



Nature, Childhood, Health and Life Pathways

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Executive Summary

Participating in physical activity and experiencing nature both play an important role in positively influencing our health and wellbeing. Yet, physical activity levels have dropped dramatically, and inactivity results in 1.9 million deaths worldwide annually, roughly one in 25 of all deaths. The costs of inactivity in the UK are £8.3 billion per year, equating to £5 million for each PCT. It is also well-established that exposure to natural places can lead to positive mental health outcomes, whether a view of nature from a window, being within natural places or exercising in these environments. Green space is important for mental wellbeing, and levels of interaction/engagement have been linked with longevity and decreased risk of mental ill-health across a number of countries.

Thus 'green exercise', comprising of activity in green places (in the presence of nature), is predicted to lead to positive health outcomes, as well as to promote ecological knowledge, foster social bonds and influence behavioural choices. Research suggests that attention should be given to developing the use of green exercise as a therapeutic intervention (green care), that planners and architects should improve access to green space (green design), and that children should be encouraged to spend more time engaging with nature and given opportunities to learn in outdoor settings (green education). Some of the substantial mental health challenges facing society and physical challenges arising from modern diets and sedentary lifestyles could be addressed by increasing physical activity in natural places. If children are encouraged and enabled to undertake more green exercise, then they are more likely to have active exposure to nature embedded in their lifestyle as adults and will reap the associated health benefits.

Although infant mortality rates have fallen over half a century from 21.8 per 100,000 in 1960 to 5.0 in 2006, new health problems have emerged. In the UK obesity in 10 year olds has risen from 10% to 16%, and mental health disorders affect 10% of 10-16 year olds. Fewer than half of children now get enough physical activity to produce health benefits.

Several important multi-decade longitudinal cohort studies indicate clearly that many of the social and environmental conditions of childhood predict or track adult health status. Ill-health tracks, and childhood mental ill-health is carried forward. Early socially-stimulating environments are crucial. Later emotional wellbeing and cognitive capacity is profoundly influenced by early social development. This suggests a need to establish good behaviours early. Engagement with wild nature secures positive adult outcomes.

The scientific literature now suggests that there are three distinct ages of childhood during which there are different needs and thus differing implications for adult behaviour and public policy.

- i) First Age of childhood (0 to 5 years) - this is when attachment, security and nurture are most important. The parental sphere of influence is dominant, and so relations between parent and child are vital for children's development.
- ii) Second Age of childhood (6 to 11 years) - this is when memories are first laid down in continuous narratives. Children engage more outside the parental sphere of control, and explore their environments to make memories and develop cognitive capacities.
- iii) Third Age of childhood (12 to 18 years) - this is when children increasingly disengage from parents as they seek both independence (from existing

structures) and inclusion (in peer social networks), when more risks are taken, and the limits of the world tested.

The interaction between the environment and children's physical activity is complex. What is now established is the importance of physical activity to children's health at all ages. Physical activity is strongly related to both the fitness and the fatness of children, as well as cognitive development. Both fitness and fatness track into adulthood where they become risk factors for metabolic disorders, cardiovascular disease and early mortality. More physically-active children are likely to be better behaved in the classroom.

Open green space and access to nature are both important for children, with the quality of their environmental exposure inextricably linked to their wellbeing. The outdoor environment is perceived as a social space which influences children's choice of informal play activities and promotes healthy personal development. Through outdoor exploration nature allows for unstructured play, generating a sense of freedom, independence and inner strength which children can draw upon when experiencing future incidents of stress. Furthermore children's relationship with nature is a fundamental part of their development, allowing opportunities for self-discovery and natural environmental experience. However, access to high quality natural environments is unequally distributed across social groups.

Green spaces are ideal surroundings for outdoor learning, where engaging with nature can lead to enhanced connectedness to nature and increased environmental knowledge, known as green education. One way to increase children's contact with nature is within the formalized educational system, both in terms of the amount of exposure to nature in the learning environment and learning about nature (green education). Recent years have seen a growth in use by schools of allotments, gardens, woodlands and green playgrounds as both learning and play environments.

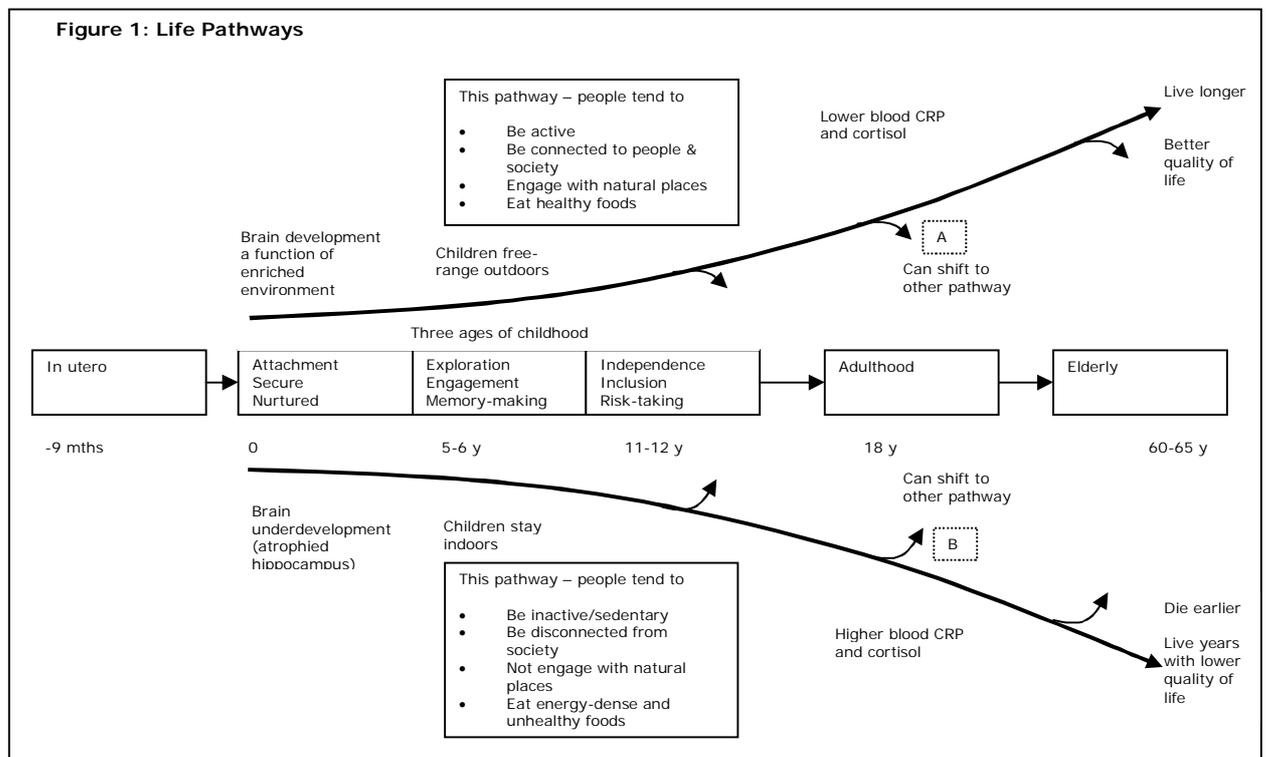
A number of nature based interventions for vulnerable groups of people exist, including those which provide therapeutic activities for vulnerable children and young people at risk of offending. This is called 'green care'. Care farming (the therapeutic use of normal farming activities) caters for many different people with defined medical or social needs and provides commissioned services for many young people, be they excluded from school, at risk of offending, disaffected, with special educational needs, or with a physical disability.

Wilderness therapy is a further emerging treatment intervention which uses a systematic approach to work with adolescents with behavioural problems. Although this is not the only group that can benefit from the outdoors, wilderness therapy is most often used with young people at risk to help them address any emotional, adjustment, addiction or psychological problems.

There is therefore growing evidence to show that children's contact with nature and consequent levels of physical activity affects not only their well-being but also their health in later life. We propose a funnel of pathways (Figure 1) within which all our lives are shaped. At the top, people live longer with a better quality of life; at the bottom they die earlier and often live years with a lower quality of life. On the healthy pathway, people tend to be active, be connected to people and society, engage with natural places, and eat healthy foods. As a result, they tend to have higher self-esteem and better mood, be members of groups and volunteer more, keep learning, engage regularly with nature and be more resilient to stress.

Many of the drivers pushing individuals towards the unhealthy lower pathway are very recent in human history: consumption of unhealthy foods, increasing inactivity, atomization of families and communities, and disengagement from nature. We suggest that the restoration of all these would improve the life of individuals as well as have a positive economic outcome for the whole country. Although it is unclear exactly how much unhealthy behaviours are costing the economy as many of the health outcomes are multifactorial: for example was a stroke caused by obesity, inactive lifestyle, poor diet or something altogether different? One thing is clear, positive well-being (physical, social and mental states) saves money.

We estimate that if an individual moves from pathway B to A, then this saves society about £2423 per year. Thus if 1% of the sedentary population moved from A to B, this would save 1063 lives and £1.44 billion per annum (Nice, 2009). The earlier, therefore, this shift occurs, then the greater number of years that these savings can accrue. Forty years at £2500 saves £100,000 for one individual (at current values); a million people making this shift saves the country £100 billion.



It is now clear that urban design affects children's health. Despite the lessons learned from the negative social consequences of poor urban planning in the post second world war period, many mistakes are still being made today as cities spread outwards, with significant consequences for public health. There appears to be a dose-response relationship, with a significant inverse relationship between the number of times an urban open green space is visited and the level of self-reported stress experienced.

Government are increasingly recognizing the need to promote daily physical activity for health. In the UK, Nice (2009) has issued guidelines and PSA targets, and the government has published a new strategy for children and young people's health. Nonetheless, rates of walking and cycling are still on the decline.

Echoing the five pieces of fruit and vegetable recommendation for diets, individuals are now being encouraged to undertake at least five half-hour bouts of moderate physical activity per week, or 10,000 steps per day (approximately 4 miles).

There are many possible policy actions that can be used to encourage widespread change, but these tend to assume that an intervention will lead to permanently changed behaviours. Simple prescriptions, such as “move more, eat a little less”; “use the stairs, park a little further away”, may help to raise public awareness, but they do not guarantee outcomes at the population level. Policies also tend to focus on facilities rather than behaviour. One notable success, though, was to make swimming at local authority swimming pools free from mid-2009, and this increased use substantially. Nonetheless, there will need to be radical changes in social and physical environments and policies if activity levels are to change permanently.

Some 15% of GPs now use exercise referral schemes, but many remain convinced they are ineffective. In the UK, 92% of GPs use anti-depressants as their most common treatment for mental ill-health. However, there are signs of change, with the Department of health calling for a well at work scheme, and Natural England calling for a focus on the values of the Natural Health Service to complement the established National Health Service. Such active living policies need to be integrated into all aspects of public policy.

We suggest ten priorities for action to improve the well-being of both children and adults:

1. Encourage a better understanding of the long-term outcomes of parental and social connections during ages 0-5.
2. Encourage more outdoor free play for children aged 6-11.
3. Develop better provisions for teenage children aged 12-18 to congregate in their own communities.
4. Encourage GPs and other medical professionals to accept that nature and the outdoors deliver important immediate and long-term health benefits.
5. Encourage planners to incorporate access to green space as a fundamental right for all people.
6. Encourage schools to incorporate use of gardens, allotments and woodlands as a regular part of the curriculum.
7. Evaluate the outcomes of outdoor play and green education on the cognitive capacities of children and their long-term health.
8. Assess the full economic benefits (personal and public) of a shift in life pathways from unhealthy to healthy for all age groups.
9. Assess how policies and institutions can best encourage widespread behaviour change that becomes a matter of preference and choice rather than enforcement.
10. Establish a national priority in all areas of public policy for all modes of physical activity in all types of green space.

1. Physical Activity, Nature and Health

Participating in physical activity and experiencing or viewing nature both play an important role in positively influencing our health and wellbeing. It is well-known that physical activity improves both physical and mental health (CDC, 1996; Laumann *et al.*, 2003; DoH, 2004; Foresight, 2007; Sandercock *et al.*, 2009). Regular physical activity also improves the survival of the elderly and their quality of life (Lim and Taylor, 2004). Yet, physical activity levels have dropped with less than 40% of men and 28% of women in England (Information Centre, 2006) not meeting UK Government guidelines which is to perform 30 minutes of exercise on most days.

Physical inactivity results in 1.9 million deaths worldwide annually (WHO, 2004) – roughly one in 25 of all deaths. Pre-industrial humans spent 1000 kcal on activity per day, whereas for modern humans the average is only 300 kcal expended. Thus, energy expenditure has fallen dramatically over the past half-century (Davis *et al.*, 2007). Inactivity increases the likelihood of obesity, and reduces life expectancy. Such physical inactivity is known to track from childhood, and is a key risk factor in many chronic diseases of later life (Dobbins *et al.*, 2009).

The costs of inactivity in the UK are £8.3 billion per year, equating to £5 million for each PCT (NICE, 2009). In the UK alone, some 23% of men and 26% of women are sedentary (NICE, 2009). We estimate that a 1% reduction in inactivity would save 1063 lives per year, reduce morbidity by 15,000 cases and save £1.4 billion. The benefits amount to £2423 per additionally active person per year (not including the mental health benefits). In the USA, sedentary behaviour costs \$90 billion per year, and it is estimated that some 30,000 of all deaths could be prevented (Rutt and Coleman, 2005). Here, there are twice the number of inactive jobs today compared with the 1950s; time spent TV viewing is up, there are more cars per licensed owner, and fewer miles travelled by foot or cycle per day (Davis *et al.*, 2007). Half of all US 12-21 year olds lack any vigorous activity at all.

