Outdoors and Health Network
Society's relationship with the natural world and the role of the outdoors in health and wellbeing

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Pilot 1 - Discussion Paper

Knowledge gaps and methodological development of a framework for a longitudinal resource in outdoors and health research

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Contents

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1 Introduction

The researchers involved in 'Pilot One' were tasked to look at quantitative data and how these can be collected, collated, and analysed to better understand the mechanisms by which access and use of the outdoors by individuals impacts on their health and health behaviours. This pilot work was focused on three main research challenges:

- What types of data could and should be collated and collected in order to populate the currently weak evidence base on the association between outdoors use, health and health behaviours?
- What methodological and analytical tools are needed to integrate social, biological and health data in a longitudinal dataset that is useful to medical and social researchers?
- How can the longitudinal collection of such data link to the development and monitoring of outdoors and health initiatives by stakeholders and policy-makers?

This report summarises the extensive review work carried out by researchers, draws conclusions on how the main research challenges can be met and makes recommendations for future research based on this analysis.

2 Knowledge gaps and methodological considerations

Margaret Currie, Aileen Marshall

2.1 Introduction

This section reviews knowledge gaps and methodological limitations identified in existing studies considering links between the outdoors and health. Six literature reviews (covering literature until 2006) that have collectively considered hundreds of studies, are the focus. OHN researchers have compared and clarified the findings of these reviews and have considered further papers published after 2006, to see whether recent studies have addressed knowledge gaps or methodological limitations related to the outdoors and health.

'Outdoors' is an ambiguous term. Generally, it appears that outdoors, greenspace and natural environment are terms used and defined similarly to describe places outside that, to some extent are natural, or contain nature. These might include wildernesses, but are more likely to include 'semi-natural' or man-made environments which contain nature, such as parks, golf courses and gardens (Health Council of the Netherlands, 2004). The term adopted appears dependent on the type of publication or audience; environmental journals tend to use 'nature' whilst planning or government studies refer to greenspace. Here, greenspace and outdoors are used interchangeably to cover a range of different types of natural, and semi-natural areas, focusing on the 'natural' in open spaces and landscapes, from public parks and private gardens to agricultural and wilderness environments. These are places where people may engage with elements of nature from which they may gain health and wellbeing benefits, whether this is intentional or not.

The six reviews included here have taken the positive and negative effects of the outdoors on health as their central theme (HCN, 2004; Croucher *et al.,* 2007; Velarde *et al.,* 2007; Bell, S. *et al.,* 2008; Bowler *et al.,* 2008; Davies and Deaville, 2008). All but one (Velarde *et al.,* 2007) was commissioned, generally by agencies interested in planning outdoor environments or promoting outdoors participation (Velarde *et al.,* 2007).

A proposed positive relationship between the outdoors and people's health and wellbeing continues to be promulgated (Mitchell and Popham, 2007; Nielsen and Hansen, 2007; Maas *et al.,* 2009), with three key theories emerging which explain relationships with developing health (Davies and Deaville, 2008; Verheij *et al.,* 2008; Nordh *et al.,* 2009b) or restoring health (Croucher *et al.,* 2007). Most reviews refer to them. These are:

- Wilson's Biophilia theory (1984), which suggests that humans subconsciously seek contact with other species and have a need to be close to nature (Croucher *et al.,* 2007);
- Ulrich's (1983) Stress Reduction Theory, in which it is suggested that the outdoors can promote recovery from stressful events through different types of environment triggering emotional and

physiological responses in the human body (Croucher *et al.,* 2007), mainly visually (Kjellgren and Buhrkall, 2010);

- Kaplan and Kaplan's (1989) Attention Restoration Theory (ART), which states that the outdoors and natural environments can assist in recovery from attention fatigue by allowing people to distance themselves from routine activities (Croucher *et al.,* 2007; Nordh *et al.,* 2009b)

Kjellgren and Buhrkall (2010: online) state that natural environments *'can help to restore depleted emotional and functional resources and capabilities'.* Arguably all three theories relate to stress reduction and boosting overall wellbeing, particularly mental health (Nordh *et al.,* 2009a). Ryan *et al.,* (2009) argue that most theories have considered low energy states such as relaxation; whereas they (Ryan *et al*) focus on the high energy state of vitality.

The Health Council of the Netherlands (HCN) (2004) dissects the health aspects related to the outdoors, as including exercise, social contact, child development and sense of purpose/personal development of adults. Natural environments are assumed to be more restorative than urban environments (Kjellgren and Buhrkall, 2010). Links between greenspace and health have been examined by several disciplines, but a smaller number of studies have been interdisciplinary (Croucher *et al.,* 2007)

As well as gaining academic attention, the relationship between greenspace and health has achieved political prominence. This is often attributed to the appreciation of nature by increasingly urbanised westernised societies (Verheij *et al.,* 2008), the growth of lifestyle-related diseases associated with insufficient exercise and increased proportions of people reporting mental health problems including stress and depression (Neilsen and Hansen, 2007; Nordh, *et al.,* 2009). Greenspace appears to be considered a potential arena for physical activity by Western governments (Verheij *et al.,* 2009). Physical activity is seen as instrumental to health improvement as it is modifiable behaviour (Cleland *et al.,* 2008). Investing in outdoor interventions to encourage physical activity should produce a knock-on effect of reducing health and social costs (Neuvonen *et al.,* 2007).

Greenspaces are, therefore, places where health-enhancing behaviour can be promoted to populations which are becoming more sedentary (Croucher *et al.,* 2007; Newton, 2007; Bowler *et al.,* 2009). Countries that have been studying the links between health and nature are generally Western and include UK, Australia, Canada, US, Denmark, Netherlands, Sweden, Finland and Japan (Croucher *et al.,* 2007; Rappe *et al.,* 2008; Schipperijn *et al.,* 2010). Studies indicate that greenspaces can enable or enhance social interaction (Bell, S. *et al.,* 2008; Verheij *et al,* 2008). Although some studies suggest that just being in, or being able to see greenspaces (Bell, S. *et al.,* 2008; Davies and Deaville, 2008) could benefit health and wellbeing (Bowler *et al.,* 2009), most reviews take the standpoint that interaction with nature is beneficial; they present evidence with this assumption, rather than taking a neutral stance. Many studies do not quantify health benefits derived or proposed (Hughes and Macdonald, 2008).

There is very little economic analysis of the costs and benefits of interventions based on exposure to the outdoors relative to other possible interventions. CJC Consulting (2005) were able to indicate highly significant potential savings by promoting outdoor activity leading to a reduction in medical interventions but emphasised that measuring behaviour change following interventions was a prerequisite for economic analysis.

2.2 Knowledge Gaps

The reviews identify knowledge gaps which we have divided as follows:

- Accessibility of greenspace and the production of benefits by different types of greenspace
- Ways that greenspace affects health and mechanisms of effect
- Greenspace as an arena for physical activity, the effectiveness of interventions to promote this and the ways in which people can be motivated or discouraged from using greenspace
- Different population groups that require further investigation.

