



THE UNIVERSITY *of* EDINBURGH

Edinburgh Research Explorer

Landscape Perceptions and Use of Green Space

Citation for published version:

Ward Thompson, C, Roe, J, Aspinall, P, Mitchell, R, Robertson, L & Brewer, M 2014, Landscape Perceptions and Use of Green Space: Sections 3.2.1- 3.2.4 cover Introduction; Focus groups; Urban green space and stress household survey; and Urban green space and stress, cortisol survey. in M David & M Jane (eds), *GreenHealth: Contribution of Green and Open Space to Public Health and Wellbeing*. vol. Final Report Project No. MLU/ECA/UGW/847/08, Scottish Government, Rural and Environmental Science and Analytical Services Division, Edinburgh, pp. 21-33. <<https://www.hutton.ac.uk/research/projects/green-health>>

Link:

[Link to publication record in Edinburgh Research Explorer](#)

Document Version:

Publisher's PDF, also known as Version of record

Published In:

GreenHealth

General rights

Copyright for the publications made accessible via the Edinburgh Research Explorer is retained by the author(s) and / or other copyright owners and it is a condition of accessing these publications that users recognise and abide by the legal requirements associated with these rights.

Take down policy

The University of Edinburgh has made every reasonable effort to ensure that Edinburgh Research Explorer content complies with UK legislation. If you believe that the public display of this file breaches copyright please contact openaccess@ed.ac.uk providing details, and we will remove access to the work immediately and investigate your claim.



GREENHEALTH

CONTRIBUTION OF GREEN AND OPEN SPACE TO PUBLIC HEALTH AND WELLBEING

Project No. MLU/ECA/UGW/847/08

Final Report

For: Rural and Environmental Science and Analytical Services Division

Scottish Government



James Hutton Institute, OPENSpace Edinburgh University, University of Glasgow,
Heriot-Watt University, Biomathematics and Statistics Scotland

February 2014

The Final Report for GreenHealth has been written and edited by the following individuals:

David Miller

Jane Morrice

Peter Aspinall

Mark Brewer

Katrina Brown

Roger Cummins

Rachel Dilley

Liz Dinnie

Gillian Donaldson-Selby

Alana Gilbert

Alison Hester

Paula Harthill

Richard Mitchell

Sue Morris

Imogen Pearce

Lynette Robertson

Jenny Roe

Catharine Ward Thompson

Chen Wang

Partner Organisations

1. James Hutton Institute, Craigiebuckler, Aberdeen AB15 8QH Tel: 01224 395000 Email: david.miller@hutton.ac.uk
2. OPENSspace Research Centre, Edinburgh School of Architecture & Landscape Architecture (ESALA), University of Edinburgh, 74 Lauriston Place, Edinburgh EH3 9DF Tel: 0131 221 6177 Email: c.ward-thompson@ed.ac.uk
3. University of Glasgow, 1 Lilybank Gardens, Glasgow G12 8RZ Tel: 0141 330 4039 Email: R.Mitchell@clinmed.gla.ac.uk
4. Heriot-Watt University, School of the Built Environment, Edinburgh EH4 4AS Tel: 0131 451 4629 Email: j.roe@hw.ac.uk

Sub-contractor

Professor Peter Aspinall, Heriot Watt University, c/o Edinburgh School of Architecture & Landscape Architecture (ESALA), 74 Lauriston Place, Edinburgh EH3 9DF. Email: p.a.aspinall@hw.ac.uk

Consultant

Dr Mark Brewer, Biomathematics and Statistics Scotland (BioSS), James Hutton Institute, Craigiebuckler, Aberdeen, AB15 8QH Tel: 01224 395125 Email: markb@bioess.ac.uk

Table of Contents

1	EXECUTIVE SUMMARY	7
2	INTRODUCTION	10
3	RESEARCH ACTIVITIES AND FINDINGS	12
3.1	Health Surveys and Geographic Modelling	12
3.1.1	Urban green space, mortality and morbidity	12
3.2	Landscape Perceptions and Use of Green Space	21
3.2.1	Introduction	21
3.2.2	Focus Groups	22
3.2.3	Urban green space and stress: household survey.....	23
3.2.4	Urban green space and stress: cortisol survey.....	28
3.2.5	Ethnographic study of uses of green space.....	33
3.2.6	Green space services: Community engagement	35
3.3	Policy relevance and practice	39
3.3.1	Policy review.....	39
3.3.2	Health inequalities.....	40
3.3.3	Land Use Strategy.....	41
3.3.4	Scottish Planning Policy and the National Planning Framework	43
3.3.5	Community Planning	44
3.3.6	Scottish Biodiversity Strategy.....	45
3.3.7	Land reform review	46
3.3.8	Environmental and socio-economic data.....	46
3.3.9	Policy Consultations	47
4	OVERALL CONCLUSIONS.....	48
5	GREENHEALTH AND ENVIRONMENTAL DETERMINANTS OF PUBLIC HEALTH IN SCOTLAND' (EDPHiS) 50	
6	CONSULTATIVE GROUP AND STAKEHOLDER ENGAGEMENT	51
6.1	Consultative Group	51
6.2	Knowledge Exchange.....	51
7	ACKNOWLEDGEMENTS	54
8	REFERENCES	55
9	POLICIES AND STRATEGY DOCUMENTS	56
10	BIBLIOGRAPHY.....	58
11	APPENDICES	68

List of Figures

Figure 3.1 Risk of mortality by amount of green space in the area (urban areas and working age men only)	14
Figure 3.2 Risk of mortality in income groups 2 to 4 compared with the wealthiest group	15
Figure 3.3 Datazones in Glasgow classified by the combination of green space types they contain. Information in this map derived from Ordnance Survey Data	16
Figure 3.4 Use of green space for physical activity, by amount of green space in the neighbourhood and income.....	17
Figure 3.5 Relationship between where people are physical active and risk of poor mental health	18
Figure 3.6 Popularity of different environments as ‘escape places’, visited when the respondent needs to escape everyday problems and stresses.....	19
Figure 3.7 Mean levels of life satisfaction among those who do, and do not choose to escape everyday problems and stresses through visiting a natural environment, by level of financial strain.....	20
Figure 3.8 Mean perceived stress and green space quantity for men (n = 101) and women (n = 130). Error bars are two standard errors.	24
Figure 3.9 The relationship between stress and green space for men estimated to spend more time at home (n=22; Retired 77%, Disabled or long-term sick 23%), expressed as a partial regression plot.	25
Figure 3.10 The relationship between stress and green space for women estimated to spend more time at home (n =44; Looking after the home/family 41%, Retired 50%, Disabled or long-term sick 9%).	25
Figure 3.11 The relationship between wellbeing and green space for men estimated to spend more time at home (n=22; Retired 77%, Disabled or long-term sick 23%), expressed as a partial regression plot. .	26
Figure 3.12 Escape response preferences (n = 305).....	27
Figure 3.13 Median green space coverage for each escape response (n = 206). Error bars are the interquartile range	27
Figure 3.14 The relationship between % green space within a 300m buffer for individuals opting for one of four responses to ‘escape’ stress	27
Figure 3.15 Levels of self-reported stress in area of low ($\leq 43\%$) and high ($>43\%$) urban green space	30
Figure 3.16 Difference in cortisol slope between participants living in high versus low green space areas	31
Figure 3.17 Differences in mean cortisol slope in women living in high vs low green space areas	31
Figure 3.18 Differences in purpose for green space visit in the cortisol study sample (n=98)	32
Figure 3.19 Overview of the Finlathen Park area in the Virtual Landscape Theatre.....	36
Figure 3.20 (a) Features added by participants to the 3D model of Finlathen Park, (b) An audience of younger people in the Virtual Landscape Theatre	36
Figure 3.21 Example spatial plan for park and adjacent area derived from engagement events.....	38

ACRONYMS

ACA	Adaptive Conjoint Analysis
BHPS	British Household Panel Survey
BioSS	Biomathematics and Statistics Scotland
CAPI	Computer Aided Personalised Interview
CHAID	Chi squared Automatic Interaction Detector
CRESH	Centre for Research on Environment, Society and Health
CSGN	Central Scotland Green Network
EA	Ecosystem Approach
EBM	Ecosystem Based Management
EEA	European Environment Agency
ESALA	Edinburgh School of Architecture and Landscape Architecture
ESS	Ecosystem Services
FCS	Forestry Commission Scotland
GHQ	General Health Questionnaire
GUA	Green Urban Area
KTE	Knowledge Transfer and Exchange
PSS	Perceived Stress Scale
RESAS	Rural Environment Science and Analysis Services
SEPA	Scottish Environment Protection Agency
SG	Scottish Government
SHS	Scottish Health Survey
SIMD	Scottish Index of Multiple Deprivation
SNH	Scottish Natural Heritage
SPSS	Statistical Package for Social Sciences
SRDP	Scottish Rural Development Plan
WEMWBS	Warwick-Edinburgh Mental Wellbeing Scale

1 EXECUTIVE SUMMARY

This report sets out the findings from the Scottish Government's GreenHealth project, which explores the relationship between green space and human health using a range of methods and disciplinary approaches at different scales (individual, community and population). Findings show that urban green and open spaces contribute widely to public health and wellbeing by promoting physical activity and reducing health inequalities while also promoting mental and social health.

The GreenHealth project aimed to:

1. test for associations between people's perceptions of their health and wellbeing and their surroundings, using different spatial measures, and other indicators of access to green space within these surroundings;
2. test for quantitative factors associated with people's local environment and their health and wellbeing; and
3. report on how our research findings relate to public policies on planning and managing the environment to promote health and wellbeing.

The research was guided by two overarching questions:

1. Are the optimal policies and policy priorities in place to ensure that investment in the environment enhances people's health and wellbeing?
2. Can investments in the environment be targeted better to enhance public health and wellbeing?

Main Findings

- There was no evidence of a relationship between the amount of green space in urban neighbourhoods and mortality and various measures of morbidity. The exception is men living in deprived urban areas where higher amounts of local green space were associated with a lower risk of mortality.
- For those who did use green spaces for physical activity, no relationship was found between obesity and self-reported cardiovascular or respiratory health. However, levels of c-reactive protein (a marker of inflammatory response in the body) were lower in men living in urban areas who regularly used green space for physical activity than those who did not.
- There was no relationship between the amount of green space in urban neighbourhoods and mental health and wellbeing. However, urban dwellers who used green space such as woods and forests for physical activity had a lower risk of poor mental health than non-users of these types of green spaces. Regular use of woods and forests appeared to be more protective of mental health than exercising in the gym or streets.
- In three deprived urban areas in Edinburgh and Dundee (total sample 300), analysis of self-perceived stress levels were found to be associated with the amount of green space within deprived urban neighbourhoods. However, the strength and direction of relationships varied by gender.
- In the deprived urban communities, more green space was associated with lower levels of stress as evidenced by salivary cortisol patterns for a sample of middle-aged men and women not in work. More green space has a greater effect on cortisol concentrations in women than in men in these groups.
- Individuals and social groups attach different meanings to green space, and experience differing wellbeing benefits. For most people social interaction is significant in using local green space.

- Larger urban green spaces provide multiple functions for communities of place, and communities of interest; smaller areas of green space provide important spaces for short periods outdoors. There is significant community interest in involvement in decision-making about local green spaces.
- The visibility of green space can make a significant difference to the interpretation of accessibility.

The above findings are limited in their applicability to other age groups or living circumstances. Although adequate for finding significant effects, our sample was comparatively small and cross-sectional only, limiting any interpretation of causality. However, not all studies do find a link between green space and health; the relationship varies by country, gender, socio-economic position and, importantly, by the measure of health used. The reasons for this variation are not yet clear.

GreenHealth findings are supportive of a range of public policies, and are particularly relevant for the Scottish Land Use Strategy and its Action Plan; land reform; Scottish Planning Policy and the National Planning Framework; community planning; the Scottish Biodiversity Strategy; and policy that improves public access to environmental and socio-economic data.

Research Undertaken

We used a wide range of research methods: health surveys; geographic modelling; policy analysis; focus groups; neighbourhood surveys; cortisol testing; mobile and visual ethnography; community engagement case study; and green-space mapping. Drawing on national level data analysis from other parts of the UK, Europe and North America that suggested the links between experience of natural environments and stress or mental health were strongest for lower income-level populations, we decided to focus our research on comparatively deprived urban populations in Scotland. Thus, fieldwork was undertaken in four relatively deprived urban areas: two in Edinburgh and two in Dundee. Our research confirmed diurnal patterns of salivary cortisol as an ecologically valid method for measuring and understanding the salutogenic (i.e. health promoting) effects of green space. We also developed a method to enable spatial assessments of physical access to and visibility of green spaces at the level of individual properties.

Overall Conclusions

Our research cannot prove that green space *per se* protects mental health; it does echo findings from small-scale laboratory and field experiments, providing more confidence in our results. While our research does not show a causal relationship between green space and health and wellbeing, it suggests that the amount of green space in the residential environment contributes to the health and wellbeing of residents of deprived urban communities in Scotland, particularly those likely spend more time in and around the home. Increasing confidence that there is a protective relationship between regular use of green space and risk of poor mental health is an important result.

We found that the social contexts through which green spaces are encountered and understood are multiple and complex. What green spaces mean to dominant groups can result in the accepted uses of the spaces which might enhance wellbeing for some individuals or groups but marginalise or exclude others. Individuals, representatives and community officers all expressed desire for communities to have greater responsibility for managing areas of green space for community benefit and in delivering locally identified priorities. This is consistent with the development of community planning.

Our research indicates that policies and policy priorities to ensure that investment in the environment enhances people's health and wellbeing are being put in place. Policy areas are increasingly conceptualising key issues of equalities in the access, use and management of green space in ways that should result in better public health and wellbeing. In practice, implementation should ensure that the contribution of green space to public health and wellbeing becomes a key component in Scottish public policy.

Policy implications

So can investments in the environment be targeted better to enhance public health and wellbeing? Simply increasing the amount of green space available in urban areas is unlikely to have impacts on population mortality rates or socio-economic health inequalities. Our findings do suggest that increasing green space in deprived areas where little is present could contribute to reducing stress levels and increased wellbeing for some residents, especially those who spend more time around the home. However, other aspects of green space which impact on perceptions and use, such as quality and safety, how power and knowledge affect meaning, and how different groups are positioned in relation to these resources, must also be taken into account. Helping people to become and stay regular users could be a useful additional means of protecting and enhancing mental health. Our findings with regard to policy recommendations are summarised below:

- Policy makers, planners and green space managers should ensure that communities have access to a range of different kinds of green space, to allow all to enjoy the wellbeing benefits of using these spaces.
- The identification of sub-areas of the green space which support compatible functions could increase the overall effectiveness of such spaces in delivering multiple functions, and safeguard its value for relaxation and escape.
- Those who use green spaces as children are far more likely to do so as adults. Schemes proven to be effective in introducing and encouraging children to use these spaces should be expanded. This may produce a lasting, multi-generational impact.
- Evaluations of local walking groups have found them to be effective at introducing adults to, and maintaining their use of, green spaces for physical activity. These should be promoted as a resource for mental as well as physical health.
- The effect of green space on stress may be mediated by gender, with a stronger positive effect in our sample of increasing green space on cortisol concentrations in women (meaning green space is having a more positive effect on stress regulation in women than in men). More research is needed to substantiate this for a wider sample and age range.
- There is community interest in having greater responsibility for the management of areas of green spaces for local benefit; increased social wellbeing may be promoted through facilitating mechanisms of community engagement. Using newly available mapping and visualisation tools stimulates interest.

Limitations

Our research focused on middle-aged men and women living in deprived urban areas. The findings are therefore limited in their applicability to other age groups or living circumstances. Although adequate for finding significant effects, our study was small and cross-sectional compared to other existing studies (e.g. Groenewegen et al., 2006), limiting any interpretation of causality. This study would benefit from wider replication, particularly in longitudinal studies over time. Nonetheless, our results mark a step forward in our understanding of possible mechanisms behind any salutogenic green space effect.

2 INTRODUCTION

The Strategic Framework for Environment and Health (Scottish Government, 2007), later to become Good Places Better Health (Scottish Government, 2008a), identified that effective policy on the environment for health and wellbeing implies a fuller understanding of how to exploit positive environments for better and more equal health, a recognition of a psychosocial dimension in the relationship between people and their surroundings, a new engagement with communities and stakeholders on environmental issues, and a capacity to navigate complexity.

The classical representation of environment and health begins with a focus on ill health, linking environmental hazards with exposure, and then disease. Morris, in his presentation to the GreenHealth Scotland Conference in March 2013, argued that we might now consider the links between environmental hazards or environmental goods, exposure or experience, and health and wellbeing, i.e. extend the focus to include positive health. He also draws attention to the context of social and economic factors, cultural influences, and factors relating to individuals or population groups, including their perceptions of these. In combination, the GreenHealth and EDPHiS¹ projects provide new ways of improving our understanding of the relationship between environment and health.

At the outset of the GreenHealth project, there was a lack of evidence at a national level on the relationships between the quality, quantity, and accessibility of green space and people's health and wellbeing. It was not clear what aspects of green space relate to what aspects of health and wellbeing, nor for whom. As the project evolved, more scientific evidence became available, and in discussion with the team of stakeholders from across policy areas, our aim became to better understand psychosocial dimensions in the relationships between people and their surroundings, focusing on links between green space, human health and wellbeing, the interactions of social and environmental factors and characteristics of individuals and groups, and to report on how such understanding might inform approaches to providing equality of potential health and wellbeing in the population..

The aims of the GreenHealth project were: to test for associations between people's perceptions of their health and wellbeing and their surroundings, using different spatial measures, and other indicators of access to green space within these surroundings; to test for quantitative factors associated with people's local environment and their health and wellbeing; and to report on how our research findings relate to public policies on planning and managing the environment to promote health and wellbeing.

These aims were incorporated in two overarching research questions: i) Are the optimal policies and policy priorities in place to ensure that investment in the environment enhances people's health and wellbeing? ii) Can investments in the environment be targeted better to enhance public health and wellbeing?

Our approach was to address these two questions by combining analysis of national data on health and wellbeing and the extent and content of green spaces, with a set of case studies selected to test associations and to provide supporting empirical evidence.

¹ At the same time as funding GreenHealth, Scottish Government also granted funding to a related project - 'Environmental Determinants of Public Health in Scotland' (EDPHiS). The EDPHiS researchers sought to support the development of public policy in Scotland, insofar as it might affect public health through people's interactions with their environment. In practice, this involved working closely with, and supporting the Scottish Government [Good Places, Better Health](#) (GPBH) initiative. The EDPHiS partners were keen to develop a quantitative model of the complex relationship between environment and human health (EDPHiS, 2008a). Generally, it was found that interactions with green space play an important role in improving childhood mental health and wellbeing as well as reducing obesity, and possibly asthma (EDPHiS, 2008b). It also found that whilst access to green space may increase rates of unintentional injury, the benefits probably outweighed this negative effect. Findings are available at www.greenspacescotland.org.uk/greenhealth-conference, and the other findings at www.edphis.org. See section 5 for details.

Our report summarises the principal GreenHealth research activities. These are the analysis of health surveys and associated geographic modelling at national and regional levels, which guided the project surveys, which in turn focused on the case study areas selected to address landscape perceptions and the use of green and open spaces. This summary is followed by discussion of our findings with respect to policy areas relevant to green space, health and wellbeing.

3 RESEARCH ACTIVITIES AND FINDINGS

3.1 Health Surveys and Geographic Modelling

3.1.1 Urban green space, mortality and morbidity

Background

Studies from around the world have found a link between how much green space a neighbourhood has and the health of the resident population. Such a link is expected because evidence from experimental studies on individuals in the laboratory and field suggests that being in natural environments may reduce stress, enable recovery from fatigue, lower blood pressure, and promote healing. Green spaces may also encourage physical activity, and social contact. However, not all studies do find a link between green space and health; the relationship varies by country, gender, socio-economic position and, importantly, by the measure of health used. The reasons for this variation are not yet clear.

There has been very little work looking at the relationships between green space and health in Scotland specifically and this part of the GreenHealth project aimed to correct that situation. The work was underpinned by two hypotheses that:

- i) access to green environments is generally associated with better population health and well-being.
- ii) the strength and direction of association will vary by population type (e.g. relatively richer or poorer, relatively older or younger, male or female) and type/quality of green environment (woodland, open hillside, urban park etc.).

The aim was to test each hypothesis for a variety of health outcomes which reflect both physical and mental health and wellbeing of people living in Scotland.

How was the research structured?

The first part of the research compared health in neighbourhoods with varying amounts of green space to see if living in a greener environment was linked to better health. It then sought differences in the link by age, gender and wealth. As this part of the research proceeded, it became clear that the findings were not what we expected. We did not find links between the amount of green space in a neighbourhood and the physical health of the resident population in Scotland as a whole. Moreover, the only population sub-group (defined by age, gender and wealth) for which we found a significant, protective relationship between mortality and green space, was working age men living in the poorest two income-deprivation quartiles. Among these men, those residing in the greenest urban areas were about 16% less likely to die than those residing in the least green urban areas. This surprising result (which is explored in detail below) necessitated a shift in our approach. Rather than moving on as planned to try and understand how different kinds of green space might affect health differently, the focus moved more quickly to asking whether there were any health benefits of green space in Scotland at all. The analysis focused more than we had anticipated on individuals, their health and their use (or not) of green space.

With this new framework, the research was still able to answer its three key questions:

1. Is there a link between green space and population health in Scotland?
2. Is it the *amount* of green space in the neighbourhood or the *use* of green space that matters more for health?
3. How does the link between green space and health vary by age, sex and level of affluence?

The research process was in-depth and thorough, conducted over a long time period. It used many

different definitions of 'health', including mortality, physical and mental morbidity, measures of physiological health, measures of wellbeing and measures of quality of life. It also looked at how the answers to the research questions varied by geographical scale and whether the choice of data set affected the answers.

Green space data

At the start, we needed to identify the best data describing green space in Scotland. We had planned to document and map green space data coverage (and hence green space itself) across Scotland. However, we discovered that this task was also being carried out by Greenspace Scotland and so we joined forces². We determined that green-space data coverage across Scotland was, then, very variable in terms of quality, method used and completeness. This had two implications. For Greenspace Scotland it justified the production of a single national green space data set for Scotland; a remarkable achievement which was recently completed. For this project, it meant that existing datasets were not suitable for the national, regional and local level analyses specified in our funding bid. We could not be sure, for example, that any differences we saw in the relationship between green space and health in different parts of Scotland would be real, rather than reflecting inconsistencies in the data.

Instead, we opted to use an existing green space data set which was available on a consistent basis across Scotland, and which had already been used in published research. These data were created by the Centre for Research on Environment, Society and Health (CRESH) at the Universities of Glasgow and Edinburgh and are publicly available³. Their main disadvantage was that they did not capture variety in types and sizes of individual green spaces within neighbourhoods. The data simply provide a value for the percentage of a neighbourhood's land area which could be classified as 'green'. They also excluded private gardens.

Neighbourhood level analysis

The first part of the research used data documenting each death registered in the UK between 1999 and 2005. The data gave a residential location, age, sex and cause of death. Knowing the location of residence for the deceased allowed us to connect information about their death with information about the social and environmental circumstances of their neighbourhood. For this work, neighbourhood was defined as a Census Area Statistic ward. These are small areal units used in the reporting of the decennial census. They have a mean population size of about 4000.

We used statistical models to ask if there was a link between the amount of green space in a neighbourhood and the risk of mortality amongst the resident population. To do this, we compared the risk of mortality between neighbourhoods with <25%, 25 to <50%, 50 to <75% and ≥75% green space. The analyses allowed for differences in affluence between neighbourhoods, the age and sex of the populations, levels of air pollution and the spatial clustering of the data. We looked at urban neighbourhoods only (defined as being within a settlement of more than 10,000 population). We looked at the links between green space and risk of death from: all causes (excluding causes such as suicide and road traffic accidents), all cancer, lung cancer, colorectal cancer, prostate cancer, oesophageal cancer, skin cancer, cardiovascular disease, respiratory disease. Using different causes of death helped to identify the mechanisms by which green space might affect health and also helped guard against spurious results. If, for example, there was an association with a cause of death for which there is no plausible connection to green space, it indicated that something was wrong with our approach. We also looked for associations with the degree to which the population reported that they have a limiting long-term illness or that their health was 'not good'. This information is provided in the decennial census. Our approach assumed that place of residence at death was a good proxy for

² <http://www.greenspacescotland.org.uk/scotlands-greenspace-map.aspx>

³ Available from: <http://cresh.org.uk/cresh-themes/green-spaces-and-health/ward-level-green-space-estimates/>

exposure to green space in life. This is a problematic but necessary assumption. We compared results in Scotland with those from England and Wales.

Figure 3.1 shows the relationship between the amount of green space in urban neighbourhoods and the risk of mortality from all causes for working age men. The risk is shown relative to urban areas with the least amount of green space, and the further a bar extends below the horizontal axis, the lower the mortality rate in that type of area. The graph shows that in England and Wales, the risk of mortality falls as the amount of green space in an urban neighbourhood increases. The relationship was not found in Scotland.

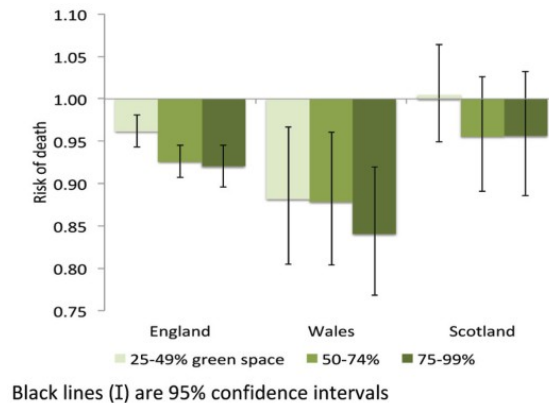


Figure 3.1 Risk of mortality by amount of green space in the area (urban areas and working age men only)

These relationships were also explored separately for men and women, for older, working and younger age people, for more and less urban areas and for richer and poorer groups. The absence of effects for women echoes findings in England and Wales, and is likely linked to gender differences in the frequency and type of green space use. Women are known to use green spaces less often than men (Richardson and Mitchell, 2010). In Scotland, we only found a significant, protective relationship between mortality and green space for working age men living in the poorest two income-deprivation quartiles. Among these men, those resident in the greenest urban areas were about 16% less likely to die than those resident in the least green urban areas.

We investigated, at great length, what could be lead to such different results in Scotland, England and Wales. We checked whether:

- there was a Glasgow effect (in which very poor health in Glasgow was masking a protective effect of green space elsewhere in Scotland)
- the definition of 'urban' that was used to determine which neighbourhoods were included in the model could have disadvantaged Scotland somehow
- the measure of deprivation used to control for confounding (i.e. that greener neighbourhoods tend to be wealthier) could have disadvantaged Scotland somehow
- Scotland's small population size had influenced the results
- Scotland's urban areas are somehow less green than those in other countries.

None of these issues explained the results for Scotland. We then also tested a different measure of green space to see if it gave different results. Data describing green urban areas were derived from two other European sources; the Green Urban Areas dataset (GUA), and CORINE, both provided by the European Environment Agency (EEA). These data were only available for Glasgow, Edinburgh, Dundee, Aberdeen and the Three Towns in Ayrshire (which is why they were not used initially). They had the advantage of describing size and location of individual green spaces, and offering the chance to research at a smaller spatial scale (datazone level). We found no association between datazone level mortality rates and either the amount of green space in the datazone, or the mean distance to the nearest green space across the datazone.