Modern life has brought astonishing technological advances, but it has also led to rapid changes in ways of living that have pervasive health outcomes. Diets have so changed that obesity has within a generation risen in incidence to take it from 3-6% of adult populations to more than 25% in many industrialized countries (Foresight, 2007). Although diet is a key factor influencing health it is not addressed in this paper. Furthermore, less time spent outdoors in green spaces has resulted in drops in ecological knowledge and understanding, as well as having negative effects on mental health (Pretty *et al.*, 2007; Pilgrim *et al.*, 2007).

It is now well-established that exposure to natural places can lead to positive mental health outcomes, whether a view of nature from a window, being within natural places or exercising in these environments (Moore, 1982; Ulrich, 1984; Hartig *et al.*, 2003; Pretty *et al.*, 2005; Barton *et al.*, 2009). Green space is important for mental well-being, and levels of interaction/engagement have been linked with longevity and decreased risk of mental ill-health in Japan, Scandinavia and the Netherlands (Takano *et al.*, 2002; DeVries *et al.*, 2003; Grahn and Stigsdotter, 2003). In addition, the importance of vitamin D obtained from being outdoors in sunshine has recently been identified as playing a role in long-term health (see Box 1).

Box 1. Sunlight and vitamin D (Holick, 2004; Kampman *et al.*, 2007)

Humans depend on exposure to the sun for the synthesis of adequate amounts of vitamin D. Ultra violet B is absorbed by dehydrocholesterol in the skin, which is transformed and further converted to vitamin D3. This is then metabolised by the liver to its biologically active form. Lack of vitamin D has long-been recognised as causing rickets in children, as well as exacerbating osteoporosis and even osteomalacia in adults. More recently it has been recognised that vitamin D deficiency is associated with increased risks of some cancers, cardiovascular disease, multiple sclerosis, rheumatoid arthritis, and type I diabetes, with possible links to type II diabetes and schizophrenia (Holick, 2004).

The incidence of multiple sclerosis has also been shown to be effected by latitude with people at lower latitudes with reduced risk (due to reduced sunlight exposure). Although Norway appears to be an exception. This may be as a result of increased summer outdoor activities in childhood which have been shown to protect against MS. Consumption of fish and cod-liver oil further reduces risk as these also increase Vitamin D levels (Kampman *et al.*, 2007). It is conceivable that concerns over skin cancers combined with less time spent outdoors is reducing exposure to sunlight and thus contributing to the incidence of some of these chronic diseases. However, sensible exposure to the sun 5-10 minutes three times per week is likely to highly beneficial.

Thus 'green exercise', comprising of activity in green places (in the presence of nature), is predicted to lead to positive health outcomes (Ulrich *et al.*, 1991; Hartig *et al.*, 1991; Van den Berg, 2003; Morita *et al.*, 2006; Hine *et al.*, 2007; Mind, 2005; Pretty *et al.*, 2007), as well as to promote ecological knowledge (Pilgrim *et al.*, 2007, 2008; Pretty, 2007), foster social bonds (Kawachi *et al.*, 1997; Takano *et al.*, 2002; Brugha *et al.*, 2003; Pretty, 2007) and influence behavioural choices (Kuo *et al.*, 1998; Maas *et al.*, 2006; Mitchell & Popham, 2008; Peacock *et al.*, 2008).

Research on nature and health from the US, Scandinavia, Japan and the UK has variously focused on these themes:

1. Levels of engagement with nature – the view from the window (Moore, 1982; Ulrich, 1984; Parsons *et al.*, 1998; Diette *et al.*, 2003; Pretty *et al.*, 2005), the role of nearby nature and urban green space (Takano *et al.*, 2002; De Vries *et al.*, 2003; Grahn and Stigsdotter, 2003), participating in countryside activities (Butryn and Furst, 2003; Hartig *et al.*, 2003; Morita *et al.*, 2006; Yamaguchi *et al.*, 2006; Pretty *et al.*, 2007) and in wilderness programmes (Davis-Berman and Berman, 1989; Cason and Gillis, 1993; Russell, 2003).
2. Types of engagement with a wide range of activities including walking, gardening, fishing, hunting (Samson and Pretty, 2005; Pretty, 2007), and different types of environment from the urban built environment to countryside and wilderness.
3. Mental health outcomes using a range of measures of self-esteem, mood and stress (Ulrich *et al.*, 1991; Hartig *et al.*, 1991, 1996, 2003; Van den Berg, 2003; Pretty *et al.*, 2005, 2007).
4. Physical health outcomes using heart rate, blood pressure, Body Mass Index (BMI), waist measures (waist circumference and waist to hip ratios) and physical activity level (Laumann *et al.*, 2003; Hartig *et al.*, 2003; Pretty *et al.*, 2005; Wells *et al.*, 2007; Sandercock *et al.*, 2009).

5. Epidemiological studies showing associations between home proximity to green space and health (Maas *et al.*, 2006; Mitchell and Popham, 2007, 2008) and associations between presence of nature on urban estates and reduced recorded crime (Kuo *et al.*, 1998; Kuo and Sullivan, 2001a, 2001b).

These findings suggest that attention should be given to developing the use of green exercise as a therapeutic intervention (green care), that planners and architects should improve access to green space (green design), and that children should be encouraged to spend more time engaging with nature and given opportunities to learn in outdoor settings (green education). Some of the substantial mental health challenges facing society (Foresight, 2008; HSE, 2008) and physical challenges arising from modern diets and sedentary lifestyles (Wanless, 2002, 2004; DoH, 2004; Sport England, 2006; Wells *et al.*, 2007; NICE, 2008, 2009; DCSF, 2009) could be addressed by increasing physical activity in natural places. If children are encouraged and enabled to undertake more green exercise, then they are more likely to have active exposure to nature embedded in their lifestyle as adults and will reap the associated health benefits.

2. The Three Ages of Childhood

There are 11.6 million children (up to 18 years old) in England. Children have the opportunity to be healthier with vast improvements in medical care and a better understanding of potential threats to health (including pollution and diet). Although infant mortality rates have fallen from 21.8 per 100,000 in 1960 to 5.0 in 2006 (DCSF, 2009; Nice, 2008, 2009; DoH, 2009) new problems have emerged. In the UK obesity in 10 year olds has risen from 10% to 16%, and mental health disorders affect 10% of 10-16 year olds (Foresight, 2007). Fewer than half of children now get enough physical activity to produce health benefits (Dobbins *et al.*, 2009).

The prevalence of adolescent problem behaviour has steadily increased with drug, tobacco and alcohol abuse, aggressive and anti-social behaviour, violence, teenage pregnancy and suicide rates becoming growing problems (Stevens and Griffin, 2001; Pesta, 2002; Scott *et al.*, 2002). Some 9% of 10-18 year olds have behavioural problems, and each one costs society £25,000 per year for treatment (Foresight, 2008). A further 3% have conduct disorders and these cost £70,000 per individual per year. The total cost of youth crime in Great Britain in 2004 exceeded £1 billion (The Prince's Trust). Estimates suggest that the annual cost of sending a person to a Young Offenders Institution is around £50,800. Secure Training Centres are more costly (£164,750) and placing a child in a Local Authority Secure Children's Home represents a total annual cost of £185,780 (House of Commons Committee of Public Accounts, 2004). Therefore, as the number of juvenile offences continues to increase there is a real demand for effective alternative programmes, which particularly target recidivists who account for the majority of cases (Kauffman, 1990; Thomas *et al.*, 2002). More importantly, when questioned, more than 8 out of 10 victims of crime agreed that they would like more constructive activities to be introduced for young people to prevent them getting into the cyclical criminal process (Smart Justice, 2008).

Multi-decade longitudinal cohort studies indicate clearly that many of the social and environmental conditions of childhood predict or track adult health status. These include the 1972 Dunedin (now 30+ years after start), Cambridge (48 years after), Maudsley (21 years) and nun studies (60 years) (Danner *et al.*, 2001; Foresight, 2008). Danner *et al.* (2001) investigated the autobiographies that a group of ageing nuns had written six decades earlier at the age of 20. Since then, their lives had been very similar, yet those in the lower half of the

cohort when ranked for positive comments about life died nine years earlier than those in the top half. Positive mental health affected survival 60 years later in life.

It is clear that there is considerable tracking from childhood to adulthood (Wells and Lekies, 2006). Ill-health tracks (Frenn *et al.*, 2005), and childhood mental ill-health is carried forward (Foresight, 2008). It has been shown that 80% of children of low socioeconomic status (SES) become overweight adults, whereas only 40% of those with high SES become overweight (Wells and Lekies, 2005). Such tracking, though, is clearer from adolescence than early childhood. Early socially-stimulating environments are, however, crucial. Later emotional well-being and cognitive capacity is profoundly influenced by early social development (Ainsworth and Bell, 1970, Ainsworth *et al.*, 1974).

This suggests a need to establish good behaviours early. Engagement with wild nature secures positive adult outcomes (Wells and Lekies, 2005). A visit to a woodland as a child increases the number of visits made as an adult (Ward-Thompson *et al.*, 2008). Play affects brain development. Outdoor activity has a positive effect on long-term memory (Rickinson *et al.*, 2004), and cognitive development is influenced by free play and exploration (Bixler *et al.*, 2002; Berman *et al.*, 2008). The need for engaging children with nature at an early age is clear. In a recent report, Natural England recognises this and states that *“contact with nature can play an important role in the education and social development of children; and that early contact with nature plays an important role in developing pro environmental values and behaviours”* (Natural England 2009)

The scientific literature now suggests that there are three distinct ages of childhood during which there are different needs and thus differing implications for adult behaviour and public policy.

1. First Age: 0 to 5 years

This is when attachment, security and nurture are most important. The parental sphere of influence is dominant, and so relations between parent and child are vital for children's development.

The attachment theory of Ainsworth (e.g. Ainsworth and Bell, 1970) has shown that attachment between very young children and parents is a determinant of later social, emotional and behavioural outcomes. Infant attachment behaviour is a clear survival mechanism: the infant is seeking to ensure that the parent will provide the conditions necessary for survival. This is called 'serve and return'; mutual eye contact by infant and parent cements bonds and contributes to brain development. At birth, 100 billion neurons have not yet been connected. Experiences form these networks lay down the conditions for further cognitive development.

Studies on rats and mice have shown that those raised in enriched environments have more hippocampal neurons and better memories (Kempermann *et al.*, 1997; Burdette and Whitaker, 2005). In early childhood, social conditions are vital. Warm, secure and attached parenting has a profound influence, as it can lead to an increase in glucocorticoid receptors in the hippocampus and prefrontal cortex (Van Praag *et al.*, 2000; Liu *et al.*, 1997, 2000). These all increase levels of learning and memory, and increase resilience in later life.

2. Second Age: 6 to 11 years

This is when memories are first laid down in continuous narratives: adults can remember fragmented memories before this age, but joined-up continuous ones tend only to begin here. This is when children engage more outside the parental sphere of control, and explore their environments to make memories and develop cognitive capacities. It is suggested through this process of primary experiences, the ability to form place attachments is developed and with it the motivation to understand and protect that area. With natural environments offering so many creative, and social play experiences (shown to be more engaging than the same experiences in built playgrounds (Taylor *et al.*, 1998)) it is not surprising that time spent in these areas is more enjoyable and so leaves a more memorable impression in a person's mind (Chawla, 2007) while at the same time expanding environmental competence (Chipeniuk, 1995).

3. Third Age: 12 to 18 years

This is when children increasingly disengage from parents as they seek both independence (from existing structures) and inclusion (in peer social networks). This is when more risks are taken, and the limits of the world tested. Just as emotional well-being and cognitive capacity is profoundly influenced by early social development, the likelihood of children growing up with a connection to, and a predisposal to engage with nature is increased if links to nature are established in early childhood. This needs to happen before the third age, when young people become more independent. Chipeniuk (1995) found those who spent more time foraging in childhood to have better sense of biodiversity as adults; hypothesising that the act of foraging "*triggers an intuitive sense of biodiversity in much the same way linguists believe exposure to language triggers development of grammar.*"

3. Physical Activity Levels in Children

Physical activity is difficult to measure because it is a complex behaviour characterised by multiple dimensions and domains, and there is no precise biological marker with which it can be measured and quantified (Trost, 2007). A multitude of methods exist by which to monitor physical activity in children and adolescents including both subjective measures: activity diaries and questionnaires and objective measures: pedometers, accelerometers and heart rate monitoring (Welk *et al.*, 2000; Harro and Riddoch, 2000; Sallis and Saelens, 2000; Sirard and Pate, 2001).

Determination of physical activity levels requires the utilisation of instruments appropriate to the population under study and requires as a minimum the measurement of four dimensions: mode, intensity, duration and frequency. We have developed the Actilog (Activity log: www.actilog.co.uk) as the first internet based activity log specifically for use as a large scale measurement tool in the paediatric population. The Actilog has increased compliance of reporting over other self-report methods of recording activity levels due to an integrated SMS-based text messaging system that reminds users to complete the activity diary on a daily basis, thus improving adherence. Furthermore, the Actilog has additional features which supply information with respect to who the individual was engaged in the activity with, for example playing football with friends and where the activity took place, for example in the park.

Children and adolescents tend to 'play', and such episodes of activity are often unplanned and involve spontaneous changes of activity mode rendering them more difficult to quantify compared to planned single-mode sessions, in which adults typically engage. Objective tools such as accelerometers provide a more powerful monitoring tool in young children, who do not possess the cognitive ability to accurately recall and report bouts of physical activity. Furthermore, accelerometers can measure physical activity bouts of seconds, which better captures the transitory pattern of short bursts of activity observed in young children (Bailey *et al.*, 1995).

The East of England Healthy Hearts Study includes data on nearly 8,000 9–16 year olds from Essex and Suffolk and is now the largest English study of children's physical activity and fitness. It has been shown that English children's aerobic fitness is lower than the global average in most age groups (Sandercock *et al.*, 2008) and that it is declining by nearly 1% per year (Sandercock *et al.*, 2009), nearly twice the global average rate.

