship with green space, Bell et al., (2008) explored whether greenness and residential density are independently associated with 2-year changes in the BMI of children and youth in the US. They found that over the 2 year period, higher green space was significantly associated with lower BMI scores regardless of residential density characteristics, and higher greenness was also associated with lower odds of the sample increasing their BMI scores.

- A cross-sectional survey study undertaken in Denmark (Nielsen and Hansen, 2007) investigated the links between access and use of green space, body mass index and experienced stress. The results suggest that greater distance from home to green spaces was a better predictor of higher stress levels for all groups and obesity in younger respondents (aged 25 or below).

- However, research conducted in England by Cummins and Fagg (2012) found that there was a counterintuitive association between green space and BMI in urban areas. The research was undertaken using a cross-sectional observational study over two time-periods. Participants were adults from a nationally representative sample of the English population for the time periods 2000-2003 (n=42,177) and 2004-2007 (n=36,959) using Generalised Land Use Database for England. The study found that in 2000-2003 residence in the greenest areas was significantly associated with increases in overweight (12%) and obesity (23%). In 2004-2007, there was a small protective effect of green space for that living in the greenest areas, but this was not statistically significant.

- Richardson et al., (2013) used data from the New Zealand Health Survey and linked it to neighbourhood-level green space (n= 8,157). The greenest neighbourhoods had the lowest risks of poor mental health and cardiovascular disease, independent of individual risk factors. Green space availability was not related to overweight. Overall, levels of physical activity were higher in greener neighbourhoods, although it did not fully explain the green space and health relationship.

- In a study in Bristol, UK Coombes et al., (2010) used data from the Bristol Quality of Life in your Neighbourhood Survey' (n=6,821) to examine the association between objectively measured access to green space, frequency of green space use, physical activity, and the probability of being overweight or obese. Results showed that reported frequency of green space use declined with increasing distance, respondents living closest to green space were more likely to achieve the physical activity recommendation and less likely to be overweight or obese. However, the association with physical activity, but not with overweight or obesity, remained after adjustment for respondent characteristics, area deprivation, and a range of characteristics of the neighbourhood environment.

- West et al., (2012) studied 67 metropolitan areas in the United States using data from the Trust for Public Land's 2010 City Park Facts and The Behavioral Risk Factor Surveillance System to examine the association between park density, physical activity and overweight. The results demonstrate that higher parkland density was significantly associated with a higher likelihood of meeting the physical activity guidelines and reduced likelihood of being overweight or obese.

The Social Value of the Natural Environment

3.34 The search strategy identified 9 papers that addressed the nature of social contact in public spaces, including green spaces. These included 1 quasi-experimental study (Kuo et al., 1998), 1 cross-sectional study (Fan et al., 2011), 2 ethnographic studies (Holland *et al*, 2007; O'Brien er al., 2011), 3 studies which collated qualitative interview data (Kweon et al., 1998; Krenichyn, 2004; Ashbulby et al., 2013; Dines et al., 2006) and 1 large-scale programme evaluation (Bragg et al., 2013).

3.35 A range of findings were identified by the research relating to the social value of green space. A number of the studies found that urban green space can increase neighbourhood social ties and provide a sense of social cohesion (Kuo et al., 1998; Fan et al., 2011), particularly for those from different ethnic communities and social groups (Dines et al., 2006); people from older age groups (Kweon, 1998); and for women (Krenichyn, 2004). The Holland et al., (2007) ethnographic study also found that urban green space was more relaxed, free, intimate and less formal than other urban public spaces. This meant that urban green space attracted those who may have felt excluded from other urban public spaces, including groups of young people, street drinkers, the homeless and unemployed.

3.36 Ashbulby et al., (2013) found that beaches in the South West UK were a valuable source of outdoor space for families, who used the beaches for physical activity, to promote active play, to encourage stress relief and promote engagement with nature. O'Brien et al., (2011) and Bragg et al., (2013) evaluated green volunteer programmes and MIND's 'Ecotherapy' programme, respectively, found that these programmes improved social skills and social inclusion among participants, increased appreciation of and engagement with nature, and were particularly valuable for those with poor mental health and those from marginalised groups.

3.37 Taken overall, the evidence suggests that there is a social value to green space, above the direct impacts to health already identified by this review. Coupled with strong rates of usage of the natural environment (MENE, 2013) it appears that the natural environment is a valuable resource for its users. However, it is also clear that its use is mediated by additional factors such as area deprivation, socio-economic status, age, ethnicity, gender, season and weather conditions.