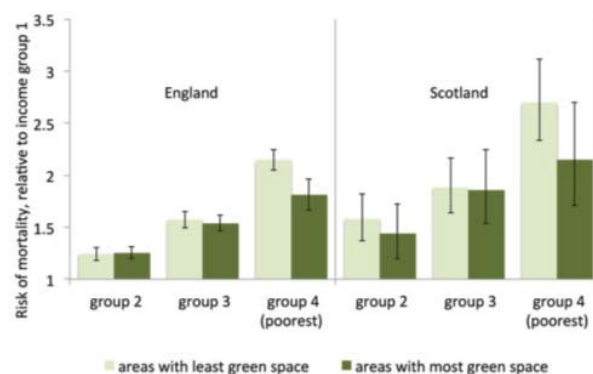
What could cause the absence of an effect in Scotland?

It seems unlikely that the physical and psychological effects of contact with green space that have been identified by experimental studies, are absent in Scotland. Scots are biologically similar to other residents of the UK. Also, the detection of a significant effect amongst the poorest men, where it was also strongest in the rest of the UK, suggests that green space can achieve health benefits in Scotland. More plausible explanations were:

- That the contact Scots have with their green spaces is somehow less, or different, to that which occurs in other nations. Perhaps the weather is so poor here that people are unable to access these environments sufficiently, or perhaps culture dictates less contact with green environments.
- That the type of green space to which urban dwelling Scots have access is somehow different to that in other countries and that the types of space which give most health benefit are either not present / poorly provided, or not widely distributed.
- That the effects are present, but that they are offset by other poor health behaviours or poor health status, for which the Scottish population is well known. Thus, beneficial impacts of green space on health are being outweighed by other detrimental effects. However, the detection of effects among the poorest (who also face the greatest burden of ill health) argues against this.

Inequalities in mortality

A study in England (Mitchell and Popham, 2008) suggested that socio-economic health inequalities might be narrower among those living in greener urban areas, perhaps because green space in such areas is a freely and readily available resource for protecting health. Our next step was to see if the same kind of relationship existed in Scotland. The socio-economic health 'gap' was compared between the least and most green urban areas. We measured the gap between 5 income-related groups. Figure 3.2 shows the risk of mortality in income groups 2 to 4, compared with the wealthiest group, 1. As income-deprivation increases, the relative risk of mortality rises (the bars on the graph get taller). However, the rise is less steep in the areas with most green space. In the most green urban areas in England, the gap in risk of mortality between the most and least deprived is significantly smaller than in the least green areas. This is also true in Wales, though these results are not shown in Figure 3.2. Whilst the pattern is similar in Scotland, reduction in the health gap in the greenest areas is not statistically significant. This pattern of results was replicated for the urban areas of Scotland using the GUA/CORINE green space data and again, we found no significant narrowing of socio-economic health inequality.



Black lines (I) are 95% confidence intervals

Figure 3.2 Risk of mortality in income groups 2 to 4 compared with the wealthiest group

Developing work on 'types' of green space

An original aim of the project was to explore how both access to green space, and its health benefits, might vary by green space type. However, the absence of a consistent nation-wide data set to facilitate

this work, together with the unexpected absence of associations between all green space and health at a neighbourhood level, led to this part of the project being reduced. Some analyses were still developed for the City of Glasgow, a wholly urban environment. Data from the Ordnance Survey can tell the difference between different types of green space, including between woodlands of different types, parks, lawns and scrub. Working with a Masters in Public Health student at Glasgow University, we produced classifications of neighbourhoods in Glasgow which reflected the combinations of types of green space they contained. Figure 3.3 shows datazones in Glasgow classified according to the combinations or domination of particular green space types. Further work showed that more and less deprived neighbourhoods have quite different types of green space. For example, more deprived areas had greater quantities of green space, but it was more likely to be low quality scrub. Associations between these neighbourhood green space types, and health were also distinct. Perhaps not surprisingly, neighbourhoods dominated by private gardens tended to have lower mortality rates. From these preliminary analyses, it was not possible to determine the extent to which this apparent health benefit was simply due to gardens being a marker of affluence.

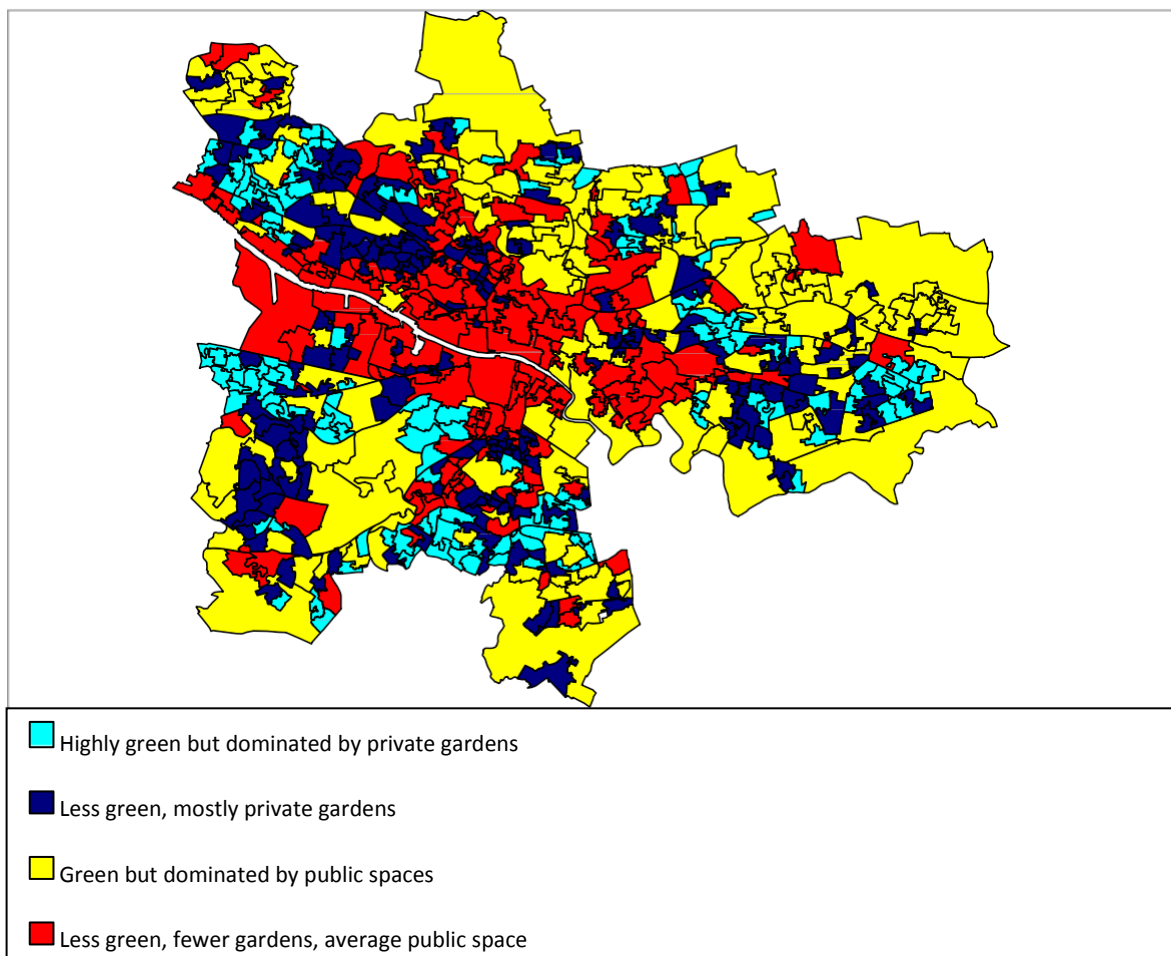


Figure 3.3 Datazones in Glasgow classified by the combination of green space types they contain. Information in this map derived from Ordnance Survey Data.

© Crown Copyright/ 2012. An Ordnance Survey/EDINA supplied service.

Individual level analyses

The second part of the research was focused on individuals, rather than neighbourhoods. It began by using the Scottish Health Survey (SHS) (2008) to look for links between the health and wellbeing of individuals, the amount of green space in their neighbourhood and, crucially, whether they used green space or not. To do this, data from the SHS (sample size of 3679) were matched to the CRESH green space data used in part one of the research. The matching process was undertaken by the Scottish

Health Survey team at the Scottish Government so that the anonymity of respondents was preserved. The result was a dataset which described, in detail, the health behaviours and health status of a representative sample of Scottish residents, and which told us how much green space these individuals had in their neighbourhood.

The SHS included many different measures of health and health behaviour. We used two measures of mental health and wellbeing; the General Health Questionnaire (GHQ) and the new Warwick-Edinburgh Mental Wellbeing Scale (WEMWBS). We also used body mass index (BMI) and waist-hip ratio as measures of weight, self-reported measures of cardiovascular and respiratory health problems, and physiological measures including blood pressure and c-reactive protein levels. C-reactive protein is a marker of inflammatory response in the body and lower levels are healthier. We also used a measure of how much physical activity people do.

A great advantage of the SHS was that it also asked people which environments they use for physical activity, and how often. The locations in which 1890 respondents were physically active were Woodland, Open space/park, Country paths, Beach/river, Sports field/outdoor court, Swimming pool, Gym/sports centre, Pavements/streets, Home/garden, Somewhere else, None of these places. This enabled a clear division to be made between physical activity in natural and non-natural environments and so we could consider both the amount of green space in an individual's neighbourhood, and whether the individual used green space or not. The analyses took account of respondent's age, sex, income and smoking status (where appropriate). As before, analyses also compared results for older and younger, male and female, wealthier and poorer respondents.

Working with Katherine Ord, a PhD student at the University of Glasgow, we looked first at whether people in greener areas visited green spaces more. Our measure captured use of green space for any kind of physical activity (such as going for a walk). Figure 3.4 shows that use of green space for physical activity was not strongly related to level of green space in the neighbourhood. For those on lower incomes in particular, more green space in the neighbourhood did not equate to greater use for physical activity. These results probably also explain why we found no strong indications that the amount of green space in a respondent's neighbourhood alone was related to the measures of health in the SHS. This work is now published (Ord et al., 2013).

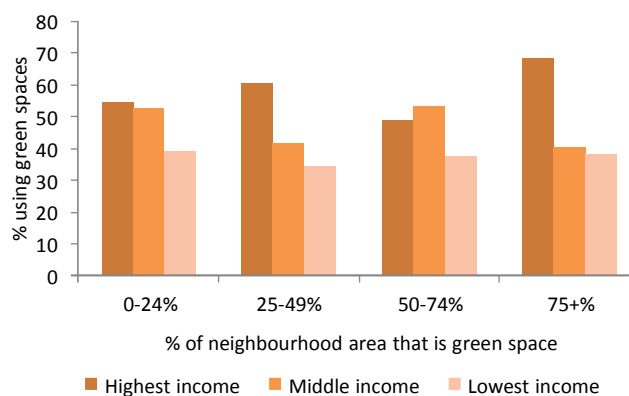


Figure 3.4 Use of green space for physical activity, by amount of green space in the neighbourhood and income

Although the amount of green space in the neighbourhood seemed un-related to health and wellbeing, we did see evidence that *visiting* green spaces for physical activity carried health benefits and we explored these in detail. To do this, we needed to take account of all the environments that people used for their activity, so that we could be sure an apparent effect of using green space was not really being driven by the other environments that green space visitors also use.

Regular physical activity in green environments appeared far more protective of mental health, measured by GHQ, than that in other places, like the gym or streets (Figure 3.5). Regular users of green space for physical activity had about half the risk of poor mental health among non-users. We

found no evidence of effects from exercise in green environments on either positive or negative well-being, as measured by WEMWBS however. This work is now published (Mitchell, 2012).

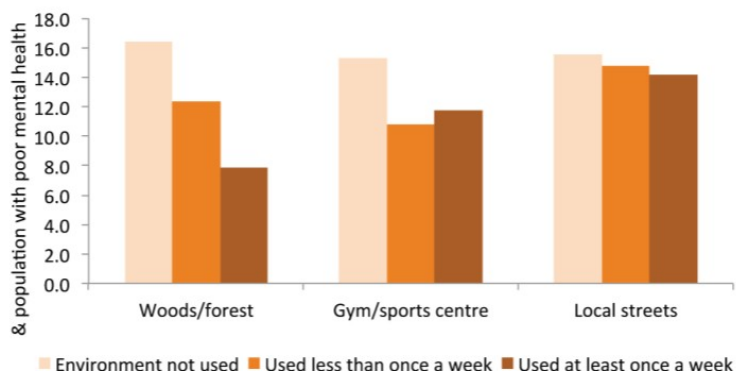


Figure 3.5 Relationship between where people are physical active and risk of poor mental health

We found that levels of c-reactive protein were lower in men who used green spaces at least once a week than in those who did not, but saw no other evidence that regularly visiting green spaces for physical activity brought special health benefits. We also found no evidence that socio-economic inequalities in these aspects of health were related to levels or use of green space.

Differences by gender

When working at the neighbourhood level, we had found no apparent protective effects of green space for women’s health, either in Scotland or elsewhere in the UK. Existing research suggested that this could be due to gender differences in the frequency and type of green space use. If women use their green spaces less than men, or for different kinds of things, they might not get such great health benefits. Using individual level data we were able to explore this gender difference in more detail. We used data from the Scottish Social Attitudes Survey 2009 to ask if there were gender differences in the frequency with which urban green spaces were used and, if so, why. We confirmed that women did use their local green spaces much less than men, although women who did use green spaces seemed to do the same kinds of activities as men. Even after taking account of gender differences in family responsibility, perceptions of green space access, safety and quality, and wider neighbourhood circumstances however, we could not explain why women seemed to use their green spaces less. A paper has been submitted for publication.

Differences by age

Both the neighbourhood and individual level analyses suggested that the relationship between green space and health varied by age. This is perhaps not surprising since time for, orientation to, and ability to access, green spaces is likely to vary by life stage. However, a detailed analysis of these changes over time is difficult without data which follow the same individual through time, repeatedly surveying their health, geographical location and wider life circumstances as they age. We worked to develop such an analysis with Dr Thomas Astell-Burt at the University of Western Sydney, Australia and Prof Terry Hartig at Uppsala University, Sweden. The analysis used the British Household Panel Survey (BHPS), linked to the CRESH green space data set described above. The BHPS follows a large sample of people through time. By linking it to green space data, we were able to examine how both mental health, and health-related behaviours such as exercise, change over time and to see both if there was any protective effect of living in a green area, and whether this varied by age. Results suggested that the protective effects of green space on mental health appear to be strongest in mid-life, but this trajectory varied between men and women. As yet, the reason for this mid-life effect is not known. A paper will be submitted for publication.

Using green spaces to ‘escape’ everyday problems and stresses

Analyses of relationships between green space and health typically assume that the health benefits

come from the apparent ability of these environments to be ‘restorative’; to sooth tired and stressed minds and bodies. Many analyses, including ours, have looked for a difference in the levels of stress and fatigue between those who do and do not use green space, or even before and after their use. Our final analysis took a different approach to exploring this issue; it asked whether people actively choose green spaces to visit when they are stressed and tired and in need of restoration. If green space is soothing, should not stressed people naturally seek it out?

The Scottish Social Attitudes 2009 survey (a nationally representative sample of 1,500 people) asked people where they go when they need to escape everyday stresses and problems, giving a range of possible destination types (Figure 3.6).

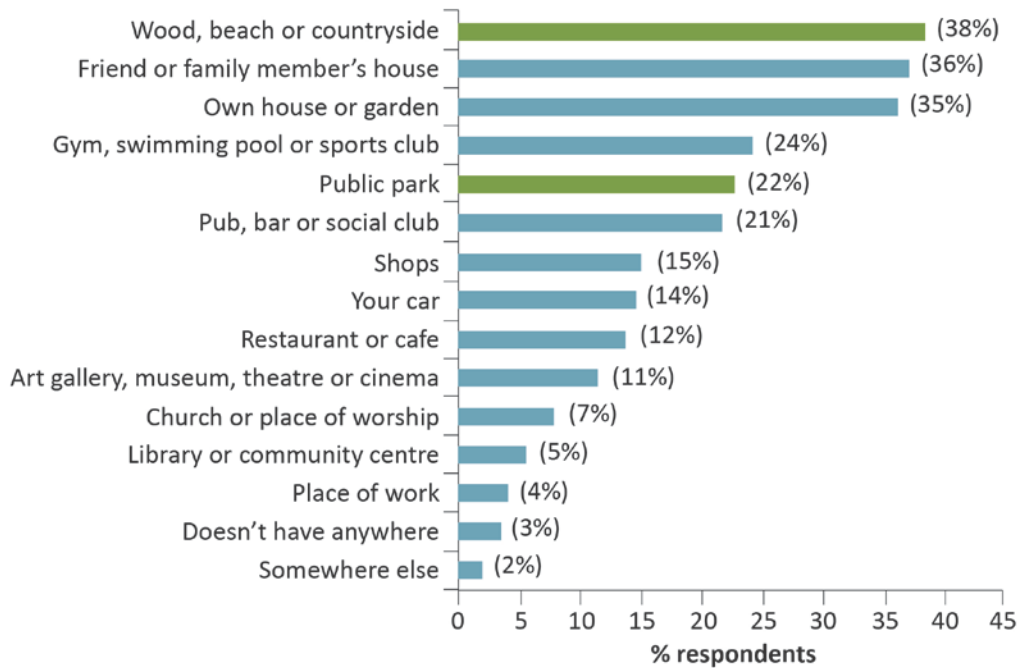


Figure 3.6 Popularity of different environments as ‘escape places’, visited when the respondent needs to escape everyday problems and stresses.

The majority of people reported that they escape to some kind of natural environment, with wood, beach or countryside the most cited environment. Whether a respondent chose a natural environment as an escape place or not was heavily related to how accessible the environment was to them. Those with a car, or those who had such a space within 5 minutes’ walk of their home, were far more likely to choose to use a natural environment in this way. The study contained enough respondents for us to then also examine *only* those who had a natural environment within 5 minutes’ walk of their home (sample size of 1057). For this group only, we asked whether choice of a natural environment as an escape place appeared to affect their life satisfaction. Among this group as a whole we found no overall relationship between life satisfaction and using a natural environment as an escape place. However, we saw an interesting difference according to the level of financial strain the respondents were under. Figure 3.7 shows that, among those with no financial problems, escape to nature made no difference to their life satisfaction. Yet, among those facing financial problems, those who escaped to nature had a higher life satisfaction. This relationship survived adjustment for other potential influences.

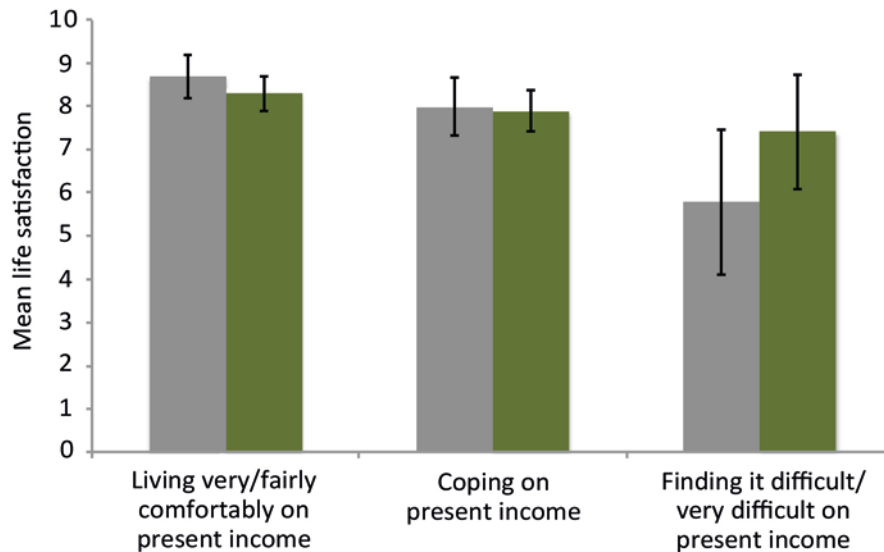


Figure 3.7 Mean levels of life satisfaction among those who do, and do not choose to escape everyday problems and stresses through visiting a natural environment, by level of financial strain

A key limitation of this research

All of the analyses in this part of GreenHealth were ‘observational’. This means that they could not prove for certain that the green space was *causing* any apparent health benefits. Only experimental studies can do that, but it is very difficult to do experimental studies on large populations. However, many of the results obtained echoed findings from small-scale laboratory and field experiments which showed that contact with nature can *cause* beneficial changes in markers of mental and physical health. This provided more confidence that the results here were capturing a ‘real’ effect of green space on health, where these associations or ‘effects’ exist.

Summary

The overall findings from this part of the project were:

- Relationships between the amount of green space in a neighbourhood and risk of mortality are largely weak or absent in Scotland.
- More green space in the neighbourhood is associated with a lower risk of mortality among Scotland’s poorest men.
- Socio-economic health inequalities are significantly narrower in the greenest urban areas than in the least green in England and Wales, but not in Scotland.
- Scots who use green spaces for physical activity have a lower risk of poor mental health than those who use non-natural environments, such as the gym or streets.
- Green space in the neighbourhood is not associated with a reduced risk of obesity, or with markers of poor cardiovascular or respiratory health, in Scotland.
- There are marked gender differences in the frequency with which men and women use their local green space; women are far more likely not to use their local green space at all.
- Green spaces are the most popular choice of environment to visit when people need to seek recovery from everyday stresses and problems.

Recommendations from the research are:

- Simply increasing the amount of green space available in urban areas is unlikely to have positive impact on population mortality rates or socio-economic health inequalities.
- Regular use of green space does appear to be good for mental health, and helping people to become or stay regular users could be a useful additional means of protecting and enhancing

mental health.

- Future research should explore the difference in health impacts of different kinds of green spaces.

3.2 Landscape Perceptions and Use of Green Space

3.2.1 Introduction

Green space is part of the wider landscape in which people live and work. The European Landscape Convention (Council of Europe, 2003) emphasises the importance of people's everyday landscapes – not just those designated as having special qualities. To understand how green and open spaces may impact on health, this part of the GreenHealth project explored how people actually experience and respond to everyday landscapes. Moreover, we sought to understand the factors that shape such experiences and any impact this might have on health and wellbeing. Our work on landscape perception and use of green or open space was undertaken in parallel with our work on geographic modelling and was initiated before the findings outlined above were available. We assumed that, as for England and Wales (Mitchell and Popham, 2008), a relationship was likely to exist between the amount of green space in a neighbourhood and the health or wellbeing of urban populations in Scotland, and sought to understand this better at a local level.

Our work was underpinned by the following broad hypothesis:

Access to and perceptions of particular qualities in the green environment, and different types and levels of use of that environment, will be associated with better or worse health and wellbeing for particular sectors of the population (e.g. by age, or SEG), or for the population as a whole.

As the research developed, we explored the rapidly expanding literature on links between green space and health, reflecting an international interest in the topic. Higher levels of residential green space have been associated with lower mortality rates, lower blood pressure and obesity levels, and better self-perceived health (e.g. Maas et al., 2006). We recognized that one important question was: *what might be the causal pathways between green space and health?* Other recent research suggested that contact with green and natural environments was particularly important in offering relaxation and relief from stress (e.g. Nordh et al., 2011; Lea, 2008; Hansen-Ketchum et al., 2010). Therefore, we planned a series of investigations to study whether the amount of green space near people's homes was related to people's levels of stress or mental wellbeing, and their physical activity levels. Further, we wanted to explore whether factors such as people's perceptions of and reasons for visiting green space, their different activities in green space (including use for social purposes), how often people visited green spaces, and whether or not they had good views of green space from their homes, were related to better or worse stress and mental wellbeing and, in turn, whether the amount of green space nearby influenced these factors.

Drawing on national level data analysis from other parts of the UK, Europe and North America that suggested the links between experience of natural environments and stress or mental health were strongest for lower income-level populations (Evans, 2003) we decided to focus our research on comparatively deprived urban populations in Scotland. In discussion with the GreenHealth project consultative group, we determined to focus on locations in the Central Belt of Scotland. Case-study areas were identified based upon poverty levels and quantity of green space, as measured at ward level using the Centre for Research on Environment, Society and Health (CRESH) green space data (described earlier). We attempted to identify urban areas which had:

- a) high indices of poverty (using Carstairs indices⁴)

⁴ The Carstairs indices of deprivation are used in spatial epidemiology to identify socio-economic confounding. They are based on four census indicators: low social class, lack of car ownership, overcrowding and male unemployment. Areas are then split by postcode, using these variables. See Carstairs V, Morris R. Deprivation and health in Scotland. Aberdeen: Aberdeen University Press, 1991. 0080379796

- b) high quantities of green space or low quantities of green space.

After much searching and careful consideration of the options, two wards (one high green space, one low) were chosen in both Dundee and Edinburgh based on the above criteria:

Dundee: Fintry (high GS %) versus Stobswell (Low GS %)

Edinburgh: Craigmillar (high GS %) versus Pilton (Low GS %)

A series of focus groups were held within each of the four communities early on, to explore differences between case-study areas in perceptions and experience of green space, and behaviour in relation to it. This allowed us to better understand the ways in which green space might be influencing health and wellbeing, and helped guide the development of further research activity

3.2.2 Focus Groups

Four focus groups were held in autumn 2009 in each of our case-study areas, recruited via local community groups. A total of 29 participants (9 men and 20 women), aged 16+, took part. The focus group discussions covered the following themes:

- people's perceptions of health and wellbeing
- people's perceptions of and use of local urban green space: its quality, amount etc.
- people's perception of current views available in their locality, both from home and walking around
- people's need manage stress and anger through escape; the types of strategies employed and the places used.

The main findings can be summarised as follows:

a) Similarities between groups: Mental health seems to be more important than physical health or social cohesion in people's perceptions of health and wellbeing. Health was defined as:

"Being able to do the things you want to do"

"Feeling good about yourself"

"Your attitude and not feeling down in the dumps".

There seemed to be a belief, unanimous across all groups, that green space could positively influence physical and mental health and social wellbeing:

"automatically, if you've greenery you lighten up you see the green, and your face lights up"

"if you've got a good green space, you could walk around in a good community spirit and you could blether more".

There was unanimous agreement amongst all participants on the need to 'escape from everyday problems and stresses'. The strategies for escape, however, varied among groups.

b) Differences between participants living in high and low percentage green space: In Dundee we found markedly different responses in relation to where people would go to escape everyday problems and stress, with participants in our low green space area (Stobswell) much more likely to say they stayed indoors than in Fintry, where hedges and trees apparently made an important contribution to participants' visual experience of their neighbourhood. There was also a difference in the perception of friendliness and trust within their respective neighbourhoods, with residents from Fintry more positive on this and unanimously agreeing it was a good place to live.

In Edinburgh, between-group differences were more noticeable in relation to anger management strategies. In West Pilton (low green space), anger management is a serious problem and experienced on a day-to-day basis. The response was largely to stay indoors. The occurrence of anger, and need for strategies to manage it, were noticeably less prevalent in the Craigmillar group. By contrast, in

Craigmillar, walking outdoors was much more prevalent. In this group, failure to exercise was attributed to intrinsic lack of motivation, whereas in West Pilton the quality of local green space was clearly a barrier to accessing the outdoors.

These initial findings were used to develop four research activities to address our initial hypothesis, further exploring the relationship between green space, health and wellbeing and focusing on case-study areas. The activities were: (i) a household survey to explore perceptions, behaviour and preferences in relation to green space, and how this relates to self-reported stress and mental wellbeing and to stress management strategies; (ii) a survey to explore how levels of green space in the home environment may be linked to levels of physiological stress as measured by cortisol secretion, as well as by self-report; (iii) an ethnographic study of green space use, (iv) a study of community visions for green space. The principal activities and findings are described below.

3.2.3 Urban green space and stress: household survey

A survey was designed to address the hypothesis that, *amongst deprived communities, the restorative effect of living in close proximity to a green environment has a positive outcome on stress, as measured by self-reported stress and wellbeing and preferences for stress management.*

The principal research question was: In residents of deprived city areas in Scotland, what role does green space play in management strategies for escaping the stress of everyday life?

Background

International evidence suggests that exposure to 'green' environments is associated with health benefits, including lower mortality rates, blood pressure and obesity levels, and better self-perceived health. Previous studies also suggest that increasing the availability of green space in areas of deprivation may help to reduce health inequalities. This research sought to identify the links between health and wellbeing and the amount of green space in deprived urban communities in Scotland.