The built environment can influence children's physical activity positively by providing opportunities via open space and leisure provision or negatively via increased road density perceived danger, and the presence of litter and graffiti (Sallis *et al.*, 2006). As an example of how the built environment may influence physical activity in children, we have found very low levels of cycling in the East of England. This is despite the region's flat relief and relatively dry, mild climate. Only about 7% of boys and less than 2% of girls cycle to school. Interestingly, we have also found that those who do cycle were much more active at other times of day and much more aerobically fit than those who used other modes of transport, particularly car users (Voss *et al.*, 2010). These data agree with those from countries where cycling is more prevalent (Cooper *et al.*, 2003, 2006).

Children's health is a major concern and is one point of leverage often used to influence policy on development and travel. Environmental concerns in relation to travel are now gaining ground on health concerns and may be a valuable tool for campaigners and lobbyists. We have calculated an annual carbon dioxide reduction of over 70,000 tonnes per year if children who are currently driven to school and live within the cycleable range of 2.5 miles switched to cycling (Nelson *et al.*, 2008).

It is difficult to ascertain whether there are differences in children's physical activity between urban and rural areas. Most data on this topic come from the US, where the built environment is very different to the UK as are levels of car ownership and use. These US studies suggest little difference in physical activity levels between rural and urban children. However, European data from Italy (Tognarelli *et al.*, 2004) and Cyprus (Loucaides *et al.*, 2004; Bathrellou *et al.*, 2007) suggest that time spent outdoors is a significant predictor of overall physical activity and that children who are provided with areas to play safely outside are more physically active.

Although the densely urbanised and complex geography of the UK (including inner cities, cities, towns, suburbs, villages and isolated hamlets) makes generalisation of findings difficult using Defra land use classifications we have found that rural children (hamlets and isolated dwellings) have the highest levels of physical activity (unpublished findings). This may, again, be evidence for a mechanism by which exposure to nature may have health benefits for children via increased physical activity.

The interaction between the environment and children's physical activity is clearly complex. What is now firmly established is the importance of physical activity to

children's health. Physical activity is strongly related to both the fitness and the fatness of children, as well as cognitive development (Sibley and Etinier, 2003). Both fitness and fatness relate to metabolic risk (Eisenmann, 2007) as well as tracking into adulthood where they become risk factors for metabolic disorders (dyslipidaemia, type II diabetes) cardiovascular disease and early mortality (Eisenmann *et al.*, 2005). In addition, more physically-active children are likely to be better behaved in the classroom (Ofsted, 2008)

4. Children and Exposure to Nature

4.1 Benefits of Nature

Open green space and access to nature are both important for children (Kaplan & Kaplan, 1989; Kahn & Kellert, 2002; Bingley & Milligan, 2004; Thomas & Thompson, 2004; Louv, 2005; Ward-Thompson *et al.*, 2006, 2008); with the quality of their environmental exposure inextricably linked to their wellbeing (Thomas & Thompson, 2004). The outdoor environment is perceived as a social space which influences children's choice of informal play activities and promotes healthy personal development (Thomas & Thompson, 2004). Through outdoor exploration nature allows for unstructured play, generating a sense of freedom, independence and inner strength which children can draw upon when experiencing future incidents of stress (Wells & Lekies, 2006). Furthermore children's relationship with nature is a fundamental part of their development, allowing opportunities for self-discovery and natural environmental experience (Bird, 2007). However, access to high quality natural environments is unequally distributed, especially between children living in rural and urban areas.

Research into childhood outdoor experiences has also identified increased cognitive functioning to be a key beneficiary (Chipeniuk, 1995; Dierking and Falk 1997; Wells, 2000). Wells (2000) conducted a longitudinal study with children of low-income urban families and assessed the effects of nature on their cognitive functioning. When the families were relocated to houses with more nearby nature they had higher levels of cognitive functioning and their enhanced ability to direct attention continued for several months after moving. Another quasi-experimental study explored the idea that nature could act as a buffer to stressful events among rural children. Wells and Evans (2003) reported that 8-10 year old children exposed to high levels of nearby nature, both indoors and outdoors, were less stressed and recovered from stressful events more successfully than those in homes and backyards that lacked contact with nature. However, cause and effect can be difficult to disentangle and decipher. Does contact with nature aid development of stress coping mechanisms, which are used in later life; or does nearby nature provide the opportunity for stress recovery; or does it provide the opportunity to play with other children (social contact); or is the improved tolerance to stress due to a combination of many factors?

Taylor *et al.* (1998) found that nearly twice as many children chose to play in open spaces with trees compared with barren spaces lacking nature. They engaged in much more creative play and were more likely to spend time with adults, which facilitated social development. Scandinavian research demonstrates that factors such as children's social play, concentration and motor ability are all positively influenced following play in nature (Fjortoft, 1999; Jorgensen, 2001). This was particularly apparent in a study involving children with attention deficit hyperactivity disorder (ADHD) (Taylor *et al.*, 2001). Children worked better and their concentration improved after participating in activities in green surroundings.

Research has indicated that childhood exposure to nature and the frequency of visits to green places at a young age correlate with adult patterns of behaviour. Infrequent woodland or green space experiences as a child correlates with a lower frequency of visits during adulthood (Ward Thompson *et al.*, 2008). Childhood experience of unstructured play with minimal adult supervision, in woodland areas, significantly influenced the perception of woodlands in adult life and the seeking out of outdoor spaces when stressed (Bingley and Milligan, 2004). Therefore, lack of outdoor experiences during childhood may hinder any desires to visit such places as adults to engage in physical activity or benefit from its emotional restorative qualities.

With research suggesting so many key beneficiaries of access and exposure to play in nature it is concerning that opportunities for children resident in both urban and rural neighbourhoods to join in safe play are rapidly diminishing, mainly because of parental fear of crime and road traffic. Other reasons include loss of natural spaces for free play and the attractions of indoor alternatives, such as computer games, TV and the internet. The amount of time and contact children have with nature is ever declining, with less than 10% of children playing in natural places such as woodlands, countryside and heaths, when compared with 40% of children 30-40 years ago (Natural England, 2009). Children now wander less, and discover less, and perhaps are losing some important connections to nature and place. With children spending less time outdoors today than they used to (Orr, 2002; Louv, 2005) there is a concern that children have become more disconnected from the natural environment, thus understand it less (Bird, 2007).

4.2 Childhood and Ecological Knowledge

In recent years, a significant decline in young peoples' understanding of the natural environment has been widely reported, particularly in urban areas of industrialised communities (Pyle, 2001, 2003; Orr, 2002; King, 2003; Pilgrim *et al.*, 2008). A number of reasons have been put forward to explain this decline, including a reduction in the number and accessibility of green spaces, more classroom-based learning and less outdoor-learning opportunities (more textbooks and less butterfly nets; Pyle, 2001), and busier lifestyles leading to fewer countryside visits with family members. These all culminate in the phenomenon Pyle (2001, 2003) describes as the 'extinction of experience', whereby children are experiencing nature far less than ever before in history. As a consequence, they are unfamiliar with nature's many components. Being able to recognise and name something (e.g. a tree or bird species) is a prerequisite to forming a bond with it and, thus, caring about it. Consequently, they act less to protect the species with which they are unfamiliar, and further species loss and environmental destruction can continue unnoticed and unabated. This downward spiral of disconnection and disassociation can begin in childhood and continue through to adulthood.

Studies have shown the strong correlation between ecological knowledge and frequency of visits to green spaces (Pilgrim *et al.*, 2007). It is hard to determine the direction of this relationship (e.g. whether heightened knowledge leads to an increased number of outdoor visits or vice versa), but it is likely to be bi-directional. In the past local ecological knowledge was taught in schools. Today, however, global ecological issues such as climate change and regional biodiversity loss take precedence in the school curricula over local species and habitats. Are we at risk of training a generation of ecologists able to predict slight global shifts but unable to notice the decline of sparrows in their garden? Despite this, more

than 80% of children from industrialized countries rely on television and schooling to provide them with their ecological knowledge (Nabhan and Trimble, 1994).

Studies have shown that knowledge of the local environment is most successfully transferred orally, between friends and family members (King, 2003; Pilgrim *et al.*, 2007). People who acquire ecological knowledge in this way often go on to pursue outdoor hobbies and careers, with subsequent health benefits. Therefore, increasing ecological knowledge in younger generations could well provide a means of heightening the interest of young people in their local environment and increasing outdoor engagement throughout adulthood.

4.3 Free or Organised Play?

There is growing evidence to show that children today spend less time outdoors than previous generations. Time outdoors has fallen from 86 to 42 minutes per day since the 1980s (Orr, 2002). In addition, time outdoors is now more likely to be organized, managed or overseen by adults, whether parents, teachers or community-group leaders. Thus free and unstructured play in streets, fields, open areas, abandoned buildings, gardens and wild habitats is being lost. Some have called for children to become 'free-range' (Ward-Thompson *et al.*, 2006). Such free play has three functions: i) bonding social connections with friends, ii) exploration and risk-taking, and iii) connections with nature.

The presence of play structures and formal places to play (such as gyms, pools, playgrounds, and leisure centres) in both rural and urban areas is clearly significant in determining children's patterns of play (Brownson *et al.*, 2005). The assumption being that the existence of such structures ought to predict physical activity and health, however, this does not account for the potential or actual levels of free play.

Natural environments are varied and changeable and so provide greater opportunities for free explorative play. Indeed this type of unstructured play gives greater opportunities for decision-making while at the same time promoting creative, diverse and imaginative play, which are all seen as important elements of a child's personal and cognitive development (Taylor *et al.*, 1889, Kellert, 2002; O'Brien, 2004). In addition, free play in natural environments has also been shown to result in increased levels of social interactions which promote aptitude for learning (Hein, 1991)

4.3.1 Exploration and Risk Taking

Children often perceive their parents' views of the local neighbourhood to be more negative than their own (Timperio *et al.*, 2003), and though parents recognize their own childhood experiences, they still today want to limit their own children (O'Brien, 2004). One method used in many studies of children's outdoor behaviours centres on asking parents about their own children, assuming that they know (e.g. Veitch *et al.*, 2005).

Society has become increasingly risk-averse for young children, and this may mean a whole generation is condemned to poorer quality later lives. This suggests that whole communities should be encouraged to recognize the value of having children and young people spend time outside (Pretty *et al.*, 2009). If children are over-supervised, they will be prevented from taking risks, and thus will learn less about a potentially dangerous world. Risk-taking is about learning limits. If today's children cannot learn about taking risks, where will the country's entrepreneurs come from in the future?

4.3.2 Connections with Nature

When children have free play in nature at a young age, a connection to nature is likely to remain in adult life. However, the countryside means different things to different people. Many teenagers, for example, say that the countryside is boring and conservative (Ward-Thompson, 2006), yet want spaces in communities where they can congregate away from adults. Therefore wild spaces to teenagers are just as likely to be town centres and abandoned buildings as to be countryside or urban greenspaces.

Evidently the type of environment has a profound effect on the type of play or activity initiated. Time spent in 'wild' nature such as hiking and playing in the woods has been shown to have more positive long term effects on children than time spent in 'domesticated' nature such as picking flowers, planting seeds or trees (Wells and Lekies, 2006). It has been suggested that the structure of 'domesticated' outdoor activities may hinder the experience by not allowing for "*extensive, spontaneous engagement with nature*" (Kellert, 2002) and so do not have such profound influence on the individual.

4.4 Urban Design and the Built Environment

Urban design matters too. Time spent outdoors predicts physical activity and health (Veitch *et al.*, 2005; Burdette and Whitaker, 2005a, b), and proximity to open space does affect use (Gomez *et al.*, 2004). Studies which examine the existence of play structures and formal play areas have found no relationship between obesity, health and access or use (e.g. Burdette and Whitaker, 2004). Thus, although school PE is also important (Dobbins *et al.*, 2009), on their own such facilities are not sufficient to encourage physical activity in children (Norman *et al.*, 2004, 2006).

Hence, because of the importance of active travel (physical activity undertaken not through choice but necessity), the location of schools in neighbourhoods is especially important. Children who can walk to school are better off in physical activity terms than those who have to be driven. There is more walking in dense neighbourhoods (Braza *et al.*, 2004), and in places with more sprawl less physical activity and active travel to work and school (Ewing, 2005). In the US, adults living in the county with the most urban sprawl are 2.9 kg heavier than those in the least sprawling county (Vandergrift and Yokad, 2004).

4.5 Green Education

Green spaces are ideal surroundings for outdoor learning, where engaging with nature can lead to enhanced connectedness to nature and increased environmental knowledge, known as green education. One way to increase children's contact with nature is within the formalized educational system, both in terms of i) the amount of exposure to nature in the learning environment and ii) actually learning about nature (green education).

4.5.1 Nature in the Learning Environment

The realisation of the importance of outdoor learning has not gone unnoticed by the UK government who have sought to broaden and develop out of classroom education through the Learning Outside the Classroom Manifesto (2006). This vision is backed by the DfSE who highlighted its value in motivating young

people, reducing truancy, improving behaviour and meeting Every Child Matters criteria rather than specific environmental outcomes. However the manifesto itself does recognise the need for young people to find out *“how what they learn in school relates to their life outside it and to the world around them”*; making recommendations for providing ‘out of the classroom learning’ both within the school grounds and further afield.