3.38 **SUMMARY:** There is some evidence to suggest that green space may improve neighbourhood social ties and increase social cohesion, particularly between different ethnic communities and social groups, among people from older age groups and women. The evidence suggests that natural environments are an important space for social contact, physical activity, to encourage stress relief and promote engagement with nature. Further evidence suggests that green volunteer programmes can increase participants sense of social inclusion and engagement with nature, and are particularly valuable for those with poor mental health and for people from marginalised groups. However, the evidence is relatively limited and this is an important area for further rigorous research before more concrete conclusions can be drawn.

- Kuo et al., (1998) found that for 145 urban public housing residents in Chicago, US, randomly assigned to 18 architecturally identical buildings, levels of vegetation in common spaces predicted both use of common spaces and neighbourhood social ties, with higher levels of green space indicating improved neighbourhood social cohesion.

- Using data from a community health survey in Chicago, Fan et al., (2011) found that different components of neighbourhood green spaces have distinct roles in influencing stress. They concluded that park spaces indirectly mitigate stress by fostering social support.

- Holland *et al* (2007) observed a number of different types of public spaces in a regional town in the south east of the UK, including green spaces, shopping centres and town centre street locations. The use of green spaces was most affected by the seasons, time of day, and weather conditions. People using the municipal park and canal towpath were seen to behave in less formal and sometimes more intimate ways. These spaces were free, and not highly regulated, which made some feel uncomfortable, but attracted others, particularly those who might have been “excluded” from town centre or commercial meeting places. Certain groups of young people, and groups of street drinkers, homeless and unemployed people used the municipal park all year round.

- Krenichyn (2004) explored the themes of relationships and caring among women undertaking physical activity in an urban park in New York. This study used qualitative interviews to offer particular insights into the use of green spaces by women, and how the presence of others in green spaces promoted feelings of safety and enjoyment, as well as providing opportunities for social interaction and support for undertaking physical activity.

- Kweon *et al* (1998) found from results of interviews with 91 older adults (between the ages of 64 and 91 years) from one inner-city neighbourhood

in Chicago, US, that use of green outdoor common spaces predicted both the strength of neighbourhood social ties and sense of community.

- Dines *et al*, (2006) showed that parks in East London (and other types of public spaces, such as street markets) were a means of bringing different communities together, as they offered opportunities for regular informal contacts between different groups and individuals.

- Ashbulby et al., (2013) explored how families engage with beach environments in their local areas and use them in health promoting ways. Fifteen families with children aged 8-11 years living in coastal regions in Southwest England participated in individual semi-structured interviews. The findings indicate that beaches encouraged families to be physically active. Although families valued the opportunities for physical activity and active play afforded by beaches, the key health benefits emphasised were psychological, including experiencing fun, stress relief and engagement with nature. Increased social and family interaction was also highlighted as benefits.

- O'Brien et al., (2011) collated ethnographic and interview data from participants in 'green' volunteer programmes. The study found self-reported and observed evidence that contact with nature was beneficial to the volunteers, particularly those from excluded groups. Three key themes of particular relevance to the marginalized participants were identified as: (1) improving relations with others and nature; (2) working alongside others who are different; and (3) developing social and employable skills.

- A programme evaluation conducted by Bragg et al., (2013) for the mental health charity MIND, evaluated the organisation's 'Ecominds' programme which consisted of 130 'ecotherapy'[2] projects. A total of 803 participants took part in the evaluation. Important findings suggested that participants significantly improved both their self-esteem and mental wellbeing through their involvement with the programme, in addition to a large majority of participants experiencing significant improvements in mood, anger, confusion, depression and tension. Other benefits of the programme were improvements in social engagement and inclusion, an enhanced 'connection to nature', improved healthy lifestyles and improved environmentally-friendly behaviours.

[2] 'Ecotherapy' (sometimes called green care) comprises of nature-based interventions in a variety of natural settings for people with poor mental health. Ecotherapy approaches are therapeutic in nature in addition to including some formal therapy such as counselling, CBT and psychotherapy, as an integral part of the programme. For more information on ecotherapy click on the following link: http://www.mind.org.uk/ecotherapy

4. Conclusion

4.1 This literature review has appraised the available evidence relevant to the health benefits of promoting engagement with the natural environment among the general population. This hypothesis has generated considerable interest in recent years and the search strategy identified a total of 63 studies which addressed this topic. Studies identified were predominantly from the UK but also from the US, Canada, the Netherlands, Australia, Japan and Sweden.

4.2 Studies were of varying size, methodology and quality. Observational studies, including cohort, cross-sectional and ecological studies, dominate the literature. The search strategy identified only a small number of experimental studies, in addition to 2 systematic reviews. Where relevant, qualitative and ethnographic studies were also included, in addition to a small number of large-scale, peer-reviewed programme evaluations.