Methodology

The study investigated the use of local green spaces in managing stress. The four case study areas of deprived communities were surveyed, with approximately 100 participants from each: Pilton and Craigmillar in Edinburgh, and Stobswell and Fintry in Dundee. Stress levels were measured using the Perceived Stress Scale (PSS) and Wellbeing was measured using the shortened version of the Warwick-Edinburgh Mental Wellbeing Scale (SWEMWBS). Relationships were examined separately for men and women and key sub-groups such as those likely to spend more time at home, and thus have the highest level of exposure to the neighbourhood environment. The research also took into account factors other than green space that might influence stress and wellbeing, such as age, income, and deprivation. In all cases described below, these potential confounders have been controlled for in the analysis.

Three measures of green space quantity of differing resolution and composition were used: (i) Ward level (CAS Ward, public open space only); (ii) Zone level (Scottish Datazones, with and without gardens); and (iii) PAN65 Total Green Space (Scotland Green Space Map typologies, including roadside grass and trees). Visual access to green space was measured on a three point scale: low, medium and high greenspace. Affluence was assessed using a four point 'Income Coping' measure, and the deprivation scores used in the analysis were from the Carstairs Index.

The results presented are for a subset of the data with Craigmillar removed. Stress scores were significantly higher at Craigmillar compared to those reported at the other three sites, and wellbeing scores were significantly lower, and thus Craigmillar was excluded from the pooled data analysis (giving a total sample of n = 305).

Findings

Perceived stress levels were inversely associated with green space quantity for both men and women (Figure 3.8), but, after controlling for confounding variables, green space was only an important factor for men. Green space accounted for about 5% of the variation in stress levels, and the regression coefficient, or slope, was -0.24. Thus, for every unit increase in green space coverage, stress levels reduced by 0.24 units. The relationship between stress and green space was stronger for a sub-group of men who were estimated to spend more time at home (those looking after the home/family, retired, or long-term sick or disabled), with green space accounting for up to up to 34% of the variability in perceived stress (Figure 3.9). This relationship was observed for between 25% and 69% green-space coverage. The green space regression coefficient was -0.62.

For women who were likely to spend more time at home, the analysis revealed a more complex relationship between stress and green space than for men, with a negative relationship between green space and stress for one group of participants (stress decreasing with increasing green-space coverage), but a positive relationship for others (Figure 3.10). Previous research on perceptions and use of green space has shown that safety concerns, especially in poor quality green spaces, deter women more than men. This may be reflected in the findings of a positive relationship between green space and stress (for a sub-group of women, Figure 3.10).

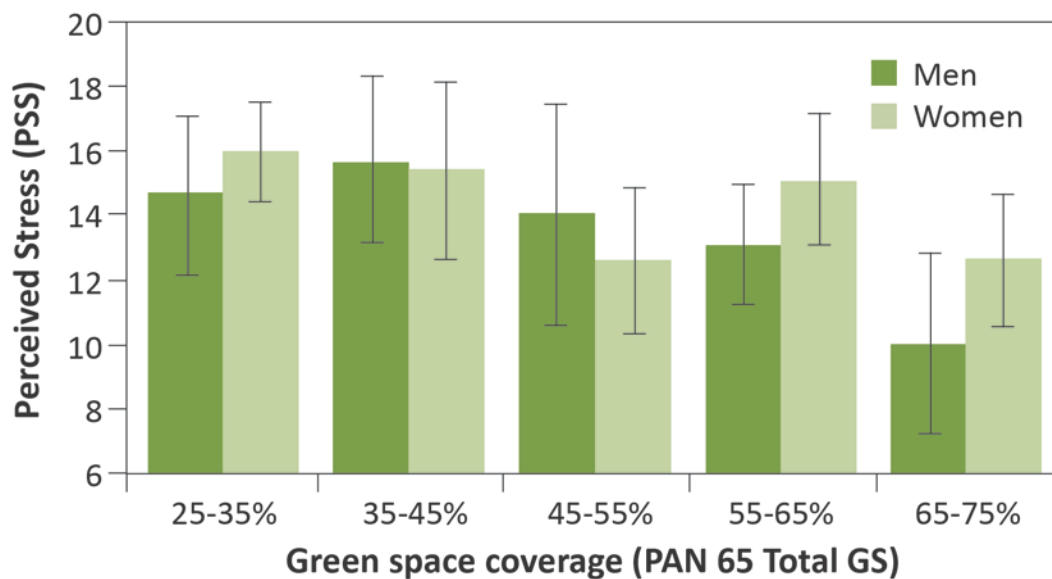


Figure 3.8 Mean perceived stress and green space quantity for men (n = 101) and women (n = 130). Error bars are two standard errors.

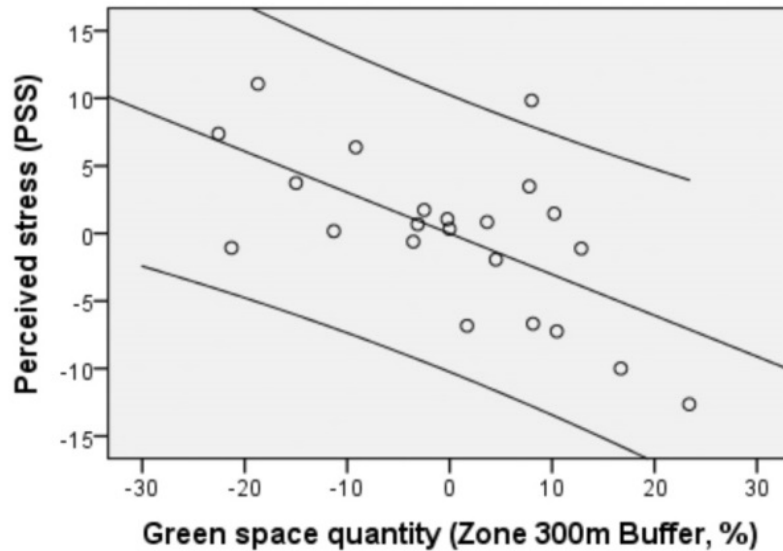


Figure 3.9 The relationship between stress and green space for men estimated to spend more time at home (n=22; Retired 77%, Disabled or long-term sick 23%), expressed as a partial regression plot.

The y-axis shows PSS increasing from bottom to top, and the x-axis shows green-space quantity (%) increasing left to right. Confidence intervals shown are 95%.

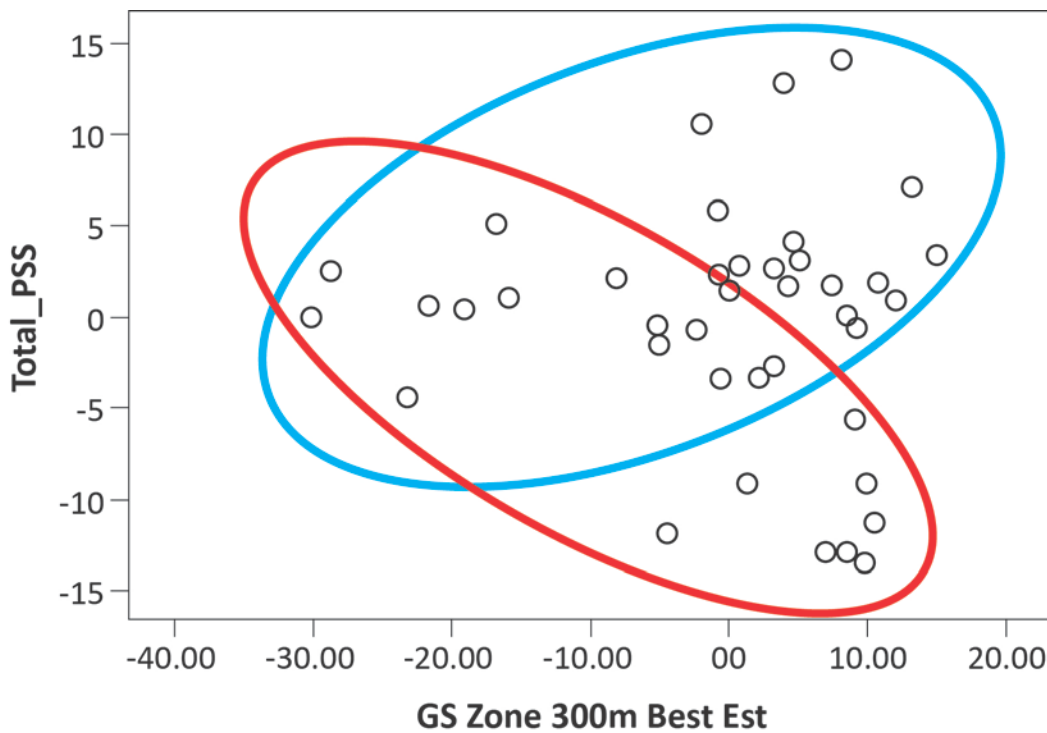


Figure 3.10 The relationship between stress and green space for women estimated to spend more time at home (n =44; Looking after the home/family 41%, Retired 50%, Disabled or long-term sick 9%).

There was no association between green-space quantity and wellbeing for the total sample of men in the study, but, for the sub-group who were likely to spend more time at home, there was a positive relationship between wellbeing and green space (Figure 3.11), with green space accounting for about 14% of the variability in wellbeing. This relationship was observed over 25 to 69% green space coverage, and the regression coefficient was 0.4.

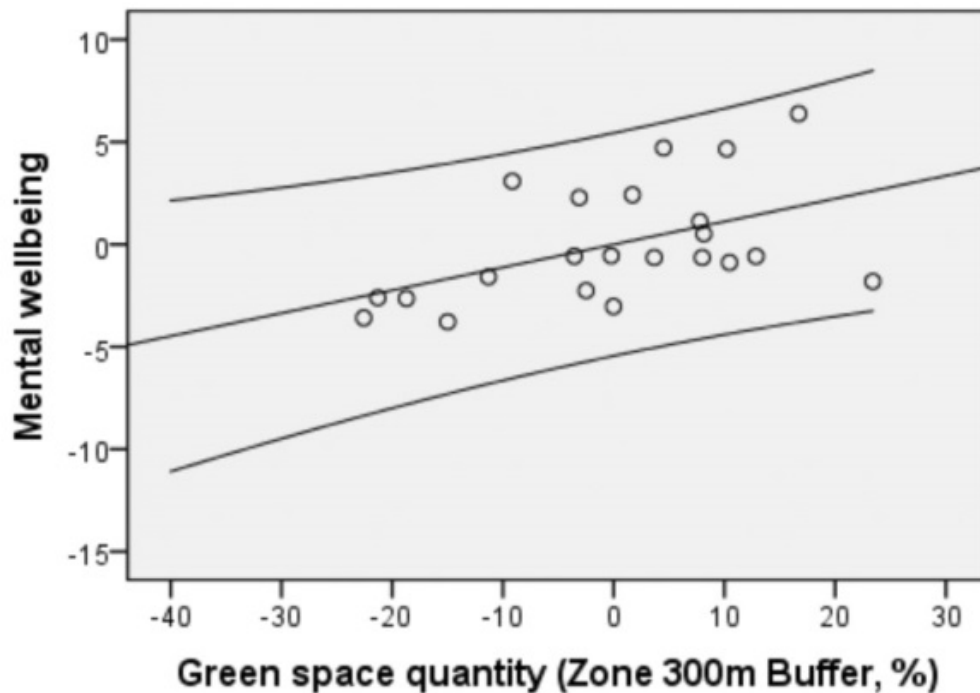


Figure 3.11 The relationship between wellbeing and green space for men estimated to spend more time at home (n=22; Retired 77%, Disabled or long-term sick 23%), expressed as a partial regression plot.

The y-axis shows mental wellbeing increasing from bottom to top, and the x-axis shows green space quantity (%) increasing left to right. Confidence intervals are 95%.

For the total sample of women in the study, lower mental wellbeing was associated with higher levels of green space, with green space accounting for about 8% of the variability in wellbeing (green space coverage 22 to 69%; regression coefficient = -0.31). However, as in the case of the relationship between stress and green space, there were two groups of women (Figure 3.12): (i) a group for which wellbeing was positively associated with green space (horizontal oval), and (ii) a high green-space group (vertical oval) where wellbeing ranged from the lowest to some of the highest values recorded. As indicated for stress levels, this latter group may reflect perceptions of lack of safety in green space for a sub-group of women.

The proportion of individuals opting for one of four responses to ‘escape’ stress is shown in Figure 3.13. About half the individuals opted to stay in their own home. There was no difference in stress scores across the escape choices. Escape preference was linked with green-space quantity (but not with having a view of green space from the home). Individuals who opted to ‘seek company’ tended to have lower green-space coverage compared to those opting for any of the other escape responses (Figure 3.14).

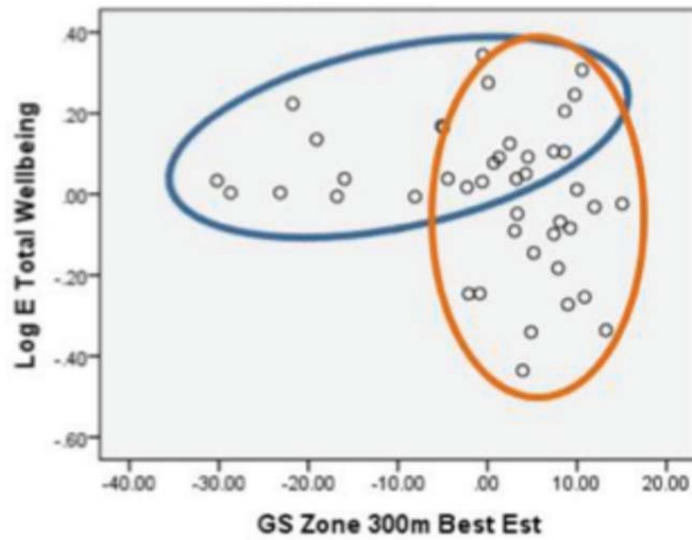


Figure 3.12 Escape response preferences (n = 305)

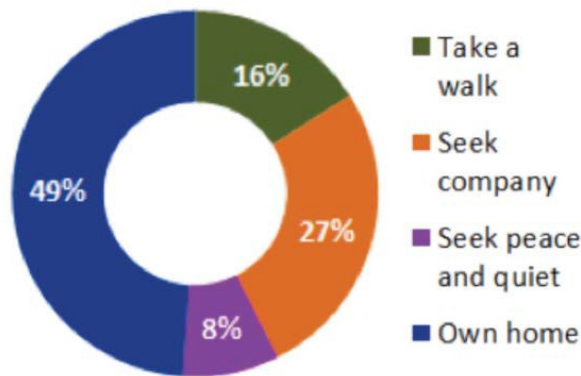


Figure 3.13 Median green space coverage for each escape response (n = 206). Error bars are the interquartile range

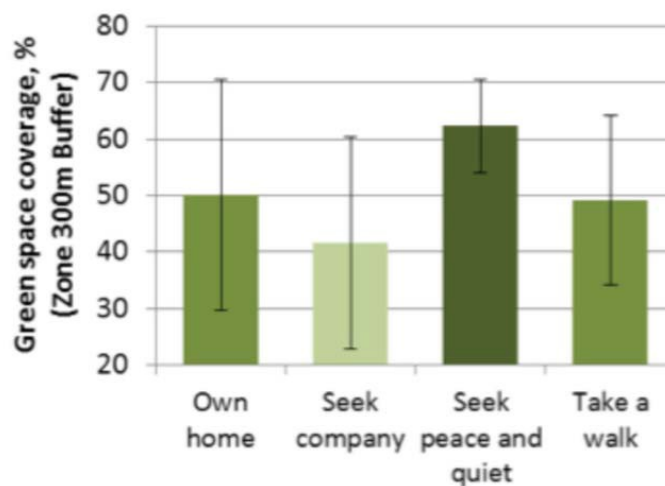


Figure 3.14 The relationship between % green space within a 300m buffer for individuals opting for one of four responses to 'escape' stress

The median green-space coverage for the 'seeking company' group was 42%, 8 to 21% lower than those for the other three groups. Escape responses were investigated further using conjoint analysis,

and a dynamic computer simulation model, which gives insights into the trade-offs between environmental and other situational factors people choose to make when stressed.

This cross-sectional study cannot show a causal relationship between green space and health and wellbeing. Nonetheless, it suggests that the amount of green space in the residential environment is a factor contributing to the health and wellbeing of residents of deprived urban communities in Scotland, particularly those who are likely to spend more time in and around their home or neighbourhood. The study suggests that increasing green space coverage in areas where there is little could contribute to reducing stress levels and increased wellbeing for some; however, other aspects of green space which impact on perceptions and use, such as quality and safety, must also be taken into account.

The overall findings are:

- Perceived stress and wellbeing were linked with green space quantity, and the strength and direction of relationships varied by gender and likely level of exposure to the neighbourhood environment.
- Stress levels were lower for men living in areas with higher levels of green space, but the relationship was more complicated for women, with higher levels of green space associated with lower levels of stress for some women, but higher levels of stress for others.
- Stress and wellbeing was linked with green space quantity for a sub-group of men who stayed at home (retired, long-term sick, disabled), and those who were likely to have the highest level of exposure to the residential environment, with the individuals who were living in areas with more green space having the highest levels of wellbeing.
- For women, the relationship between general wellbeing and green space quantity was more complicated, with a positive relationship between the two variables for one group, and no relationship for a second stay-at-home group living exclusively in high green space areas.
- Preference for 'escaping' from stress was linked with green space quantity, but not with having a view from home.

3.2.4 Urban green space and stress: cortisol survey

Background

As indicated earlier, contact with green space has been associated with benefits to mental health, including stress recovery. This outcome is understood to arise from one or more of three possible pathways: the greater opportunities green space affords for physical activity which, in turn, improves mood; the increased opportunities that urban parks and green space offer for social contact – impromptu or planned; and opportunities for psychological restoration⁵.

It is believed that the 'soft' visual stimuli of natural settings support involuntary attention⁶ and recovery from the high cognitive demands of urban environments (e.g. from high levels of noise and traffic). However, objective physiological evidence of these benefits is currently limited to a small number of – mostly laboratory – studies showing positive effects of green space on blood pressure, heart rate, skin conductance and muscle tension.

Cortisol, secreted in the adrenal glands, is frequently referred to as 'the stress hormone' and levels of secretion are an important indicator of our 'fight or flight' response to stress. In recent years a number of studies have begun to explore salivary cortisol levels as a measure of the impact of green space on stress recovery. However, these experiments are largely limited to intervention studies measuring levels immediately before and after exposure to different green space settings. Whilst these

⁵ The term 'restorative' is used to define psychological restoration from low mood, fatigue and stress. (See Roe, J (2008) The Restorative Power of Natural and Built Environments, Heriot Watt University, http://www.openspace.eca.ac.uk/pdf/JennyRoePhD_Final_March09-1.pdf

⁶ The term 'involuntary attention' refers to attention requiring no effort; it may be described as fascination or curiosity. (See Roe, J (2008) The Restorative Power of Natural and Built Environments, Heriot Watt University, http://www.openspace.eca.ac.uk/pdf/JennyRoePhD_Final_March09-1.pdf

studies found that contact with natural environments reduced stress, their external validity is limited because they either had very small numbers of participants or limited categories of participant (e.g. university students, allotment gardeners) and/or they used very controlled, specific settings. None of these studies have measured diurnal cortisol patterns, which offer a more reliable biomarker of someone's longer-term stress condition. A healthy diurnal (i.e. daily rhythm) cortisol pattern is typically indicated by a clear decline in cortisol concentrations across the day, falling after a sharp rise upon awakening.

Based on existing evidence the following two research questions were posed:

1. Among residents of deprived urban areas in Scotland, is the presence of different levels of green space in the local community environment associated with stress as measured by diurnal patterns of salivary cortisol secretion and self-reported stress?
2. Are there any sub-group patterns, for example in men compared with women?

Methodology

This was a two part study. Firstly, an exploratory study was carried out to test the protocol for using salivary cortisol as a biomarker of stress in a socially-deprived urban population, and to find out whether the test appeared sensitive to different levels of green space within the study population. Participants were asked to collect samples of salivary cortisol at different times of day over a time period. This study found good adherence to the data gathering protocol. Results showed significant relationships between measures of neighbourhood green space quantity, perceived stress and the diurnal pattern of salivary cortisol secretion. Higher levels of neighbourhood green space were linked with lower levels of perceived stress and a steeper (i.e. healthier) diurnal decline in salivary cortisol secretion.

A second, study was then carried out to expand these earlier findings within the same socially deprived urban population in a larger sample, paying particular attention to gender differences. The study was cross-sectional in design. Since cortisol concentration is highly sensitive to age, the sample was restricted to men and women aged 33 to 55 years. In previous research, green space and health links have been shown more strongly in poorer communities and in people whose time is more likely to be spent in and around the home. So we targeted as participants people not in work for any reason (e.g. job-seeking unemployed, on invalidity benefit, carers) living in socio-economically deprived areas of Dundee as measured by the Carstairs Index of Deprivation, obtained via each participant's postcode.

Recruitment was carried out via unemployment centres in Dundee (study 1) or door-to-door (by a survey company) with follow-up appointments carried out by the research team (study 2). The total sample size was 106, 50% male, 50% female. Participants were briefed on the protocol for cortisol sampling and completed a short questionnaire on individual characteristics, including income coping, stress, wellbeing and exercise levels, covering the same items as the landscape perception questionnaire survey described earlier. Repeated salivary cortisol sampling took place over 2 consecutive weekdays (2 days, 4 times per day) with texts sent to participants as reminders. Data were carefully checked for compliance with the protocol and suspect samples removed.

The percentage of green space in each participant's residential area was measured using the Census Area Statistics (CAS) for Wards. Dundee contains 31 CAS Wards with a mean percentage of green space of 33.89% (2001). The green-space measure includes parks, woodlands, scrub and other natural environments, but not private gardens (although participants were asked whether they had access to a garden). This CAS Ward measure is the same measure as the first option used in the landscape perceptions questionnaire survey described earlier.

In statistical analyses, we explored green-space percentage as a continuous variable ('% green space') and a binary variable ('high' or 'low' green space) split at an optimal level of less than/equal to or more than 43% (this best place at which to split 'high' versus 'low' green space for the purpose of our study was established using a regression discriminator (SPSS AnswerTree) and a CHAID test (CHI

squared Automatic Interaction Detector)). The term ‘low green space’ henceforth refers to areas with less than or equal to 43% green space; ‘high green space’ to areas with over 43% green space. The variable ‘private gardens’ was one of those tested as a potential confounder in the analysis (Roe et al., 2013).

Findings

With respect to self-reported stress, regression analyses showed that the level of green space (continuous variable) was a significant predictor of perceived stress ($p < 0.05$); perceived stress was lower in our high green space areas (see Figure 3.15); in general, higher stress levels were associated with being female, and for males only, not having a garden.

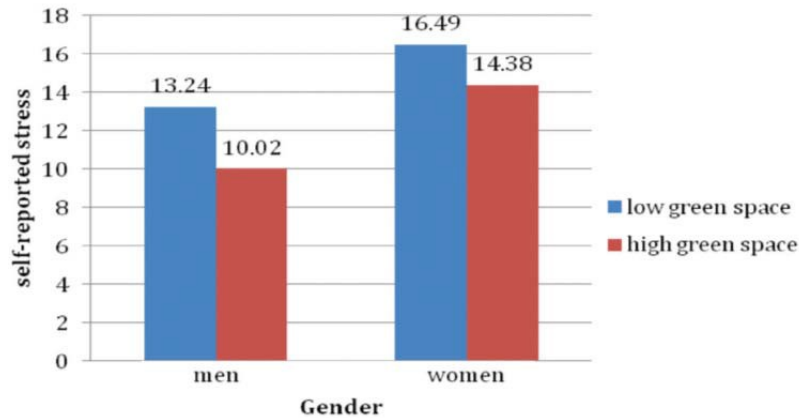


Figure 3.15 Levels of self-reported stress in area of low ($\leq 43\%$) and high ($>43\%$) urban green space

The core characteristic of healthy cortisol secretion is that levels are carefully regulated by the hypothalamic-pituitary-adrenal axis, leading to very different cortisol concentrations at different times of the day. The circadian cycle (with levels changing from a daytime peak that may be as high as 20nmol/l shortly after awakening to a low of perhaps 1nmol/l in the early hours of sleep, see Edwards et al., 2001) signals to other body systems when it is night and day. The circadian cycle of cortisol secretion is thus sensitive to the effects of chronic stress (Meerlo et al., 2002; Nader et al., 2010), affording not only a biomarker of chronic stress but also a mechanism by which stress and health are linked.

Healthy diurnal patterns of cortisol secretion show a daytime peak shortly after awakening. However, a range of conditions are associated with a flattening of the cortisol circadian rhythm, i.e. the angle of the declining slope from morning through to the evening. In some cases, a ‘flatter’ slope is associated with increased overall cortisol secretion (a ‘high flat’ slope), for example in normal ageing or in clinical depression (Deuschle et al., 1997; Weber et al., 2000). In other conditions the flatter slope is associated with an overall reduction in levels of cortisol secretion (a ‘low flat’ slope), for example in post-traumatic stress disorder (PTSD), a combination of PTSD and long term negative life events, repressive anxiety, and chronic fatigue (de Kloet et al., 2007; Giese-Davis et al., 2004; Jerjes et al., 2005; Li et al., 2007; Witteveen et al., 2010).

A steep decline in cortisol concentrations post-awakening is indicative of less stress. However, in men, stress has been associated with higher cortisol concentrations post-awakening and a reduction in the diurnal cortisol decline (i.e. a high and flat pattern). Whereas, in women, stress is associated with a lower cortisol concentration, and reduction in the diurnal cortisol decline (i.e. lower and flatter). From the GreenHealth study, Figure 3.16 shows the patterns of cortisol concentrations for the nine hours post-awakening (on the x-axis), for the population samples, split between high and low available green space. The findings show that higher levels of neighbourhood green space were linked with lower levels of perceived stress and a steeper (i.e. healthier) diurnal decline in salivary cortisol secretion.

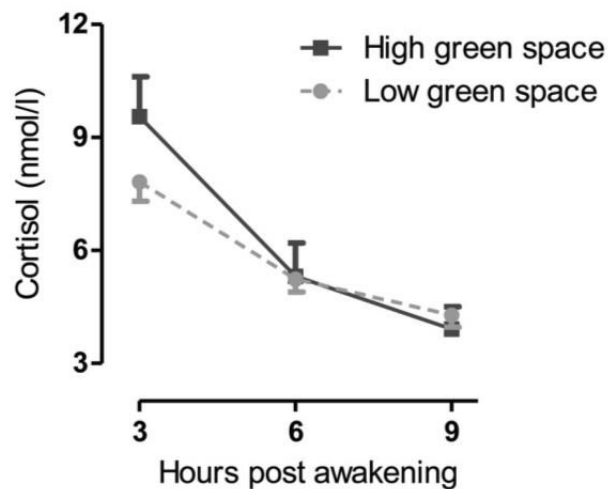


Figure 3.16 Difference in cortisol slope between participants living in high versus low green space areas

Significantly lower average cortisol concentrations were found in women, indicative of chronic stress. There was also a significant interaction effect between percentage green space and gender: more neighbourhood green space was associated with higher – and healthier – diurnal cortisol levels among women (the solid black profile in Fig 3.16). In low green space, women showed a ‘low and flat’ slope indicative of long term stress, chronic stress or ‘burn out’ (the dotted line in Figure 3.17).