- The economic costs and benefits of health interventions based on exposure to the natural outdoors

The most frequently highlighted gaps are: accessibility of greenspaces (for example, how close does greenspace need to be to home to have impact (Croucher *et al.,* 2007; Bell, S. *et al.,* 2008; Davies and Deaville, 2008)); and the ways types of greenspaces might promote different health benefits (HCN, 2004). Quality and quantity of greenspace may determine health benefits and may be mediated by levels of disadvantage or urbanisation (Mitchell and Popham, 2007). Accessibility of greenspaces might impact on frequency of uptake and time spent outdoors; there might be benefit in stipulating the amount of exposure required to gain health benefits (HCN, 2004; Newton, 2007).

Reviews highlight gaps in knowledge about how types of greenspace might contribute to different health outcomes (HCN, 2004; Croucher *et al.,* 2007; Velarde *et al.,* 2007; Davies and Deaville, 2008) or provide different impacts for population groups (Newton, 2007). For example, a better understanding is needed of whether certain landscape attributes such as trees or ponds can affect health in different ways (Velarde *et al.,* 2007), or what features of greenspaces makes them more or less attractive (Jones *et al.,* 2009).

Maas *et al.,* (2009) and Crouch *et al.,* (2007) argue that causation is not understood. HCN (2004) suggests studies should examine if/how greenspace promotes exercise, effects on quality of living working environments and the role of greenspaces in healing and convalescence, particularly considering garden therapies, care farms and hospital grounds (also suggested by Croucher *et al.,* 2007). Isolating the role of greenspaces from other factors such as social interaction is required (Bell, S. *et al.,* 2008) as is comparing the effects of activities indoors and outdoors so that the added value of the outdoors can be determined (Bowler *et al.,* 2008).

Several studies suggest greenspace promotes physical activity. Given this, Croucher *et al.,* (2007) suggest understanding people's use of greenspace in more detail - considering passive and/ or active use. Pretty *et al.,* (2007) have noted that 'green' exercise has not been compared with 'just being' in greenspaces or exercise alone. Interventions have been developed to promote physical activity in greenspaces, but it is difficult to establish or isolate the role of being outdoors to such interventions (HCN, 2004). Jones *et al.,* (2007) think that physical activity may be promoted more effectively by establishing interventions rather than addressing type and accessibility of greenspaces. Alternatively, Newton (2007) states that research is needed on effective monitoring and evaluation of interventions; for example, by assessing the impact of change in physical activity behaviour on health outcomes. As well as the positive features of greenspace, it has been suggested that research is required that considers the ways people are discouraged from using greenspaces e.g. through fear of crime (Newton, 2007; Davies and Deaville, 2008).

Motivation to use greenspaces requires investigation (Neuvonen *et al.,* 2007); for example: the ways that greenspace may motivate people to undertake physical activity compared with non greenspace initiatives (HCN, 2004); whether living in or close to greenspaces promotes more physical activity (HCN, 2004); and encouraging sedentary or overweight people to undertake physical activity in greenspaces (Newton, 2007).CJC Consulting (2005) emphasise that such an understanding is necessary in order to undertake cost-benefit analyses of interventions.

Future studies should also consider a wider range of the population, and the ways in which it is used by different people at different stages of their lives (Bell, S. *et al.,* 2008). Population groups requiring further investigation include children, young people (Davies and Deaville, 2008) and non-deprived groups (Newton, 2007); and comparisons are required across social groups (Pretty *et al.,* 2007).

2.3 Gaps filled by recent research

Schiperijn *et al.,* (2010) argue studies on the use of the outdoors in the last decade can be divided into three categories; firstly, those focusing on one type of greenspace; secondly, focusing on regional or natural

samples of a particular type of greenspace; and finally, the types of greenspace that are available close to peoples' homes.

Neuvonen *et al.,* (2007) considered supply and frequency of participation in close-to-home recreation opportunities in Helsinki and found that as the number of greenspaces increased, so did number of visits, and that participation increased with inaccessibility. Schiperijn *et al.,* (2010) undertook a Danish survey considering the accessibility and frequency of use of greenspaces. They found that two thirds of the population lived within 300 metres of greenspace. Mitchell and Popham (2008) found that in England populations that were exposed to the greenest environments also had the lowest health inequality related to income deprivation. They conclude that physical environments that promote good health might be important to reduce socioeconomic health inequalities.

Maas *et al.,* (2009) considered whether the amount of greenspace in peoples' living environment was related to social contact and whether this explained the relationship between greenspace and health. They found that people who lived within a kilometre of greenspace had better self-rated health. People in the study with lower accessibility to greenspace were found to be lonelier, with poorer self-rated health. Maas et al (2009) concluded that greenspace can strengthen sense of community but little evidence was found that social contact is the mechanism by which greenspace improves health.

Some studies reported negative findings. Neilsen and Hansen (2007) found that the use of greenspace could not explain changes in health indicators. Jones *et al.,* (2009) found that access to greenspace was better in the more deprived areas of Bristol, but that social factors influenced the relationship between what was provided and what was perceived to be available. Residents living in more deprived areas did not always view greenspaces as having been provided for them and were more likely to travel to access greenspaces with certain characteristics. Richardson *et al.* (2010) found that contrary to expectations, there was no evidence to suggest that in New Zealand green space influenced cardiovascular disease mortality. The authors suggest that the relationship between greenspace and health may vary according to national, societal or environmental context.

These studies suggest that, in some places, people living close to greenspace will visit more frequently than others, which may produce health benefits. Findings were conflicting, suggesting further study is required.

Studies have considered greenspace's impact on vitality (Ryan *et al.,* 2009), mental health or stress-relief (Nordh *et al.,* 2009a). Korpella *et al.,* (2008) reflected on the restorative values of non-greenspace 'favourite places'. Kjellgren and Buhrkall (2010) compared the psychological and physiological restorative effects for people when placed in natural and artificial environments. Both environments were found to reduce stress, but natural environments performed better altering states of consciousness and increased energy. Two Japanese studies (Park et al (2009) and Tsunetsugu et al (2009)) examine the therapeutic physiological and psychological effects of "Shinrin-yoku" (taking in the forest atmosphere or forest bathing). They find that forest environments can lower stress, aid relaxation compared with a city setting but more research is needed on the effects on different population groups.

Schiperijn *et al.,* (2010) suggest that groups with different characteristics (including gender, age, education, marital status, and ethnic origin) have different patterns of using greenspace and so different intervention strategies will be necessary. Zsuzanna *et al.,* (2009) explored children's health and outdoors exposure and found that children perceive not going outdoors could lead to illness. Another study (Cleland *et al.,* 2008) considered children's time spent outdoors, physical activity and weight, with a three year follow-up. Researchers found that children who spent more time outdoors were more active and less likely to be overweight. They postulated that, as the amount of time spent outdoors increased, so did physical activity. Richardson and Mitchell (2010) conducted a UK-wide study and found gender differences in the associations between urban greenspace and health, with no significant associations being found for women. They

concluded that it is important to understand that benefits may not be uniform between population subgroups.