The Office for Standards in Education (Ofsted, 2008) has recently published guidance on learning outside the classroom reinforcing environmental education objectives which are now part of the English revised curriculum (Qualifications & Curriculum Authority, 1999). As such educators are required to *“develop [pupils’] awareness and understanding of, and respect for, the environment in which they live, and secure their commitment to sustainable development at a personal, local, national and global level.”*

Outdoor learning is more than just fieldwork for natural history or geography: it is the notion that a great deal of learning for all disciplines can take place in outdoor settings (Rickinson *et al.*, 2004). It has been suggested that it is the additional benefits associated with the outdoor activity combined with quality of learning which result in the outdoors being a more effective venue for education. Dymont (2005) for example concludes that green school grounds can provide an area where many subjects can be taught both formally and informally, with the outdoor natural space providing additional opportunities for critical thinking, creative inquiry, and problem solving; fundamental life skills permitting students to *“think critically about issues pertinent to their lives and the world outside the classroom”* (Pollock, 2004).

Despite evidence that outdoor education leads to improved cognitive outcomes; better behaviour both in the classroom and at home; and improved working conditions for teachers (Sibley and Etinier, 2003) there are barriers to undertaking such activities. Outdoor education and excursions do take time, effort and organizational skills with Rickinson *et al.* (2004) adding, *“it is naive to think that short terms excursions to the environment will become significant life experiences.....poor field work is likely to lead to poor learning”*. However measures are being taken to break down barriers to providing quality outdoor experiences for example through the provision of a quality badge assurance which was introduced this year by the LOTC Manifesto.

It is now clear that fieldwork and outdoor learning lead to long term gains for attitudes, beliefs, self-perceptions interpersonal social skills, and memory creation and retention (Rickinson *et al.*, 2004; Berman *et al.*, 2008; Ofsted, 2008).

4.5.2 Learning about Nature

In the UK, the Forest Education Initiative has set up a number of Forest Schools. This concept originated in Scandinavia in the 1950s as a way of teaching children of all ages about the natural world and providing hands on learning in a woodland environment. By the 1980s it had become an integral part of the Danish primary education syllabus. Several schools have been set up in England and Wales with the main aim of providing contact with woodlands on a regular basis and over an extended period of time for young people. Participation in the forest school improves children's confidence, well-being and self-esteem, motivates them to learn and encourages pride in, and ownership of, their local environment ((Bishops Wood Centre, 2005). At the same time, there has been a rapid growth in the number of initiatives to develop allotments in or close to school grounds to grow vegetables (see Box 2).

Box 2. Eastfeast an example of green education (Eastfeast 2009)

Eastfeast is a team of professional gardeners, artists and teachers that helps schools deliver more effective learning based on working a school allotment through the seasons, culminating in a community feast. Eastfeast started in 2005 with a year long pilot programme at Aldeburgh Primary School in Suffolk and the project continues to evolve, in partnership with a growing number of schools in East Anglia, through a series of linked but independent creative learning programmes.

Eastfeast schools pupils spend more time outdoors as children become involved in activities focused around working an allotment. This creates connections between nature and learning which may result in memories that impact on choices young people make later in life, so they choose to spend more time outdoors. The Eastfeast initiative has been shown to be successful in developing links between creative learning activities and local resources eg allotments, growers, food producers and cultural centre. By helping to get the local community involved, a 'shared learning ethos' is developed both inside and outside the formal school boundaries and this helps pupils to gain the confidence to make their own decisions about learning and is likely to have an effect on life pathways. In partnership with the University of Essex, Eastfeast will enable the schools involved with the programme to investigate the impact of outdoor learning and the arts on children's well-being.

4.5.3 Green Playgrounds

Despite the mounting evidence that observing a natural environment or directly engaging within a natural environment has both physiological and mental health benefits in adults, there is a paucity of evidence in this area directly focussed on the paediatric population. The school grounds may provide a vital opportunity for children who do not have access to a garden or live near a park to have contact with nature and experience their natural environment first hand. Currently, there appears to be limited active play in green spaces within the school environment as much of the play seems to be concentrated around concrete playgrounds. Individually both physical activity and interaction with nature can have a positive impact on psychological well-being (Bingley, 2004; Paluska and Schwenk, 2000), therefore combining these activities, as "green exercise" may strengthen this response.

Recent research at the University of Essex has assessed which types of playtime activity were most effective for increasing physical activity and improving psychological health in primary school children. Three playtime interventions were introduced including an outdoor clothing strategy (to enable outdoor play in poor weather), the provision of sports equipment (to improve motor skills) and the installation of an orienteering course (to increase use of green space). Children had access to the interventions during both their mid-morning and lunch time breaks and each intervention was introduced for a week in both the winter and summer terms.

Physical activity levels were measured using accelerometers and psychological well-being was assessed using self esteem questionnaires. Results showed that the activity where the interaction with nature was greatest, namely orienteering, had the largest effect on self esteem. However, the provision of sports equipment produced the largest increase in physical activity. Furthermore, there could be significant benefits for those children identified as overweight and obese in terms of improvement in their health and psychological wellbeing. It is essential that a multi-faceted approach be utilised in order to address the linked problems of obesity and sedentary behaviour, whilst also taking advantage of the numerous psychological health benefits derived from playing in green spaces.

4.6 Green Care

A number of nature based interventions for vulnerable groups of people exist, including those which provide therapeutic activities for vulnerable children and young people at risk of offending. This 'green care' is a growing movement which comprises many contexts, including therapeutic applications of green exercise activities, Social and Therapeutic Horticulture (STH), Animal-Assisted Interventions (AAI), ecotherapy, care farming and wilderness therapy.

4.6.1 Care farming

Care farming (the therapeutic use of normal farming activities – Hassink, 2003; Braastad, 2005; NCFI, 2009) caters for many different people with defined medical or social needs and provides commissioned services for many young people, be they excluded from school, at risk of offending, disaffected, with special educational needs, or with a physical disability (Hassink and van Dijk, 2006; Hine *et al.*, 2008a, b).

In addition to developing a connection with nature, taking part in a structured therapeutic or educational programme consisting of farming related activities has also been shown to provide both social benefits and improvements to physical and mental health. These improvements include increased self-esteem, enhanced well-being and beneficial changes in mood, an increase in self-confidence, trust in other people, calmness, formation of a work habit and the development of social skills and a sense of personal responsibility. In a recent study of participants, which included disaffected young people, on seven UK care farms, participants experienced significantly increased self-esteem, a reduction in feelings of anger, confusion, depression, tension and fatigue, whilst also feeling more active and energetic (Hine *et al.* 2008a, b). Care farming can help young people to feel better and is an example of a partnership between participants, farmers and health, social or educational care providers, which can help to transform life pathways.

4.6.2 Wilderness experiences

Although wilderness therapy is a relatively new concept in the UK, programmes have been in existence for many years in the US. Connor (2007) describes wilderness therapy as *"an experiential program that takes place in a wilderness or remote outdoor setting"*, but essentially wilderness therapy uses the 'wilderness as co-therapist' in addition to any professional individual or group therapy that takes place outdoors.

Wilderness therapy is an emerging treatment intervention which uses a systematic approach to work with adolescents with behavioural problems. Although this is not the only group that can benefit from the outdoors, wilderness therapy is most often used with young people at risk (Bandoroff & Scherer, 1994; Russell *et al.*, 1998; Cooley, 1998; Russell, *et al.*, 2000; Russell, 2003a; Russell, 2003b; Caulkins *et al.*, 2006; Russell, 2006a, b; Bettmann, 2007) to help them address any emotional, adjustment, addiction or psychological problems (Russell, 1999).

Wilderness therapy programmes typically provide healthy exercise through hiking and physical activity, a healthy diet, individual and group therapy sessions, education, primitive skills training, group-living with peers, opportunities for solo time and reflection, leadership training and challenges based on 'back-to basics' living. The rationale for these interventions involves separating disaffected young

people from daily negative influences and placing them in safe outdoor environments. Spending time in a natural setting enables participants to access those aspects of their self that may elude them in more conventional personal development or therapeutic settings. The programmes facilitate self-awareness, communication, cooperation and contribution to the wellbeing of the group (Connor, 2007). Participation helps to address problem behaviours by fostering personal and social responsibility and providing the opportunity for emotional growth. Facing challenges in a wilderness setting gives participants the experience of daily successes which help to challenge old, negative beliefs and lead to new, more optimistic self-perceptions. This in turn can help the young person move towards a more positive life pathway (see Box 3).

Box 3. TurnAround - an example of wilderness therapy

The prevalence of adolescent problem behaviour has steadily increased and these 'young people at risk' are often labelled as underachievers, socially inept, untrustworthy and of low self esteem. Low levels of self-esteem are often associated with self-destructive behaviour such as violence and crime, alcohol and drug abuse, dropping out of school, and poor academic achievement. Spending time in the natural environment facilitates stress recovery, encourages exercise participation, stimulates development in children and provides opportunities for personal development.

'The TurnAround 2007 Project' was a nine month intensive personal development project designed to help vulnerable young people at risk aged 15-18 years in social care in Essex. The project was designed to use the power of nature as a catalyst for long term changes, empowering the young people to take personal responsibility for their futures. It combined the use of wilderness trails (involving experts in wilderness therapy), monthly personal development workshops and one to one life coaching (coordinated by a professional coaching manager). The programme was delivered by coaches drawn from the local community, volunteers and those on work experience and was intended to bring about a change in outlook, foster self esteem and improve social ability and life skills amongst the vulnerable young people.

Self-esteem scores significantly improved after participating in the first wilderness trail. Levels dropped when participants returned to their usual environments, yet they never regressed to starting values and from that point forward they continued to steadily increase. The final score after the second wilderness trail was also significantly better in comparison to baseline scores at the start of the project. Spending time in wilderness environments enabled the young people to connect with nature and connectedness-to-nature scores steadily increased over the duration of the project. For some participants it was their first opportunity to spend time in an environment that they could not control or manipulate.

The programme was successful in initiating many changes in young people's behaviour, attitude and values, and both participants and coaches alike experienced personal developmental changes. The majority of participants learnt how to manage their behaviour and express their emotions more constructively. As the programme progressed the frequency of negative events reduced, criminal activity declined, substance abuse improved and participants displayed less anti-social behaviour.

5. Life Pathways

5.1 Alternative Life Pathways

There is therefore growing evidence to show that children's contact with nature and consequent levels of physical activity affects not only their well-being but also their health in later life. We propose a funnel of pathways (Figure 1) within which all our lives are shaped. At the top, people live longer with a better quality of life; at the bottom they die earlier and often live years with a lower quality of life. On the healthy pathway, people tend to be active, be connected to people and society, engage with natural places, and eat healthy foods. As a result, they tend to have higher self-esteem and better mood, be members of groups and volunteer more, keep learning, engage regularly with nature and be more resilient to stress.

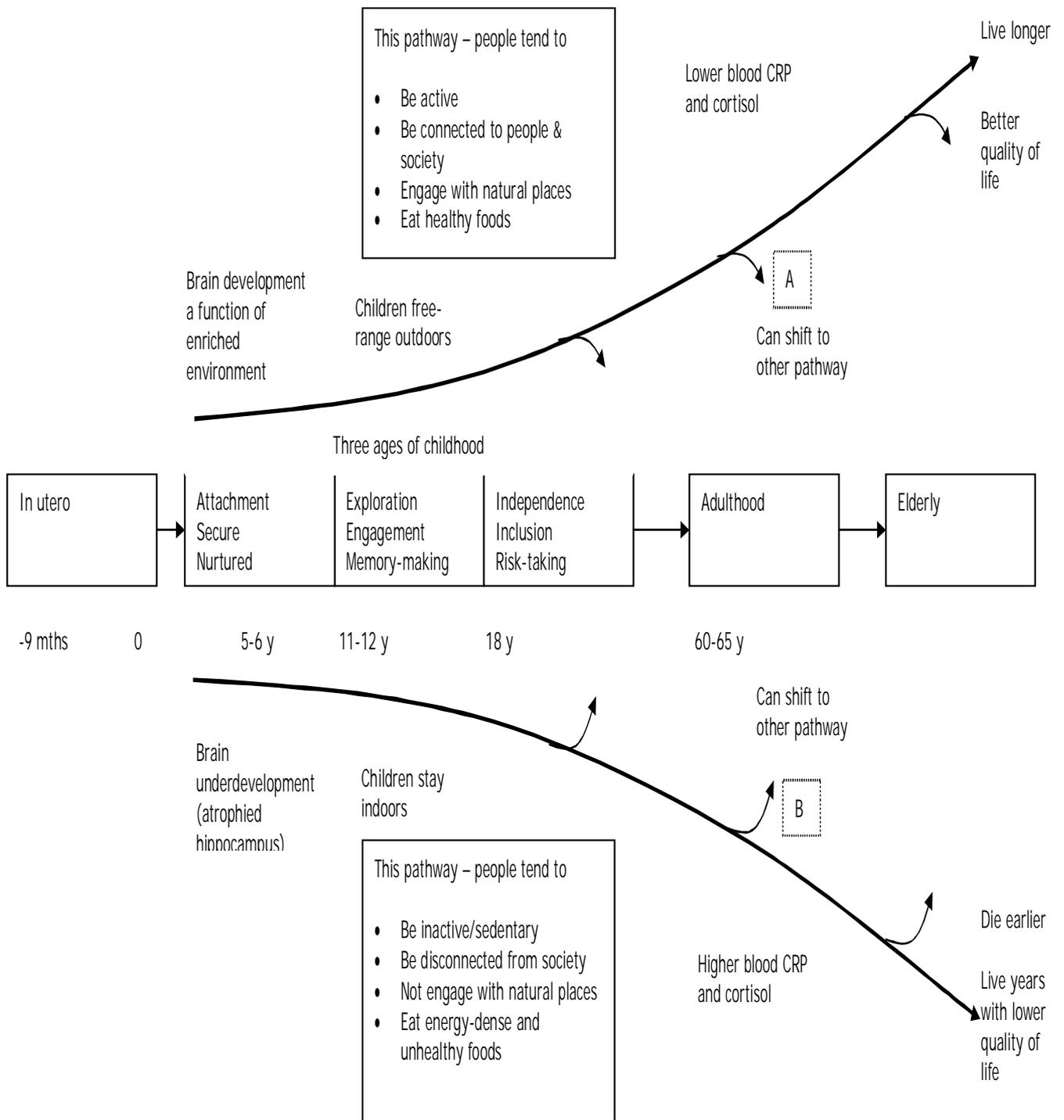
On the unhealthy pathway, people tend to be inactive and sedentary, be disconnected from society and social groups, not engage with natural places, and eat energy-dense and unhealthy foods. They also tend to have lower socio-economic status, be in more stressful jobs (5 million people in the UK), live where active travel to work or school is difficult, have increased likelihood of being mentally ill (16% of adult UK population), and be overweight or obese (25% of adults and 16% of children are now obese.) (Foresight, 2007). We propose that it is possible to shift across these pathways – from B towards A as a result of adopting healthy behaviours, or from A to B as a result of shocks or an accumulation of stresses. Resilient individuals remain able to absorb and cope with shocks and stresses and remain on pathway A.

