



transforming urban spaces

greenspace scotland research report

greenspace and quality of life:

a critical literature review

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Executive summary

This report presents the findings of a major literature review relating to greenspace and a number of different themes. The review was commissioned by **greenspace scotland** in partnership with SNIFFER and Scottish Natural Heritage and was carried out by staff at the OPENspace Research Centre, Edinburgh College of Art/Heriot Watt University. It forms part of a wider research programme managed by the Quality of Life partnership (greenspace scotland, SNH, NHS Health Scotland, Scottish Government, Forestry Commission Scotland and SNIFFER). The literature review is intended to inform future project development and policy advocacy, as well as providing a resource for a range of audiences interested in greenspace.

The brief asked for a review of recent and current research relating to the links between greenspace and a range of quality of life issues. The reviews were broken down by theme, and aimed to identify gaps in knowledge where relevant. As the review was built on the existing 'Making the Links' study, greenspace scotland wanted to see an emphasis on critical review of evidence quality, and highlighting of research gaps.

Areas reviewed

In accordance with the brief, a specific number of areas were included in the review:

- Health and wellbeing
- Social and community value of greenspaces
- Economic value/impacts of greenspaces
- Environmental value of greenspaces
- Planning and design

The review considers material from sources that include peer-reviewed literature and also so-called 'grey literature' which meets certain criteria. Slightly different standards were applied to material included in the section on health and wellbeing where specific evidence of outcomes was desired. This is easier to identify for the field of health and wellbeing compared with some of the other subjects examined in the review. The search for this review covered the last 10 years 1997 to 2007 (with some additional material from 2008).

Greenspace and health

The review expanded on but did not repeat another review undertaken by Croucher et al at the University of York (Croucher et al, 2007 – hereafter referred to as 'the York review').

The key findings are as follows:

- The proximity and accessibility of greenspaces in relation to residential areas appears to affect the overall levels of physical activity/exercise. This is true of children and young people (the subject of one sub-section), older people (receiving special study at present) as well as generally for all age groups. Some studies show stronger associations than others.
- Many of the studies are based on self-reported data, which limits the value; although some of the studies on adolescent girls use objective data.
- Although not especially relevant to Scotland, greenspaces reduce the heat island effect which can help in turn to reduce heat stress among vulnerable people, such as older people, during the summer.
- Physical exercise in greenspaces is generally positively associated with promoting wellbeing and recovery from stress. However, only limited numbers of studies use objective measurements, such as blood pressure monitoring, to assess this: the rest use self-reported data.
- There is evidence that some behavioural or emotional problems in children, such as attention deficit disorder, can be improved by exposure to greenspace.

- Being able to view greenspaces also seems to have positive effects, especially on stress reduction or restoration. The studies also include some carried out using pictures rather than real landscapes, so that the evidence may be contradictory and needs strengthening.
- Promoting active exercise of a specific type in at-risk groups such as sedentary men is strongly supported by the evidence from one robust study. This relates to golf, a very pertinent subject in Scotland. This is potentially an interesting approach if it could be applied to other at risk groups.
- Health benefits and social/community benefits may be linked when people participate in communal or group activities in greenspace. Whether there is something specific about performing such activities in greenspace, or whether it is the group activity itself, regardless of where it takes place, is not fully tested but potentially of great interest.
- Safety aspects of greenspace covered here (as opposed to those reviewed in the York report) relate to children's play, where the need for safety has to be balanced against the need for challenging environments to stimulate children and to help them develop motor skills. This is a subject that is becoming more important but lacks any research on the challenge side of the equation.

Social and community values of greenspace

The findings for this section are as follows:

- Many studies examined the link between greenspace and people's health and wellbeing. Disadvantaged urban places, such as public housing settings, have received special attention. Social aspects such as social cohesion are associated with an overall sense of wellbeing for certain sections of society who may feel excluded for one reason or another. Greenspace plays a role in providing places for social interaction.
- Individuals who have some nearby vegetation or live closer to greenspace seem to be more effective in managing major life issues, coping with poverty and performing better in cognitive tasks. This applies to both adults and children, especially those living in difficult social or economic circumstances.
- Greenspace and vegetation provide different benefits to urban dwellers in diverse ways. For children, the research findings show a clear pattern of cognitive and social benefits. For older people, there is a connection with place attachment. Some of the findings relate to specific locations, mainly non-UK and there may be problems in transferring the application of the results to places with different social and environmental conditions, such as Scotland.
- Amount of vegetation (e.g., tree density) is not necessarily correlated with lack of safety or crime, as has been previously stated in some studies. The whole area of safety and design of greenspace is still open for much more research as the evidence to date is contradictory and may depend on many local factors, given the way the research has been conducted to date, with small groups of respondents in specific local areas.
- In terms of research methods, most studies are based on correlational designs and the findings cannot support cause-and-effect conclusions. Several studies are descriptive and based on case-studies. This opens up the scope for further work with more attention to cause and effect relationships.
- In theoretical terms, the concept of affordances has been used to guide some of the empirical studies. This is noted when there is a concern in determining how greenspaces can affect wellbeing in a wider sense. There is scope to develop this approach in further research
- In relation to practice and application – many studies tried to link research and design by showing how the research findings could inform design. However, this is not done in a systematic way and the guidance may be location specific. There is scope for more research and development in this area.

- Issues of gender, ethnicity, ageing and disability have received limited attention and some of the studies undertaken do not have a strong methodology. This needs to be improved if further research is to be robust and taken seriously.
- Greenspaces are perceived differently by different age groups (see comments on Gross and Lane's study) but this is not considered in practice to any large extent. As people move from one life stage to another and use greenspaces differently then their needs will change but so far this has not been considered.
- Some studies which are methodologically quite robust may not be transferable due to the specific social or economic situation of the study location.
- There is some evidence that greenspaces do actually promote social cohesion amongst and between different groups in different places, such as parks and gardens. In a multicultural society of increasing demographic complexity this is worth further exploration.