Although knowledge has been added to since 2006, there are still gaps in evidence. These relate to: the type and proximity of greenspace and its associated benefits; understanding the way in which greenspace can affect health; the use of interventions for promoting physical activity in greenspaces; and understanding the needs of different population groups and how greenspace might affect their health differently.

2.4 Methodological Limitations/ Considerations

2.4.1 Research Designs

A wide range of research designs have been used (Velarde *et al.,* 2007), but a high proportion of studies reviewed were observational and cross-sectional. This makes direction of causation difficult to discern (Maas *et al.,* 2009; HCN, 2004; Bowler *et al.,* 2008; Cleland *et al.,* 2008) and studies are unable to explain the ways that the outdoors affects health (Croucher *et al.,* 2007). Confounding issues identified in the reviews include: whether outdoor areas promote positive memories which may be linked to better mental health (Newton, 2007); personality traits which are conducive to a healthier lifestyle (Croucher *et al.,* 2007); increased social contact and physical activity occurring in outdoor areas (Ryan *et al.,* 2009); quality of outdoor areas and number and frequency of visits made (Neuvonen *et al.,* 2007). These make it difficult to understand the dimension that just being in the outdoors adds to health (Croucher *et al.,* 2007).

Newton (2007) observes the difficult challenge of separating the differential effects of short-term and long-term exposure and frequency of contacts with the outdoors. Several experimental studies have produced strong evidence about the positive effects of nature in promoting recovery from stress and attention fatigue (HCN, 2004; Maas *et al.,* 2009). However Velarde *et al.,* (2007) criticises these for their lack of use of control groups. Recent research does not seem to have overcome these problems.

2.4.2 Data Quality

Many studies examining measures of health have asked respondents to self-report. While some measures such as the SF12 are validated and show correlation with objective health status, there is some criticism of self-reporting in the literature (The Heath Council of the Netherlands, 2004; Bell, S. *et al.,* 2008; Bowler *et al.,* 2008; Davies and Deaville, 2008; Maas *et al.,* 2009).

2.4.3 Sampling Issues

Many studies reviewed were small scale (Kjellgren and Buhrkall, 2010) and location-specific (Bell, S. *et al.,* 2008). This limits generalisability (Croucher *et al.,* 2007; Bell, S. *et al.,* 2008). Because of this, Velarde *et al.,* (2007) question the validity and overall representativeness of these. Some recent studies have included the population of a country or city (Jones *et al.,* 2009: Schiperijn *et al.,* 2010).

Considering inclusion, many studies sampled only healthy adults (HCN, 2004; Newton, 2007). Velarde *et al.,* (2007) thought that the general population, students and some people with mental health issues were the focus of many studies. Bell, S. *et al.¸* (2008) observed that marginal groups were often excluded (particularly in relation to gender, ethnicity, ageing and disability); there were suggestions that more studies should consider variation between social groups (Newton, 2007; Pretty *et al.,* 2007). Other issues included: low response rates from some groups e.g. older people and men (Schiperijn *et al.,* 2010); and selection bias, where often subjects dropped out of follow-up studies (Cleland *et al,* 2008) or during a study (Nordh *et al.,* 2009a).

2.4.4 Interventions

Methods of evaluating interventions were considered (Croucher *et al.,* 2007; Pretty *et al.,* 2007; Bowler *et al.,* 2009; Nordh *et al.,* 2009a). Two groups raise the challenge of establishing relationships between being in the outdoors and health benefits gained (Croucher *et al.,* 2007; Bowler *et al.,* 2009). Bowler *et al.,* (2009) and Nordh *et al.,* (2009a) state that interventions are generally assessed quantitatively and argue that, as most

studies are short-term, it is difficult to assess long-term implications.. Pretty *et al.,* (2007) observe that most initiatives involve implementing a project and these have not always been evaluated. They argue that studies which have assessed interventions could be more objective, for example by including people who are not already participating in the interventions.

2.4.5 Qualitative work

There have been fewer qualitative studies. Their reliability and validity are questioned, but it is now recognised that qualitative research could be useful, particularly in contextualising the effects of the outdoors (Bowler *et al.,* 2009). Kessel *et al.,* (2009:37) state that: *'the strength of qualitative work lies in its power to elucidate the meaning of phenomena and to suggest new ways of thinking about them'*. Davies and Deaville (2008) argue that qualitative study can add richness that allows for people's feelings to be expressed, whilst Jones *et al.,* (2009) assert that qualitative study can aid in understanding underlying relationships, particularly those intangible aspects which are not easily quantifiable (Newton, 2007). Nordh *et al.,* (2009) found qualitative methods worked well for people with mental health issues. Mixed-methods study combining qualitative and quantitative approaches can provide the robustness deemed suitable for policy makers (Kessel *et al.,* 2009) and disciplines driven by more positivist epistemologies, such as epidemiology.

Croucher *et al.,* (2007) state that qualitative studies on perceptions have been regarded as useful, although with limitations; these include: ethnographic approaches, which Pinder *et al.,* (2009) feel could help to understand the ways in which environments might promote health and how people conceptualise these relationships; and observational techniques. Cleland *et al.,* (2008) warn that the latter may exaggerate the links between time spent outdoors and physical activity, producing potentially confounded findings. They suggest addressing this by using a combination of techniques such as accelerometry or reported time spent outdoors.

3 Utility of datasets and questionnaires

Liz O'Brien, Richard Mitchell, Jenny Roe, Catharine Ward Thompson, Aileen Marshall, Ben Wheeler

The literature review has emphasised the importance of gathering longitudinal data in order to provide evidence of causality between outdoor exposure and health outcomes. OHN researchers looked at what existing data were published already that could be analysed to populate the currently weak evidence base. Researchers have carried out a mapping of the existing longitudinal, secondary UK data sets that provide information on health and use of the outdoors[1]. The secondary aim of this task was to identify specific questionnaire modules or questions that would best capture high quality data on health or environment. These tasks were complementary in that the first catalogued the longitudinal data that is already available from various different sources and the second selected the best questions that researchers could use to gather new data on health and use of outdoor landscapes. In both cases, the aim was to identify potential content for future surveys that could be shared with the research community and also to highlight particularly effective and robust questions or modules that might be recommended to contribute to raising the standard of research in this area. The aim of the latter is to further the evidence base on any link between nature and health. This section will discuss the findings of the mapping exercise and highlight the main conclusion with regard to useful question sets. We do not address the data needs for economic cost-benefit analysis. Such analysis will require longitudinal quantitative datasets relating to scale and longevity of the effects of interventions.