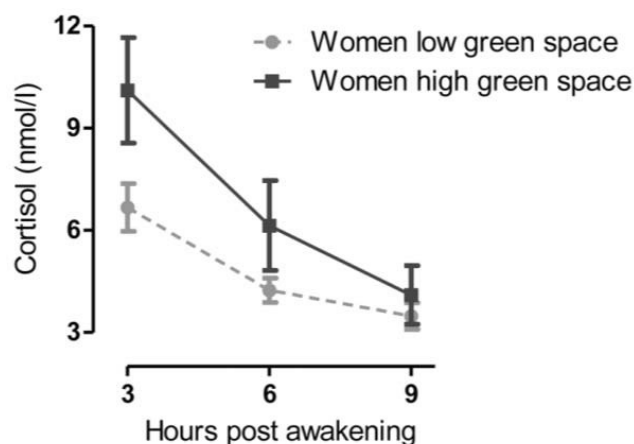


Figure 3.17 Differences in mean cortisol slope in women living in high vs low green space areas

The key finding here is that levels of green space in residential environments can significantly predict levels of self-reported stress and diurnal patterns of cortisol – a biomarker of stress – in deprived urban communities. The effect of green space on stress may be mediated by gender, with a stronger positive effect of increasing green space on cortisol concentrations in women. Measuring diurnal patterns of salivary cortisol offers an ecologically valid and objective method to demonstrate evidence of the effect of living near high levels of green space. In addition to its key role in responding to acute stressors, cortisol is a vital hormone for orchestrating healthy body functioning around the 24 hour circadian cycle. Disrupted patterns of cortisol secretion are indicative of circadian rhythm dysregulation which is associated with poor mental and physical health. Thus, as diurnal cortisol patterns reflect everyday circadian rhythms of health as well as longer term effects of stressors in the social and physical environment, this is an important step in understanding the pathways by which access or exposure to green space may influence stress and wellbeing. However, it must be noted that

people who are less stressed may have been able to secure housing in areas of high green space, i.e. they may have been less stressed to begin with.

A paper on the exploratory, initial cortisol study was published (Ward Thompson et al., 2012) and a further paper on the main cortisol study now also published (Roe et al., 2013).

We explored additional questions relating to perceptions and use of green space as measured in the questionnaire accompanying the cortisol sampling protocol.

Responses on green space perceptions, activities and use in relation to green space quantity

We found statistically significant differences between responses on the following, when comparing high and low green space neighbourhoods:

- usage of green space: participants in low green space used their local green space more for ‘peace and quiet’ whereas those in high green space visited more to see wildlife.
- quality of life factors (including satisfaction with the local neighborhood): these were higher in participants living with more green space.
- social usage of green space: people living with low levels of green space were more likely to visit alone. Women were much more likely to use green space for social reasons and men for peace and quiet (see Figure 3.18).

We found no statistically significant differences in our high and low green space areas on: social wellbeing indicators, perceptions of green space quality, reported levels of views to green space, frequency of visits or levels of physical activity.

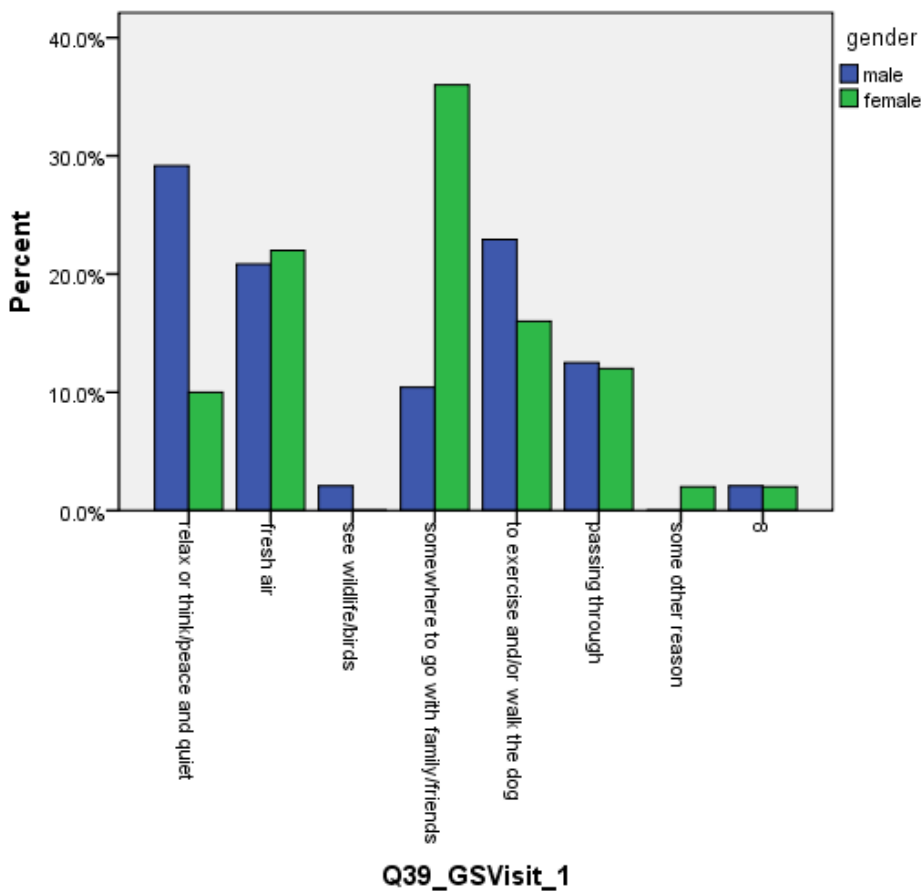


Figure 3.18 Differences in purpose for green space visit in the cortisol study sample (n=98)

Limitations

Our findings came from a middle-aged group of men and women not in work and living in deprived urban areas in one Scottish city. The findings are therefore limited in their applicability to other age groups or living circumstances. Although adequate for finding significant effects, our sample was comparatively small and cross-sectional only, limiting any interpretation of causality. This study would benefit from wider replication, particularly in longitudinal studies over time. Nonetheless, they mark a step forward in our understanding of possible mechanisms behind any salutogenic green space effect.

The overall findings from this study are:

- More green space in deprived urban communities is also associated with lower levels of self-reported stress for a sample of middle-aged men and women not in work.
- More green space in the home neighbourhood is associated with lower stress as shown by salivary cortisol patterns for a sample of middle-aged men and women not in work.
- More green space in deprived urban communities is also associated with lower levels of self-reported stress for a sample of middle-aged men and women not in work and living in a deprived urban community.
- Higher levels of green space have a stronger relationship with diurnal cortisol concentrations in women than in men in such demographic groups in deprived communities.
- High green space availability does not appear to be associated with higher levels of visits to green space or higher levels of physical activity.
- We have validated an innovative and objective method for measuring salutogenic effects of local green space.

3.2.5 Ethnographic study of uses of green space

Background

To understand the relationship between health and green space there is a need to understand both how and why people engage with green space. In order to answer these questions, an ethnographic approach was used in the two case study areas in Dundee, Baxter Park, near the inner city area of Stobswell, and Finlathen Park, near the northern boundary of the city, to explore the role that green, or open, space plays in how human health and wellbeing are produced. Ethnographic studies involve in-depth fieldwork, which is time consuming so we decided to focus on only one GreenHealth study area for maximum depth.

Methodology

Firstly, participant observation was undertaken in order to familiarise the research team with the two case study areas and the local environment. Key contacts were identified in each area. A total of four interviews took place with eleven participants, including urban rangers, local community officers, youth workers and volunteer leaders. This provided an in-depth picture of each case study area in terms of its local history and social relations, as well as the geography and physical features of each area.

For example, these interviews provided background information about the case study areas, with Baxter Park in the last ten years having undergone a 'restoration' that emphasised its Victorian heritage, and that Finlathen Park has, in the past, been the site of teenage 'turf wars' between rival secondary schools and council housing estates. Such local cultural knowledge is important in understanding how and why people use green spaces in the ways they do, attending to the social environment as well as physical and geographical layout and features. Contextualising the case study areas in this way helped gain an understanding of some of the cultural ideas and expectations that

might influence the ways in which people access and engage with such spaces. In other words, people do not engage green spaces afresh, i.e. as blank slates, but approach them with meanings and intentions that are part of a complex set of interactions, values and emotions arising from their social and cultural background, identity and other social relations.

Ten participants were recruited through local community groups, all of whom were regular users of either Baxter Park or Finlathen Park. Participants included both sexes, and age ranged from 19 to 60+ years. Participants were recruited individually; however in about half the cases it was difficult to pursue this methodology on an individual basis as their use of green space included others, through being part of a voluntary group or being accompanied by friends or family. Thus other people, not necessarily 'officially' recruited as participants to the project, became involved through being part of the participants' green space experience and engagement. These people included members of the Friends of Baxter Park group, and the volunteers of the Dighty Environmental Group in Finlathen Park, and pre-school children. . People present in the parks when conducting walk-along interviews and video recordings can also be seen as non-official participants.

An ethnography was conducted consisting of the following four stages:

- a one-to-one, face-to-face semi-structured pre-activity interview of some 45 minutes
- unstructured individual or group walk-along interview of between one to two hours
- participant- or researcher-directed video-recording of green space use and engagement
- individual or group review of video data lasting for approximately one hour.

Data collection took place between January and June 2011. Methodological issues addressed over this period included the 'bounding' or containing of the case study areas, as socially and geographically they spread out into other areas, and expanding participant assumptions and ideas about green space with respect to more complex ideas about health and well-being.

Interview transcripts and most video data were imported into Nvivo, a computer software program for managing and coding qualitative data, including video films. Interview transcripts were checked against voice files prior to being imported. Initial coding was carried out independently by three researchers, generating a rich set (and large number) of categories relating to the many aspects of green space attitudes and behaviour that emerged. Secondary coding brought these three analytical frameworks together, refined the categories most closely relating to health and wellbeing meanings of green space, and investigated indirect behaviour relating to health and wellbeing, such as daily routines, type of social relations, and use of leisure time.

Findings

Wellbeing, from the participants' point of view, emerged as something implicit and common-sense, with the benefits of green space interaction felt later (e.g. children sleeping, felt better, healthy glow, etc.) rather than at the time. This idea aligns with an emerging theory in cultural geography literature that positive states of health are largely invisible; that people give attention to their health and wellbeing only when they are absent (Zeiler, 2010). Positive and negative social aspects of well-being also emerged, e.g. frequent mention of green space as a place for both formal and informal social events; formal and informal regulatory practices which prohibit/discourage some users and some activities at certain times (e.g. nearby secondary school discouraged use by young families during lunchtime).

Embodied and sensory experiences were noted by participants, e.g. effects of weather, seasons, light, which may or may not affect perception of health and wellbeing. Through use of urban green spaces participants observed and experienced weather, wildlife, seasons, plants and flowers and changes, in other words the environment or 'nature' in its widest sense.

How different people move through, around and in green space, is important in understanding links to social order (e.g. keeping to the path), adherence or not to other formal and informal regulations

governing acceptable behaviour, and who has access to green space, when and for what purposes. Evidence emerged of tensions between different users, including dog owners, fitness groups and those for whom green space should not include other people.

The overall findings of the ethnographic study are:

- Meanings of green space, and hence any wellbeing benefits derived from engagement, vary between different people and social groups
- For most people the social aspect of meeting others is a key part of using their local green space and hence important to any wellbeing benefits derived from it
- For a small minority of people the notions of escape and 'getting away from it all' are important to green space use and hence wellbeing comes through group activity; this gives their activity meaning and purpose and provides them with a strong social identity in relation to the space
- The activities of different groups affect the experiences of others both positively and sometimes negatively, for example, teenagers playing on park equipment can deter mothers and younger children from using it.
- A social value is attached to green networks, providing functions beyond of those of biodiversity of wildlife, for example the ability to use an attractive route when walking from place to place.
- The use of green space led to increased understanding of the local environment, specifically in relation to wildlife, and changes in vegetation through the seasons.

3.2.6 Green space services: Community engagement

Background

To improve understanding of how green spaces can deliver multiple functions, we in turn need an improved understanding of how uses can complement each other. Some uses may be incompatible with creating environments conducive to human health and wellbeing. To achieve this, participatory techniques were used to explore current uses with community stakeholders in the Finlathen Park green space, Dundee, expanding on the ethnographic study on how and why people engage with green spaces.

Methodology

Maps and aerial imagery were used to represent the principal features in the park and surrounding area, such as the Dighty Burn, viaduct, and surrounding buildings and roads. The imagery was used in discussions with residents and park users to capture information on the different uses of the park; factors which might deter use such as lack of facilities, anti-social behaviour, footpath quality; means of physical access, and views. Photographs and computer simulations of the park from different viewpoints were then used to tailor the level of detail of the visualisation of features referred to, or associated with the park (e.g. trees, burn, sports football pitch) to match with the purpose of selection and location of features and to test recognition of the site. These data were used to develop a prototype 3D model of Finlathen Park, which was then used with local stakeholders to test its functionality in a virtual reality environment, and the design of the engagement activities. The model was then used with 155 people from community groups, with audiences comprising elected representatives, planners, community workers, residents – both those familiar and unfamiliar with the area - plus some groups of ages under 18. Figure 3.19 shows an overview of the Finlathen Park area presented in the Virtual Landscape Theatre.



Figure 3.19 Overview of the Finlathen Park area in the Virtual Landscape Theatre

Figure 3.20 shows (a) features added by participants to the 3D model of Finlathen Park , and (b) an audience of younger people in the Virtual Landscape Theatre.



Figure 3.20 (a) Features added by participants to the 3D model of Finlathen Park, (b) An audience of younger people in the Virtual Landscape Theatre

To explore opinions on specific features and areas of the park, audiences were invited to prioritise topics (e.g. woodland, access, facilities transport, lighting, etc.), and then select individual types of feature to locate in the park. Subsequent discussion of opinions in the group identified options for park management, layout or content which might increase use or other benefits (e.g. personal health, biodiversity, water quality in the burn, social space for different age groups). The geographic distribution of features identified in the engagement sessions led to the mapping of alternative options and associations of key functions within the park.

Although the focus was on Finlathen Park, information was obtained on other green spaces in the locality, or local to participants. Their content, quality, proximity to home or work, and issues associated with their use were documented, and some metrics collected later, such as size, and the type of boundary (e.g. road, wall, building).

Findings

Finlathen Park provides multiple services for communities of place, generally adjacent to the north and south, and some communities of interest, e.g. relating to the burn and sports facility. Participants

identified a number of multiple functions of the green space, in particular the role of additional trees for extending habitats and dampening noise from vehicles. Both the wooded nature of the area and the Dighty Burn were associated with the wider areas of green space east and west of Finlathen, and recognition of the role that what happened in that park had potential impacts along the wider green and blue space network.

Interest in the Dighty Burn was attributed to: (i) local history, most significantly with respect to the improvements in water quality, and its links with adjacent areas; (ii) its role in the provision of a peaceful location for relaxing; (iii) the focus it provided for community groups (e.g. Dighty Connect). Stretches of the burn, with limited disturbance, provided a resource which is valued for peace and relaxation. Community groups provide a focus for the maintenance and enhancement of this feature, which is also recognised as being associated with other environmental benefits of water quality and habitat.

Commonly expressed uses of the green space for adults and children were for peace and quiet outdoors, a sense of fresh air, and enabling the avoidance of disturbance such as noise, argument, music or television. It is a place for meeting with friends, taking physical exercise, and for fresh air. The green space used for dog walking was most often small in size, the closest to home, and frequently used in the early morning or late evening, at regular times daily, or weekly.

Focal points emerged for different types of uses, around the sports areas, the two children's play areas, stretches alongside the Dighty Burn, the viaduct/bridge across the park, and open space of grass on the east of the bridge. In addition to football and cycling, such areas were also associated with less energetic uses, for example looking at birds and plants. For children, uses of the green space included meeting to play with friends, taking advantage of the mix of trees, bushes, open grass and the edge of the burn, and the burn itself for fishing with nets.

People suggested improvements to the green space included additions of features, refurbishment, or the provision of new or extended facilities. Of repeated interest was a desire to increase the extent of woodland around the western and northern edges of the park to dampen noise from traffic on the main road to the west (Dundee/Aberdeen road), and infill gaps in the woodland around the area to the north. However, this also had the effect of reducing views of the children's play area by parents overlooking that space, so there was some precise positioning of additional woodland in this area. Improvements also include footbridges over the burn to enable more varied routes for walks through the green space.

Other changes to the green space were grouped into those which would improve the quality of the resources offered by the green space, and those which could not be provided at home due to a lack of private garden, or suitable common space. Additional facilities identified for local community activities included further children's play areas, seating for adults to use to oversee children in play areas, relaxing (e.g. for reading), and shelters for adults watching children's football or sport, and permanent barbeque equipment.

People disagreed about specific additions or changes to green space, such as additional lighting for footpaths. Some felt that this would increase accessibility to parts of the park beyond the open and edges in the dark, particularly in winter, but others felt that lighting would be intrusive and would diminish the park's value as a natural environment. Some people were also concerned about some features being vandalized; however, people from most age groups did not see this as a serious problem, so long as their design was appropriate. Reference was made to existing, appropriate facilities nearby, for example, seating made from stone, and permanent barbeques in another park.

Those familiar and unfamiliar with the specific park expressed similar opinions on certain issues.. However, those unfamiliar with the park were unaware of specific issues (e.g. cars parking on grass banks), the loss of a sports building, the level of noise from the major road nearby. Those familiar with the park, older than school age, noted aspects of the history of parts of the areas for anti-social

activities (e.g. fights between neighbourhoods) but, significantly, the removal of such experiences over the last 20 or more years.

Although the park provides multiple services and functions there is some incompatibility of uses of the park, some most closely related to opportunities for, and types of, physical activity and wellbeing. Examples included dog fouling of footpaths, cars parking on grass banks during football games at the weekend, and different groups using the park at the same time (e.g. school age children in school breaks).

Other factors raised in relation to access and use of green spaces included the potential for greater involvement in managing part of such a green space, with an emphasis on how small spaces can be used for community-identified priorities, with reference made to other discussions in Dundee on the same theme. Concerns expressed included the loss to housing of small green spaces, which had been used for exercising a dog at night, or for being out of the house and where there was no private garden.

The recognition of sub-areas of the park could provide more mutually compatible services, such as areas for peace and escape, others for active sport and play, and a wider context of enhanced ecological and physical connectivity. Figure 3.21 shows one such subdivision which would provide a framework for targeting investment in resources to improve the space, including the enhancement of an environment offering benefits of wellbeing.

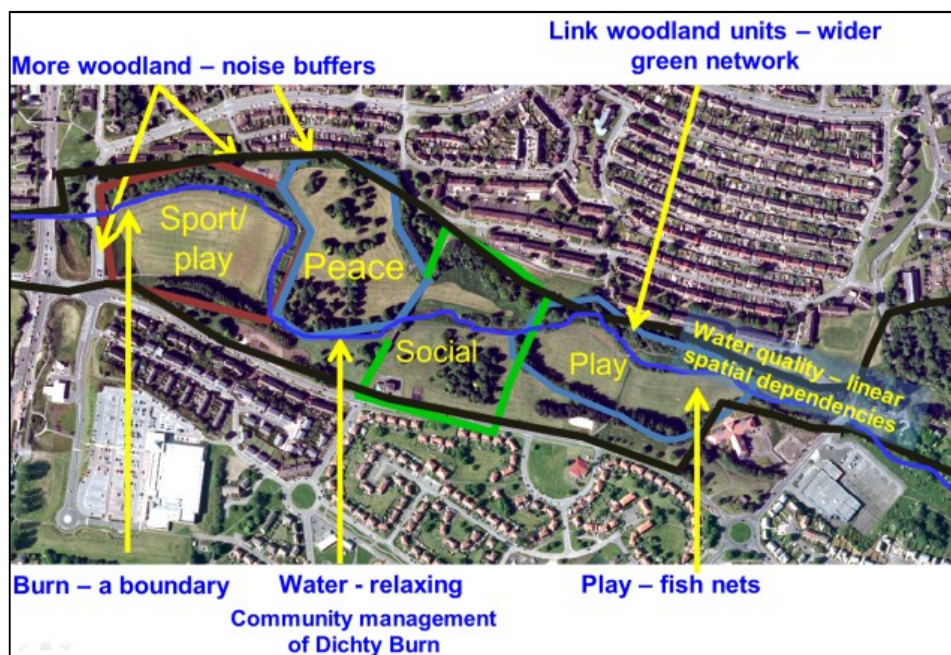


Figure 3.21 Example spatial plan for park and adjacent area derived from engagement events

Community interest in exploring means of land tenure to enable greater responsibility for the management of areas of green space for community benefit could assist delivery of locally identified priorities, of which the green space studied appears to be a contributor to health and personal and community wellbeing.

The overall findings are:

- The identification of sub-areas of green spaces supporting compatible functions could to increase the overall effectiveness of such spaces in delivering multiple functions, and safeguard its value for relaxation and escape.
- The uses identified of small areas of green space in close proximity to houses, for short time periods suggests that their loss could have a disproportionately adverse impact on opportunities

for overall provision than the loss of an equivalent area from a larger green space, reducing the availability of places for short periods of escape.

- A focus of local interest, such as the Dighty Burn, provides peace and relaxation for local residents. Community maintenance of the burn brings multiple benefits, such as good water quality, recreation space and wildlife habitats.
- Positive reactions to the participatory mechanisms of the research suggested an enthusiasm for taking a greater role in planning changes in the green space.

3.3 Policy relevance and practice

3.3.1 Policy review

We reviewed Scottish public policy documents and examined their content for connections to ten relevant National Outcomes, assessed in terms of 13 key policy issues, through 2008 to 2011⁷. As expected, some policies quoted the Government's statement of a particular Outcome, although others dealt with an Outcome in much greater depth. The extent to which each Outcome was addressed tended to be sectoral. For example, planning policies usually focused on "*We value and enjoy our built and natural environment*" and "*We live in well-designed, sustainable places*"; they then concentrated on the key issues of 'planning and economy' and, to a lesser degree, 'accessibility'. Conversely, FCS and SNH tended to address the first of these Outcomes but then concentrate on the key issue of Natural Environment.

In the documents reviewed, the presence of accessible green space, potentially as a 'Green Network' or 'Green Infrastructure', in both urban and rural contexts, was regarded as an essential component in enhancing public health and wellbeing. These documents are consistent in stating that green spaces should be accessible to all members of the public, including disadvantaged communities, people with disabilities, and all age groups. They agree that green spaces should be regarded as safe places to visit, and as providing the environment for the multifunctional uses of space required by the local community. If this is achieved, green spaces are more likely to be used by local people, with resulting benefits for health through exercise, and for public wellbeing through social interaction and relaxation in a restful environment. The wide range of benefits and functions of green spaces, in the context of green infrastructure, are summarised in 'Green Infrastructure: Design and Placemaking' (Scottish Government, 2011a) as including placemaking, economics, climate change, environment, community and social and health and wellbeing.

We found that the greatest variation in the policies examined was the extent to which health was mentioned, particularly mental health. Relatively little reference was made to physical and mental health in planning policies, but notably they received considerable attention in Forestry Commission documents. Clearly health was the key feature of specifically health-related policies, yet some of these did not identify health links to green spaces. Several policies placed a strong emphasis on the health and wellbeing of children, with obesity being very commonly addressed.

Thirty-nine of the fifty-seven documents in our database mention health inequalities or deprivation, mainly in the context of poor access to facilities (e.g. to National Health Service Scotland and GPs in rural areas), and only seventeen discuss health inequalities in the context of green space. Mostly these are reports that focus on health (e.g. *Equally Well* and associated reports; *Good Places Better Health*). Others included the *Biodiversity Implementation Plan* (2008) and the subsequent *Developing the contribution of natural heritage to healthier Scotland* (2009), which aims to (a) provide opportunities for children, especially those from deprived areas and backgrounds, to interact freely with biodiversity in a safe environment, and (b) to improve adults' mental wellbeing and increase

⁷ Policy issues reviewed in relation to green/open space, as agreed with stakeholders: planning and economy, healthy and active lives, mental health, location, accessibility, safety, inequality, social activity, identity, natural environment, green networks, education, research (GreenHealth Consolidated policy review, November 2010).

healthy life expectancy in deprived areas. Similar aspirations appear in the *Scottish Forestry Strategy* (2010), which includes a future target to revise the *Woods for Health* strategy, placing increased focus on health inequalities, mental health and wellbeing, child health and equality and diversity. In addition, the forestry strategy aims to develop links with disability forums to promote a greater range of ways for people to enjoy woodlands.

In the following sections, we summarise some of the policy topics to which the GreenHealth project findings provide some support, both by adding to the scientific evidence base, and by suggesting approaches to achieving the stated aims of these policy areas.

3.3.2 Health inequalities

The Health Inequalities Task Force was established in 2007. The Task Force report 'Equally Well' (Scottish Government, 2008b) highlighted that *"health inequalities remain a significant challenge in Scotland"*. It proposed priorities for cross-cutting government activity to achieve measurable outcomes in reducing inequalities, recommended practical measures to reduce the *"most significant and widening inequalities"*, and argued the need for key sectors and organisations to collaborate to build commitment and support. Such collaborations should exploit the community planning process and embody actions in Single Outcome Agreements (SOAs). Its recommendations were reported in relation to the five National Objectives in Scotland's Performance Delivery Plan (i.e. Safer and Stronger, Greener, Healthier, Smarter, Wealthier and Fairer).

Of the nine recommendations under the Greener heading, five relate to the function of green spaces covering topics of: the provision of environmental goods to foster better physical and mental health, and improving community cohesion; prioritising the creation, retention and promotion of high quality green spaces, especially in communities at risk of poor health; public sector organisations should take specific steps to encourage the use and enjoyment of green space by all; local authorities and others should foster greater public responsibility for maintaining local environments; and, that children's play areas and recreation areas for young people generally should have high priority in both planning and subsequent maintenance by the responsible authorities.

By 2012, Audit Scotland reported on *'Health Inequalities in Scotland'* (Audit Scotland, 2012). This report notes the inequalities in health between different social groups are linked primarily to deprivation with age, gender and ethnicity also factors. It stated *"There is a mixed picture of progress in tackling health inequalities. For some indicators, such as deaths from coronary heart disease, inequalities have decreased but other indicators, such as healthy life expectancy, mental health, smoking, and alcohol and drug misuse, remain significantly worse in the most deprived parts of Scotland."*

In evidence to the Scottish Government Audit Committee, the Chief Medical Officer (CMO) stated: *"For me health inequalities are the biggest issue facing Scotland just now because, not only are health inequalities a problem, but health inequalities are really a manifestation of social inequalities, social complexity... social disintegration that drives things like criminality, like poor educational attainment. It drives a whole range of things that we would want to see different in Scotland"*.

The Chief Medical officer recognised that causes of health inequalities are complex and poorly understood and that there are no easy solutions. It suggests that to address such pressing problems requires concentrated effort across the whole of Scottish society, new relationships and new ways of working together. The cross-links between Scottish Government policies relating to different topic domains such as planning, land use, biodiversity, climate change and health inequalities suggest recognition of the need for this approach, which is reinforced in the proposals for Community Planning in Scotland, being driven by a need for partnership working.

The research findings suggest that urban green spaces are environments which directly, or indirectly, help foster health and wellbeing, and that may have a role to play in tackling health inequalities because they are free and freely accessible. However, in less green areas, accessing places to exercise

(such as the gym) or to relax may require more resources or transport.

Urban green space is thought to protect or enhance population health via three main mechanisms: by providing a venue for physical activity; by promoting social contact; and through direct impacts of green spaces on psychological and physical health. This direct effect operates via psycho-neuro-endocrine pathways and is probably the most important. The study of urban green space and stress (the 'cortisol' study) found that healthier diurnal cortisol patterns among highly-deprived Scots who had relatively more green space in their neighbourhood, than among those with relatively less (Ward Thompson et al., 2012).

A study of the English urban population found that socio-economic inequalities in cardiovascular and respiratory mortality were narrower in urban areas with relatively more green space than in those with relatively less (Mitchell and Popham, 2008). When this analysis was repeated for Scotland in the GreenHealth study, it found results in the same direction (i.e. that inequalities in health were narrower in greener areas), but effects that were not statistically significant. The area-level associations between quantity of neighbourhood green space and rates of mortality also appeared much weaker in Scotland than in England or Wales.