Many of the drivers pushing individuals towards the unhealthy lower pathway are very recent in human history: consumption of unhealthy foods, increasing inactivity, atomization of families and communities, and disengagement from nature. We suggest that the restoration of all these would improve the life of individuals as well as have a positive economic outcome for the whole country. Although it is unclear exactly how much unhealthy behaviours are costing the economy as many of the health outcomes are multifactoral: for example was a stroke caused by obesity, inactive lifestyle, poor diet or something altogether different? One thing is clear, positive well-being (physical, social and mental states) saves money.

We estimate that if an individual moves from pathway B to A, then this saves society about £2423 per year. Thus if 1% of the sedentary population moved from A to B, this would save 1063 lives and £1.44 billion per annum (NICE, 2009). The earlier, therefore, this shift occurs, then the greater number of years that these savings can accrue. Forty years at £2500 saves £100,000 for one individual (at current values); a million people making this shift saves the country £100 billion.

Figure 1 illustrates a dichotomous model with the two pathways representing the extremities, but there are clearly numerous pathways that lie between healthy path A and unhealthy path B. The figure has been simplified for illustration purposes only, but the many rich and varied pathways will encapsulate different configurations and patterns. There are many other factors that affect children's long-term life and health pathways. Here, though, our focus has been on describing the key mediators, such as social status, mental health, social capital, physical activity, urban design and contact with nature.

Figure 1: Life Pathways



5.2 Socio-Economic Status and Long-Term Health Inequalities

In industrialised countries, people of low socio-economic status (SES) tend to be more inactive and more overweight (Veitch *et al.*, 2005; Mitchell and Popham, 2008). In developing countries, it is the opposite: poverty and low income brings with it physical activity (e.g. farm work, long-distance travel to work or market) and diets with fewer excess calories.

Low SES in industrialized countries at an early age sets children and adults on pathway B:

- There is double the risk of lung cancer in manual (low SES) versus non-manual (higher SES)_workers;
- Cortisol levels are higher in low SES children;
- Cortisol levels increase with months in care;
- C-reactive protein (C-RP) levels are higher in deprived groups who smoke compared with affluent groups who smoke; (High C-RP predicts heart disease and strokes, and increases the risk of type II diabetes);
- Chronic stress leads to shorter telomeres (these are shorter in manual compared with non-manual workers; shorter telomeres indicate greater 'biological age');
- Stress (higher economic and social stress in lower SES groups) leads to atrophy of the hippocampus.

At risk children are more likely to be unemployed as adults, have criminal convictions, be pregnant as teenage girls, and engage in substance abuse (refs).

Anti-social conduct at age 8-10 years leads to poor employment outcomes at 30 years (refs). Those with mental health problems at 10 years of age have lower incomes at 30 years. In the US, lower income groups have greater ill-health (Frenn *et al.*, 2005). High material deprivation leads to lower physical activity (Lee *et al.*, 2005). Environments that promote good health are crucial for whole populations (Mitchell and Popham, 2008).

5.3. Mental Health and Life Pathways

Mental ill-health costs society some £77 billion per year in the UK (Foresight, 2008). Common mental disorders affect 16% of the adult population at any given time. There are now 700,000 new dementia cases per year (dementia costs the nation £17 billion a year), and these are predicted under current circumstances to rise to 1.4 million by 2040. Five million people are estimated to be stressed in the workplace, and the consequent physical and mental ill health results in a loss of 10% of GNP per year (Mind, 2005). Stress, poverty and low SES are all bad for mental health (Mitchell and Popham, 2008). Simple interventions such as a walk in the park at lunchtime or walking or cycling to work are likely to be effective in reducing stress and improving mental health.

Mental ill-health brings stigma, prejudice and discrimination, and is known to be carried forward from childhood to adulthood (Foresight, 2008). Positive mental health is not the same as a lack of ill health: it is about living life well (Huppert *et al.*, 2007). Positive emotions and well-being improve health and long-term survival (Ostir *et al.*, 2001; Huppert and Whittington, 2003;). Positive mood increases serotonin levels (Flory *et al.*, 2004), and green exercise improves mood.

Self-esteem and mood are important indicators of current and future well-being and therefore affect life pathways of both adults and children. Self-esteem is a determinant of short- and long-term psychological wellbeing. It refers to a positive or negative attitude towards self and is an evaluation of a person's sense of worth or value (Blascovich and Tomaka, 1991). It is commonly accepted as a key indicator of emotional stability and is thus a contributor to mental wellbeing, quality of life and survival (Huppert and Whittington, 2003). High self-esteem is related to security and closeness in relationships (Murray, 2005) which helps to foster social connectedness. Young people with high self-esteem are less susceptible to peer pressure and alcohol abuse and perform better at school (Zimmerman *et al.*, 1997), and adolescents with high self-esteem are less vulnerable to bullying (O'Moore & Kirkham, 2001). By contrast, low self-esteem is closely linked to mental illness and the absence of psychological wellbeing. Individuals exhibiting low self-esteem often show signs of self-rejection, self-dissatisfaction and self-contempt.

An individual's level of self-esteem also has implications for health behaviours, motivations and lifestyle choices. High levels of self-esteem are associated with healthy behaviours, such as healthy eating, participating in physical activities, not smoking and a lower suicide risk (Torres and Fernandez, 1995). High self-esteem is also associated with positive qualities such as independence, adaptability, leadership, stress resilience, life satisfaction, social adjustment and greater academic and work achievements (Biddle *et al.*, 2001).

Mood is the host of "transient, fluctuating affective states" that can be both positive and negative (Hull, 1991). Mood is an integral component of daily life and has a strong influence on feelings of happiness, being able to appreciate the moment, being willing to help others, coping with stressful situations and general quality of life (Berger *et al.*, 1999). Mood is linked with physical health and is known to affect the immune system and healthy behaviours, and has the potential to affect the onset of specific diseases (Melamed, 1995; Flory *et al.*, 2004). Stimulating mood states of fear and anger can lead to heart disease, strokes and reoccurrence of chronic autoimmune diseases, such as rheumatoid arthritis or asthma, and long-lasting moods of fatigue and hopelessness may be associated with the development of cancer and repeat myocardial infarctions (Leventhal *et al.*, 1998).

Mood states are known to influence long-term health by both direct and secondary pathways. Direct pathways relate to the immune system, with numbers and activities of B and T lymphocytes, macrophages, antibodies, leukocytes, pathogen invasion responses and shift in energy balance all affected by mood states (Maier *et al.*, 1994). Secondary pathways centre on lifestyle choices which are influenced by mood states. Outcomes of these behaviours may include obesity, nutritional deficiencies, eating disorders, smoking, illicit drug use and reduced physical activity participation (Cohen & Rodriguez, 1995; Thayer *et al.*, 1994). Acute changes in mood are generally maintained for 2-4 hours post exercise (Raglin & Morgan, 1987; Thayer, 1996). However, this relatively short duration of enhanced mood has a positive influence on quality of life including more social interaction, improved productivity and better behavioural choices (Berger *et al.*, 1999). Engaging in regular exercise over the long-term can contribute to more sustained changes in mood.

5.4. Social Capital, Activity and Health

It is well-established that trusting relationships help to change attitudes and behaviour as well as having an effect on health (Kawachi *et al.*, 1997; 2001;

Cuddeford *et al.*, 2004). Conversely isolation and negative feelings make change more difficult and also affect health (Ostrom, 1990). The value attached to relationships constitutes a form of capital, which has come to be known as social capital. This includes a person's contacts and networks; the common rules, norms and sanctions that regulate behaviour together with the reciprocity and exchanges that build friendships, respect and ultimately trust (Pretty and Ward, 2001).

Three types of social capital are commonly identified. These are the ability to engage positively with those closest to us who share similar values (referred to as bonding social capital). Working effectively with those who have dissimilar values and goals is called bridging social capital. Finally the ability to engage positively with those in authority either to influence their policies or obtain resources is termed linking social capital (Woolcock, 1998, 2001; Pretty, 2003; Hall and Pretty, 2008). To gain the most from social capital, individuals and communities require a balanced mixture of bonding, bridging and linking relationships (NESF, 2003). Social capital is a valuable asset that helps people achieve their own goals.

One of the central themes of Putnam's *Bowling Alone* (1995) is that although just as many people in the US go ten-pin bowling as they did in the past, today they tend to bowl alone or in small groups of existing friends. When individuals were members of competitive teams in a league, then they tended to play teams from other social and ethnic groups within cities, and as a result bridging social capital was built through regular contact.

It is clear that people engage with the outdoors not just for the connection to nature, but to provide the setting for the building of social capital (Kawachi *et al.*, 1997; Brugha *et al.*, 2003; Krenichyn, 2004, 2005). Nature is good for health; green places are good for social capital. Strong social support keeps the elderly alive (Brugha *et al.*, 2003), and membership of sports clubs contributes to well-being. There are 30,000 football clubs in the UK, and some 350,000 people participating at least once per week in rugby, cricket, athletics and swimming.

There are clear benefits to children of formal sports. The majority of schools in the UK achieve the recommended target of two hours of curriculum PE every week (DCSF, 2007), although PE lessons alone do not provide sufficient opportunity to meet current guidelines for physical activity. PE can have a positive influence on children's perception of the importance and value of activity and exercise and shapes their attitude towards it (QCA, 2005). The Government is currently aiming to increase school and community sports participation by young people to 5 hours per week (PE and sport strategy for young people).

Thus, investing in social capital would improve morbidity and mortality rates (Kawachi *et al.*, 1997). High trust reduces mortality, and group membership reduces all-case mortality. Income inequalities leads to disinvestment in social capital (Brugha *et al.*, 2003). Volunteering has also been shown to increase longevity in the elderly (Greenfield and Marks, 2004).

6. Policies, Design and Interventions

6.1 Urban Design

It is now clear that urban design affects children's health. Despite the lessons learned from the negative social consequences of poor urban planning in the post second world war period, many mistakes are still being made today as cities spread outwards, with significant consequences for public health (Davis, 2002; Frumkin *et al.*, 2004; Frumkin, 2005). As urban regions diffuse into former rural areas, they produce settlements with low density, a heavy reliance on motor cars for transport, and increasing segregation of communities from one another. Urban sprawl also influences air pollution, produces heat islands, changes physical activity patterns, increases motor vehicle crashes, makes physically active transport difficult, and eventually shapes mental health and social capital. All this leads to significant health consequences which are rarely acknowledged by urban planners.

In the USA the average for daily travel to work is now 40 miles (Brownson *et al.*, 2005a, b). Vehicle miles per day since 1950 are up from 8 to 25 miles, and vehicles per licensed owner have increased from 0.7 in 1950 to 1.1 today. In the UK, private car numbers rose from 2 million in 1950 to 15 million in 1980 and 26 million today. Walking declined from 87 hours per year in 1975 to 67 hours in 2005. The prevalence of open space and urban design affects levels of activity (Gomez *et al.*, 2004; Atkinson *et al.*, 2005; Lee *et al.*, 2005). Thus "environments that promote good health might be crucial in the fight to reduce health inequalities" (Mitchell and Popham, 2008). Greenways and parks in cities are important for active travel, and also increase local property value (Lindsey *et al.*, 2004; Wendell-Vos *et al.*, 2004; Savills, 2006). There also tends to be more walking and biking in dense neighbourhoods and to small schools (Braza *et al.*, 2004).

In the USA, it has been found that "*greener neighbourhood common spaces give rise to stronger neighbourhood social ties*". Residents in urban areas with more local green space had "*more social activities and more visitors, knew more of their neighbours, reported their neighbours were more concerned with helping and supporting one another and had stronger feelings of belonging*". This indicates that regular contact with nature is indispensable, as residents prefer areas with trees and grass and negatively respond to barren areas without vegetation. The mere presence of trees encourages more frequent use of the outdoor space and experiencing nature reduces mental fatigue, diminishes sensations of stress and has positive effects on mood (Kuo *et al.*, 1998; De Vries *et al.*, 2003). This raises a question as to why we not do this routinely in the planning of settlements.

There appears to be a dose-response relationship, too, with a significant inverse relationship between the number of times an urban open green space is visited and the level of self-reported stress experienced. A recent study of eight European cities found that in places with more greenery and less graffiti, people were more likely to take exercise and thus reduce obesity. Residential environments with high levels of local green space had people three times more likely to be physically active, and 40% less likely to be overweight (Grahn and Stigsdottir, 2003; Ellaway *et al.*, 2005). The amount of time spent per week in urban green areas is also influenced by the distance to home or work. People who live 50 metres or less from the nearest green area visit them three to four times per week. If this distance is increased to 300 metres, then the number of visits falls to two and a half, and if the distance is 1000 metres, then visits occur only once a week. If residents have few green environments within their local area,

they do not compensate for this by visiting more distant public parks or urban forests more frequently.