3.1 Secondary data sources – recreation and the natural environment

Thirty-nine UK-based surveys were identified that contained questions related to recreation, use and enjoyment of the outdoors. Examples of surveys included in the mapping are: the Defra Survey of Public

[1] The search identified 71 records in total. A journal article written by OHN members used a different number of records as different criteria were applied and the paper focused specifically on longitudinal government and public organisation surveys.

Attitudes and Behaviours towards the Environment; the Green Space Scotland Omnibus Survey, and the Welsh Outdoor Recreation Survey. Meta-data were collected for each survey including the main topics they covered, the frequency of repetition, methods and sampling and outdoors terms used. Although a few of these surveys did contain a small number of health related questions, this was not the primary focus. Researchers were looking for surveys that ask questions about where people go, what activities they do in the natural environment, how often and with whom etc. They also wanted to understand how these environments make people feel. The reason for looking at these types of question is to identify data that could be used in conjunction with health data to further the evidence of a link between the outdoors and health. The surveys can be grouped into three main groups:

1. Use of, and activity in, outdoor nature
2. Perceptions, attitudes and behaviour towards outdoor landscapes including perceptions of quality of local green spaces
3. Perceptions of quality of broader neighbourhood/local spaces

Questions taken from these surveys were categorised into the following five groups: access, use, quality, value and management/maintenance[2]. These categories are thought to be important to people's use and engagement with outdoor environments and the associated health and well-being impacts. By using these categories the database of surveys can provide resources tailored to researchers' specific needs.

3.2 Secondary data sources – Physical and Mental Health

Researchers found 25 datasets capturing data on the health of individuals. Local level surveys were not included and the chosen datasets represent the best and most widely-used health data sets in the UK. There are several repeat cross-sectional surveys, including the Health Survey for England and the Scottish Health Survey. These are large-scale studies, which combine questionnaires with clinical measures to capture information on health status and behaviours. The same individuals do not take part in each survey wave so it is impossible to follow changes in an individual's health over time, but this kind of survey can be useful for tracking changes in population behaviours. The disadvantage of this kind of survey is that it does not tell us much about behaviours in natural environments other than by assuming contact due to the type of neighbourhood environment the participants live in.

Genuine cohort studies[3] recruit a group of people and follow them through their life course gathering data using repeated surveys, interviews and clinical assessments. By gathering data on the same individuals over time it is possible to track the social, economic and health trajectories they take over their lifetime and identify determining factors affecting these paths. Also useful are the UK decennial census data sets. Researchers can follow individuals over time by accessing each of their census questionnaires along with their use of health services, cancer registrations, births and deaths.

There are several cross sectional surveys which are not focused on health but include some health questions usually on general health and self-reported morbidity. These kinds of surveys allow us to connect health data with a wide range of life circumstances such as employment, crime, education, economic status etc. They are increasingly gathering information on attitudes to features of the neighbourhood such as green space and attitudes to environmental issues.

Many records are collected routinely through medical service use and life events such as death. When gathered together they can provide a timeline of an individual's health across the life course. These records can be used to assess the association between particular events recorded (e.g. cancer registration) and

[2] These five categories emerged from a Heriot Watt University/OPENspace collaborative research study 'Urban Green Nature: Building the Evidence Base (www.cabe.org.uk/publications/urban-green-nation).

[3] Studies such as the National Child Development Study (NCDS)

environmental circumstances. Aggregated analysis can explore, for example, whether neighbourhoods with low hospital admissions also have a high proportion of green space.

Although the number of surveys making connections between health and contact with natural environments is increasing, there is not as yet enough data for longitudinal analyses matching behaviour change with health change. The only options to do this at present are to use emerging smaller scale studies or to attach environmental data to current health datasets. The latter is problematic, as although we are able to attach data about the respondents' local neighbourhood, we are unable to attach data on their actual use of this environment. There are also issues of confidentiality, which limit access to exact locations of respondents.

3.3 Recommended Questions and Question Modules

Pilot One researchers were also tasked to identify specific questionnaire modules or questions that would best capture high quality data on health or the environment. To this end, surveys were examined from two perspectives, using the expertise of the network members: firstly health surveys were examined for questions or modules relating to access to the natural environment and, secondly natural environment surveys, for questions or modules relating to health and wellbeing. The key objective was to identify a few, key, question modules on the outdoor environment that might be particularly recommended for adding to surveys that focus on health and, similarly, a few, key question modules on health that might be particularly recommended for adding to surveys that focus on recreation and the natural environment.

A series of ten questions have been selected that OHN researchers recommend as the minimum to be included in any survey exploring relationships with greenspace and well-being. Researchers felt there are too many questions on recreation and the outdoor environment in the database for them all to be recommended for placing into a single health survey. In order to identify key questions, OHN researchers have attempted to narrow down the focus and concentrate on specific issues. The approach taken was to focus on physical, social and mental well-being, as potential health outcomes, and identify questions on outdoor environment and recreation that are most likely to offer useful information in relation to these. Examples include this two-part question:

> *Part A: In the past week how many days have you done a total of 30 minutes or more of physical activity, which was enough to raise your breathing rate?*
> *Part B: How much of this physical activity was done in natural places outdoors?*

The best questions for capturing health data have also been selected by OHN researchers. They have been selected for capturing general health status (which might influence attitudes and activity levels)

> e.g. *Over the last 12 months, would you say your health has on the whole been: good, fairly good, not good.*

These questions are widely used, comparable with other datasets and are strong predictors of mortality, hospital use and other health outcomes. OHN researchers chose the *General Health Questionnaire 12* (GHQ12) instrument as the best questions for capturing mental health. This well-validated set of 12 questions is widely used. It focuses only on minor psychiatric morbidity and is a licensed question set that may incur a charge for use. The question set selected for capturing a range of physical and mental health and for tracking health change over time is another licensed instrument, the *SF-12v2*. This set measures physical and mental health from a variety of perspectives and gives scores relevant to each sub-domain. It is widely used and can produce a continuous score for detecting change over time. Finally the question recommended for measuring physical activity is:

> *In the past week, on how many days have you done a total of 30 minutes or more of physical activity, which was enough to raise your breathing rate?*

As the previous example showed, there is the potential to pair questions like this with a recreation or environment question to give an environmental aspect to their response e.g. *where did they do the physical activity? how did being in a certain environment make them feel?*

One important consideration when developing and/or selecting questions was that any recommendations being developed through this accumulating database are able to deliver standards of evidence acceptable to the medical and public health professions and policy-makers as well as to environmental planners and landscape managers.

4 Review of methodological and analytical tools

Benedict Wheeler, Justine Geyer, Beth Christie, Peter Higgins, Aileen Marshall

To provide different types of data that can complement quantitative or qualitative data, data collection methods that produce objective physical, outdoors exposure, activity and/or spatial data were considered. There are several tools that can be employed by researchers. In particular, researchers considered the use of Geographical Information Systems (GIS), Global Positioning System (GPS) and accelerometers to study behaviour and activity patterns in the outdoors.