However, when looking at those who *use* green space for physical activity and/or 'escape' from everyday problems and pressures, the positive impacts on mental health and on life satisfaction were clear and substantial (Mitchell, 2013). In particular, among those facing the greatest financial strain, people who use green spaces to 'escape' and relax, have significantly higher life satisfaction than those who do not.

In Scotland, it seems that use of green space, rather than how much is available in the neighbourhood, is crucial to its benefits. A key predictor of whether someone uses green space in adulthood is whether they did so in childhood (Ward Thompson et al., 2008). It is understood that there are socio-economic inequalities in children's use of green space, but also that when children are introduced to such places it kindles a lasting desire for them to re-visit (Ward Thompson et al., 2008). Therefore, there is an opportunity for a lasting, inter-generational effect.

The recommendation from these observations is that urban green spaces are protected, expanded and promoted and that, in particular, children's use of such spaces is supported, consistent with the earlier recommendation of the *Equally Well* report.

The output from the community engagement study included a spatial plan for the green space which represents one means of accommodating these potential incompatible uses, generated from community inputs and representing one form of input to the planning of green space, as sought by the *Equally Well* report.

3.3.3 Land Use Strategy

The Scottish Land Use Strategy and its Action Plan include direct consideration of the role and importance of land use for human health and wellbeing (Scottish Government, 2011b; 2011c). The vision is 'A Scotland where we fully recognise, understand and value the importance of our land resources, and where our plans and decisions about land use deliver improved and enduring benefits, enhancing the wellbeing of our nation'. While there has been a great deal of research in the last decade on how the natural environment affects human health and wellbeing, it is not yet clear how its health-promoting benefits are realised. Overall, the GreenHealth project provides data, new knowledge, and activities that contribute to our understanding of the associations between urban green space and wellbeing. In particular, our findings contribute to achieving a key Land Use Strategy objective, of "urban and rural communities better connected to the land, with more people enjoying the land and positively influencing land use."

Connecting people to the land: The Land Use Strategy notes that 'connection can mean many things'. The mapping component of our research includes visibility from homes, a new dimension of green space access, which has important implications for assessing use and benefits of local green

spaces. Findings from the ethnographic study showed the importance of some green spaces for promoting social identity, given that urban green spaces often have a role as a place to meet friends or take part in group activities. We found that perceptions of 'ownership' of all or part of a green space, as developed by some social groups, can progress to fostering public responsibility for maintaining local environments, e.g. the Dighty Environmental Action Group in Dundee. Other findings about wellbeing and place show that experiences of place are derived from engagement with nature in particular social contexts. Our findings also show that uses made of green spaces may not match those of their designs, and highlight the importance of recognising the social relationships that contribute to the context of urban green-space use and management.

More specifically, our GreenHealth research findings contribute to an evidence base which can illustrate the implementation of the Proposals and Principles of the Strategy. For example, two proposals to which the research was identified as being of relevance were:

Proposal 8, Demonstrate how the ecosystem approach could be taken into account in relevant decisions made by public bodies to deliver wider benefits, and provide practical guidance; and **Proposal 12**, Identify and publicise effective ways for communities to contribute to land-use debates and decision-making.

Identifying people's uses and ideas for planning green spaces was one focus of the project. Our research adopted an ecosystem approach to classifying current uses of green spaces in terms of their compatibility and incompatibility of uses, multiple benefits, the services they support, and community views on opportunities for future uses. In developing the classification, we drew on the approach outlined in the Scottish Government Information Note 'Applying an ecosystems approach to land use' (Scottish Government, 2011d). The research sought to demonstrate effective ways for communities to contribute to land use debates and decision-making (Proposal 12), and how an ecosystem approach could be taken in developing plans for delivering benefits from use of urban green spaces (Proposal 8).

The research process and findings provide some regard for the Principles outlined in the Strategy, and four in particular.

Principle A: Opportunities for land use to deliver multiple benefits should be encouraged.

The process followed in our case study of community views on current and future uses of green space is an example of an opportunity recognised in the Land Use Strategy Action Plan (Scottish Government, 2011c; Section 4). Our findings show that decisions about a small area make an impact on ecosystem services delivery over a wider area, resulting in outcomes consistent with Principle A, i.e. encouraging opportunities for land use to deliver multiple benefits. Lessons learnt from the engagement process used in the research are part of ongoing feedback to local authorities and relevant agencies, through dissemination of our GreenHealth briefings, knowledge exchange events, and one-to-one meetings between research team members and policy makers. Such feedback aims to assist in addressing the practical challenges of using an ecosystems approach, as identified in the Land Use Strategy Action Plan (Section 5).

Principle E: Landscape change should be managed positively and sympathetically, considering the implications of change at a scale appropriate to the landscape in question, given that all Scotland's landscapes are important to our sense of identity and to our individual and social wellbeing.

Our findings indicate that maintenance and management of change in green spaces is important, and should reflect sensitivity in both the nature and scale of change (e.g. selling areas for development; reducing maintenance levels). These findings support the Land Use Strategy's Principle E, in relation to the positive and sympathetic management of the landscape, with consideration of the implications of change at a scale appropriate to the landscape in question. Our findings show that people attach great importance to smaller areas of local green space, e.g. grassy areas and trees on streets, indicating that this scale should not be overlooked when planning change.

Principle H: Outdoor recreation opportunities and public access to land should be encouraged, along with the provision of accessible green space close to where people live, given their importance for health and wellbeing.

Our project findings support the basis of Principle H of encouraging opportunities for outdoor recreation, public access to land, and provision of green space close to people's homes. We found that in Scotland people who use green spaces for physical activity have a lower risk of poor mental health compared to people who use non-natural environments (e.g. gyms or streets); that more green space in a local area is associated with lower risks of mortality amongst the poorest men, and lower levels of self-reported stress among residents; and is associated with lower stress levels for middle-aged men and women not in work. Higher levels of mental wellbeing are also associated with greater amounts of green space for a sub-group of men who are likely to spend much of their time around their homes.

Principle J: Opportunities to broaden our understanding of the links between land use and daily living should be encouraged.

Our findings identified sub-areas of green space, which support different yet compatible functions, and show how overall effectiveness of delivering multiple functions in these spaces could be improved. Our study includes an example of the importance people attach to urban woodland. Participants' desired addition of more trees in specific areas around Dundee's Finlathen Park shows how decisions at the local, or small, scale could make positive contributions to broader ecosystem functions, such as developing habitat networks. Our findings broaden understanding of the links between land use and daily living (Principle J), and the potential importance of the loss of small areas of green spaces to development (e.g. housing).

3.3.4 Scottish Planning Policy and the National Planning Framework

The GreenHealth research findings have potential implications for the planning and design of green spaces to increase effectiveness of their use for public health, and their contribution to the wider green infrastructure. Overall, our research illustrates the principle identified in the draft Scottish Planning Policy, paragraph 35, page 11 (Scottish Government, 2013a) of taking a holistic and integrated approach, which will respond to contexts and "balance the range of interests and opportunities over the long term".

Relevant findings include communities' recognition of the potential multiple benefits from green space, such as relaxation, de-stressing, and biodiversity, and the role of green space as a focal feature for adjacent residents and local communities. These findings support the aims of the draft Scottish Planning Policy (SPP) (published in April 2013), which recognises the community value of green space, the quality of the space, and the diversity of current uses. However, support for greater engagement of communities in planning requires provision of appropriate advice and training in processes and tools. Such support needs to be targeted at the most relevant parts of governance structures in community planning, helping develop shared outcomes in partnership with communities. Provision of such advice could further enhance events of the type organised by Greenspace Scotland, and the Sharing Good Practice series held by Scottish Natural Heritage, perhaps augmented by an 'extension service' similar to that available for rural land managers.

The draft SPP also provides guidance on factors to be considered when designing new green infrastructure, including being "*fit-for-purpose and capable of being adapted to accommodate the changing needs of users*". Findings from our study of green-space quantity, stress and wellbeing highlight factors that impact on perceptions and use, such as environment quality and people's safety. We also found that increasing the quantity of green space in deprived areas that currently have little such resource could contribute to reducing stress and increasing wellbeing among residents.

The draft SPP argues for a focus on "*positive place-making*", one quality of which is adaptability and the provision of "compatible uses and communities". Findings from our community engagement study illustrate the types of services highlighted as desirable by one local community, and the research

provides a spatial composition which might satisfy their needs. This composition shows uses that are compatible in space, and at different times of the day. The combined findings of the GreenHealth project support consideration of the mix of functions that green infrastructure (GI) can offer in the context of place, including its contribution to spatial connectivity. Our research suggests that development planning should consider potential routes for delivering multi-functional uses of GI, and ensure that these are resilient to future change (e.g. contribute to climate change adaptation rather than be susceptible to it).

The draft SPP sets out how the planning system should help address climate change through mitigation and adaptation measures, providing relevant examples for planning authorities to consider, including the promotion of open space resource audits, and how well plans meet community needs. The Scottish Government's Draft Scottish Climate Change Adaptation Programme (Scottish Government, 2013b) includes a closely-related objective of sustaining and enhancing the benefits, goods and services that the natural environment provides through integrated land management (Objective N3). The findings from this project and others (e.g. BlueHealth, Miller et al., 2012) show the multiple services that green and associated blue spaces can provide, giving examples of how positive planning of woodland and waterways delivers to community preferences. Green and blue space management also contributes to community wellbeing, with any increase in regular use beneficial for enhancing mental health, and with good management of their physical and ecological functions delivering to wider climate change adaptation and mitigation strategies.

At a more strategic level, the draft National Planning Framework 3 (NPF3) represents the spatial expression of government policy as informed by policies across a wide range of topics, which include transport, energy, health and wellbeing, climate change, and land use. NPF3 presents a strategic view on how planning can facilitate community-led development, investments in infrastructure, and locally-driven growth to develop community resilience.

NPF3 proposes retention of the Central Scotland Green Network (CSGN), introduced in NPF 2, as a national development. CSGN's role is to *"deliver a high quality green network to meet environmental, social and economic goals to improve people's lives, promote economic success, allow nature to flourish, and help Scotland respond to the challenge of climate change."* CSGN's partnership with public agencies and stakeholders is a collaboration to align policies, programmes and actions to achieve a common aim. This makes it a cross-sectoral mechanism well-suited to help deliver GI planning, as envisaged in the European Biodiversity Strategy to 2020. Our research findings, along with the positive engagement of a wide range of stakeholder interests and of areas of policy relevant to green space, show that the CSGN provides a strong institutional framework for supporting both protection and enabling of urban ecosystem services (to which green spaces contribute) and promoting the wider opportunities offered by green infrastructure.

3.3.5 Community Planning

The Christie Commission on the Future Delivery of Public Services (Scottish Government, 2011e) concluded that many of the challenges driving negative public service outcomes, and increasing financial costs, result from deep-rooted and complex causes. The Commission argued that such causes can best be tackled collectively, with a focus on long-term change, such as support of local place-making. This reflects a change in emphasis from reactive problem solving to root cause prevention. Community Planning and associated Single Outcome Agreements (SOAs) are proposed as key foundations for effective partnership working. These should show understanding of, and responsiveness to local needs and opportunities. The Scottish Biodiversity Challenge to 2020 (Scottish Government, 2013c) also notes the role of community planning and health partnerships in developing collaborative approaches to delivering public services and providing public goods.

A significant aspect of Community Planning is the co-production of better outcomes with communities, using mechanisms that can "influence and drive planning and investment decisions by partners". This should increase people's perceptions of being able to influence decisions made about

their local area and services. Findings from the ethnographic and community engagement work also identified the value of suitable mechanisms for enhancing local involvement. Indeed, even the availability and implementation of the processes could be beneficial for community wellbeing. Co-production can contribute to the CPPs' 'understanding place', by drawing on the *"knowledge and resources of all relevant local and national agencies to develop a clear and evidence-based understanding of local needs and opportunities, underpinned by robust and relevant data, and be capable of monitoring this over time"*.

The increasing availability of data at scales suitable for discussions of needs at a community level (discussed later in this section) will contribute to the interpretation of needs of different local areas. Examples include Scotland's Greenspace Map, the reporting of green space types and extents by different geographies (e.g. datazone, postcode, access distance), and the analysis of change in green spaces belonging to areas studied in the GreenHealth project. These data are being discussed with Scottish Natural Heritage as they develop indicators about green space, and its accessibility. Support for local reporting on such indicators could inform the monitoring of change by CPPs, which was the topic of a Sharing Good Practice event in March 2013, which the GreenHealth team contributed to planning.

3.3.6 Scottish Biodiversity Strategy

GreenHealth project findings have potential implications for planning and designing green spaces, especially to increase effectiveness of their use, and enhance their contribution to wider green infrastructure, as envisaged in the European Biodiversity Strategy to 2020 (European Commission, 2012). The Strategy proposes that *"by 2050, European Union biodiversity and the ecosystem services it provides – its natural capital – are protected, valued and appropriately restored for biodiversity's intrinsic value and for their essential contribution to human wellbeing and economic prosperity, and so that catastrophic changes caused by the loss of biodiversity are avoided."* The '2020 Challenge for Scotland's Biodiversity' (Scottish Government, 2013c) devotes considerable attention to the links between natural heritage and human health and wellbeing. Our research findings provide support for Scotland's response to the European strategy, and in particular for its desired outcome of the *"improved health and quality of life for the people of Scotland, through investment in the care of green space, nature and landscapes (Chapter 3)."*

Our analysis of green space using Scottish Health Survey data shows that simply increasing the amount of green space available in urban areas is unlikely to make impacts on population mortality rates or socio-economic health inequalities, except for the poorest men in deprived areas. However, our findings show that regular use of green space is good for mental health, so helping people to become and remain regular users could be a useful additional way to protect and enhance the population's mental health. Adults are more likely to use green spaces if they did so as children; therefore schemes that have proven effective in introducing and encouraging children to use such spaces can be used to extend this approach, producing a lasting, multi-generational impact (Ward Thompson et al., 2008). Therefore, investment in good quality green space in and around schools and other centres of learning for younger people could have multiple benefits in terms of education and health, as sought in the Scottish Biodiversity Strategy (Scottish Government, 2013c; page 41).

These findings provide support for one of the three principal aims of the 2020 Challenge, to *"connect people with the natural world, for their health and wellbeing and to involve them more in decisions about their environment"*. In particular, our findings support the aim of *"encouraging greater physical activity and contact with nature through informal recreation and play, environmental volunteering and outdoor learning."* Scottish Government (2013c, page 35).

Findings also show that improving access management underpins enhancement of access takers' relationships with green space and the associated environment, and improves the role of green space in educating people about aspects of the environment. These groups should be promoted as a resource for mental as well as physical health. This would be consistent with one aim of the 2020

Challenge (Scottish Government, 2013c), encouraging physical activity and contact with nature, and with SNH's 'Simple Pleasures Easily Found' campaign that encourages people to explore local green space and path networks.

3.3.7 Land reform review

As noted by the Scottish Government's land reform review and Land Use Strategy, there is increasing community interest in participating in the management of green spaces. These areas of policy interest outline the benefits that arise from empowering people to contribute to decisions about their environment, and to engage with nature for enhanced health and wellbeing.

The ethnographic study identified the importance of green spaces for creating connections with place, fostering a sense of ownership of the space or its component features (e.g. streams), and enabling a variety of pursuits. Sense of ownership may relate to individuals, or to groups. The study found that involvement in actively managing a green space provides individuals with education and knowledge about wildlife and the weather, as well as new skills, contributing to societal wellbeing and community resilience. Ways to promote such involvement could be advanced by the current review of land reform in Scotland. In its interim report, the Land Reform Review Group (LRRG) (2013) notes scope for progress *"towards forms of engagement that give people a stake in the land without going as far as ownership"*, shared governance, management and use of land, and *"community interest and land ownership across Scotland, and specifically encompassing urban experiences and evidence"*.

Findings from the community engagement study also revealed community interest in opportunities to realise ideas about providing facilities for local people (e.g. for recreation, play, relaxation), and in exploring types of tenure that could facilitate community authority for managing some areas of green space. The LRRG notes that *"land, its use and ownership contribute to outcomes for society and communities"*, and stresses the applicability of land reform to urban as well as rural Scotland. The Scottish Allotments & Garden Society's submission to the consultation (Land Reform Review Group, 2013), notes the importance of some type of ownership (or long-term management) but emphasises that many urban groups are not in a position to own land, therefore other forms of security of tenure are needed.

3.3.8 Environmental and socio-economic data

The experience of delivering the project highlighted the importance of high levels of access to environmental and socio-economic data. Such access was possible in our research because of the both progress in the development of data by public sector organisations, and public policy that increases access to these data, which has been implemented in a number of complementary ways in Scotland.

The Aarhus Convention on Access to Information, Public Participation in Decision-making and Access to Justice in Environmental Matters (1998) (European Union, 1998) sets out principles for public engagement and participation which have been incorporated into public policies across Europe. At a European level, a related response to the Convention is the EU INSPIRE Directive (European Union, 2007), which, in general, requires public bodies to make specified environmental data accessible. In Scotland, its principles are reflected within a range of public policies and strategies, including the Land Use Strategy, Biodiversity Strategy, and Scottish Planning Policy, and programmes of reporting on trends and indicators (e.g. SEWeb). Such policies and strategies both support implementation of the INSPIRE Directive in Scotland, and draw on its outcomes.

The GreenHealth project has benefited from a number of initiatives relating to geographic data. In particular, these are:

- (i) agreement between Scottish Government (and its agencies) with Ordnance Survey on simpler and more extensive access to geographic data through the 'One Scotland Mapping Agreement'
- (ii) access to Ordnance Survey data on urban features and their boundaries, addresses, roads

and footpaths

- (iii) creation and implementation of Scotland's Greenspace Map and dissemination of the Web Mapping Service version via the SSDI (<http://scotgovsdi.edina.ac.uk/srv/en/main.home>), and also available through the website of Scottish Natural Heritage www.snh.gov.uk/planning-and-development/advice-for-planners-and-developers/greenspace-and-outdoor-access/open-space-audits-and-strategies/dataset/), and Scotland's Environment Web (SEWeb), www.environment.scotland.gov.uk/.

Public policy of opening access to other environmental and socio-economic data have enabled analysis of the Scottish Index of Multiple Deprivation and population data by different geographies (e.g. different levels of post code, datazones, wards), and Scottish Health Survey data. These data have provided a basis for much of the research based on the case study areas, and underpin a number of peer reviewed outputs (e.g. Mitchell, 2012).

Increasing capability to further develop findings from the project, and to undertake complementary studies, would arise from:

- (i) Continuation of support for the policy of enabling access to environmental and socio-economic data (e.g. Scottish Health Survey)
- (ii) Continuation of resources to support access to data such as those from Ordnance Survey under the One Scotland Mapping Agreement, and the extension to include aerial imagery
- (iii) Updating and maintenance of spatial data on public green spaces in Scotland's GreenspaceMap, including a process of increasing internal consistency.

3.3.9 Policy Consultations

Findings from GreenHealth have informed submissions to policy consultations. These were made by the project team to the consultation on the draft Land Use Strategy (Dec. 2010) (under the GreenHealth banner). Other submissions from the James Hutton Institute which also include GreenHealth findings are: Land Reform Review (January 2013); Scottish Planning Policy; and the National Planning Framework 3. Our research also informed the oral evidence given to the Scottish Parliament Rural Affairs and Environment Committee during its scrutiny of the Land Use Strategy (December. 2010; D Miller), and to the Aberdeen City Open space Strategy (July 2011; D Miller).

4 OVERALL CONCLUSIONS

Public policy in recent years shows a significant increase in the attention being paid to issues of green space and health and wellbeing. This reflects the importance being placed on addressing issues of mental health and individual and societal wellbeing, and availability of scientific evidence of associations between health and wellbeing and environmental factors.

Our findings show that relationships between how much green space people have in their neighbourhood and their risk of mortality are weak or absent in the Scottish population as a whole. This is different to England and Wales. There does, however, appear to be a protective relationship for working age men in the poorest two income-deprivation quartiles living in Scotland. There are some suggestions that Scottish socio-economic inequalities in health are narrower among populations with more green space in their neighbourhood, but although the relationship was not in the direction expected, it was weak and not statistically significant.

Evidence was found of a link between green space quantity and both perceived stress and mental wellbeing, although the cross-sectional study undertaken in Dundee cannot show a causal relationship between green space and health and mental wellbeing. Using diurnal salivary cortisol patterns in a sample of middle-aged men and women not in work showed that more urban green space is associated favourably with lower levels of self-reported stress and reduced physiological stress. The effect of green space on stress may be mediated by gender, with a stronger positive effect of increasing green space on cortisol concentrations in women (meaning green space is having a more positive effect on stress regulation in women than in men). The benefits may be particularly pertinent to women living in deprived urban communities, who appear to experience higher levels of stress.

However, simply increasing the amount of green space available in urban areas is unlikely to have impacts on population mortality rates or socio-economic health inequalities (as measured by mortality rates). Increasing the amount of green space available in urban areas offers the potential for significant mental health benefits from reduced stress levels and increased wellbeing for some residents of deprived communities, especially those who spend more time around the home, and in areas where there is currently relatively little green space.

Analysis of Scottish Health Survey data found that people who use their green space regularly are at much lower risk of poor mental health than those who do not, and men who are regular green-space users may also have lower, and thus healthier, levels of c-reactive protein, which is associated with risk of cardiovascular and respiratory health problems. Therefore, helping people to become and stay regular users could be a useful additional means of protecting and enhancing mental health, while helping protect against cardiovascular and respiratory diseases. Although these findings do not prove that green space *per se* protects mental health, they do echo those from small-scale laboratory and field experiments, providing more confidence in the results.

The social contexts through which green spaces are encountered and understood are multiple and complex and contested between different individuals and groups. Although green spaces provide multiple services and functions, these are not always compatible, and they may have different meanings for different people and social groups. People's understanding and interpretation of green space influences their engagement with such places and hence any wellbeing benefits that might be derived from using them. Balancing multiple demands between different users is needed to ensure that the wellbeing benefits of some social groups are not achieved at the expense of other groups. Potential approaches include sub-dividing green spaces to provide more mutually compatible services, such as areas for peace and escape, others for active sport and play, and a wider context of enhanced ecological and physical connectivity.

In Scotland, those who use green spaces for physical activity have a much lower risk of poor mental health than those who use non-natural environments such as the gym or streets. Regular use of green space appears to be good for mental health. Helping people to become and stay regular users could be a useful additional means of protecting and enhancing mental health. Mechanisms which support stronger elements of social use, such as coordination groups, e.g. volunteer organisations and 'Friends of', can enhance wellbeing through providing a purpose and sense of achievement. This then helps foster public responsibility for maintaining local environments.

Members of the public, across genders and age ranges within the Dundee case study area, identified green spaces as assets, which had a positive contribution to health and personal and community wellbeing. There is some evidence of community interest in having greater responsibility for the management of areas of green spaces for local benefit. Individuals, representatives and community officers all expressed support for communities to have greater responsibility for managing areas of green space for community benefit and in delivering locally identified priorities. People with formal responsibility for community development and voluntary groups are increasingly seeking advice on mechanisms, access to materials, and opportunities to promote community engagement in local decision-making.

This echoes the Chief Medical Officer's views that "*...we will not narrow health inequalities through actions taken by the NHS on its own*". He calls for greater use of shared resources across the public, private and third sectors, as part of a concentrated effort across the whole of Scottish society, and the adoption of new relationships and ways of working to address health inequalities, which he sees as the biggest issue currently facing Scotland. The causes of health inequalities are complex and poorly understood and cannot be easily resolved.

Public policies now emphasise the need for shared efforts to achieve multiple benefits from land uses, and articulate human health and wellbeing in the context of ecosystem services. All contemporary policies and actions relating to urban and rural land use, including the Scottish Land Use Strategy, and those on biodiversity, planning and community planning, climate change mitigation and adaptation, now link with human health and wellbeing, and green spaces.

These policies and actions are the drivers to deliver positive environments for health and wellbeing that will shape our environment and places. The GreenHealth research has provided new evidence which recognises the psychosocial dimension in the relationship between people and their surroundings, new means of engagement with communities, and the need to navigate socio-ecological complexity. This research also provides evidence in support of Morris's conceptual model of ecological public health which links human health and wellbeing to the health of ecosystems.

5 GREENHEALTH AND ENVIRONMENTAL DETERMINANTS OF PUBLIC HEALTH IN SCOTLAND' (EDPHiS)

At the same time as funding GreenHealth, Scottish Government also granted funding to a related project - 'Environmental Determinants of Public Health in Scotland' (EDPHiS). The EDPHiS researchers sought to support the development of public policy in Scotland, insofar as it might affect public health through people's interactions with their environment. In practice, this involved working closely with, and supporting the Scottish Government *Good Places, Better Health* (GPBH) initiative. GPBH had identified four key Scottish childhood health outcomes (asthma, unintentional injuries, mental health and wellbeing, obesity) to which a prototype phase was directed. However, in addition to exploring the relationship between the nominated child health outcomes and the environment and how policy on environment might be most effective, Scottish Government sought, through the GPBH prototype to better understand and address social complexity in the relationship between environment and human health. As funders, they also wished to reflect growing understanding of the capacity of good places to nurture better more equal health and wellbeing and, more generally, a psychosocial dimension in the relationship between people and their surroundings. The work of EDPHiS made a key contribution to the work of the GPBH Intelligence Partnership. Recognising that GreenHealth also addressed many of these challenges from a different perspective, EDPHiS and Intelligence Partnership also had regard to the findings of GreenHealth as they began to emerge.

The relationship between aspects of environment and human health is inherently complex. Difficulties in assessing both exposures and health outcomes are widely recognised, as in the challenge of exploring relationships between them. Health and wellbeing emerge from an interaction of social and environmental factors and characteristics of the individual, creating a complex and often contested evidential landscape and difficulties at the science:policy interface. The EDPHiS researchers, in partnership with the GPBH interests in Government, NHS Health Scotland, Health Protection Scotland and Government, adopted an innovative approach to summarising that evidence insofar as it related to the GPBH priorities. As far as practicable the EDPHiS partners were keen to develop a quantitative model of these relationships (EDPHiS, 2008a). Generally it was found that interactions with green space play an important role in improving childhood mental health and wellbeing as well as reducing obesity, and possibly asthma (EDPHiS, 2008b). It also found that whilst access to green space may increase rates of unintentional injury, the benefits probably outweighed this negative effect.

The EDPHiS findings highlighted the importance of good design and maintenance of green space to meet the needs of families and children. In taking account of non-quantifiable links of exposures to environmental factors, and potential risks, there is scope to analyse the ethnographic community identification of current and potential uses of green spaces in GreenHealth, to help understand the how people in differing circumstances relate to and engage with their environment.

In terms of policy recommendations, EDPHiS proposed that potential cross-cutting policies could include ensuring that all children live within a 5 minute walk of good quality green space. As access to green space was found to be so central to EDPHiS, links maintained with GreenHealth enabled information to be shared between the two projects, which will continue with follow-up discussions on the exploitation of findings.

Findings of EDPHiS of most relevance to green spaces, health and wellbeing were presented at the conference in March 2013, a copy of which is available at www.greenspacescotland.org.uk/greenhealth-conference, and the other findings at www.edphis.org.

6 CONSULTATIVE GROUP AND STAKEHOLDER ENGAGEMENT

6.1 Consultative Group

The project Consultative Group ran for the period of the project, meeting five times since August 2008. Over this time they provided advice and guidance on specific topics including at the outset definitions and terminology relating to green space, upcoming policy and strategy developments, assistance on addressing specific challenges, and agreement on changes in activity or priorities.

Members of the Group also provided information and support on a range of topics, often on a one-to-one basis. These included enabling access to data (e.g. green space), supporting requests for means of recruiting volunteers (e.g. an official request to the DSS Job Centre). They also attended topics specific meetings, such as consideration of the proposed cortisol study (Sheila Beck, September 2009). Such engagement assisted wider stakeholder discussion on project changes to follow-up lines of enquiry, in this example leading to the innovative study on cortisol and green space.