4.3 Taken overall, the evidence suggests an association between the natural environment and health, with the majority of the studies in the review finding a positive relationship. The evidence indicates that contact with the natural environment may offer considerable benefit to health and have a positive effect on communities, including:

- improved mental health and wellbeing
- improved population health
- reduced health inequalities
- increased levels of physical activity
- improved levels of social cohesion.

4.4 Whilst the available evidence is sufficient to suggest that there may be a major trend at work, it is also clear that the evidence base is still evolving and there is a definite need for further rigorous research in this area. The current evidence is dominated by observational studies with only a small number of low-level RCTs. As such, the evidence available at present may be subject to confounding and is unable to demonstrate a causal relationship.

Thematic Conclusions

4.5 As a broad area of research, the literature review was structured thematically. The conclusions from each of these areas are discussed below.

- **Mental Health**

4.6 The relationship between mental health and the natural environment represented the most numerous and robust area of enquiry. The evidence suggests that there may be considerable benefits to mental health to be gained from doing physical activity in natural environments as opposed to synthetic environments. Observed physiological changes are suggestive of potential systematic relaxation, in addition to improved self-esteem, positive mood and decreased anxiety levels. However, the existing research is hampered by poor methodological quality, and additional, rigorous research is required to quantify *which* aspects of mental health are benefited through contact with green space and to quantify *what* physiological mechanisms cause this effect?

4.7 The evidence suggests that there may be benefits to mental health from living in areas with good access to green space. Benefits may include reduced stress, anxiety and depression and better overall mental health and wellbeing. Additional research should focus on understanding the role of confounding factors in this relationship, and to quantify the type (quantity, quality etc.) of natural environment which is beneficial to mental health.

4.8 There is some, limited evidence to suggest that there may be a positive relationship between child mental health and access to green space. Potential benefits may include improved concentration and functioning in children with ADHD, improved concentration, self-discipline and self-worth and reduced stress. Considerable further, rigorous research needs to be conducted in this area before conclusions can be drawn.

- **Population Health**

4.9 The evidence suggests that there may be benefits to general health from living in areas with good access to green space. The literature indicates that green space may positively affect longevity, perceived overall physical and mental health and wellbeing and reduce the number of health problems experienced. However, further research is required before a full understanding of this relationship can be drawn. Additional research should focus on understanding the role of confounding factors in this relationship, and quantifying the types (quantity, quality etc.) of natural environment which are most beneficial to population health.

- **Health Inequalities**

4.10 There is some limited evidence to suggest that good access to green space may reduce health inequalities. However, this observation is taken from an ecological study design which may have methodological faults. This point is particularly relevant in the light of further studies which suggest that there may be other important confounders in this relationship such as childhood experience of accessing green space and area deprivation. As such, further research must be undertaken in this area before conclusions can be drawn.

- **Physical Activity**

4.11 There is some, limited evidence to suggest that there may be a positive association between green space and physical activity. However, evidence is largely contextually specific and it is clear that this relationship is complex with a range of other influencing factors which are not yet fully understood. As such this remains an important area for further research.

- **Overweight/ obesity**

4.12 From the available evidence, it is not possible to draw any conclusions concerning the relationship between access to the natural environment and the likelihood of being overweight or obese. Studies are contextually specific and it is clear that there are a range of complex factors also involved in this relationship. As such, this should be a priority for further research.

- **Social Value**

4.13 There is some evidence to suggest that green space may improve neighbourhood social ties and increase social cohesion, particularly between different ethnic communities and social groups, among people from older age groups and women. The evidence suggests that natural environments are an important space for social contact, physical activity, to encourage stress relief and promote engagement with nature. Further evidence suggests that green volunteer programmes can increase participants sense of social inclusion and engagement with nature, and are particularly valuable for those with poor mental health and for people from marginalised groups. However, the evidence is relatively limited and this is an important area for further rigorous research before more concrete conclusions can be drawn.

4.14 **SUMMARY:** there is some evidence to suggest that there may be considerable health benefit to be gained among the general population from promoting engagement with the natural environment. The evidence indicates that accessing the natural environment may improve mental health and wellbeing, improve general population health, reduce health inequalities, increase levels of physical activity and promote increased levels of social cohesion. However, this evidence is both variable and tentative. It is clear that the evidence base is still evolving and this remains an important area for further rigorous research. Further research should focus on: (1) quantifying the effect of any health benefits, understanding *which* aspects of health are benefited, and understanding the physiological mechanisms which cause it; (2) understanding what *types* (quantity, quality, qualities) of natural environment are beneficial; (3) understanding the role of potential confounding factors (such as area deprivation, socioeconomic status, childhood experience, gender, age, ethnicity and disability), in addition to quantifying the economic and social costs and benefits.

5. Author and Date

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Date: January 2013

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