4.1 GIS/GISc

Geographical Information Systems/Science (GIS/GISc) have a relatively long history of application to ecology and environmental science, and a somewhat shorter history of use in health and social research. GIS provides a methodology to link environmental features/characteristics - which are inherently geographical - to health and wellbeing data, at individual and population levels.

GIS has frequently been applied in investigations of the association between greenspace (and other environmental characteristics) and health/health related behaviour. For example, a 2006 study using the Norfolk Cohort of the European Prospective Investigation into Cancer and Nutrition (EPIC) allocated each of the cohort members with greenspace accessibility, size and quality measures based on the distance from their home to the nearest greenspace (Hillsdon et al. 2006). In this study, boundaries of local greenspaces were geographically captured (digitised) and assessed for quality by the investigators. This greenspace spatial dataset was then analysed in conjunction with the cohort data based on each individual's home location. A US study used satellite image data to measure neighbourhood 'greenness' around children's residences, and associated this greenness variable with the participants' Body Mass Index (BMI) and change in BMI over time (Bell J.F. et al. 2008). A Dutch study used a national land cover database to investigate associations between neighbourhood greenspace and morbidity from a general practice database (Maas et al. 2009). Ecological small-area studies can also use GIS to combine routine, aggregate datasets for analysis, such as one that related greenspace in a English national land use database to the standardised rate of 'not good' health from the 2001 census (Mitchell & Popham 2007).

This type of study, investigating residential proximity to (or neighbourhood density of) environmental characteristics is useful in describing how the characteristics of where people live, work, go to school etc. are associated with their health and wellbeing. This is an important consideration in determining what makes a healthy neighbourhood, which in turn may inform planning policy and other decision making processes. However, these methods alone do not allow us to measure how much time people actually spend outdoors, in different outdoor environments, or in proximity to environmental risk factors. Global Positioning System (GPS) technology provides the opportunity to obtain this kind of detailed location data.

4.2 GPS

Self-reported time-activity diaries can be used to generate data regarding where study participants spend their time (e.g. Biddle et al. 2009), but these data suffer from validity and recall issues, and lack location precision. Recent developments in the precision and affordability of Global Positioning System receivers

(GPSr) (Rodriguez et al. 2005) mean that objective, accurate, location-based estimation of 'exposure' to outdoors environments is now possible, even for studies with fairly large samples. For example, a UCL study asked 200 participating children to wear GPS receivers and to keep travel and activity diaries in order to assess associations between location and self-reported transport-related physical activity (Mackett & Paskins 2008).

A GPSr can typically record location, altitude and speed up to every few seconds, and can store data in a format that is relatively straightforward to import to GIS and statistical analysis packages. For some participants, the loan of a state-of-the-art GPS enabled mobile phone may also act as an incentive to take part in what could be perceived as research that is markedly intrusive to privacy and without immediate tangible benefits to the participants (Geyer et al, 2010).

Techniques for using GPS receivers to collect data on exactly where study participants spend their time are rapidly developing, as are methods for analysing the resulting datasets. The Global Positioning Systems in Health Research Network (www.gps-hrn.org) was launched in mid-2009, and provides a useful international forum for sharing methodological developments, and opinions on different GPS technology. Commercial GPS receivers (e.g. Garmin Forerunner) have been frequently used, but units designed as simple 'data loggers' are now available with significant benefits for research purposes (longer battery life due to lack of screen; no buttons, preventing study participants changing settings, and so on). Tools developed for spatial analysis of GPS data in other disciplines can be readily applied to human health and wellbeing studies. For example, the 'Geospatial Modelling Environment' (www.spatialecology.com/gme) extension to ArcGIS was designed for ecological studies, particularly animal tracking, but the tools are equally useful for human GPS studies.

To provide context for GPS data points, high-resolution, national and international environmental datasets are readily available to the research community, along with other contextual geographical data. For example, the Ordnance Survey MasterMap dataset provides a very detailed topographical spatial data layer for Britain, and is available through the Edina Digimap service (www.edina.ac.uk/digimap). MasterMap land parcels are categorised by the OS using a variety of classifications useful for defining the nature of environmental features, and can also be attributed with Generalised Land Use Database categories, including greenspace (England only). Socio-economic and health data from sources such as the Census and ONS mortality records can be readily mapped for small areas across the UK (see www.edina.ac.uk/ukborders). A directory of available spatial datasets exists at the Go-Geo portal (www.gogeo.ac.uk), and a useful resource for small-area socio-economic data is ONS Neighbourhood Statistics (www.neighbourhood.statistics.gov.uk).

4.3 Accelerometers

Accelerometers are a well-established and validated means of objectively quantifying physical activity, and are capable of capturing data at high temporal resolution for sustained periods. They measure 'accelerations' ('counts'), and counts per time period can be used as an objective measure of physical activity. Threshold values relating counts per minute to established physical activity classifications (such as 'sedentary', 'moderate' or 'vigorous') are a subject of debate, but are a useful way to understand the somewhat arbitrary-seeming numbers produced by accelerometry. For example, values above a threshold of 3200 counts per minute have been validated as indicating moderate-vigorous physical activity (MVPA) in children (Puyau et al. 2002). The validity of accelerometers is sufficiently accepted that they have been used for validation of self-report/diary activity metrics such as the International and Global Physical Activity Questionnaires (IPAQ/GPAQ, see for example, Bull et al. 2009).

First generation accelerometers measure accelerations on a single axis (e.g. Actigraph GT1M, www.theactigraph.com), while more recent versions can measure on 3 axes (dimensions) simultaneously, and use these to produce an estimated count of 'steps' (e.g. Actigraph GT3X). There are some issues with using accelerometers during specific activities – for example they tend to underestimate activity through cycling, given the smoothness of movement, and water sports present similar issues along with potential

water damage to the devices. There is a body of research on the methods of use of accelerometers, comparing placement on different parts of the body, and validity for monitoring different activities (see for example Parkka et al. 2007).

Datasets produced by accelerometers can be readily imported and analysed using standard database/statistical packages. Software designed specifically to analyse accelerometer data is also available. The MRC Epidemiology Unit at Cambridge has produced a free package allowing aggregation and analysis of accelerometer datasets (Mahuffe, www.mrc-epid.cam.ac.uk/Research/PA/Downloads.html). Commercial packages are also available, providing a variety of analytical tools. Actigraph produce their own software (ActiLife) to download and analyse data from their accelerometers. Kinesoft (www.kinesoft.org) has an extensive range of tools for importing, checking and processing accelerometer data, with the ability to create summary variables for activity volume, intensity, bouts and so on.