The Group also supported or facilitated knowledge exchange activities (e.g. Knowledge Scotland Open Houses, 2009); invited project presentations at stakeholder organized events (e.g. Greenspacescotland, Sharing Good practice seminar - open space audits and strategies, Stirling, September 2008, D Miller).

Such engagement provided contemporary information to inform project activities, and opportunities to feedback to group members and wider and stakeholder community on current ideas in relation to green space and health and wellbeing through presentations at group meetings.

6.2 Knowledge Exchange

Information Notes

The purpose and format of summaries of project outputs in the form of information or briefing notes was discussed at meeting of the Consultative Group, with feedback on format and level of detail. A selection of topics for these briefing notes was discussed with the project officer and a subset of stakeholders in September 2012, the final style of presentation, and draft materials prepared. A number of stakeholders, principally those involved throughout the project, reviewed the content and tone of the Information Notes. They provided feedback on the content, key messages to highlight, and guidance on the relevance to different areas of policy.

GreenHealth Briefing Notes 1 to 6 have been produced on different aspects of the research, along with one providing an overall summary (Briefing Note 7):

- 1 Urban green space, mortality & morbidity
- 2 Green space quantity, stress and wellbeing
- 3 Urban green space and stress
- 4 Urban green space and wellbeing
- 5 Green space services: community engagement case study
- 6 Mapping physical and visual access to green spaces
- 7 The contribution of green and open space in public health and wellbeing

These briefing notes will be hosted on WWW sites of Scottish Government, James Hutton Institute, Greenspacescotland, and CRESH. Summaries have also been designed for access via the Knowledgescotland.org WWW site, supported by the Scottish Government Rural Environment Science Analysis Service (RESAS).

A limited number of copies of the briefing notes have been being printed for distribution to specific stakeholders in the public and private sectors, including current and past participants in the project

Consultative Group, and for use by project partners. They have also been disseminated at a range of events in 2013 including to attendees of the Science at the Parliament event on health, 13th November 2013, Our Dynamic Earth; and Places and Spaces for Health and Wellbeing, 25th November 2013, CoSLA Conference Centre, Edinburgh.

Stakeholders

A final project conference took place on 11th March 2013. The aims of this conference were to disseminate key findings from the project amongst practitioners involved in green-space planning and management; to feedback outputs to stakeholders who contributed at different stages over the project period; and, to elicit opinions of attendees on topics of relevance to green space, policy and practice.

Greenspacescotland were commissioned to organise the conference. This exploited their central role in brokering information and relating to green spaces in Scotland, extensive network of contacts, and track record in organizing events relating to the topics of the project. A total of 160 people expressed interest in attending, from which 80 attendees were invited to attend due to limitations of space at the venue. Attendance came from a range of organisations including local authorities, public agencies in Scotland and England, NHS Health, researchers, charitable, and community groups.

Copies of the presentations and recommendations from the conference attendees are available on the Greenspacescotland website (www.greenspacescotland.org.uk/greenhealth-conference.aspx).

Links with other relevant public sector organisations have also led to presentations highlighting project research and findings. These include the Green space and health: Glasgow and Clyde Green Network. Oct. 2011, R Mitchell; green infrastructure and urban green space, European Environment Agency, Copenhagen, Sept. 2012, D Miller; and displays at the SAC/SEPA biennial conference, April 2012; CAMERAS conference, May 2012; Scottish Government Biodiversity Science Group March 2012, J Roe; Green Infrastructure, design and placemaking, Glasgow, June 2013, project team; and, Places and Spaces for Health and Wellbeing, Edinburgh, November 2013, project team..

There is an ongoing process of the dissemination of findings to different types of stakeholders in the vicinity of case study areas, Scottish public, private and voluntary sectors, and to UK and international agencies. Further opportunities included the provision of feedback on digital environmental data through the SNH Sharing Good Practice event on Environmental Data for use in Single Outcome Agreements (March 2013).

Scientific audiences

Throughout the project period opportunities have been taken to present papers which outlined the proposed work, early findings and final results. This has included a number of international and national conferences, several as keynotes. Such conferences included:

Landscape and Health Conference, Birmensdorf, Switzerland, Jan. 2012 (R Mitchell, Keynote address)

Environmental Design Research Association, Chicago, 2011

European Public Health Association, Copenhagen, 2011

American Association of Geographers, New York, 2012

Royal Geographical Society/Institute of British Geographers, Edinburgh, 2012

International Association of People-Environment Studies, Glasgow, 2012

International Congress on Environmental Modelling and Software, Leipzig, 2012.

The Environmental Design Research Association, EDRA 44, Providence, Rhode Island, 2013.

As the findings are completed they are being submitted for peer review with the following now published in scientific journals:

Ward Thompson, C. Roe, J., Aspinall, P., Mitchell, R., Clow, A. and Miller, D. (2012) More green space is linked to less stress in deprived communities: Evidence from salivary cortisol patterns. *Landscape and Urban Planning*, 105: 221–229, doi:10.1016/j.landurbplan.2011.12.015.

Richardson, E.A. and Mitchell, R. (2010) Gender differences in relationships between urban green space and health in the United Kingdom. *Social Science and Medicine*, 71(3):568-575.

Richardson, E., Mitchell, R., Hartig, T., de Vries, S., Astell-Burt, T. and Frumkin, H. (2012) Green cities and health: A question of scale? *JECH 2011* doi:10.1136/jech.2011.137240.

Roe, J., Ward Thompson, C., Aspinall, P.A., Brewer, M.J., Duff, E., Miller, D., Mitchell, R., Clow, A. (2013) Green Space and Stress: Evidence from Cortisol Measures in Deprived Urban Communities. *International Journal of Environmental Research and Public Health* 10(9), 4086-4103.

Dinnie, E., Brown, K. M. and Morris, S. (2013) Community, cooperation and conflict: Negotiating the social wellbeing benefits of urban green space experiences. *Landscape and Urban Planning*, 112(0), 1-9. doi: <http://dx.doi.org/10.1016/j.landurbplan.2012.12.012>.

Ord K., Mitchell, R. and Pearce, J. (2013) Is level of neighbourhood green space associated with physical activity in green space? *International Journal of Behavioral Nutrition and Physical Activity* 10: 127.

Other papers are in submission or preparation, and presentation submitted to conferences scheduled for the coming year. Copies or links to these papers will be circulated to members of the Consultative Group when they are published.

Public

Feedback is ongoing to public groups which contributed to project activities. These include voluntary organisations which supported the recruitment of volunteers for the cortisol, ethnographic and green-space planning surveys and events. These groups have been engaged in the preparation of findings for some briefing notes, and will be provided with copies of the set when finalised. Members of the public who agreed to receiving feedback from surveys or events will also be provided with final copies of the relevant briefing notes.

Organisations which provided venues for events (e.g. community centres, local authorities) will be provided with copies of the briefing notes.

The Finmill Centre in Fintry, Dundee, hosted the visioning and planning study (September 2012). Poster were displayed which summarised aspects of the research to which local people contributed. Amongst attendees were local MPs, MSPs, councillors for the two local wards, planning officer and community group coordinators, and community groups such as Dighty Connect. Each grouping received a short presentation on findings relating to the local area, and invited to provide follow-up information and feedback.

A similar opportunity was provided by the James Hutton Institute Open Day in Dundee (June 2012). Local MSPs, councillors and community groups were invited to participate in the submission of further information regarding the use of green spaces, their perceptions of constraints and functions, and hear presentations on findings from the ethnographic, access and green-space planning studies.

Further opportunities will be sought to disseminate findings to public audiences, within the study areas and further afield. This will include distributing printed copies of briefing notes to representatives of community groups which participated in the research, individuals who intimated willingness to receive updates on findings, and voluntary groups with roles in supporting community health or managing green spaces.

It will also include stakeholders who are current or past participants in the project Consultative Group, and for future use by project partners.

7 ACKNOWLEDGEMENTS

The project team is grateful to the time and effort of members of the Consultative Group, and the team at Scottish Government led for some time by Caspian Richards, with Susan Macintyre, Paul Tyrer, Gil Cruikshank, Kathryn Gilchrist and Jackie Horne. Funding was from the Scottish Government Environment and Health Programme, through the Rural and Environment Science and Analytical Services Division (RESAS). Thanks to the members of Scottish Government who reviewed and commented on the GreenHealth Briefing Notes and draft final report, and Sheila Beck and George Morris for doing the same from stakeholder perspectives. Acknowledgement is also due to the Ordnance Survey for use of their data under licence, and data, documentation and time provided from organisations represented in the Consultative Group.

8 REFERENCES

- Audit Scotland (2012) Health Inequalities in Scotland, A report for the Auditor General for Scotland and the Accounts Commission. December 2012. pp 43.
- Carstairs, V. and Morris, R. (1991) *Deprivation and Health in Scotland*. Aberdeen University Press, Aberdeen.
- De Kloet, C.S., Vermetten, E., Geuze, E., Lentjes, E.G.W.M., Heijnen, C.J., Stalla, G.K. and Westenberg, H.G.M. (2007) Elevated plasma corticotrophin-releasing hormone levels in veterans with posttraumatic stress disorder. *Progress in Brain Research* 167: 287-291.
- Dinnie, E., Brown, K.M. and Morris, S. (2013) Community, cooperation and conflict: negotiating the social wellbeing benefits of urban greenspace experience. *Landscape and Urban Planning*, 112, 1-9.
- EDPHiS (2008a) Environmental Determinants of Public Health in Scotland D.3 Obesity case Study. www.scotland.gov.uk/Resource/0039/00398348.pdf
- EDPHiS (2008b) Environmental Determinants of Public Health in Scotland D.3 Asthma Case Study. www.scotland.gov.uk/Resource/0039/00398347.pdf
- Edwards, S., Clow, A., Evans, P. and Hucklebridge, F. (2001) Exploration of the awakening cortisol response in relation to diurnal cortisol secretory activity. *Life Science* 68(18): 2093-2103.
- Evans, G.W. (2003) The built environment and mental health. *Journal of Urban Health* 80(4): 536-555.
- Giddens, A. (1991) *Modernity and Self-identity: Self and Society in the Late Modern Age*. Cambridge: Polity.
- Giese-David, J., Sephton, S.E., Abercrombie, H.C., Duran, R.E. and Spiegel, D. (2004) Repression and high anxiety are associated with aberrant diurnal cortisol rhythms in women with metastatic breast cancer. *Health Psychology* 23(6): 645-650.
- Groenewegen, W., van den Berg, A., Vries, S. and Verheij, R. (2006) Vitamin G: effects of green space on health, wellbeing, and social safety. *BMC Public Health* 6:149.
- Hansen-Ketchum, P.A. and Halpenny, E.A. (2010) Engaging with nature to promote health: bridging research silos to examine the evidence. *Health Promotion International* 26(1): 100-108.
- Jerjes, W.K., Cleare, A.J., Wessely, S., Wood, P.J. and Taylor, N.F. (2005) Diurnal patterns of salivary cortisol and cortisone output in chronic fatigue syndrome. *Journal of Affective Disorders* 87(23): 299–304.
- Lea, J. (2008) Retreating to nature: Rethinking ‘therapeutic landscapes’. *Area* 40(1): 90-98.
- Li, L., Power, C., Kelly, S., Kirschbaum, C. and Hertzman, C. (2007) Life-time socioeconomic position and cortisol patterns in mid-life. *Psychoneuroendocrinology* 32: 824-833.
- Maas, J., Verheij, R.A., Groenewegen, P.P., de Vries, S. and Spreeuwenberg, P. (2006) Green space, urbanity and health: how strong is the relation? *Journal of Epidemiology and Community Health* 60(7): 587-592.
- Meerlo, P., Sgoifo, A. and Turek, F.W. (2002) The effects of social defeat and other stressors on the expression of circadian rhythms. *Stress* 5(1): 15-22.
- Miller, D., Morris, S., Morrice, J. and Netto, G. (2012) Blue health: Water, health and wellbeing – Flood risk, mental health & wellbeing. CREW Research Summary www.crew.ac.uk/sites/www.crew.ac.uk/files/publications/crew%20research-flood%20risk.pdf
- Mitchell, R. and Popham, F. (2008) Effect of exposure to natural environment on health inequalities: an observational population study. *The Lancet* 372(9650):1655-60.

Mitchell, R. (2013) Is physical activity in natural environments better for mental health than physical activity in other environments? *Social Science & Medicine* 91: 130-134.

Nader, N., Chrousos, G.P. and Kino, T. (2010) Interactions of the circadian CLOCK system and the HPA axis. *Trends in Endocrinology and Metabolism* 21: 277-286.

Nordh, H., Alalouch, C. and Hartig, T. (2011) Assessing restorative components of small urban parks using conjoint methodology. *Urban Forestry & Urban Greening* 10: 95-103.

Ord K, Mitchell R, and Pearce J (2013) Is level of neighbourhood green space associated with physical activity in green space? *International Journal of Behavioural Nutrition and Physical Activity* 10:127

Richardson, E. and Mitchell, R. (2010) Gender differences in relationships between urban green space and health in the United Kingdom. *Social Science & Medicine* 71: 568-575.

Roe, J., Ward Thompson, C., Aspinall, P.A., Brewer, M.J., Duff, E., Miller, D., Mitchell, R., Clow, A. (2013) Green Space and Stress: Evidence from Cortisol Measures in Deprived Urban Communities. *International Journal of Environmental Research and Public Health* 10(9), 4086-4103.

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 Behavior*; 40(1):111-43.

Ward Thompson, C., Roe, J., Aspinall, P., Mitchell, R., Clow, A. and Miller, D. (2012) More green space is linked to less stress in deprived communities: Evidence from salivary cortisol patterns. *Landscape and Urban Planning*; 105(3):221-9.

Weber, B., Lewicka, S., Deuschle, M., Colla, M. and Heuser, I. (2000) Testosterone, androstenedione and dihydrotestosterone concentrations are elevated in female patients with major depression. *Psychoneuroendocrinology* 25(8): 765-771.

Witteveen, A.B., Huizink, A.C., Slottje, P., Bramsen, L., Smid, T. and van der Ploeg, H.M. (2010) Associations of cortisol with posttraumatic stress symptoms and negative life events: A study of police officers and firefighters. *Psychoneuroendocrinology* 35: 1113-1118.

Zeiler, K. (2010) A phenomenological analysis of bodily self-awareness in the experience of pain and pleasure: on dys-appearance and eu-appearance. *Medicine Health Care & Philosophy* 13(4): 333-342.

9 POLICIES AND STRATEGY DOCUMENTS

European Commission (2012) Our life insurance, our natural capital: an EU biodiversity strategy to 2020.

http://ec.europa.eu/environment/nature/biodiversity/comm2006/pdf/2020/1_EN_ACT_part1_v7%5B1%5D.pdf (Checked 1/02/2014).

European Union (1998) Convention on Access to Information, Public Participation in Decision-making and Access to Justice on Environmental Matters. <http://live.unece.org/fileadmin/DAM/env/pp/documents/cep43e.pdf> (Checked 1/02/2014).

European Union (2007) Directive 2007/2/EC of the European Parliament and of the Council of 14 March 2007 establishing an Infrastructure for Spatial Information in the European Community (INSPIRE).

Forestry Commission (2006) The Scottish Forestry Strategy. www.forestry.gov.uk/forestry/infd-6c3d4g (Checked 22/10/12).

Land Reform Review Group (2013) Interim report: Land Reform Review Group, 13 May 2013. pp 52. www.scotland.gov.uk/About/Review/land-reform/events/InterimReport

NHS Scotland Physical Activity Task Force (2009) Five Year Review of 'Let's Make Scotland More

Activity' A Strategy for Physical Activity www.scotland.gov.uk/Resource/Doc/47032/0017726.pdf
(Checked 30/10/2012).

Scottish Executive (2004) Scotland's Biodiversity: It's in Your Hands. A Strategy for the Conservation and Enhancement of Biodiversity in Scotland. Scottish Executive, Edinburgh: 66pp.

Scottish Executive (2006) Rural Development for Scotland 2007-2013. The Strategic Plan. Scottish Executive, Edinburgh. www.scotland.gov.uk/Publications/2006/02/08132503/8

Scottish Natural Heritage (2005) Core Paths Plan. www.outdooraccess-scotland.com/upload/Core_Paths_Plans.pdf

Scottish Government (2003) Let's Make Scotland More Active.
www.scotland.gov.uk/Topics/Health/health/Introduction/statframe

Scottish Government (2004) Guidance for the Spatial Framework of Scotland to 2025.
www.scotland.gov.uk/Publications/2004/04/19170/35317

Scottish Government (2005) Scottish Planning Policy 15: Planning for Rural Development.
www.scotland.gov.uk/Publications/2005/02/20624/51511

Scottish Government (2006) Green Space. Scottish Planning Policy 21.
www.scotland.gov.uk/Publications/2006/04/24122020/0

Scottish Government (2007) Environment and Health Strategic Framework – A New Approach.

Scottish Government (2008a) Good Places, Better Health – A New approach to Better Health and Environment in Scotland. www.scotland.gov.uk/Topics/Health/Healthy-Living/Good-Places-Better-Health

Scottish Government (2008b) Equally Well: Report of the Ministerial Task Force on Health Inequalities. www.scotland.gov.uk/Publications/2008/06/25104032/0

Scottish Government (2008c) Planning and Advice Note 65 Planning and Open Space.
www.scotland.gov.uk/Resource/Doc/225179/0060935.pdf

Scottish Government (2011a) Green Infrastructure: Design and Placemaking, pp28.
www.scotland.gov.uk/Resource/Doc/362219/0122541.pdf

Scottish Government (2011b) Getting the best from our land: A land use strategy for Scotland, March 2011, pp. 48.

Scottish Government (2011c) Getting the best from our land: A land use strategy for Scotland, Action Plan, December 2011, pp. 33.

Scottish Government (2011d) Applying an ecosystems approach to land use. Information Note. pp 11.

Scottish Government (2011e) Commission of the Future Delivery of Public Services.
www.scotland.gov.uk/Resource/Doc/352649/0118638.pdf

Scottish Government (2013a) Scottish Planning Policy, Consultation Draft,
www.scotland.gov.uk/Resource/0042/00421076.pdf.

Scottish Government (2013b) Climate Ready Scotland: Scottish Climate Change Adaptation Programme, Scottish Government, Edinburgh, July 2013. pp 71.

Scottish Government (2013c) 2020 Challenge for Scotland's Biodiversity – A Strategy for the Conservation and Enhancement of Biodiversity in Scotland.
www.scotland.gov.uk/Publications/2013/06/5538

10 BIBLIOGRAPHY

- Abraham, A., Sommerhalder, K. and Abel, T. (2010) Landscape and wellbeing: a scoping study on the health-promoting impact of outdoor environments. *International Journal of Public Health* 55: 59-69.
- Adevi, A.A. and Lieberg, M. (2012) Stress rehabilitation through garden therapy. A caregiver perspective on factors considered most essential to the recovery process. *Urban Forestry & Urban Greening* 11: 51-58.
- Alves, S., Aspinall, P., Ward Thompson, C., Sugiyama, T., Brice, R. and Vickers, A. (2008) Preferences of older people for environmental attributes of local parks: The use of Choice-Based Conjoint Analysis. *Facilities* 26(11/12): 0263-2772.
- APSE (2008) Health Impact Assessment of Green space. Briefing 08/57. Joint report by Health Scotland, Green space Scotland, Scottish Natural Heritage and Institute of Occupational Medicine.
- Barbosa, O., Tratalos, J.A., Armsworth, P.R., Davies, R.G., Fuller, R.A., Johnson, P. and Gaston, K.J. (2007) Who benefits from access to green space? A case study from Sheffield UK. *Landscape and Urban Planning* 83: 187-195.
- Balram, S. and Dragicevic, S. (2005) Attitudes towards urban green spaces: integrating questionnaire survey and collaborative GIS techniques to improve attitude measurements. *Landscape and Urban Planning* 71: 147-162.
- Barton, H. (2009) Land use planning and health and wellbeing. *Land Use Policy* 265: S115-S123
- Barton, J., Hine, R. and Pretty, J. (2009) The health benefits of walking in green spaces of high natural and heritage value. *Journal of Integrative Environmental Sciences* 6(4): 261-278.
- Barton, J. and Pretty, J. (2010) What is the best dose of nature and green exercise for improving mental health? A multi-study analysis. *Environmental Science & Technology* 44: 3947-3955.
- Bell, S., Montarzino, A. and Travlou, P. (2007) Mapping research priorities for green and urban space in the UK. *Urban Forestry & Urban Greening* 6: 103-115.
- Bergman, P. (2009) Health enhancing physical activity, sociodemographic factors and the neighbourhood environment. Report by Department of Biosciences and Nutrition of the Karolinska Institute.
- Berto, R. (2005) Exposure to restorative environments helps restore attentional capacity. *Journal of Environmental Psychology* 25: 249-259.
- Bird, W. (2009) Benefits of green space for mental health. Natural England Evidence Sheet 2: *Mental Health and the Natural Environment*: 1-4.
- Bowler, D., Buyung-Ali, L., Knight, T. and Pullin, A. (2010) The importance of nature for health: is there a specific benefit of contact with green space? Collaboration for Environmental Evidence Review Report www.environmentalevidence.org/SR40.html (Checked 29/10/2012).
- Bowler, D.E., Buyung-Ali, L.M., Knight, T.M. and Pullin, A.S. (2010) A systematic review of evidence for the added benefits to health of exposure to natural environments. *BMC Public Health* 10: 456.
- Brown, G. and Weber, D. (2011) Public Participation GIS: A new method for national park planning. *Landscape and Urban Planning* 102: 1-15.
- Brown, K.M., Dilley, R. and Marshall, K. (2008) Using a head-mounted video camera to understand social worlds and experiences. *Sociological Research Online* 13(6) www.socresonline.org.uk/13/6/1.html. (Checked 29/10/2012).
- Building4change (2011) How best to green the city (article). www.building4change.com/page.jsp?id=802 (Checked 25/10/12).

Burls, A. (2007) People and green spaces: Promoting public health and mental wellbeing through ecotherapy. *Journal of Public Mental Health* 6(3): 24-39.

CABE Space (2010) Urban green nation: Building the evidence base. <http://webarchive.nationalarchives.gov.uk/20110118095356/http://www.cabe.org.uk/publications/urban-green-nation> (Checked 24/11/2012).

CABE Space (2010) Community green: using local spaces to tackle inequality and improve health. CABE Space Report: 1-60. www.designcouncil.org.uk/Documents/Documents/Publications/CABE/community-green-full-report.pdf (Checked 29/10/2012).

Cameron, R.W.F., Blanusa, T., Taylor, J.E., Salisbury, A., Halstead, A., Henricot, B. and Thompson, K. (2012) The domestic garden – Its contribution to urban green infrastructure. *Urban Forestry & Urban Greening* 11: 129-137.

Carpiano, R.M. (2009) Come take a walk with me: The “Go-Along” interview as a novel method for studying the implications of place and wellbeing. *Health & Place* 15: 263-272.

Carstairs, V. and Morris, R. (1991) *Deprivation and Health in Scotland*. Aberdeen University Press, Aberdeen.

Central Scotland Green Network Partnership (2011) The vision - Working together to secure quality environments for our communities. www.centralscotlandgreennetwork.org/Vision/vision.html (Checked 25/10/12).

Cervinca, R., Roderer, K. and Hefler, E. (2011) Are nature lovers happy? On various indicators of wellbeing and connectedness with nature. *Journal of Health Psychology* 17(3): 379-388.

CIWEM (2010) Multifunctional urban green infrastructure. CIWEM Briefing Report. www.ciwem.org/media/279866/MUGI%20Briefing%20report.pdf (Checked 24/11/2012).

CJC Consulting (2005) Economic benefits of accessible green spaces for physical and mental health: scoping study. Forestry Commission Report: 1-67. [www.forestry.gov.uk/pdf/FCHealth10-2final.pdf/\\$FILE/FCHealth10-2final.pdf](http://www.forestry.gov.uk/pdf/FCHealth10-2final.pdf/$FILE/FCHealth10-2final.pdf) (Checked 29/10/2102).

Clow, A. and Fredhoi, C. (2006) Normalisation of salivary cortisol levels and self-reported stress by a brief lunchtime visit to an art gallery by London City workers. *Journal of Holistic Healthcare* 3(2): 29-32.

Clow, A., Thorn, L., Evans, P. and Hucklebridge, F. (2004) The awakening cortisol response: Methodological issues and significance. *Stress* 7: 29-37.

Cohen, D.A., Marsh, T., Williamson, S., Derose, K.P., Martinez, H., Setodji, C. and McKenzie, T.L. (2010) Parks and physical activity: Why are some parks used more than others? *Preventative Medicine* 50: S9-S12.

Cohen, S., Kamarck, T. and Mermelstein, R. (1983) A global measure of perceived stress. *Journal of Health and Social Behavior* 24: 385-396.

Conradson, D. (2005) Landscape, care and the relational self: therapeutic encounters in rural England. *Health & Place* 11: 337-348.

Coombes, E., Jones, A.P. and Hillsdon, M. (2010) The relationship of physical activity and overweight to objectively measured green space accessibility and use. *Social Science & Medicine* 70: 816-822.

COST (2007) Health and the Natural Outdoors. Final report www.umb.no/statisk/greencare/general/strategic_workshop_final_report (Checked 12/11/2012).

Countryside Survey (2007) Countryside Survey 2007. www.countryside-survey.org.uk/outputs/scotland-results-2007 (Checked 22/10/12).

- Daugbjerg, S., Kahlmeier, S., Racioppi, F., Martin-Diener, E., Martin, B., Oja, P. and Bull, F. (2009) Promotion of physical activity in the European region: Content analysis of 27 national policy documents. *Journal of Physical Activity and Health* 6: 805-817.
- Dadvand, P., de Nazelle, A., Figueras, F., Basagna, X., Su, J., Amoly, E., Jerrett, M., Vrijheid, M., Sunyer, J. and Nieuwenhuijsen, M. (2012) Green space, inequality and pregnancy. *Environment International* 40: 110-115.
- Dallimer, M., Tang, Z., Bibby, P., Brindley, P., Gaston, K. and Davies, Z. (2011) Temporal changes in green space in a highly urbanized region. *Biology Letters* 7: 763-766.
- Dawe, G. and Millward, A. (Eds.) (2008) 'Statins and Green spaces': health and the urban environment. Proceedings of conference held by UK-MAB Urban Forum, University College London.
- De Jong, K., Albin, M., Skarback, E., Grahn, P. and Bjork, J. (2012) Perceived green qualities were associated with neighbourhood satisfaction, physical activity, and general health: Results from a cross-sectional study in suburban and rural Scania, southern Sweden. *Health & Place* 18(6): 1374-1380.
- De Kloet, C.S., Vermetten, E., Geuze, E., Lentjes, E.G.W.M., Heijnen, C.J., Stalla, G.K. and Westenberg, H.G.M. (2007) Elevated plasma corticotrophin-releasing hormone levels in veterans with posttraumatic stress disorder. *Progress in Brain Research* 167: 287-291.
- De Vries, S., Verheij, R.A., Groenewegen, P.P. and Spreeuwenberg, P. (2003) Natural environments - healthy environments? An exploratory analysis of the relationship between green space and health. *Environment and Planning A*, 35: 1717-1731.
- Depledge, M.H., Stone, R.J. and Bird, W.J. (2011) Can natural and virtual environments be used to promote improved human health and wellbeing? *Environmental Science & Technology* <http://dx.doi.org/10.1021/es103907m>.
- Deuschle, M., Schweiger, U., Weber, B., Gotthardt, U., Korner, A., Schmider, J., Stanhardt, H., Lammers, C-H. and Heuser, I. (1997) Diurnal activity and pulsatility of the hypothalamus-pituitary-adrenal system in male depressed patients and healthy controls. *Journal of Clinical Endocrinology and Metabolism* 82(1): 234-238.
- Di Nardo, F., Saulle, R. and La Torre, G. (2010) Green areas and health outcomes: a systematic review of the scientific literature. *Italian Journal of Public Health* 7(4): 3001-3012.
- Dinno, A. (2007) Loop analysis of causal feedback in epidemiology: An illustration relating to urban neighborhoods and resident depressive experiences. *Social Science & Medicine* 65: 2043-2057.
- Duvall, J. (2011) Enhancing the benefits of outdoor walking with cognitive engagement strategies. *Journal of Environmental Psychology* 31: 27-35.
- Edwards, S., Clow, A., Evans, P. and Hucklebridge, F. (2001) Exploration of the awakening cortisol response in relation to diurnal cortisol secretory activity. *Life Science* 68(18): 2093-2103.
- English, J., Wilson, K. and Keller-Olaman, S. (2008) Health, healing and recovery: Therapeutic landscapes and the everyday lives of breast cancer survivors. *Social Science & Medicine* 67: 68-78.
- Evans, G.W. (2003) The built environment and mental health. *Journal of Urban Health* 80(4): 536-555.
- Faber Taylor, A., Kuo, F.E. and Sullivan, W. (2002) Views of nature and self-discipline: evidence from inner city children. *Journal of Environmental Psychology* 22: 49-63.
- Forestry Commission (2002) National Inventory of Woodland and Trees. www.forestry.gov.uk/inventory (checked 22/10/12).
- Forestry Commission (2007) Woods for Health Strategy, [www.forestry.gov.uk/pdf/fcfc011.pdf/\\$FILE/fcfc011.pdf](http://www.forestry.gov.uk/pdf/fcfc011.pdf/$FILE/fcfc011.pdf) (Checked 22/10/12).