6.2 Government Policies

Government are increasingly recognizing the need to promote daily physical activity for health. In the UK, Nice (2009) has issued guidelines and PSA targets, and the Department for Schools, Communities and Families (2009) has published a new strategy for children and young people's health. Nonetheless, rates of walking and cycling are still on the decline. Echoing the five pieces of fruit and vegetable recommendation for diets, individuals are now being encouraged to undertake at least five half-hour bouts of moderate physical activity per week, or 10,000 steps per day (approximately 4 miles).

There are many possible policy actions that can be used to encourage widespread change (Matson-Koffman *et al.*, 2005), but these tend to assume that an intervention will lead to permanently changed behaviours. Simple prescriptions, such as "move more, eat a little less"; "use the stairs, park a little further away", may help to raise public awareness, but they do not guarantee outcomes at the population level (Norman and Mills, 2004). Increased provision of school PE and outdoor play is known to help, as are after-school programmes (Romero, 2005). Again, though, if such programmes cease because of lack of funding, there is no certainty that behaviour will not revert. Transport policy is similarly hard to change, as the motor car has become central to most people's mobility (Smith and Bird, 2004). In Finland, for example, progressive policies increased participation in recreational physical activity in all age groups, especially around sports and the outdoors (Vuori *et al.*, 2004). But participation in cycling and walking fell, as these were affected by different factors and policies.

Policies also tend to focus on facilities rather than behaviour. One notable success, though, was to make swimming at local authority swimming pools free from mid-2009, and this increased use substantially. From April 2009, 211 councils offered free swimming to under 16s and over 60s, with investment from the government Free Swimming Programme (DH, 2009). Nonetheless, there will need to be radical changes in social and physical environments and policies if activity levels are to change permanently (Pretty, 2006; Sallis *et al.*, 2006).

Many of the effects of unhealthy behaviours are reversible, and it is never too late to gain the benefits of change (e.g. walking for the elderly; Fisher and Fuzhong, 2004). Cardiac rehabilitation programmes that include physical activity increase survival and reduce re-hospitalisation, but tend also to need social support, a positive environment, and personal motivation amongst participants to continue the behaviour (Fleury *et al.*, 2004). Breast cancer rehabilitation with regular exercise (30 mins walking five times a week) and increased fruit and vegetable consumption doubles the survival rate after 5-11 years (Pierce *et al.*, 2007), with the death rate falling from 14% to 7% for those with the healthy lifestyles.

It is also clear that rehabilitation of degraded natural habitats works and pays – it results in an increase in the number of visits and people then stay longer (Evenson *et al.*, 2005; Barton *et al.*, 2009). In a similar way, engagement with the national forest has been shown to change attitudes and establish new and important memories (Morris and Urry, 2005; Ryan and Greese, 2005). There are thus good economic reasons for protecting existing green spaces and rehabilitating other places to increase access and use. The costs and benefits of bike and pedestrian trails in Nebraska have been assessed: per capita costs are \$209 per year, but medical benefits are \$564 per capita, giving a cost-benefit

ratio of 2.94. This suggests that these kinds of investments are worthwhile. In the UK, an analysis of the Walking the Way to Health Initiative's 500 local schemes has recently shown that if all the population of England were afforded good access to green space and walked regularly, then there would be a saving to the health service of £2 billion annually (NE, 2009).

Some 15% of GPs now use exercise referral schemes (there are estimated to be 1300 across country: Mental Health Foundation, 2005), but many remain convinced they are ineffective. In the UK, 92% of GPs use anti-depressants as their most common treatment for mental ill-health. However, there are signs of change, with the Department of Health calling for a well at work scheme (DoH, 2009), and Natural England calling for a focus on the values of the Natural Health Service to complement the established National Health Service (NE, 2009). In short, Active Living policies (Sallis *et al.*, 2006) need to be integrated into all aspects of public policy.

7. Ten Priorities

We suggest ten priorities for action to improve the well-being of children and adults:

1. Encourage a better understanding of the long-term outcomes of parental and social connections during ages 0-5.
2. Encourage more outdoor free play for children aged 6-11.
3. Develop better provisions for teenage children aged 12-18 to congregate in their own communities.
4. Encourage GPs and other medical professionals to accept that nature and the outdoors deliver important immediate and long-term health benefits.
5. Encourage planners to incorporate access to green space as a fundamental right for all people.
6. Encourage schools to incorporate use of gardens, allotments and woodlands as a regular part of the curriculum.
7. Evaluate the outcomes of outdoor play and green education on the cognitive capacities of children and their long-term health.
8. Assess the full economic benefits (personal and public) of a shift in life pathways from unhealthy to healthy for all age groups.
9. Assess how policies and institutions can best encourage widespread behaviour change that becomes a matter of preference and choice rather than enforcement.
10. Establish a national priority in all areas of public policy for all modes of physical activity in all types of green space.

References

- Ainsworth M D S, Bell S M and Stayton D J. 1974. Infant-mother attachment and social development. In Richards M P M. *The Integration of a Child into a Social World*. Cambridge University Press, Cambridge
- Ainsworth M D S, Bell S M. 1970. Attachment, exploration and separation: illustrated by the behaviour of one year olds in a strange situation. *Child Development* 41 (1), 49-67
- Atkinson J L, Sallis J F, Saelens B E, Cain K L and Black J B. 2005. The association of neighbourhood design and recreational environments with physical activity. *Am J Public Health Promotion* 19, 304-09
- Bailey R C, Olson J, Pepper S L, Porszasz J, Barstow T J and Cooper D M. 1995. The level and tempo of children's physical activities: an observational study. *Med Sci Sports Exerc*, 27(7), 1033-1041
- Bandoroff S and Scherer DG. 1994. Wilderness family therapy: An innovative treatment approach for problem youth. *Journal of Child and Family studies* 3, 175-191.
- Barton J, Hine R and Pretty J. 2009. The health benefits of walking in green space of high natural and heritage value. *Journal of Integrated Environmental Sciences* 6.4, 1-18
- Bathrellou E, Lazarou C, Panagiotakos D B and Sidossis L S. 2007. Physical activity patterns and sedentary behaviors of children from urban and rural areas of Cyprus. *Cent Eur J Public Health* 15(2): 66-70
- Berger B, Pargman D and Weinberg R S. 2002. *Foundations of Exercise Psychology*. Fitness Information Technology, Morgantown
- Berman M C, Jonides J and Kaplan S. 2008. The cognitive benefits of interacting with nature. *Psychological Science* 19, 1207-1212
- Bettmann J. 2007. Changes in adolescent attachment relationships as a response to wilderness treatment. *Journal of the American Psychoanalytic Association*, 55, 259-265.
- Biddle S J H, Fox K R and Boutcher S H. 2001. *Physical Activity and Psychological Well-Being*. : Routledge, London
- Bingley A and Milligan C. 2004. *Climbing Trees and Building Dens: Mental health and well-being in young adults and the long-term effects of childhood play experience*. Institute for Health Research, Lancaster University, Lancaster
- Bird, W. 2007. *Natural Thinking*. A report for the Royal Society for the Protection of Birds, Investigating the links between the Natural Environment, Biodiversity and Mental Health
- Bixler R D, Floyd M F and Hammitt W E. 2002. Environmental socialization. Quantitative tests of the childhood play hypothesis. *Environment and Behaviour* 34, 795818
- Blascovich J and Tomaka J. 1991. Measures of self-esteem. In *Measures of personality and social psychological attitudes, Volume 1*, Robinson, J.; Shaver, P.; Wrightsman, L., Eds. Academic Press: San Diego, CA
- Braastad B. 2005. Green care in agriculture. COST action proposal. Norwegian University of Life Sciences, Norway
- Braza M, Shoemaker W and Seeley A. 2004. Neighborhood design and rates of walking and biking to elementary school in 34 Californian communities. *Am J Health Promotion* 19(2), 128-136
- Brownson R C, Boehmer T K and Luke D A. 2005. Declining rates of physical activity in the US: what are the contributors? *Annual Rev Public Health* 26, 421-43
- Brownson R C, Haire-Joshu D and Luke D A. 2006. Shaping the context of health: a review of environmental and policy approaches in the prevention of chronic diseases. *Annual Review Public Health* 27, 17.1-17.30
- Brugha T S, Morgan Z, Bebbington P, Jenkins R, Lewis G, Farrell M and Meltzer H. 2003. Social support networks and type of neurotic symptom among adults in British households. *Psychological Medicine* 33, 307-318
- Brugha T, Morgan Z, Bebbington P, Jenkins R, Lewis G, Farrell M, et al. 2003. Social support networks and type of neurotic symptom among adults in British households. *Psychological Medicine* 33, 307-18
- Burdette H and Whitaker R C. 2004. Neighbourhood playgrounds, fast food restaurants, and crime: relationships to overweight in low-income preschool children. *Preventative Medicine* 38, 57-63
- Burdette H and Whitaker R C. 2005. A national study of neighbourhood safety, outdoor play, television viewing and obesity in preschool children. *Pediatrics* 116, 657-662
- Burdette H L and Whitaker R C. 2005. Resurrecting free play in young children. *Arch Pediatr Adolesc Med* 159, 46-50
- Butryn T M, Furst D M. 2003. The effects of park and urban settings on the moods and cognitive strategies of female runners. *J Sport Behav* 26(4): 335-355
- Cason D R, Gillis H L. 1993. A meta analysis of adventure programming with adolescents. *J Experiential Education*, 4, 25-27
- Caulkins M C, White D D and Russell K C. 2006. The Role of Physical Exercise in Wilderness Therapy for Troubled Adolescent Women. *Journal of Experiential Education*, 29, 18-37
- CDC (Centres for Disease Control and Prevention). 1996. *Physical Activity and Health*. A Report of the Surgeon General. Washington D C
- Chawla L. 2007. Life paths into effective environmental action. *J Env Education* 31(1), 15-26
- Chipeniuk R. 1995. Childhood foraging as a means of acquiring competent human cognition about biodiversity. *Environment and Behaviour* 27(4), 490-512

- Cohen S and Rodriguez MS. 1995. Pathways linking affective disturbances and physical disorders. *Health Psychology*, 14, 374-380
- Conner M. 2007. What is Wilderness Therapy and a Wilderness Program? Website: <http://www.wilderness-therapy.org/Wilderness/WhatIsWilderness.htm>
- Cooley R. 1998. Wilderness Therapy can Help Troubled Adolescents. *International Journal of Wilderness*, 4, 18-20.
- Cooper A R, Page A S, Foster L J and Qahwaji D. 2003. Commuting to school: are children who walk more physically active? *Am J Prev Med* 25(4): 273-276
- Cooper A R, Wedderkopp N, Wang H, Andersen L B, Froberg K and Page A S. 2006. Active travel to school and cardiovascular fitness in Danish children and adolescents. *Med Sci Sports Exerc* 38(10): 1724-1731.
- Cuddeford V, Langer J, Lucyk C and MacRae R. 2004. Advanced Environmental Farm Planning in Canada: Thoughts on Concepts, Tools and Implementation. *World Wildlife Fund Report*. March 31st 2004
- Danner D, Snowdon D and Friesen W. 2001. Positive emotions in early life and longevity: Findings from the Nun Study. *Journal of Personality and Social Psychology*, 80:804-813
- Davis M. 2002. *Dead Cities*. The New Press, New York
- Davis A, Valsecchi C and Fergusson M. 2007. Unfit for Purpose: How car Use Fuels Climate Change and Obesity. IEEP, London
- Davis-Berman J, Berman D S. 1989. The wilderness therapy programme. *J Contemp Psychotherapy*, 19, 271-281
- DCSF. 2007. *School Sports Survey, 2006/07*. London
- DCSF/DoH. 2009. *Healthy Lives, Brighter Futures: The Strategy for Children and Young People's Health*. London
- De Vries S, Verheij R A, Groenewegen P P and Spreeuwenberg, P. 2003. Natural environments – healthy environments? An exploratory analysis of the relationship between greenspace and health. *Environment and Planning A* 35, 1717-1731
- Department of Health. 2004. *At least five a week: Evidence on the impact of physical activity and its relationship to health*. London
- DH. 2009. *Be Active and Healthy. A Plan for Getting the Nation Moving*. London
- Diette G B, Lechtzin N, Haponik E, Devrotes A and Rubin H R. 2003. Distraction therapy With nature sights and sounds reduces pain during flexible bronchoscopy. A complementary approach to routine analgesia. *Chest Journal* 123, 941–48
- Dierking L D and Falk J H. 1997 School field trips: assessing their long-term impact. *Curator* 40 (3), 211–8
- Dobbins M, De Corby K, Robeson P, Husson H, Tirilis D. 2009. School-based physical activity programs for promoting physical activity and fitness in children and adolescents aged 6-18. *Cochrane Database Systematic Reviews* Jan 21; (1):CD007651
- Dyment J E. 2005. Gaining ground: The power and potential of green school grounds in the Toronto District School Board. Toronto, Ontario: Evergreen. URL www.evergreen.ca/en/lq/lq-resources.html
- Eastfeast 2009. See <http://www.eastfeast.co.uk/>
- Eisenmann J C, Wickel E E, Welk G J and Blair S N. 2005. Relationship between adolescent fitness and fatness and cardiovascular disease risk factors in adulthood: the Aerobics Center Longitudinal Study (ACLS). *Am Heart J* 149(1): 46-53
- Eisenmann J C. 2007. Aerobic fitness, fatness and the metabolic syndrome in children and adolescents. *Acta Paediatr* 96(12): 1723-1729
- Evenson K R, Herring A and Huston S L. 2005. Evaluating change in physical activity with the building of a multi-use trail. *American Journal of Preventative Medicine* 28, 177-185
- Ewing R. 2005. Can the physical environment determine physical activity levels? *Exercise and Sports Sciences Reviews* 33, 69-75
- Fisher K J and Fuzhong L. 2004. A community-based walking trial to improve neighbourhood quality of life in older adults: a multilevel analysis. *Annals of Behavioural Medicine* 28, 186-194
- Fjortoft, I. 1999. The natural environment as a playground for children. The impact of outdoor play activities in pre-primary school children. *Proceedings of OMEP's 22nd World Congress and 50th Anniversary on the child's right to care, play and education*. Copenhagen, Denmark.
- Fleury J, Lee S M, Matteson M A and Belyea M. 2004. Barriers to physical activity after cardiac rehabilitation. *Journ Cardiopulmonary Rehabilitation* 24, 296-307
- Flory J D, Manuck S B, Matthews K A and Muldoon M F. 2004. Serotonergic function in CNS as associated with daily ratings of positive mood. *Psychiatry Research* 29, 11-19
- Foresight. 2007. *Tackling Obesity: Future Choices*. Government Office of Science, London
- Foresight. 2008. *Mental health - Future challenge*. Government Office of Science, London
- Frenn M, Malin S, Villarruel A M, Slaikeu K, McCarthy S, Freeman J and Nee E. 2005. Determinants of physical activity and low-fat diet among low income African American and Hispanic school students. *Public Health Nursing* 22, 89-97
- Frumkin H (ed). 2005. *Environmental Health: From Global to Local*. Jossey-Bass, San Francisco
- Frumkin H, Frank L and Jackson R. 2004. *Urban Sprawl and Public Health*. MIT Press, Cambridge, MA
- Gomez J E, Johnson B A, Selva M and Sallis J F. 2004. Violent crime and outdoor physical activity among inner-city youth. *Preventative Medicine* 39, 876-881
- Grahn P and Stigsdotter U A. 2003. Landscape planning and stress. *Urban Forestry & Urban Greening* 2: 1-18