Accelerometers are rapidly becoming the method of choice in both small and large scale research on free-living physical activity behaviour in youth (Dollman *et al.*, 2009, Corder *et al.*, 2008). The many advantages of accelerometers such as: being low in burden to participants; having a lower technical error than methods such as self-report on questionnaires and the ability to detail the intensity and timing of physical activity are frequently determined to outweigh the disadvantages such as complexity in data handling. The lack of contextual information such as type of activity and where it takes place can be problematic and cost is often a disadvantage. The use of other quantitative and qualitative methods is often necessary to attempt to overcome this problem.

4.4 GPS & Accelerometers

GPS and accelerometry data can be combined to relate activity levels to specific location, and can in turn be integrated with environmental and other geographical data in a GIS (Oliver et al. 2010). With GPS resolution down to a few metres, and the possibility of both instruments recording data at high frequency, the combination can produce a very high resolution space-time dataset. One example is the PEACH (Personal and Environmental Associations with Children's Health) cohort (www.bris.ac.uk/enhs/peach), which involved around 1,300 children in final year of primary school, with a follow-up in first year of secondary school (further waves may be possible). At both waves, participants were asked to wear an accelerometer for a week and a GPSr for four of those days, to complement data collected through anthropometry, self-administered questionnaires and activity diaries. The GPS and accelerometer recorded location/physical activity at 10-second intervals, and data were merged using the date-time stamp recorded by both devices. The GPS receivers used for this study do not receive a signal indoors, meaning that a comparison of time outdoors/indoors is possible (Cooper et al. 2010). GIS-based analysis of the association between activity and greenspace has been carried out using the OS MasterMap/Generalised Land Use Database (paper submitted).

In another example, a subsample of 100 children from the Norfolk SPEEDY (Sport, Physical activity and Eating behaviour: Environmental Determinants in Young people) cohort also wore GPS receivers and accelerometers for four days. Data were overlaid with a land cover dataset in a GIS to assess how activity varied in different environments (Jones et al. 2009).

Combining datasets from accelerometers and GPS receivers using date/time is relatively straightforward conceptually, but can pose challenges in terms of dataset sizes, formats and aggregation. Data from the PEACH and SPEEDY studies have been analysed using bespoke solutions (the Stata statistical package has been used for PEACH, and a custom Java programme for SPEEDY). Commercial products are being developed, such as Actigraph's GPS Correlator, although this only works with a specific range of Garmin GPS receivers, and has very basic functionality given its cost.

4.5 Related methodologies

In addition to GPS and accelerometers, other technological and methodological developments may prove applicable to studies of the outdoors and health. A New Zealand study combined GPS with heart rate monitors, rather than accelerometers, to measure activity (Duncan et al. 2009). With GPS capability being added to many devices (especially mobile phones/smartphones), there is increasing potential for novel data collection methods such as 'crowd-sourcing' (e.g. see CASA working paper 143 http://www.casa.ucl.ac.uk/publications/workingPaperDetail.asp?ID=143).

GPS can be integrated with other 'sensors' to produce a wide variety of geo-referenced data. Cycle couriers in Cambridge have carried GPS receivers and air pollution monitors, allowing high resolution mapping of air quality (http://bioinf.ncl.ac.uk/message/), and providing the potential for individual pollution exposure estimation. Digital cameras can be linked to GPS receivers, allowing the collection of geo-referenced digital photographs (see for example, GeoPlace article at tinyurl.com/yewaap9). These can serve to record qualitative/visual environmental data linked to precise locations, permitting subsequent assessment and mapping of environmental quality indicators. Emotional biomapping uses GPS combined with data from galvanic response sensors placed on participants' skin. It measures emotional/fear response which is then paired with the GPS locations (e.g. see Christian Nold's emotion maps http://www.emotionmap.net)

Much of the relevant research applying GIS to environment-health issues has been quantitative, but qualitative, participatory and mixed-method GIS are emerging methodologies with great scope for application here (Cope & Elwood, 2009; Dunn, 2007). GPS data can be made into visual maps that demonstrate a participant's use of their local area which can then be used in interviews to stimulate discussion about attitudes and behaviours. This is similar in principle to the use of photographs in interviews, known as photo-elicitation interviewing (Rose, 2007). It has been successfully used for this purpose by several researchers (Wiehe *et al.*, 2008, Bamford *et al.*, 2008). Geyer (2010), in her study capitalised on the fact that her respondents had been loaned GPS enabled mobile phones, by administering a '*mobile-text daily minisurvey*' about their activities. This allowed her to gather feedback and clarification at the end of days when the participants had been monitored using GPS and accelerometers whilst the day was still clear in their minds.

5 Review of the development and monitoring of outdoor & health interventions

Aileen Marshall

To answer the final research challenge related to Pilot One: "How can the longitudinal collection of such data link to the development and monitoring of outdoors and health initiatives by stakeholders and policy-makers?" OHN researchers undertook a review of outdoors use and health promotion interventions currently planned, underway or completed in the UK. Researchers scrutinised the evidence base used to design these interventions and how the interventions have been evaluated, to see what longitudinal data collection is undertaken and to identify opportunities for development and use of such a resource.

Over 120 interventions were found to meet the predefined selection criteria and their details entered into a database. The criteria used were: it must have taken place in the UK; it must be recent (finished in last 5 years), current or planned for future; it must have health or wellbeing improvement as a stated aim; it must include contact with the natural environment; sports schemes are excluded unless they have a specific aspect involving contact with the outdoors; interventions promoting healthy lifestyles indirectly through changing/improving the environment are included; physical activity RCTs are included that do not specify activities happen in the outdoors. Examples of the types of interventions include: health walking groups, green gym type activities, horticultural 'eco-therapy' projects, forest schools, and conservation volunteering. The aims were predominantly centred on improving health, improving the quality of and access to the natural environment in local areas, and improving the general wellbeing of the target groups.

In terms of use of existing longitudinal data, there is little evidence of analysis of secondary data from large scale surveys in the design stage of the interventions reviewed. A selection of policy documents, government strategies and guidance documents has been used by several of the larger interventions. The National Institute for Health and Clinical Excellence (NICE) guidance documents[4] have also been referred to, which are informed by systematic reviewing of mainly randomised controlled trials. Peer-reviewed and grey literature has also been reviewed by intervention developers as a source of evidence, as well as existing evaluations of interventions. There is a distinct difference between the evidence base used for population level interventions and the individual level projects addressing local needs. Projects at the local level are less likely to undertake a rigorous literature and policy review to inform their project ideas. More often, they are based on analysis of local needs.

However, several government bodies e.g. Natural England and the Forestry Commission, have used large amounts of secondary data and statistics to inform their national level policy using techniques such as GIS to help them identify geographic areas where interventions might offer greatest potential benefits. An example of this is the Public Benefit Recording System (PBRS)[5] developed by the Forestry Commission. Although the system was originally designed to identify where woodland could be created in derelict, underused and neglected land, by layering different types of data such as land use, indices of multiple deprivation, and obesity levels, they can focus investment and interventions in the green spaces closest to the most deprived areas with the highest obesity problems. Adding a longitudinal element to this analysis allows the tracking of changes over time, a useful tool for monitoring the impacts of policy initiatives.