- Forest Research (2010) Urban health and health inequalities and the role of urban forestry in Britain: a review. [www.forestry.gov.uk/pdf/urban_health_and_forestry_review_2010.pdf/\\$FILE/urban_health_and_forestry_review_2010.pdf](http://www.forestry.gov.uk/pdf/urban_health_and_forestry_review_2010.pdf/$FILE/urban_health_and_forestry_review_2010.pdf) (Checked 20/11/2012).
- Fuller, R.A. and Gaston, K.J. (2009) The scaling of green space coverage in European cities. *Biology Letters* 5: 352-355.
- Fuller, R.A., Irvine, K.N., Devine-Wright, P., Warren, P.H. and Gaston, K. (2007) Psychological benefits of green space increase with biodiversity. *Biology Letters* 3: 390-394.
- Gesler, W.M. (1992) Therapeutic landscapes: Medical issues in light of the new cultural geography. *Social Science & Medicine* 34: 735-746.
- Gesler, W.M. (1993) Therapeutic landscapes: Theory and a case study of Epidaurus, Greece. *Environment and Planning D: Society and Space* 11: 171-189.
- Gesler, W.M. (2003) *Healing Places*. Oxford: Rowman and Littlefield.
- Giddens, A. (1991) *Modernity and Self Identity*. California: Stanford University Press.
- Gidlow, C.J. and Ellis, N.J. (2011) Neighbourhood green space in deprived urban communities: Issues and barriers to use. *Local Environment* 16(10): 989-1002.
- Gidlow, C.J., Ellis, N.J. and Bostock, S. (2012) Development of the Neighbourhood Green Space Tool (NGST). *Landscape and Urban Planning* 106: 347-358.
- Giese-David, J., Sephton, S.E., Abercrombie, H.C., Duran, R.E. and Spiegel, D. (2004) Repression and high anxiety are associated with aberrant diurnal cortisol rhythms in women with metastatic breast cancer. *Health Psychology* 23(6): 645-650.
- Godbey, G. (2009) Outdoor recreation, health and wellness. Understanding and enhancing the relationship. Discussion Paper prepared for the Outdoor Resources Review Group, Washington.
- Grahn, P. and Stigsdotter, U.K. (2003) Landscape planning and stress. *Urban Forestry & Urban Greening* 2: 1-18.
- Grahn, P. and Stigsdotter, U. (2010) The relation between perceived sensory dimensions of urban green space and stress restoration. *Landscape and Urban Planning* 94: 264-275.
- Green Space Forum Ltd (2012) Green Future. A study of the management of multifunctional urban green spaces in England. Report: www.green-space.org.uk/downloads/Publications/Green%20Future%20web%20version.pdf (Checked 12/11/2012).
- GreenspaceScotland (2008) Health Impact Assessment of Green space – A Guide. www.greenspacescotland.org.uk/SharedFiles/Download.aspx?pageid=133&mid=129&fileid=134 (Checked 22/10/12).
- GreenspaceScotland (2008) Transforming urban spaces: 1-75. www.openspace.eca.ac.uk/pdf/appendixf/OPENspacewebsite_APPENDIX_F_resource_9.pdf (Checked 29/10/2012).
- GreenspaceScotland (2008) Single Outcome Agreements and Green Space. www.greenspacescotland.org.uk/default.asp?page=458 (Checked 29/10/2012).
- GreenspaceScotland (2009) State of Scotland's Green space 2009. www.greenspacescotland.org.uk/SharedFiles/Download.aspx?pageid=131&mid=127&fileid=163 (Checked 12/11/2102).
- Groenewegen, W., van den Berg, A., Vries, S. and Verheij, R. (2006) Vitamin G: effects of green space on health, wellbeing, and social safety. *BMC Public Health* 6:149.
- Guite, H.F., Clark, C. And Ackrill, G. (2006) The impact of the physical and urban environment on

mental wellbeing. *Public Health* 120: 1117-1126.

Gupta, K., Kumar, P., Pathan, S. And Sharma, K.P. (2012) Urban Neighbourhood Green Index – A measure of green spaces in urban areas. *Landscape and Urban Planning* 105: 325-335.

Han, K-T. (2003) A reliable and valid self-rating measure of the restorative quality of natural environments. *Landscape and Urban Planning* 64: 209-232.

Hansen-Ketchum, P.A. and Halpenny, E.A. (2010) Engaging with nature to promote health: bridging research silos to examine the evidence. *Health Promotion International* 26(1): 100-108.

Hansen-Ketchum, P.A., Marck, P., Reutter, L. and Halpenny, E. (2011) Strengthening access to restorative places: Findings from a participatory study on engaging with nature in the promotion of health. *Health & Place* 17: 558-571.

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

Hartig, T., van den Berg, A., Hagerhall, C., Tomalak, M., Bauer, N., Hansmann, R., Ojala, A., Syngollitou, E., Carrus, G., van Herzele, A., Bell, S., Camilleri, M and Wasseth, G. (2011) Health benefits of nature experience: Psychological, social and cultural processes. *Forests, Trees and Human Health*. Nilsson, K., Sangster, M., Gallis, C., Hartig, T., de Vries, S., Seeland, K. and Schipperijn, J. (Eds.) Springer: 127-168.

Hitchings, R. (2012) Studying the preoccupations that prevent people from going into green space. *Landscape and Urban Planning* <http://dx.doi.org/10.1016/j.landurbplan.2012.09.006>.

Jerjes, W.K., Cleare, A.J., Wessely, S., Wood, P.J. and Taylor, N.F. (2005) Diurnal patterns of salivary cortisol and cortisone output in chronic fatigue syndrome. *Journal of Affective Disorders* 87(23): 299–304.

Jones, A., Hillsdon, M. and Coombes, E. (2009) Green space access, use and physical activity: Understanding the effects of area deprivation. *Preventative Medicine* 49: 500-505.

Kaczynski, A.T. and Henderson, K.A. (2007) Environmental correlates of physical activity: A review of evidence about parks and recreation. *Leisure Sciences* 29: 315-354.

Kaplan, R. and Kaplan, S. (1989) *The Experience of Nature: A Psychological Perspective*. New York: Cambridge University Press.

Karjalainen, E., Sarjala, T. and Raitio, H. (2010) Promoting human health through forests: overview and major challenges. *Environmental Health and Preventative Medicine* 15: 1-8.

Kearns, R.A. and Moon, G. (2002) From medical to health geography: Novelty, place and theory after a decade of change. *Progress in Human Geography* 26: 605-625.

Kessel, A., Green, J., Pinder, R., Wilkinson, P., Grundy, C, and Lachowycz K. (2009) Multidisciplinary research in public health: A case study of research on access to green space. *Public Health* 123: 32-38.

Korpella, K. and Kinnunen, U. (2011) How is leisure time interacting with nature related to the need for recovery from work demands? Testing multiple mediators. *Leisure Science* 33: 1-14.

Korpella, K.M., Ylen, M., Tyrvaïnen, L. and Silvennoinen, H. (2010) Favorite green, waterside and urban environments, restorative experiences and perceived health in Finland. *Health Promotion International* 25(2): 200-209.

Kyttä, M. (2008) SoftGIS Methods in Planning Evolution. Evaluation in Planning: 7th International Workshop. Towards Methodological Innovations in Planning Evaluation, 10-12 December 2008. School of Built Environment, Heriot-Watt University.

Lachowycz, K., Jones, A.P., Page, A.S., Wheeler, B.W. and Cooper, A.R. (2012) What can global

positioning systems tell us about the contribution of different types of urban green space to children's physical activity? *Health & Place* 18(3): 586-594.

Laforteza, R., Carrus, G., Sanesi, G. and Davies, C. (2009) Benefits and wellbeing perceived by people visiting green spaces in periods of heat stress. *Urban Forestry & Urban Greening* 8: 97-108.

Lange, E., Hehl-Lange, S. and Brewer, M. (2008) Scenario-visualization for the assessment of perceived green space qualities at the urban-rural fringe. *Journal of Environmental Management* 89: 245-256.

Land Use Consultants (2004) Making the links: green space and quality of life. Scottish Natural Heritage Commissioned Report No. 060 (ROAME No. F03AB01).

Lea, J. (2008) Retreating to nature: Rethinking 'therapeutic landscapes'. *Area* 40(1): 90-98.

Leslie, E., Sugiyama, T., Ierodiaconou, D. and Kremer, P. (2010) Perceived and objectively-measured greenness of neighbourhoods: Are they measuring the same thing? *Landscape and Urban Planning* 95: 28-33.

Leslie, E., Coffee, N., Frank, L., Owen, N., Bauman, A. and Hugo, G. (2007) Walkability of local communities: Using geographic information systems to objectively assess relevant environmental attributes. *Health & Place* 13: 111-122.

Li, L., Power, C., Kelly, S., Kirschbaum, C. and Hertzman, C. (2007) Life-time socioeconomic position and cortisol patterns in mid-life. *Psychoneuroendocrinology* 32: 824-833.

Liu, Z., Zhu, F., Wang, G., Xiao, Z., Tang, J., Liu, W., Wang, H., Liu, H., Wang, X., Wu, Y., Cao, Z. and Li, W. (2007) Association study of corticotropin-releasing hormone receptor1 gene polymorphisms and antidepressant response in major depressive disorders. *Neuroscience Letters* 414: 155-158.

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

Maas, J., Verheij, R.A., Spreeuwenberg, P. and Groenewegen, P.P. (2008) Physical activity as a possible mechanism behind the relationship between green space and health: a multilevel analysis. *BMC Public Health* 8: 206.

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

Macintyre, S., Ellaway, A. and Cummins, S. (2002) Place effects on health: how can we conceptualise, operationalize and measure them? *Social Science & Medicine* 55: 125-139.

Macintyre, S., Macdonald, L. and Ellaway, A. (2008) Do poorer people have poorer access to local resources and facilities? The distribution of local resources by area deprivation in Glasgow, Scotland. *Social Science & Medicine* 67(6): 900-914.

Mackay, G. and Neill, J.T. (2010) The effect of 'green exercise' on state anxiety and the role of exercise duration, intensity, and greenness: A quasi-experimental study. *Psychology of Sport and Exercise* 11: 238-245.

Maller, C., Townsend, M., Pryor, A., Brown, P. and St Leger, L. (2005) Healthy nature healthy people: 'contact with nature' as an upstream health promotion intervention for populations. *Health Promotion International* 21(1) 45-54.

Martens, D., Gutscher, H. and Bauer, N. (2010) Walking in 'wild' and 'tended' urban forests: The impact on psychological wellbeing. *Journal of Environmental Psychology* 31(1): 36-44.

McCormack, G.R., Rock, M., Toohey, A.M. and Hignell, D. (2010) Characteristics of urban parks associated with park use and physical activity: A review of qualitative research. *Health & Place* 16:

712-726.

Marques, S. and Lima, M.L. (2011) Living in grey areas: Industrial activity and psychological health. *Journal of Environmental Psychology* 31(4): 314-322.

Mason, P., Kearns, A. and Bond, L. (2011) Neighbourhood walking and regeneration in deprived communities. *Health & Place* 17(3): 727-737.

Meerlo, P., Sgoifo, A. and Turek, F.W. (2002) The effects of social defeat and other stressors on the expression of circadian rhythms. *Stress* 5(1): 15-22.

Millennium Ecosystem Assessment (2005) *Ecosystems and Human Wellbeing: Synthesis*. Washington DC: Island Press. www.maweb.org/en/index.aspx. (Checked 30/10/2012).

Millington, C., Ward Thompson, C., Rowe, D., Aspinall, P., Fitzsimmons, C., Nelson, N. and Murtrie, N. (2009) Development of the Scottish Walkability Assessment Tool (SWAT). *Health & Place* 15: 474-481.

Milton, K., Bull, F.C. and Bauman, A. (2011) Reliability and validity testing of a single-item physical activity measure. *British Journal of Sports Medicine* 45: 203-208.

Mitchell, R. (2007) Green space, urbanity and health: Relationships in England. *Journal of Epidemiology and Community Health* 61: 681-683.

Mitchell, R. and Popham, F. (2008) Effect of exposure to natural environment on health inequalities: an observational population study. *The Lancet* 372(9650):1655–1660.

Mitchell R (2012) Is physical activity in natural environments better for mental health than physical activity in other environments? *Social Science and Medicine*, 91:130–134.

Miyake, K.K., Maroko, A.R., Grady, K.L., Maantay, J.A. and Arno, P.S. (2010) Not just a walk in the park: Methodological improvements for determining environmental justice implications of access in New York City for the promotion of physical activity. *Cities and the Environment* 3(1): 1-17.

Morris, G., Beck, S.A., Hanlon, P. and Robertson, R. (2006) Getting strategic about the environment and health. *Public Health* 120: 889-907.

Morris, N. (2003) Health, wellbeing and Open Space Literature Review. OPENSspace: the research centre for inclusive access to outdoor environments. www.openspace.eca.ac.uk/pdf/healthwell-being.pdf (Checked 30/10/2012).

Mytton, O.T., Townsend, N., Rutter, H. and Foster, C. (2012) Green space and physical activity: an observational study using Health Survey for England data. *Health & Place* 18(5): 1034-1041.

Nader, N., Chrousos, G.P. and Kino, T. (2010) Interactions of the circadian CLOCK system and the HPA axis. *Trends in Endocrinology and Metabolism* 21: 277-286.

National Audit Office (2006) Understanding the contribution parks and green spaces can make to improving people's lives.

National Audit Office (2006) Enhancing urban green space. Office of the Deputy Prime Minister HC 935 Session 2005-2006: 1-76.

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

Nordh, H., Hartig, T., Hagerhall, C.M. and Fry, G. (2009) Components of small urban parks that predict the possibility for restoration. *Urban Forestry & Urban Greening* 8: 225-235.

Nordh, H., Alalouch, C. and Hartig, T. (2011) Assessing restorative components of small urban parks using conjoint methodology. *Urban Forestry & Urban Greening* 10: 95-103.

O'Campo, P., Salmon, C. and Burke, J. (2009) Neighbourhoods and mental wellbeing: What are the pathways? *Health & Place* 15: 56-68.

- Ottosson, J. and Grahn, P. (2005) A comparison of leisure time spent in a garden with leisure time spend indoors: On measures of restoration in residents in geriatric care. *Landscape Research* 30: 25-35.
- Park, B.J., Tsunetsugu, Y., Kasetani, T., Hirano, H., Kagawa, T., Sato, M. and Miyazaki, Y. (2006) Physiological effects of shinrin-yoku (taking in the atmosphere of the forest) using salivary cortisol and cerebral activity as indicators. *Journal of Physiological Anthropology* 26(2): 123-128.
- Peschardt, K.K., Schipperijn, J. and Stigsdotter, U. (2012) Use of Small Urban Green Spaces (SPUGS). *Urban Forestry & Urban Greening* 11: 235-244.
- Potestio, M.L., Patel, A.B., Powell, C.D., McNeil, D.A., Jacobson, R.D. and McLaren, L. (2009) Is there an association between spatial access to parks/green space and childhood/overweight/obesity in Calgary, Canada? *International Journal of Behavioral Nutrition and Physical Activity* 6: 1-10.
- Pretty, J., Griffin, M., Peacock, J., Hine, R., Sellens, M. and South, N. (2005) A countryside for health and wellbeing: The physical and mental health benefits of green exercise. Report for the Countryside Recreation Network: 1-137. [www.countrysiderecreation.org.uk/downloads/2005%20-%20Report%20-%20A%20COUNTRYSIDE%20FOR%20HEALTH%20AND%20WELL- BEING%20\(NXPowerLite\).pdf](http://www.countrysiderecreation.org.uk/downloads/2005%20-%20Report%20-%20A%20COUNTRYSIDE%20FOR%20HEALTH%20AND%20WELL- BEING%20(NXPowerLite).pdf) (Checked 29/10/2012).
- 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 wellbeing, and implications for policy and planning. *Journal of Environmental Planning and Management* 50(2): 211-231.
- Raanaas, R.K., Patil, G.G. and Hartig, T. (2011) Health benefits of a view of nature through the window: a quasi-experimental study of patients in a residential rehabilitation center. *Clinical Rehabilitation* 26(1): 21-32.
- Refshauge, A.D., Stigsdotter, U. and Cosco, N.G. (2012) Adults' motivation for bringing their children to park playgrounds. *Urban Forestry & Urban Greening* 11(4): 396-405.
- Regional Public Health (2010) Healthy Open Spaces: A summary of the impact of open spaces on health and wellbeing. Regional Public Health Information Paper, Lower Hutt. www.qualityoflife.co.nz/pdfs/RPR-DHB.pdf (Checked 12/11/2012).
- Richardson, E. and Mitchell, R. (2010) Gender differences in relationships between urban green space and health in the United Kingdom. *Social Science & Medicine* 71: 568-575.
- Richardson, E., Pearce, J., Mitchell, R., Day, P. and Kingham, S. (2010) The association between green space and cause-specific mortality in New Zealand: an ecological analysis of green space utility. *BMC Public Health* 10: 240.
- Roe, J. and Aspinall, P. (2011) The restorative benefits of walking in urban and rural settings in adults with good and poor mental health. *Health & Place* 17: 103-113.
- Rose, E. (2012) Encountering place: A psychoanalytic approach for understanding how therapeutic landscapes benefit health and wellbeing. *Health & Place* 18(6): 1381-1387.
- Ryan, R.M., Weinstein, N., Bernstein, J., Warren Brown, K., Mistretta, L. and Gagne, M. (2010) Vitalizing effects of being outdoors and in nature. *Journal of Environmental Psychology* 30: 159-168.
- Sandercock, G., Angus, C. and Barton, J. (2010) Physical activity levels of children living in different built environments. *Preventative Medicine* 50: 193-198.
- Sanesi, G., Laforteza, R., Bonnes, M. and Carrus, G. (2006) Comparison of two different approaches for assessing the psychological and social dimensions of green spaces. *Urban Forestry & Urban Greening* 5: 121-129.
- Science for Environment Policy (2012) The Multifunctionality of Green Infrastructure. In-depth

report published by European Commission's Directorate-General Environment. <http://ec.europa.eu/environment/integration/research/newsalert/pdf/IR3.pdf> (Checked 12/11/2012).

Stewart-Brown, S., Tennant, A., Tennant, R., Platt, S., Parkinson, J., Weich, S. (2009) Internal construct validity of the Warwick-Edinburgh Mental Wellbeing Scale (WEMWBS): A Rasch analysis using data from the Scottish Health Education Population Survey. *Health and Quality of Life Outcomes* 7: 15, doi:10.1186/1477-7525-7-15.

Stiglitz, J., Sen, A. and Fitoussi, J.-P. (2009) Report by the Commission on the Measurement of Economic Performance and Social Progress. www.stiglitz-sen-fitoussi.fr/documents/rapport_anglais.pdf (Checked 29/10/2012).

Stigsdotter, U., Ekholm, O., Schipperijn, J., Toftager, M., Kamper-Jorgensen, F. and Randrup, T.B. (2010) Health promoting outdoor environments – Associations between green space, and health, health-related quality of life and stress based on a Danish national representative survey. *Scandinavian Journal of Public Health* 38: 411-417.

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

Sustainable Development Commission (2008) Health, place and nature. How outdoor environments influence health and wellbeing: a knowledge base. www.sd-commission.org.uk/publications.php?id=712 (Checked 24/11/2012).

Tengart Ivarsson, C. and Hagerhall, C.M. (2008) The perceived restorativeness of gardens – Assessing the restorativeness of a mixed built and natural scene type. *Urban Forestry & Urban Greening* 7: 107-118.

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

Town & County Planning Association & Hyde Group (2010) Spatial Planning for Health. A guide to embedding the Joint Strategic Needs Assessment in spatial planning. www.apho.org.uk/resource/item.aspx?RID=116370 (Checked 12/11/2012).

Townley, G., Kloos, B. and Wright, P.A. (2009) Understanding the experience of place: Expanding methods to conceptualize and measure community integration of persons with serious mental illness. *Health & Place* 15: 520-531.

Townsend, M. and Ebdon, M. (2006) 'Feel Blue, Touch Green'. Final report www.interenvironment.org/cipa/Feel%20Blue,%20Touch%20Green.pdf (Checked 12/11/2012).

Tsunetsugu, Y. (2009) Trends in research related to 'Shinrin yoku' (taking in forest atmosphere or forest bathing) in Japan. *Environmental Health and Preventative Medicine* 15: 27-37.

Tzoulas, K. and James, P. (2004) Finding links between urban biodiversity and human health and wellbeing. In: Proceedings of 4th International Postgraduate Research Conference on the Built and Human Environment, 29th March – 2nd April, Salford, UK.

Tzoulas, K., Korpela, K., Venn, S., Yli-Pelkonen, V., Kazmierczak, A., Niemela, J. and James, P. (2007) Promoting ecosystem and human health in urban areas using Green Infrastructure: A review. *Landscape and Urban Planning* 81:161-178.

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

UNEP/CBD/COP/10/27 (2010) Report of the Tenth Meeting of the Conference of the Parties to the Convention on Biological Diversity - COP 10, Japan, October 2010.

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

Van Lenthe, F.J., Martikainen, P. and Mackenbach, J.P. (2007) Neighbourhood inequalities in health and health-related behaviour: results of selective migration? *Health & Place* 13: 123-137.

Velarde, M.D., Fry, G. and Tveit, M. (2007) Health effects of viewing landscapes – Landscape types in environmental psychology. *Urban Forestry & Urban Greening* 6: 199-212.

Verheij, R.A., Maas, J. and Groenewegen, P.P. (2008) Urban-rural health differences and the availability of green space. *European Urban and Regional Studies* 15(4): 307-316.

Ward Thompson, C. (2011) Linking landscape and health: The recurring theme. *Landscape and Urban Planning* 99: 187-195.

Weber, B., Lewicka, S., Deuschle, M., Colla, M. and Heuser, I. (2000) Testosterone, androstenedione and dihydrotestosterone concentrations are elevated in female patients with major depression. *Psychoneuroendocrinology* 25(8): 765-771.

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

Witteveen, A.B., Huizink, A.C., Slottje, P., Bramsen, L., Smid, T. and van der Ploeg, H.M. (2010) Associations of cortisol with posttraumatic stress symptoms and negative life events: A study of police officers and firefighters. *Psychoneuroendocrinology* 35: 1113-1118.

World Health Organization (2003) Healthy urban planning: Experience of European cities. Report of the WHO Action Group on Healthy Urban Planning. www.euro.who.int/data/assets/pdf_file/0003/98400/E82657.pdf

World Health Organization (2003) Healthy Urban Planning in Practice: Experience of European Cities. Report of the WHO City Action Plan on Healthy Urban Planning. www.euro.who.int/data/assets/pdf_file/0003/98400/E82657.pdf (Checked 29/10/2012).

World Health Organization (2008) International Public Health Symposium on Environment and Health Research, Science for Policy, Policy for Science: Bridging the Gap. WHO, Madrid. http://ec.europa.eu/research/environment/index_en.cfm?pg=health (Checked 29/10/2012).

World Health Organization (2008) A Healthy City is an Active City: A Physical Activity Planning Guide. www.euro.who.int/data/assets/pdf_file/0012/99975/E91883.pdf (Checked 29/10/2012).

World Health Organization (2009) WHO European Healthy Cities Network. www.euro.who.int/en/what-we-do/health-topics/environment-and-health/urban-health/activities/healthy-cities/who-european-healthy-cities-network (Checked 30/10/2012).

World Health Organization (2009) Interventions on Diet and Physical activity: What Works. www.who.int/dietphysicalactivity/whatworks/en/ (Checked 29/10/2012).

World Health Organization (2010) Urban planning, environment and health. From evidence to policy action. www.euro.who.int/data/assets/pdf_file/0004/114448/E93987.pdf (Checked 12/11/2012).

Young, R.F. (2010) Managing municipal green space for ecosystem services. *Urban Forestry & Urban Greening* 9(4): 313-321.

Zeiler, K. (2010) A phenomenological analysis of bodily self-awareness in the experience of pain and pleasure: on dys-appearance and eu-appearance. *Medicine Health Care & Philosophy* 13(4): 333-342.

11 APPENDICES

Appendix A. Supporting mapping and data

Support for the analysis of green spaces for use in case study areas used a range of datasets which became available over the course of the project. Scotland's Greenspace Map provides a unique dataset specifically derived to enable the interpretation of green spaces in Scotland. This is based on Ordnance Survey Mastermap and field studies for each of Scotland's local authorities. For the relevant period of the GreenHealth project these data were not available so alternative sources of data on green spaces were used. Some of these are described in Section 2.1 (Health surveys and geographic modelling), drawing on analysis which successfully supported other studies (e.g. Mitchell and Popham, 2008).

For the case study areas a number of datasets were used together with different socio-economic geographies including local authority boundaries, CAS Wards, datazones, post-code units, and extends derived with respect to individual sample points (e.g. addresses of participants in surveys). The most detailed mapping of green spaces which supported analysis in the surveys presented in Section 2.2 used Ordnance Survey Mastermap, recoded as interpretations of green and open space. This was used to distinguish between different urban land cover and uses. These data were checked using online aerial photography from Google and Bing, the Google Streetview product, and field visits. The classification scheme was based on that of the PAN 65 typology of greenspaces (Scottish Government, 2008), following the types of open space it lists, but subdividing the 'natural/semi-natural green spaces' into categories for supporting the testing of potential relationships with different combinations of green space, with and without domestic gardens. An example of the mapping is shown for Craigmillar in Figure App A.1, using data for 2008. For the Edinburgh area use was also made of the mapping of open spaces produced by Edinburgh City Council and Scottish Natural Heritage, with detailed field interpretation.