- Greenfield E A and Marks N F. 2004. Formal volunteering as a protective factor for older adults' psychological well-being. *The Journals of Gerontology Series B: Psychological Sciences and Social Sciences* 59, S258-S264
- Hall J and Pretty J. 2008. Then and now: Norfolk farmers' changing relationships and linkages with government agencies during transformations in land management. *Journal of Farm Management* 13(6), 393-418
- Harro, M. and Riddoch, C. 2000. Physical activity. In: *Paediatric Exercise Science and Medicine* (Eds N. Armstrong and W. Van Mechelen). pp. 77-84. New York: Oxford University Press
- Hartig T, Mang M and Evans GW. 1991. Restorative Effects of Natural Environment Experiences. *Environment and Behaviour* 23(1), 3 – 26
- Hartig, T., Evans, G., Jamner, L. D., Davis, D. S. & Garling, T. (2003) Tracking restoration in natural and urban field settings. *Journal of Environmental Psychology*, 23, 109-123.
- Hartig, T., Mang, M. & Evans, G. W. 1991. Restorative effects of natural environment experiences. *Environment and Behaviour*, 23, 3 - 26.
- Hassink J and van Dijk M (eds). 2006. *Farming for Health: Green-care farming across Europe and the United States of America*. Springer. Dordrecht. Available at: http://library.wur.nl/frontis/farming_for_health/
- Hassink J. 2003. Combining agricultural production and care for persons with disabilities: a new role of agriculture and farm animals. Wageningen University, Netherlands In: A.Cirstovao & L.O. Zorini (Eds), *Farming and Rural Systems Research and Extension. Local identities and Globalisation*. Fifth IFSA European Symposium, 8-11 April 2002, Florence. Agenzia Regionale per lo Sviluppo e l'Innovazione nel Settore Agro-forestale della Regione Toscana (ARSIA) Florence, pp. 332–341.
- Hein G. 1991. Constructivist learning theory. Institute for Inquiry. Available at: <http://www.exploratorium.edu/ifi/resources/constructivistlearning.html>
- Hine R, Peacock J and Pretty J. 2007. Green Lungs for the East of England. University of Essex, Report for the National Trust
- Hine R, Peacock J and Pretty J. 2008b. Care farming in the UK: Contexts, benefits and links with therapeutic communities. *Int. Journal of Therapeutic Communities* 29(3)
- Hine, R. Peacock, J. and Pretty J. (2008a) *Care Farming in the UK: Evidence and opportunities*. Report for NCFI(UK). Available at: <http://www.ncfi.org.uk/documents/>
- Holick M F. 2004. Sunlight and vitamin D for bone health and prevention of autoimmune diseases, cancers and cardiovascular disease. *Am J Clin Nutr* 80 (6 Suppl), 1678S-88S
- HSE. 2008. Self-reported work-related stress and workplace injuries in 2006-07. Nat Statistical Publ.
- Hull, R.B. 1991. Mood as a product of leisure: Causes and consequences. In Driver B.L, Brown P.J and Peterson G.L (Eds). *Benefits of Leisure*, State College PA: Venture Publishing, Inc
- Huppert F A., Baylis N and Keverne B. 2007. *The Science of Well-Being*, Oxford, Oxford University Press
- Huppert F.A and Whittington J.E. 2003. Evidence for the independence of positive and negative well-being: Implications for quality of life assessment. *British Journal of Health Psychology* 8, 107-122
- Information Centre. 2008. Health Survey for England 2006: CVD and risk factors adults, obesity and risk factors children. <http://www.ic.nhs.uk/pubs/hse06cvdandriskfactors>
- Jorgensen, A. 2001. Why is it important to encourage nature and wildlife near the home? Overvecht, Utrecht City Council.
- Kahn P H and Kellert S R. 2002. *Children and Nature: Psychological, sociocultural and evolutionary investigations*. Cambridge, MA: MIT Press
- Kampman M T, Wilsgaard T and Mellgren S I. 2007. Outdoor activities and diet in childhood and adolescence relate to MS risk above the Arctic Circle. *J Neural* 254, 471-7
- Kaplan R and Kaplan S. 1989. *The Experience of Nature: A Psychological Perspective*. Cambridge University Press, Cambridge
- Kawachi I, Kennedy B P, Lochner K and Prothrow-Smith D. 1997. Social capital, income inequality and mortality. *Am J Public Health* 87, 1491-8
- Kellert S R. 2002. Experiencing nature: Affective, cognitive, and evaluative development in children. In: Kahn P H and Kellert S R (eds). *Children and nature: Psychological, sociocultural, and evolutionary investigations*. Massachusetts, The MIT Press, pp.117-152.
- Kempermann G, Kuhn H G and Gage F H. 1997. More hippocampal neurons in adult mice living in an enriched environment. *Nature* 386, 493-5
- King L. (ed). 2003. Sharing a world of difference: the earth's linguistic, cultural, and biological diversity. UNESCOTerralingua-World Wide Fund for Nature, Paris, France.
- Krenichyn K. 2004. Women and physical activity in an urban park: enrichments and support through an ethic of care. *Journal of Environmental Psychology* 24, 117-130
- Krenichyn K. 2005. The only place to go and be in the city: women talk about exercise, being outdoors, and the meanings of a large urban park. *Health and Place* xxx
- Kuo F E, Sullivan W C, Coley R L and Brunson L. 1998. Fertile Ground for Community: Inner-City Neighbourhood Common Spaces. *American Journal of Community Psychology* 26(6), 823-51
- Kuo F E, Sullivan W C. 2001a. Aggression and Violence in the Inner City: Effects of Environment via Mental Fatigue. *Environment and Behaviour* 33(4): 543-571
- Kuo F E, Sullivan W C. 2001b. Environment and Crime in the Inner City - Does Vegetation Reduce Crime? *Journal of Environment and Behaviour* 33(3): 343-367

- Laumann K, Gärling T and Stormark KM. 2003. Selective attention and heart rate responses to natural and urban environments. *Journal of Environmental Psychology* 23, 125-34
- Lee R, Booth K, Reese-Smith J, Regan, G and Howard H. 2005. The Physical Activity Resource Assessment (PARA) instrument: Evaluating features, amenities and incivilities of physical activity resources in urban neighbourhoods. *International Journal of Behavioural Nutrition and Physical Activity*, 2, 13.
- Leventhal H, Patrick-Miller L, Leventhal EA and Burns EA. 1998. Does stress-emotion cause illness in elderly people? In Schaie KW and Lawton M P (Eds). *Annual review of gerontology and geriatrics: Focus on emotion and adult development*, Vol 17, pp138-184. New York: Springer
- Lim K and Taylor L. 2004. Factors associated with physical activity among older people - a population-based study. *Preventive Medicine* 40(1):33-40
- Lim K and Taylor L. 2004. Factors associated with physical activity among older people – a population-based study. *Preventive Medicine* 40(1), 33-40
- Lindsey G, Man J, Payton S and Dickson K. 2004. Property values, recreation values and urban greenways. *J Park & Recreation Admin* 22(3), 69-90
- Liu D, Diorio J, Tannenbaum B, Caldji C, Francis D and Freedman A. 1997. Maternal care, hippocampal glucocorticoid receptors and hypothalamic-pituitary-adrenal responses to stress. *Science* 277, 1659-1662
- Liu D, Diorio J, Day J C, Francis D D and Meaney M J. 2000. Maternal care, hippocampal synaptogenesis and cognitive development in rats. *Nature Neuroscience* 3, 799-806
- LOtC (Learning Outside the Classroom). 2006. LOtC Manifesto. URL <http://www.lotc.org.uk/>
- Loucaides C A, Chedzoy S M and Bennett N. 2004. Differences in physical activity levels between urban and rural school children in Cyprus. *Health Educ Res* 19(2): 138-147.
- Louv R. 2005. *Last Child in the Woods*. Algonquin Press, Chapel Hill
- Maas J, Verheij RA, Groenewegen PP, De Vries S and Spreeuwenberg P. 2006. Green space, urbanity, and health: how strong is the relation? *Journal Epidemiology Community Health* 60, 587-92
- Maier S.F, Watkins L.R and Fleshner M. 1994. Psychoneuroimmunology: The interface between behaviour, brain and immunity. *American Psychologist* 49, 1004-1017
- Matson-Koffman D M, Brownstein J N, Neiner J A and Greaney M L. 2005. A site-specific literature review of policy and environmental interventions that promote physical activity and nutrition for cardiovascular health; what works? *Am J Health Promotion* 19, 167-193
- Melamed BG. 1995. Introduction to the special section: The neglected psychological-physical interface. *Health Psychology*, 14, 371-373
- Mental Health Foundation. 2005. *Up and Running. Exercise therapy and the treatment of mild or moderate depression in primary care*. London
- Mind. 2005. *Stress and mental health in the workplace*. London
- Mind. 2007. *Ecotherapy: The green agenda for mental health*. Mind week report, May 2007. London, Mind.
- Mitchell R and Popham F. 2007. Greenspace, urbanity and health: relationships in England. *J Epidemiol Community Health* 61, 681-83
- Mitchell R and Popham F. 2008. Effect of exposure to natural environment on health inequalities: an observational population study. *The Lancet* 372, 1655-1660
- Moore E O. 1982. A prison environment's effect on health care service demands. *J Environ Systems* 11(1): 17-34
- Morita E, Fukuda S, Nagano J, Hamajima N, Yamamoto H, Iwai Y, Nakashima Y, Ohira H, Shirakawa T. 2006. Psychological effects of forest environments on healthy adults: Shinrin-yoku (forest-air bathing, walking) as a possible method of stress reduction. *Public Health* 121: 54-63
- Morris J and Urry J. 2005. *Growing Places*. Centre for Mobility Research, Dept Sociology, Lancaster University
- Murray SL. 2005. Regulating the risks of closeness: A relationship specific sense of felt security. *Current Directions in Psychological Science*, 14, 74-78
- Nabhan, G. P., and S. Trimble. 1994. *The geography of childhood: Why children need wild places?* Beacon Press, Boston, Massachusetts, USA.
- Natural England. 2009. *An estimate of the economic and health value and cost effectiveness of the expanded WHI scheme*. Natural England Technical Information Note TIN055. Peterborough
- Natural England. 2009. *Our Natural Health Service*. Peterborough.
- NCFI(UK). 2009. Website: <http://www.ncfi.org.uk/>
- Nelson N M, Foley E, O'Gorman D J, Moyna N M and Woods C B. 2008. Active commuting to school: How far is too far? *Int J Behav Nutr Phys Act* 5: 1.
- NESF. 2003. *The Policy Implications of Social Capital*. The National Economic and Social Forum Report No 28. May 2003
- Nice. 2008. *Physical activity and the environment*. London
- Nice. 2009. *Promoting physical activity for children and young people*. London
- Norman G J and Mills P J. 2004. Keeping it simple: encouraging walking as a means to active living. *Ann Behavioural Med* 28, 149-151
- Norman G J, Nutter S K, Ryan S, Sallis J F, Calfas K J and Patrick P. 2006. Community design and access to recreational facilities as correlates of adolescent physical activity and body-mass index. *J Phys Activity and Health* 1 S113-S123
- O'Brien L. 2004. *A Sort of Magical Place*. Forest Research, Alice Holt, Surrey