OHN identified challenges with existing evaluations: their questionnaires are non-standardised, generally not using validated questions, and the sampling methods are not always randomised or matched with a 'control' – a comparator where no intervention has taken place. Lessons could be learned from health sciences research, where standard, validated questionnaires such as the SF12 or 36, the GHQ and IPAQ are generally used to collect health data. This allows the results of evaluations to be more robust, more comparable with other interventions and generalisable. There is a need for further development of standard questionnaires or question sets, especially for gathering data about green space and use of the outdoors. Whilst the quality and quantity of scientific data is rapidly improving, we are still some way from being able to undertake cost-benefit analyses (a) on the relative value of different types of interventions or (b) on the value of interventions in different places or targeting different groups.

An additional difficulty is the limited time or resource allowed for evaluation of interventions, especially in relation to longitudinal data collection. It is difficult to determine whether an intervention has made a difference unless baseline, post-intervention and later, follow-up data is collected, but this is rarely the case. Furthermore, due to the complex nature of the outdoors as an experiment site, it is difficult for evaluators to attribute any perceived benefits directly to the environment. A criticism from health professionals of the types of quasi-experimental evaluations generally undertaken in this field is that they do not match up to the randomised controlled trials that are common in clinical research. The methodological difficulties in applying such methods to complex interventions within the largely uncontrollable outdoor environment mean that many studies may be discarded as evidence by the health sector. Such difficulties must be acknowledged and acceptable levels of evidence defined by both medical and environmental professionals for research in this area.

On the other hand, the many interventions being undertaken present an opportunity to develop this evidence base on outdoors and health. They could provide researchers with a rich source of longitudinal data and a test bed for understanding individual behaviour. The use of tools such as GPS and accelerometers as well as qualitative recording media such as headcams (Myrvang Brown et al., 2008), soft GIS (Tyrväinen et al., 2007), mobile telephone (Geyer, 2009) and audio visual technologies (e.g. Bisio, 2007) could strengthen

[4] In particular the 2006 public health guidance PH2 "Four Commonly used methods for promoting physical activity", the 2007 guidance PH6 "Behaviour Change", PH9 (2008) "Community engagement" and PH8 (2008) "Physical activity and the environment".
[5] http://www.pbrs.org.uk/

the objectivity of the data, complemented by use of standard questionnaires. The nature of such data collection may, however, affect people's participation and behaviour in outdoor activities and evaluations would need to account for this.

6 Conclusions and recommendations

Aileen Marshall, Margaret Currie

6.1 Knowledge gaps and methodological limitations from the literature

The review of pre-2006 literature reviews identified knowledge gaps that suggest the following research themes:

- A basis for recommending how accessible greenspace should be and the ways in which different types of greenspace produce different benefits
- The ways in which greenspace affects health and the ways in which the positive mechanisms take effect
- Greenspace as an arena for physical activity, the effectiveness of interventions to promote this and the ways in which people can be motivated or discouraged from using greenspace
- Different population groups who require further investigation.
- The economic costs and benefits of interventions.

Since 2006 other studies have been completed that go some way to providing evidence to address these issues, but knowledge gaps remain. These relate to: the type and proximity of greenspace and its associated benefits; understanding the way in which greenspace can affect health; the use of interventions for promoting physical activity in greenspaces; and understanding the needs of different population groups and how greenspace might affect their health in different ways.

Notwithstanding the methodological challenges highlighted, it can be seen that the relationship between the outdoors and health is a topic of interest to multiple disciplines. There has been a lack of communication between these and a reliance on discipline-specific theory and methodologies (Newton, 2007) that are sometimes culturally alien to other disciplines.

Quantitative approaches have been favoured, but they have limitations, particularly cross sectional studies which produce a snapshot in time, include confounding variables, and are unable to establish cause and effect. Qualitative approaches explain phenomena and relationships effectively in many circumstances and it has been suggested that they may be able to identify causal pathways; however they are not always regarded as being robust or objective. This suggests that mixed methods, although challenging (Kessel *et al.,* 2009), may be a way to overcome methodological limitations and appeal to an interdisciplinary audience.

Kjellgren and Buhrkall (2010) argue that more replication in studies is needed; HCN (2004) suggests that this could be though a range of different approaches: epidemiological, cross-sectional, systematic and controlled. Croucher *et al.*¸ (2007) suggest, however, that longitudinal research may overcome the problems of establishing causal links in cross-sectional studies. Longitudinal research may also be able to control for duration and frequency of outdoor experiences.

6.2 Framework for future longitudinal studies

6.2.1 Secondary datasets

Researchers have catalogued existing, longitudinal or repeat cross-sectional secondary datasets (See Annex A) that provide information on human health and/or the environment. They comprised: 37 surveys containing recreation, use and enjoyment of the outdoors data and 25 datasets capturing individual health data. The recreation datasets provide information on:

1. Use of and activity in the outdoors

2. Perceptions, attitudes and behaviours towards outdoor landscape and perceptions of quality of greenspace
3. Perceptions of quality of broader neighbourhood/local spaces.

The health data sets provide information on general health status, mental health, physical health and physical activity as well as life events such as death, cancer registrations etc.
Although the number of surveys making connections between health and contact with natural environments is increasing, there is still a lack of data for longitudinal analyses matching behaviour change with health change. Currently to do this the options are to use emerging smaller scale studies or to attach environmental data to current health datasets. The latter is problematic as although we are able to attach data about the respondents' local neighbourhood we are unable to attach data on their actual use of this environment. There are also issues of confidentiality, which limit access to exact locations of respondents.

6.2.2 Standardised questionnaires

Researchers have sought to identify questionnaire modules or questions that best capture high quality data on health or environment. OHN recommend that instead of designing a wholly new questionnaire on the outdoors and health, a set of key questions on health could be incorporated into existing outdoors questionnaires and vice versa. It was straightforward to select health questions for inclusion in an outdoors survey as there are already many standardised, validated tools in circulation. For our purposes the GHQ12 and SF12v2 were chosen along with a two stand-alone questions:

1. Over the last 12 months, would you say your health has on the whole been: good, fairly good, not good?
2. In the past week, on how many days have you done a total of 30 minutes or more of physical activity, which was enough to raise your breathing rate?

Ten questions were selected as the minimum to be included in a survey exploring the relationship between greenspace and health/well-being. There are no standardised modules already in place to serve this purpose. OHN researchers have focused on physical and mental health status and social factors as potential outcomes and selected outdoor environment questions most likely to offer useful information in relation to these. Consideration needs to be given, when designing future surveys, to delivering standards of evidence acceptable to both medical and environmental professionals and that a basis for standards needs to be agreed across professional domains.