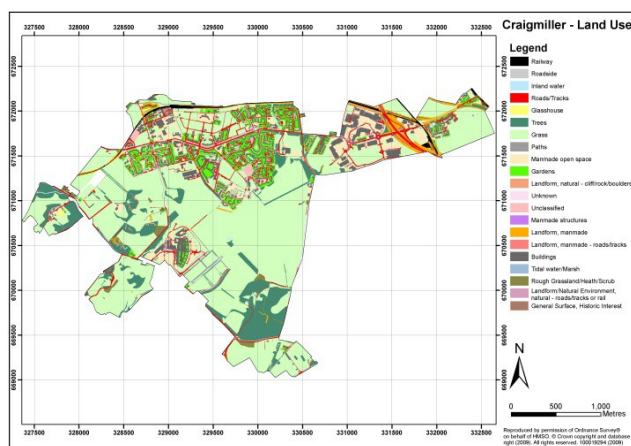


Figure App A. 1 Land use classification of Craigmillar area of Edinburgh (2008)

Field checking revealed a number of issues associated with the interpretation of the data, in particular in relation to the limitations of interpreting green space quality, rapid changes in urban land uses, and inconsistencies in mapping by the Ordnance Survey. Some such effects will also impact on the Scotland's Greenspace Map (SGM) data. Figure App A.2 shows an example of two contrasting back gardens in Dundee, one well managed and the other largely filled with waste.



Figure App A. 2 Contrasting contents of adjacent gardens as interpreted from aerial imagery (aerial imagery courtesy of Bing)

Mastermap data were obtained for 2012, classified using the same scheme as for 2008 data, and compared. Figure App A.3 shows inconsistencies in the mapping of features, and changes in land use for the Duddingston area of Edinburgh.

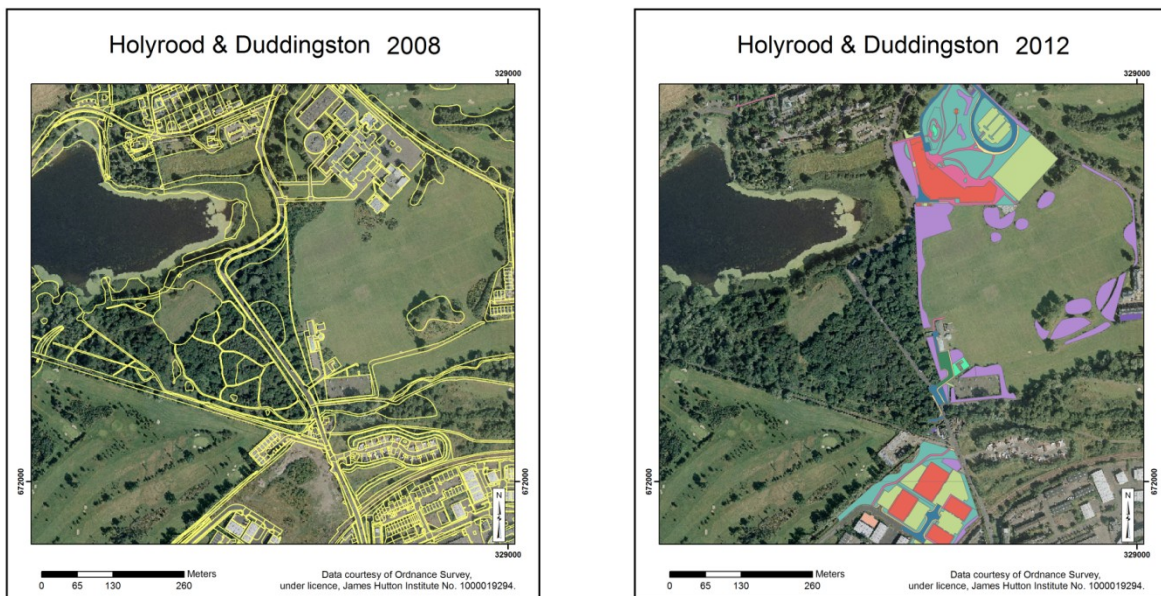
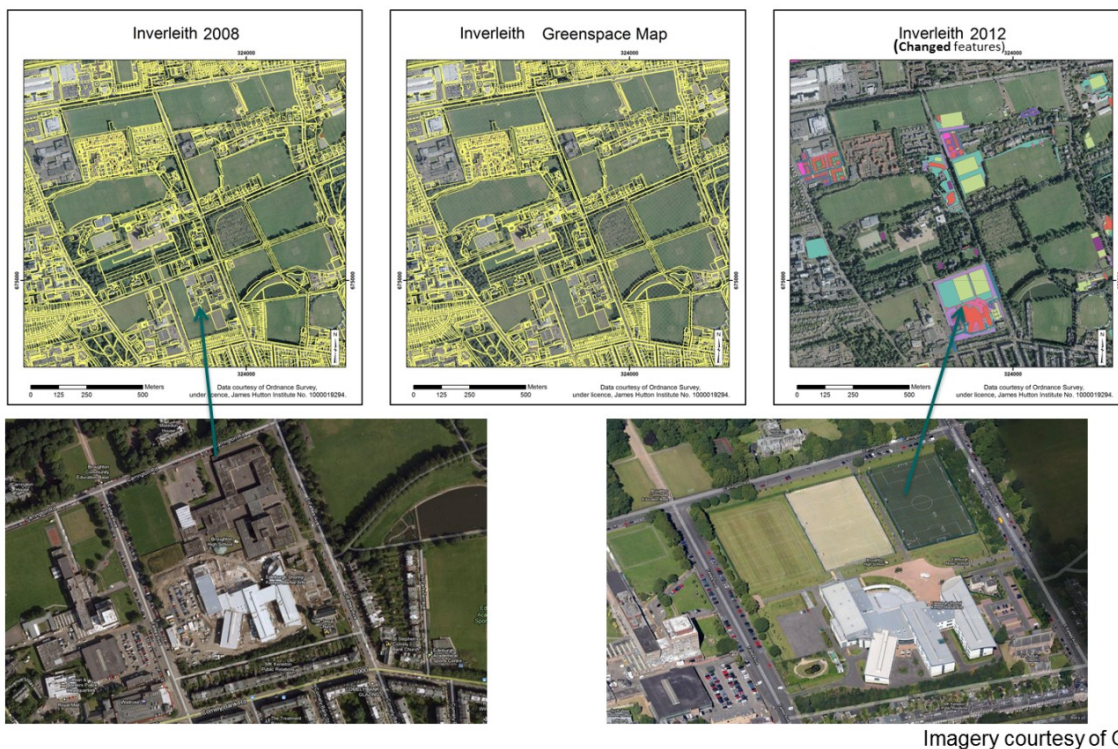


Figure App A. 3 Mapping of urban land uses for 2008 (left map) and 2012 (right map) for the Duddingston area of Edinburgh. Orange box highlights areas of difference in delineation of the same features.

The differences between land use classes for 2008 and 2012 are shown in the colours in the right map (i.e. 2012) which represent the change between those two dates. The area highlighted with the orange box shows where there is a difference in the detail of the mapping by the Ordnance Survey between the two datasets, with a more detailed delineation of the boundary of the groups of trees in the green space in 2012 than in 2008. The variable this would most impact would be that of the patches of trees in 2012 compared to 2008. No quantification of such differences in delineation was undertaken across the urban areas studied, however the observation provides an alert to the types of issues which can arise and are factors to take into account when interpreting the findings of the analysis.

The other potentially significant consideration is that of change in urban land use. In Figure App A.3 the changes at the top and bottom of the map for 2012 show the development of the new Holyrood High School and Kings Haugh industrial estate respectively. In Figure App A.4 a different type of change is shown for an area in Inverleith. This shows the Mastermap data for 2008 (left map) which form the basis of the boundaries of the SGM for this area (centre map), and the changes in playing fields shown in the data for 2012 (right map). Although the change highlighted at the bottom of the map is that of the development of the new school and playing fields at Broughton High School, the other changes

highlighted on the data for 2012 represent the development of three new all-weather sports pitches replacing cricket pitches. The changes make no difference to the area of green space for recreation, but that hides the details of the change in terms of sealed ground and provision of facilities. No estimate is available of the extent of such changes within classes.



Imagery courtesy of Google

Figure App A. 4 Mapping of urban land uses for 2008 (left map), Scotland's Greenspace Map (centre) and 2012 (right map) for the Inverleith area of Edinburgh.

Urban land use and land use change

Table App A.1 shows a summary of changes in urban land uses between 2008 and 2012 for the area of Edinburgh City Council. It shows a simplified classification of urban land uses for the two dates, and the changes between classes. For example, 46 ha have been developed for buildings from open space from 2008 to 2012, and 53 ha from open space to sealed land (e.g. car parking).

Table App A. 1 Summary of changes in urban land uses between 2008 and 2012 for Edinburgh City Council, based on Ordnance Survey Mastermap data

Class	Transport	Roadside veg.	Water	Built (other)	Trees	All open space	Sealed surface	Gardens	Landforms	Buildings	Total (ha)
Transport	1782	12	0	2	4	3	8	1	0	1	1813
Roadside	6	864	0	1	15	6	1	1	0	1	896
Water	0	0	329	0	0	3	0	0	0	0	332
Built (other)	11	7	0	63	4	65	9	12	0	16	186
Trees	2	3	1	0	2455	57	2	1	0	1	2523
All open space	20	22	1	46	156	15344	53	13	3	14	15672
Sealed surface	11	2	0	20	1	23	1042	2	0	4	1105
Gardens	1	0	0	2	1	5	2	3015	0	2	3028
Landforms	0	0	0	0	0	9	0	0	46	0	54
Buildings	1	0	0	15	0	4	8	1	0	1706	1735
Total (ha)	1834	912	332	150	2636	15518	1125	3046	49	1744	25963

The comparison gives an indication of the dynamic nature of urban land uses. No equivalent quantitative analysis is available for other time periods and thus a means of assessing the significance of the amounts of change, nor the consistency of the types of changes. Therefore, the data inform the interpretation of the quantitative analysis which uses data on the areas or proportions of urban land use.

Accessibility of green spaces

Access points to green spaces were recorded where a footpath linked with a green space, i.e. 'formal' access, or open space is adjacent to a footpath, pavement or road and no physical barrier to access exists, i.e. informal' access. For informal points of access, estimates were made of locations where there may be indications of a path having been developed. Distances between each residential property and the closest accessible green space of each type were then calculated and then repeated with updated data on properties.

Figure App A.5 (a) and (b) show the distribution of different types of green spaces and physical accessibility and proportions of residential properties with respect to 300 m walking distances in the Forth and Inverleith NPAs. Figure App A.5 shows the proportions of properties less than 300 m walking distance from an accessible green space, compared with the overall figure for Edinburgh. This enables interpretation of physical accessibility of green space categories and a comparison between different NPAs. For example, accessibility in Forth is higher than for that in Inverleith, with 75% of properties less than 300 m from the broadest category of significant open space in Forth compared with 53% in Inverleith.

The benefits conferred by views of green spaces are increasingly being taken into account in guidance for land managers and planners in the creation of new spaces, and design of hospital and care environments. For example, the Forestry Commission proposes that those confined to bed should be able to enjoy the outdoors from inside, with views of trees or a garden being made available.

To enable the calculation of visibility from properties a digital height model of the city was used as an input to the mapping of visual access to different types of urban land use, including green spaces. A database of buildings and addresses was created from Ordnance Survey data, with data on building heights from LiDAR. These data have been used to derive an index of visibility of green space from individual properties, using tools developed for architecture and used in visual impact assessments.

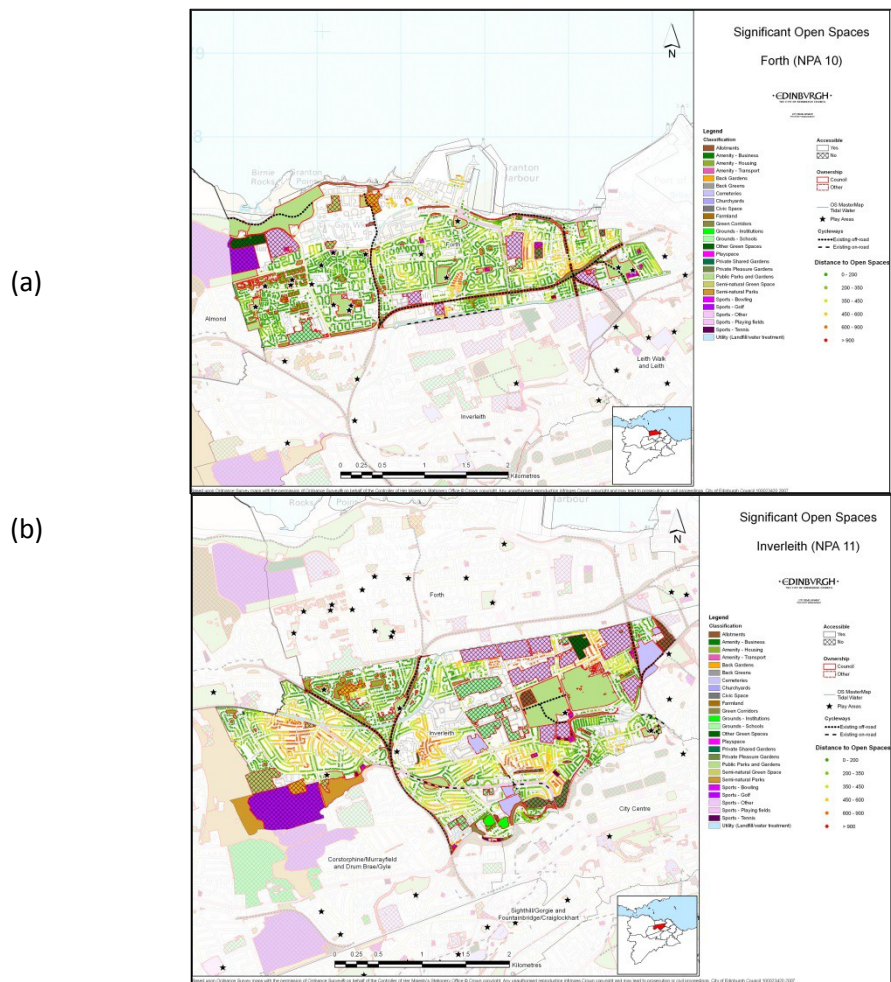


Figure App A. 5 Accessibility of significant open spaces from each property in (a) Forth, (b) Inverleith, Edinburgh

Data on physical and visual access were combined to produce assessments of access to green spaces. An example is shown for the Pilton area of Edinburgh, comprising 5,907 properties. To link to information on population, census data for 2001 were joined at the address-level, using postcodes. This database of population linked to accessibility supports queries to estimate the number of people with different levels of accessibility to different types of green spaces, linked to other data related to individual properties.

Properties were classified using a mid-point in the visibility index for splitting 'high' and 'low' visibility of green space, and the physical distance uses two examples of 300 m and 200 m walking distances as thresholds. Figure App A.6 shows the geographic distribution of properties based on the combined visual and physical accessibility for each of the two distance thresholds, and Table App A.2 summarises the number of properties in each category for each classification. The effect of the different thresholds of physical accessibility is highlighted by those properties coloured black (i.e. >300m) and yellow (i.e. > 200m). The greatest differences in accessibility between the two distance thresholds are in the housing estate to the east of the area where outer properties are closer to accessible green spaces, illustrating a lack of publicly accessible green space within the estate. Private gardens were excluded from this analysis.



Figure App A.6 Combined physical and visual accessibility of green spaces to properties in Pilton, Edinburgh: (a) 300 m walking distance; (b) 200 m walking distance.

Table App A.2 Number of properties and population in each of two classifications with respect to physical and visual accessibility to green spaces

Distance	Class	Visibility					
		High			Low		
		No. properties	Pop.	% pop.	No. properties	Pop.	% pop.
High	1	306	615	5.1	612	1237	10.3
	2	785	1607	13.3	1449	2971	24.7
Low	1	2257	4578	38.0	2732	5613	46.6
	2	1778	3585	29.8	1895	3879	32.2

Of the estimated 12,042 people living in this example area, approximately 15.4% live less than 200 m from an accessible green space, whereas the figure for those living less than 300 m is 38.0%. Approximately 5.1% have a relatively high level of visibility of green spaces from properties, and are greater than 300 m walking distance. This compares to the 24.7% who have a relatively low level of visibility and greater than 200 m walking distance.

The analysis of visual and physical accessibility of different types of green space can now be undertaken using Scotland’s Greenspace Map, with the potential to consider links to the functionality and quality of spaces through interpretation of the PAN 65 open space typology. Discussions are ongoing with Scottish Natural Heritage with respect to their development of indicators for tracking accessibility of greenspaces.

Limitations

The analysis of physical accessibility presented takes no account of several physical and social factors, such as topographic inhibitors to movement, and terrain slope, therefore maps of minimum distances may not be directly equated to minimum travel time. The output of calculations of distance is in relation to entrances to green spaces. Therefore, for features of interest, such as children’s play spaces within a green space, the distance to the feature will be greater than that output reported. The significance of differences in distance will depend upon the size and internal layout of the green space. In relation to visual access no account is taken of the temporal effects, such as the significance of foliage on trees and growing season, and the levels of visibility from different storeys of a building.

Principal findings

The principal findings are that:

- (i) The map data underlying the estimates of green space used in analysis of surveys of wellbeing contain some inconsistencies in delimiting urban land use features.
- (ii) Data on major urban land use types require to be maintained to be reliable in making contemporary assessments of green space quantity, and the associated implications for human health and

wellbeing.

- (iii) The analysis of the physical accessibility of green spaces with respect to individual properties and population numbers enables comparisons to be made of the effects of changes in green space provision and housing over time.
- (iv) Properties with similar levels of combined physical and visual accessibility tend to be geographically clustered, largely reflecting the spatial distribution and patterns of housing and green spaces.
- (v) Metrics of the physical or visual accessibility of different types of green spaces can be used to monitoring changes over time.

Appendix B. Changes in project partners and Scottish Government officers over duration of project

Over the duration of the project, a number of changes took place with the organisations in the project partnership.

In 2011, two of the project partners underwent institutional reorganisations. From 1st April 2011, the Macaulay Land Use Research Institute (MLURI), with the Scottish Crop Research Institute (SCRI), formed the James Hutton Institute. The James Hutton Institute completed the activities of MLURI in GreenHealth, through the same staff.

From 1st August 2011, Edinburgh College of Art merged with the University of Edinburgh. The College now combines with the University's School of Arts, Culture and Environment to create a new Edinburgh College of Art within the University. This organisation completed the activities of ECA in GreenHealth, through the same staff.

Dr Jenny Roe moved from Edinburgh College of Art to Heriot Watt University in March 2011, but remained in the scientific team, and thus Heriot Watt University joined as a collaborator.

Between the initial submission of the Expression of Interest and commencement of the project, Prof Richard Mitchell moved from University of Edinburgh to University of Glasgow. The latter organisation undertook the research in the project.

The role of scientific project officer at Scottish Government changed over the course of the project. Our thanks to, in chronological order, Susan Macintyre, by Caspian Richards, with Susan Macintyre, Paul Tyrer, Gill Cruickshank, Jackie Horne and Kathryn Gilchrist.

A number of changes took place in the Consultative Group. All those who participated at times over the project are listed in Appendix C.

Appendix C. Consultative Group (participants over project duration; *current group)

Sheila Beck*	NHS Health Scotland
Gillian Cruickshank	Scottish Government
Paula Charleson	Human Health Policy Adviser for Scottish Environment Protection Agency
Anne Conrad*	Scottish Environment Protection Agency
Scott Ferguson	Scottish Natural Heritage
Nuala Gormley	Scottish Government
Eilidh Johnston	Greenspace Scotland
Helen Jones*	Scottish Government
Kevin Lafferty*	Forestry Commission
Matt Lowther	Scottish Government
George Morris*	NHS Health Scotland and personal capacity
Jon Rathjen	Greener Scotland Directorate, Scottish Government
Julie Proctor*	Greenspace Scotland
Caspian Richards	Scottish Government (RESAS)
Lorraine Tulloch*	Strategic Framework for Environment and Health in Scotland (SFEHS)

Appendix D. Summary of activities and outputs with respect to Project Deliverables

Item	Period	Circulation/ audience	Status/Comment
D1 Map of details of data coverage for Scotland	Q3	Internal to project team	Complete; in 1 st progress report
D2 Report on associations between the measures of health and available measures of green environments, and how this varies by social, demographic and economic characteristics of census or survey reporting areas. Public factsheet. Scientific paper.	Q5	Scientists, RESAS, public institutions and public	Richardson E, Mitchell R, Hartig T, de Vries S, Astell-Burt T, Frumkin H. Green cities and health: A question of scale? Journal of Epidemiology and Community Health (2011) doi:10.1136/jech.2011.137240. Paper circulated to RESAS, and press release approved. Book chapter: Greenspace and population health, R. Mitchell, In: Li, Q (ed) Forest Medicine. 2011. Chapter 15. Circulated to RESAS.
D3 Report on associations between the health measures and the available localised measures of green environments, and how this varies by quality of green environment. Public factsheet.	Q9	RESAS	Reporting to Consultative Group and in progress reports (2010 and 2011). The absence of a significant protective effect on mortality in all urban Scotland presented WP1 with a challenge. The original plan was to proceed with looking at differences in the associations between green space and health by economic and demographic groups and by different qualities of green space. However, if there is either no, or a more complex, relationship to investigate, a change in plan was required. A change in tasks agreed with Consultative Group.
D4 Report on associations between the measures of health, health behaviours, and green environments at an individual level in Scotland. Scientific paper.	Q14	Scientists, RESAS and public institutions	Ord K., Mitchell, R. and Pearce, J. (2013) Is level of neighbourhood green space associated with physical activity in green space?. International Journal of Behavioral Nutrition and Physical Activity 10: 127. Briefing Note.
D5 Estimate potential health impacts of increasing exposure of people to green environments. Final report, scientific paper.	Q15	Scientists, RESAS and public institutions	Scientific paper: 'Is physical activity in natural environments better for mental health than physical activity in other environments?', R. Mitchell, Social Science and Medicine, 2012. To be circulated. Briefing Note developed.
D6 Report on stakeholder consultation and policy scoping.	Q2	Internal to project team	Complete. Provided in 1 st progress report

Item	Period	Circulation/audience	Status/Comment
D7 Report on policy analysis. Public factsheet	Q6	RESAS and public	Completed report December 2010. Presented at 2 nd Consultative group meeting, and format revised. Report sent with database to stakeholders, summarized in progress report.
D8 Report and factsheet on update of WP findings.	Q10	RESAS and Public	Updated report findings, April 2012. Report and updated database sent to RESAS as section in progress report. Briefing notes include aspects highlighted of relevance to specific public policies: Land Use Strategy, Biodiversity Strategy consultation, Land Reform consultation, CC Adaptation Framework, Planning (NPF2/3) and local authorities.
D9 Evaluation of findings from WPs1 & 3 on health and green space with respect to policy measures, and indicators relating to wellbeing. Final report, scientific paper.	Q16	RESAS and Public	Summary presented in Briefing Note. Feedback from stakeholders on relevance to policies provides context and discussion in science papers
D10 Report on scoping and identification of case study sites	Q2	Internal to project	Complete; in 1st and 2nd progress reports.
D11 Report on links between perceived landscape characteristics, green space use and measures of health. Scientific paper.	Q7	Scientists, RESAS and public institutions	Outputs from household survey Combined with D12 below for science presentation, and briefing note.
D12 Report on implications of different attributes of environment on perceived health/wellbeing. Scientific paper.	Q12	Scientists, RESAS and public institutions	Scientific paper on links between perceived landscape characteristics, green space use and measures of health and wellbeing. Paper from findings of household/conjoint survey. Analysis being completed. Presentation accepted for IAPS conference, Rhode Island, USA, July 2013. Briefing Note and Knowledgescotland summary on household survey prepared and circulated to stakeholders for comments.

<p>D13 Report on associations between perceived landscape characteristics, green-space use, and independent measures of environment and health reported by WP1. Scientific papers.</p>	<p>Q12</p>	<p>Scientists, RESAS and public institutions</p>	<p>This is covered by the published and planned scientific papers on the cortisol study and on the questionnaire study of WP3, where green-space measures from WP1 are used to inform analysis.</p> <p>Paper 2 on cortisol (Roe et al., 2013) Briefing Note and Knowledgescotland summary prepared and circulated to stakeholders for comments.</p>
<p>D14 Test of prototype indicator(s) of</p>	<p>Q13</p>	<p>Scientists, RESAS and</p>	<p>The scientific papers on the</p>
<p>health/wellbeing with respect to environmental characteristics. Scientific paper.</p>		<p>public institutions</p>	<p>cortisol study confirm the novel contribution of the diurnal cortisol pattern, as tested using salivary cortisol, as a biomarker of stress-related health with respect to environmental characteristics.</p> <p>Paper 1: Ward Thompson et al. (2012) "More green space is linked to less stress in deprived communities: evidence from salivary cortisol patterns". Landscape and Urban Planning. Circulated to RESAS and stakeholders, and press release approved.</p>
<p>D15 Report on the significance of features in rural/urban environments with respect to experiences of health/wellbeing.</p>	<p>Q14</p>	<p>RESAS and public institutions</p>	<p>Paper on urban green space and wellbeing, Dinnie et al., 'Community, cooperation and conflict: negotiating the social wellbeing benefits of urban greenspace experience'. Landscape and Urban Planning .</p> <p>Briefing Note and Knowledgescotland summary prepared and circulated to stakeholders for comments.</p> <p>Briefing Note and Knowledgescotland summary on public perspectives on contents of urban green space, in preparation, from tests with visualization tools in Dundee site.</p> <p>Note and summary prepared and circulated to stakeholders for comments.</p>

<p>D16 Geographic database for spatial reporting of indicators of provision and quality of green spaces with respect to health/wellbeing, and gaps in data coverage.</p>	<p>Q16</p>	<p>RESAS and public institutions</p>	<p>Spatial data relating to the project are also available from the website of The Centre for Research on Environment Society and Health (CRESH) is a virtual centre joining scientists from the Universities of Edinburgh and Glasgow in Scotland (http://cresh.org.uk/).</p> <p>GIS data and maps for Dundee and Edinburgh case study areas (e.g. ward and datazone summaries of green space metrics, access to green space, quality/type), from project data, and Scottish Greenspace Map. Data summaries to be made available for download.</p> <p>Briefing Note and Knowledgescotland summary on mapping of access with respect to green spaces circulated to stakeholders for comment. Paper presented at DDSS 2012 Conference, The Netherlands.</p>
<p>D17 Feedback on KE strategy</p>	<p>Q2</p>	<p>Internal to project team</p>	<p>Complete following 1st project meeting</p>
<p>D18 Development of criteria for relevance to key policy objectives</p>	<p>Q4</p>	<p>Internal to project team</p>	<p>Complete following 1st meeting of Consultative Group. Summarise materials by Strategic Priorities of government. Circulation of materials as inputs to policy review documents, and updates on awareness of development of policies from partners (e.g. Land Use Strategy, Adaptation Framework, biodiversity strategy, Woods in and around Towns, green-space mapping).</p>
<p>D19 Evaluation report on outputs from national surveys in WP1. QC for public factsheet.</p>	<p>Q6</p>	<p>Internal to project team, RESAS. Input to journal publication.</p>	<p>Feedback obtained from stakeholders at Consultative Group meetings, and one-to-one basis. Comments and suggestions on the content and wording of the draft Briefing Notes, and Knowledgescotland summaries. Feedback continuing on reporting materials.</p>

<p>D20 Evaluation report on outputs from case-study tests in WP3. QC for public factsheet.</p>	<p>Q12</p>	<p>Internal to project team, RESAS. Input to journal publication.</p>	<p>Feedback obtained from stakeholders at Consultative Group meetings, and one-to-one basis. Comments and suggestions on the content and wording of the draft Briefing Notes, and Knowledgescotland summaries. Feedback continuing on reporting materials. Feedback will inform presentations at GreenHealth conference and context and</p>
<p>D21 Evaluation report on outputs from Case-study tests. QC for public factsheets from WPs 1, 2, 3.</p>	<p>Q15</p>	<p>Internal to project team, RESAS.</p>	<p>Feedback obtained from stakeholders at Consultative Group meetings, and one-to-one basis. Comments and suggestions on the content and wording of the draft Briefing Notes, and Knowledgescotland summaries. Feedback continuing on reporting materials. Feedback will inform presentations at GreenHealth conference and context and discussion in science papers.</p>