- O'Moore M and Kirkham C. 2001. Self-esteem and its relationship to bullying behaviour. *Aggressive Behaviour*, 27 (4), 269-283
- Ofsted. 2008. *Learning Outside the Classroom*. Ofsted, London
- Orr D W. 2002. Political economy and the ecology of childhood. Pages 279–304 in P H Kahn and S R Kellert (eds). *Children and nature: psychological, sociocultural, and evolutionary investigations*. Massachusetts Institute of Technology Press, Cambridge, Massachusetts, USA.
- Ostir G V, Markides K S, Peek M K and Goodwin J S. 2001. The association between emotional well-being and the incidence of stroke in older adults. *Psychosomatic Medicine*, 63, 210-215.
- Ostrom E. 1990. *Governing the Commons: The Evolution of Institutions for Collective Action*. Cambridge University Press, Cambridge
- Paluska S A and Schwenk T L. 200. Physical activity and mental health: current concepts. *Sports Medicine* 29(3):167-180
- Parsons R, Tassinary L G, Ulrich R S, Hebl M R & Grossman-Alexander M. 1998. The view from the road: Implications for stress recovery and immunization. *Journal of Environmental Psychology*, 18, 113-139
- Peacock J, Hine R and Pretty J. 2008. *The TurnAround 2007 Project*. University of Essex, Report for the Wilderness Foundation
- Pesta G, Respress T, Major A K, Arazan C and Coxe T. 2002. Evaluation research and quality assurance. *Evaluation Review*, 26, 251-271
- Pierce J P, Stefanick M L, Flatt S W, Natarajan L, Sternfield B, Madlensky L, Al-Delaimy W K, Thomson C A, Kealey S, Hajek R, Parker B A, Newman V A, Caan B and Rock C L. 2007. Greater survival after breast cancer in physically-active women with high vegetable-fruit intake regardless of obesity. *Journal Clinical Oncology* 25, 2345-2351
- Pilgrim S, Cullen L, Smith D J and Pretty J. 2008. Ecological knowledge is lost in wealthier communities and countries. *Env Sci Tech* 42(4): 1004-1009
- Pilgrim S, Smith D J and Pretty J. 2007. A cross-regional assessment of the factors affecting ecoliteracy: Implications for policy and practice. *Ecol Appl* 17(6): 1742-1751
- Pollock J. 2004. Can Literacy be environmental? Saving the world one verb at a time. *English Teaching Practice and Critique*. 3(3): 8-15
- Pretty J and Ward H. 2001. Social capital and the environment. *World Development* 29 (2), 209-227
- Pretty J, Peacock J, Hine R, Sellens M, South N and Griffin M. 2007. Green exercise in the UK countryside: effects on health and psychological well-being. *Journal of Environmental Planning and Management* 50(2), 211-231
- Pretty J, Peacock J, Sellens M and Griffin M. 2005. The mental and physical health outcomes of green exercise. *International Journal of Environmental Health Research* 15(5), 319-337
- Pretty J. 2003. Social capital and the collective management of resources. *Science* 302, 1912-1915
- Pretty J. 2004. How nature contributes to mental and physical health. *Spirituality & Health Internat* 5(2): 68-78.
- Pretty J. 2006. Physical activity in modern society: is there also an environmental benefit? *Environ Conserv* 33 (2), 87-88
- Pretty J. 2007. *The Earth Only Endures*. London, Earthscan
- Pretty J, Brice S, Brown J, Clayton J, Goodman E, Greer G, Maskell M, Oliver T, and Tuckwell T. 2009. *Essex Rural Commission 2009 Report*. Essex County Council, Chelmsford
- Putnam R. 1995. Bowling alone: America's declining social capital. *Journal of Democracy* 6(1), 65-78
- Pyle R M. 2001. The rise and fall of natural history: how a science grew that eclipsed direct experience. *Orion* 20:17–23.
- Pyle R M. 2003. Nature matrix: reconnecting people and nature. *Oryx* 37:206–214.
- QCA (Qualifications & Curriculum Authority). 1999. *The National Curriculum: Handbook for Secondary Teachers in England. Key Stage 3 & 4*. London QCA pp11
- QCA (Qualifications & Curriculum Authority). 2005. *Physical education: 2004/5*. Annual report on curriculum and assessment. London
- Raglin J and Morgan W. 1987. Influence of exercise and quiet rest state anxiety and blood pressure. *Medicine and Science in Sports and Exercise*, 19, 456-463.
- Rickinson M, Dillon J, Teamey K, Morris M, Choi M, Sanders D and Benefield P. 2004. *A review of research on outdoor learning*. Field Studies Council, Shrewsbury
- Romero A J. 2005. Low-income neighbourhood barriers and resources for adolescents' physical activity. *J Adolescent Health* 36, 253-59
- Russell K C. 2003. A nation-wide survey of outdoor behavioural healthcare programs for adolescents with problem behaviours. *J Experiential Educ*, 25, 322-331
- Russell K C, Hendee JC & Cooke S. 1998. Potential Social and Economic Contributions of Wilderness Discovery as an Adjunct to the Federal Job Corps Program. *International Journal of Wilderness*, 4, 32-38.
- Russell K C, Hendee JC and Phillips-Miller D. 2000. How wilderness therapy works: An examination of the wilderness therapy process to treat adolescents with behavioural problems and addictions. *Wilderness Science in a Time of Change Conference*, 3, 207-217
- Russell K C. 2001. *Assessment of Treatment Outcomes in Outdoor Behavioural Healthcare*, Idaho, University of Idaho-Wilderness Research Centre
- Russell K C. 2003a Assessing treatment outcomes in outdoor behavioural healthcare using the Youth Outcome Questionnaire *Child and Youth Care Forum*, 32, 355-381
- Russell K C. 2003b. A nation-wide survey of outdoor behavioural healthcare programs for adolescents with problem behaviours. *Journal of Experiential Education*, 25, 322-331

- Russell K C. 2006a. Brat camp, boot camp, or...? Exploring wilderness therapy program theory. *Journal of Adventure Education and Outdoor Learning*, 6, 51-68.
- Russell K C. 2006b. Evaluating the effects of the Wendigo Lake Expeditions program on young offenders. *Journal of Juvenile Justice and Youth Violence*, 4, 185-203.
- Rutt C D and Coleman K J. 2005. The impact of the built environment on walking as a leisure-time activity along the US/Mexico border. *J Phys Activity and Health* 3, 257-271
- Ryan R L and Grese R E. 2005. Urban volunteers and the environment: Forest and prairie restoration. In Barlett P (ed). In Barlett P (ed). *Urban Place*. MIT Press, Cambridge Mass
- Sainsbury Centre for Mental Health. 2005. *The Economic and Social Costs of Mental Illness*. London
- Sallis J F, Cervero R, Ascher W W, Henderson K, Kraft M K and Kerr J. 2006. An ecological approach to creating active living communities. *Annual Review Public Health* 27, 14.1-14.26
- Sallis J F. and Saelens B E. 2000. Assessment of physical activity by self-report: status, limitations and future directions. *Res Q Exerc Sport*, 71(2 supp), S1-S14
- Samson C and Pretty J. 2006. Environmental and health benefits of hunting lifestyles and diets for the Innu of Labrador. *Food Policy* 31(6), p 528-553
- Sandercock G, Voss C and Gladwell V. 2008. Twenty-metre shuttle run test performance of English children aged 11-15 years in 2007: comparisons with international standards. *J Sports Sci* 26(9): 953-957.
- Sandercock G, Voss C, McConnell D and Rayner P. 2009. Declines in aerobic fitness are largely independent of body mass index in affluent English schoolchildren. *Arch Dis Child* (in press)
- Savills Residential Research. 2006. *How Building Nothing Can Increase Land Value*. London
- Scott T M, Nelson C M, Liaupsin C J, Jolivet K, Christie C A and Riney M. 2002. Addressing the needs of at-risk and adjudicated youth through positive behaviour support: Effective prevention practices. *Education and Treatment of Children*, 25, 532-551
- Sheline Y L, Wang P W, Gado MH, Csernansky J G and Vannier M W. 1996. Hippocampal atrophy in recurrent major depression. *PNAS* 93, 3908-13
- Sibley B A and Etinier . 2003. Physical activity and cognition – meta-analysis. *Ped. Ex Sci* 15, 243-56
- Sirard J R. and Pate, R R. 2001). Physical activity assessment in children and adolescents. *Sports Medicine*, 31(6), 439-454.
- Smart Justice. 2008. Smart Justice for Young People, Young People and Prison: The Facts. Website: <http://www.smartjustice.org/ypfacts.html>
- Smith A and Bird S. 2004. From evidence to policy: reflections on emerging themes in health-enhancing physical activity. *Journ Sports Science* 22, 791-799
- Sport England 2006. *Active People Survey*. London
- Stevens P and Griffin J. 2001. Youth high-risk behaviours: Survey and results. *Journal of Addictions and Offender Counselling*, 22, 31-46
- Tabbush P M and O'Brien E A. 2003. *Health and Well-being: Trees, Woodlands and Natural Spaces*. Forestry Commission, Edinburgh
- Takano T, Nakamura K, Watanabe M. 2002. Urban residential environments and senior citizens' longevity in megacity areas: the importance of walkable green spaces. *Journal of Epidemiology and Community Health* 56, 913-8
- Taylor A F, Kuo F E and Sullivan W C. 2001. Coping with ADD: the surprising connection to green play settings. *Environment and Behaviour* 33, 54-77
- Taylor A F, Wiley A, Kuo F E and Sullivan W C. 1998. Growing up in the inner city: green spaces as places to grow. *Environment and Behaviour* 30, 3-27
- Taylor A F, Wiley A, Kuo F E & Sullivan W C. 1998. Growing up in the inner city: green spaces as places to grow. *Environment and Behaviour*, 30, 3-27
- Thayer R.E, Newman J.R and McClain T.M. 1994. Self-regulation of mood: Strategies for changing a bad mood, raising energy, and reducing tension. *Journal of Personality and Social Psychology*, 67, 910-925
- Thomas G and Thompson G. 2004. *A Child's Place: Why Environment Matters to Children*. London, Green Alliance / Demos Report.
- Timperio A, Crawford D, Telford A and Salmon J. 2004. Perceptions about the local neighbourhood and walking and cycling among children. *Preventative Medicine* 38, 39-47
- Tognarelli M, Picciolli P, Vezzosi S, Isola A, Moretti F, Tommassetto E, Laura Fantuzzi A and Bedogni G. 2004. Nutritional status of 8-year-old rural and urban Italian children: a study in Pistoia, Tuscany. *Int J Food Sci Nutr* 55(5): 381-387
- Torres R and Fernandez F. 1995. Self-esteem and the value of health as determinants of adolescent health behaviour. *Journal of Adolescent Health Care*, 16, 60-63
- Trost S G. 2007. Measurement of physical activity in children and adolescents. *American Journal of Lifestyle Medicine*, 1(4), 299-314
- Ulrich R S. 1984. View through a window may influence recovery from surgery. *Science* 224(4647): 420-421
- Ulrich R S, Simons R F, Losito B D, Fiorito E, Miles M A & Zelson M. 1991. Stress Recovery During Exposure to Natural and Urban Environments. *Journal of Environmental Psychology*, 11, 201-230.
- Van den Berg A E, Koole S L and Van der Wulp N Y. 2003. Environmental preference and restoration: (How) are they related? *Journal of Environmental Psychology* 23(2), 135-46
- Van Praag H, Kempermann H and Gage F H. 2000. Neural consequences of environmental enrichment. *Nat Rev Neurosci* 1, 191-198

- Vandergrift D and Yoked T. 2004. Obesity rates, income and suburban sprawl: an analysis of US states. *Health and Place* 10, 221-229
- Veitch J, Bagley S, Ball K and Salmon J. 2005. Where do children play? A qualitative study of parents' perceptions of influences on children's active free-play. *Health and Place* xxxx
- Voss C and Sandercock G. 2010. Aerobic fitness and mode of travel to school in English schoolchildren. *Med Sci Sports Exerc* (in press)
- Vuori I, Lankenau B and Pratt M. 2004. Physical activity policy and program development: the experiences of Finland. *Public Health Reports* 119, 331-345
- Wanless D. 2002. *Securing Our Future Health: Taking a Long-Term View*. HM Treasury, London
- Wanless D. 2004. *Securing Good Health for the Whole Population*. HM Treasury, London
- Ward-Thompson C, Travlou P and Roe J. 2006. *Free-range Teenagers: the role of wild adventure space in children's lives*. OPENSspace, Edinburgh
- Ward-Thompson C, Aspinall P and Montarzino A. 2008. The childhood factor. Adult visits to green places and the significance of childhood experience. *Environment and Behaviour* 40, 111-143
- Welk G J, Corbin C B and Dale D. 2000. Measurement issues in the assessment of physical activity in children. *Res Q Exerc Sport*, 71(2), 59-73
- Wells N and Lekies K S. 2006. Nature and the life course: pathways from childhood nature experiences to adult environmentalism. *Children, Youth and Environments* 16, 1-24
- Wells N M, Ashdown S P, Davies E H S, Cowett F D and Yang Y. 2007. Environment, design and obesity. *Environ Behav* 39(1): 6-33
- Wells N M & Evans G W. 2003. Nearby nature: a buffer of life stress among rural children. *Environment and Behaviour*, 35, 311 - 330.
- Wells N M. 2000. At home with nature: effects of "greenness" on children's cognitive functioning. *Environment and Behaviour*, 32, 775-795.
- Wendel-Vos G C W, Schuit A J, De Niet R, Boshuizen H C, Saris W H M & Kromhout D. 2004. Factors of the Physical Environment Associated with Walking and Bicycling. *Medicine and Science in Sports and Exercise*, 36, 725-730.
- WHO. 2004. World Health Report. Geneva, World Health Organisation.
- Woolcock, 2001. The Place of Social Capital in Understanding Social and Economic Outcomes. *ISUMA. Canadian Journal of Policy Research* 2, 11-17
- Woolcock, M. 1998. Social capital and economic development: Towards a theoretical synthesis and policy framework. *Theory and Society* 27, 151-208
- Yamaguchi M, Deguchi M and Miyazaki Y. 2006. The effects of exercise in forest and urban environments on sympathetic nervous activity of normal young adults. *J Internat Med Res* 34: 152-159
- Zimmerman M, Copeland L, Shope J and Dielman T. 1997. A longitudinal study of self-esteem: Implications for adolescent development. *Journal of Youth and Adolescence*, 26, 117-142