6.2.3 Objective data collection and analysis

Methodological tools such as GIS, GPS and accelerometers have been considered by researchers to be useful and reliable tools for gathering and analysing data on people's outdoor activity levels, exposure and health.

Whilst GIS is useful in describing how spatial characteristics are associated with individuals' health, it cannot tell about time spent outdoors in different environments and what occurs there. GPS can give accurate location-based estimation of 'exposure' to the outdoors and GPS data can be analysed using GIS and statistical software. It is recommended that simple 'data-logger' receiver units be used to avoid battery run-down and participant tampering for best results. There are already plenty of high-resolution data sets available to contextualise the GPS data-points. Equally accelerometers are a well-established tool for measuring physical activity levels, although methodologies using this technique need to be aware of technical difficulties for some activities and with regard to positioning of the device on the body. Data sets can be downloaded to statistical packages and bespoke software is available. It is suggested that use of accelerometers can provide low burden, low technical-error data on physical activity but contextual information on the type of activity and location should be collected using quantitative or qualitative means. Combining GPS and accelerometer data can yield high resolution space-time data which can then be integrated with environmental datasets using GIS. Other devices and sensors can be integrated to give a variety of geo-referenced data. Emerging methodologies using GIS with qualitative data could be useful for studying the outdoors and health.

6.3 Utility of a longitudinal resource

A collection of longitudinal (ideally) or repeat data sets related to the environment and health would be useful for researchers, health and environmental policy-makers, planners and others. Especially in planning future interventions and policies, this resource would build a 'big picture' to inform decisions. For example, having information over the life course would allow specific age groups to be targeted in ways where most benefit could be gained. Long-term tracking of socio-economic, cultural, health and landscape changes would improve the evidence of causality, track improvements, inform about duration of behaviour change following participation in an intervention and thus illuminate the value of investments.

OHN identified several problems with existing interventions that this framework could go some way to address. Firstly, in the design stage of the intervention, analysis of the existing data sets or studies that have used these data sets could be useful in informing the specific locations, target groups and activities. A standard set of questions could assist in the robust evaluation of the interventions to a standard accepted by project funders, medical and environmental stakeholders. Tools such as GPS and accelerometers could also improve the objectivity of data collection relating to interventions. This could, in turn, provide researchers with a rich source of longitudinal data on which to test research hypotheses. Further development of this framework could provide an invaluable toolkit for town planners, medical professionals, public health and environmental agencies. Outdoor agencies and health officials will at some time require comparative economic analysis in order to make decisions about the value of interventions and also where they should be made and who should be involved. This requirement for economic analysis should be a factor in the design of data collection schemes.

6.4 Mixed methods

OHN advocate the use of mixed methods to explore the relationship between the outdoors and health. Researchers have identified benefits from combining the evidence gathered via pilot one (mainly quantitative data) and pilot two (qualitative data). Methods used to study the outdoors and health are often one-dimensional and not necessarily designed to deal with interdisciplinarity, or cross-cutting of disciplines. Mixed methods could overcome some of the methodological limitations identified in section 2.4 of this paper. Mixed methods can answer research questions that might require both inductive and deductive approaches and could be used by interdisciplinary teams to answer related questions from different epistemological stances. It allows for appropriate methods to be selected and could include methods tested by the OHN e.g. life histories, secondary datasets, participatory research; and those that have not, e.g. physiological measures.

Combining methods may help in overcoming the weaknesses of individual methodologies. In the OHN, we found this to be the case in the following scenarios:

- Quantitative methods can be used to provide a robust picture of a large sample of a population; whilst qualitative methods can be used to add depth and raise questions.
- Quantitative methods can establish the links between the outdoors and health; whilst qualitative can explains how this happens and what the benefits are and can thus add value.
- Quantitative methods may not be as effective at explaining values for different groups – qualitative can target specific groups and can explain the way in which relationships exist.

We found ways that qualitative methods may be effective in addressing research questions on health and the outdoors: some people prefer person-interactive techniques to questionnaires; qualitative methods can help to explain unforeseen or unpredictable behaviour (such as the use of peer groups in encouraging behaviour and other motivational techniques); also qualitative methods may help to understand the use of the outdoors that might be unusual, or people's motivations, which may inform methods for behaviour change that may be indirect. Quantitative methods are deemed by some to be 'more robust', and more transparent than qualitative data. Discussion paper two describes how there are mechanisms in place that can be used to assess qualitative methods for their robustness; and, as such, mixed-methods may find favour as part of a portfolio of evidence types used by policy-makers.

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8 Annex A – Secondary data sets

Recreation and greenspace data sets

1. Day visits surveys (UK)
2. Day visits surveys (GB)
3. England leisure visits
4. Welsh outdoor recreation survey
5. Scottish recreation survey
6. Public opinion of forestry
7. Quality of Experience
8. Forest visitor surveys and counts
9. All forests monitoring
10. Forestry for People
11. Active England
12. Space/Woods for people
13. Greenspace Scotland Omnibus Survey
14. Glasgow and Clyde Valley Green Network
15. ETWF (England's trees, woods and forests)
16. Woodlands in and around towns (WIAT)
17. Active People Survey
18. Sustainable indicators in your pocket 2009
19. BPVI/Place Survey
20. GreenSTAT
21. Green Flag
22. State of UK Birds
23. Environmental Quality Index mapping data
24. Local Government Quality Survey
25. Scottish social attitudes (SSA)
26. Scottish Environmental Attitudes and Behaviours Survey (SEABS)
27. Scottish Household Survey
28. Scottish Health Survey
29. New Deal for Communities Household Survey
30. Trees in Towns
31. Benchmarking data (APSE)
32. State of Natural Environment
33. British Crime Survey
34. PlaceCheck
35. Citizenship Survey
36. English Housing Condition Survey
37. Monitor of engagement with the natural environment
38. Survey of Public Attitudes and Behaviours towards the Environment
39. Public attitudes to the Environment in Scotland

Health data sets

1. Scottish Health Survey
2. Health Survey for England
3. Welsh Health Survey
4. Northern Ireland Health Survey
5. English Longitudinal Study of Ageing
6. General Household Survey
7. Scottish household survey
8. National Child Development Study (NCDS)
9. British Cohort Study (BCS70)
10. National Study of Health and Development (1946 Birth Cohort)
11. Millennium Cohort
12. Labour Force Survey
13. British Household Panel Study
14. Health and Lifestyle Survey
15. British Social Attitudes Survey
16. Avon Longitudinal Study of Parents and Children
17. Micro data from UK census
18. Census based longitudinal study
19. Scottish Longitudinal study
20. Northern Ireland Longitudinal Study
21. Annual population survey
22. Mental health surveys
23. Hospital episode statistics (HES)
24. Scottish morbidity record and linked datasets
25. Mortality records

For more information on the secondary datasets see the full working paper and accompanying database. Contact info@outdoorshealthnetwork.co.uk