Economic impacts and benefits of greenspace

This section shows that there are a number of established approaches that have demonstrated that greenspace can have a direct impact on property prices.

- They also show that different econometric approaches provide measures of other economic values of greenspace when recreational use, for example, is a public good not traded in the market.
- What is significant from this review is the fact that the available evidence is very limited to the two main areas noted above. Several aspects where there might be expected to be economic impacts, such as inward investment to an area in part as a result of environmental quality, the values for tourism or savings to the economy as a result of lower absenteeism by employees as a result of better health effects are missing from the research base.
- Some reports can be found claiming an impact on inward investment but these do not place numbers on this impact, nor are they based on research that could meet the inclusion criteria.
- Savings to employers from lower rates of absenteeism is likely to be extremely difficult to calculate, given that the evidence for health benefits is not yet fully conclusive and that the contribution of this to the total picture of absenteeism is probably unknown.
- These issues noted above are key areas where some idea of the economic impact would add greatly to the policy importance attached to providing greenspace.

Environment and greenspace

These are the main findings on environment and greenspace:

- Greening urban areas improves air quality and there is some evidence about what types of plants perform best but more is needed.
- Green areas also improve the climate and reduce the heat island effect but this is not so relevant for Scotland, where wind may be more of a factor.
- Green areas can reduce noise pollution and the visual intrusion from traffic, although more specific evidence on how this should be done in order to inform better design guidance could be useful.
- The risk of flooding is lower where there is plenty of urban vegetation to intercept and absorb storm water. Beyond the use of SUDS the wider impact of sealing urban surfaces in wetter or more flood-prone regions of Scotland needs further work.
- Urban green areas provide a diverse habitat for mainly common bird and animal species. Golf courses seem to be an underused resource in Scotland, where more research could be targeted, especially in how to manage golf courses to increase their biodiversity value.

- The long term planning of urban green areas is necessary for their development and continued functioning. Maintaining the continuity of greenspace over time is important, not only maintaining the total amount and type at a given time. This has implications for the long term management of greenspaces.
- There is an increasing availability of tools for evaluating the environmental values of green areas. These are very useful for planning and demonstrating values but need to be more widely available.

Planning and design of greenspace

These are the findings for planning and design in greenspace:

- Naturalness is the principal physical attribute of greenspace appreciated by stakeholders. Understandings of naturalness, however, vary across as well as within different societies, and do not necessarily accord with ecological complexity of greenspace habitats. This suggests that there is a need for a Scottish study of perceptions and preferences of urban greenspaces to inform planners and designers.
- Greenspace projects should be embedded in their landscape, ecological and social context. This varies from place to place so knowledge needs to be developed about this.
- Greenspace design should aim at enhancing the ecological functions of greenspace habitats. Different models can be adopted and tools are potentially available to help evaluate how well they function.
- Greenspace planning and design should aim at producing spaces attractive and accessible to people, which is confirming evidence from previous sections but guidance is needed on how best to do this, which is where good tools are needed.
- Greening projects should be evaluated with clearly defined criteria for their ecological and recreational benefits, once again, needing a good set of tools.
- Planning should be as participatory as possible – there is increasing evidence that places developed with the active participation of local people meet their needs better and help people develop place attachment as borne out by the evidence presented under the section on social and community aspects.

Gaps in research

The review concluded with the identification of gaps in research and some ideas of how these might be filled.

Greenspace and health

- A need to test more widely the issue of proximity, accessibility and type of greenspace for different age, social, economic and ethnic groups. This suggests a large-scale project using mixed methods including recording activity levels and a conjoint-type choice experiment to test the trade-offs amongst different factors, similar to work being undertaken in the I'DGO project at OPENspace.
- Some work of an applied nature to target key at-risk groups, similar to the project on sedentary middle-aged men and golf could be carried out. Given the significance of golf in Scotland this subject could be an important area for exploration as part of such work.
- The impact of views to greenspace could be significant but more work in a range of locations could be needed to be able to capture enough data to form a definitive view of the evidence.

- More work on the role of greenspaces in promoting increased health and wellbeing through community activity is needed, in order to be able to isolate the role of greenspace itself from other aspects, such as social integration.
- More research is needed on how to design play areas which, while being safe enough, contain more challenge and play value. This could include exploring attitudes to risk, measuring the different benefits of play for different ages and in different environments and play with natural materials and elements. This is a complex and challenging area but an extremely valuable one.

Social and community values

The gaps in research which could fruitfully be pursued are as follows:

- Since the potential social benefits of greenspace appear potentially quite large, there could be merit in undertaking studies in particular deprived areas of Scottish towns and cities could be undertaken, perhaps alongside or integrated into planning and design projects aimed at improving the environmental quality of deprived areas. The methods could be borrowed from the robust American studies or else specific methodologies could be developed.
- More work on the relationship between fear, safety, crime and greenspace is needed. This could involve using a large sample from different areas, combining both qualitative and quantitative approaches, with correlation between perceptions and data from crime reporting etc, and linked to different measurable characteristics of greenspace.
- Since greenspaces are used differently by people as they move from one life stage to another, a means of assessing this – “life-stage analysis” – could be developed as a valuable, practical tool for planners and designers.
- Transferring research findings into practical design guidelines is also an area that needs a lot more work, although it is not original research per se.
- Gardens are an under researched subject. More research could be undertaken on how they function as private or public/community spaces in different areas, such as private gardens in suburbs, shared private gardens in cities or community gardens and allotments elsewhere. This would suit an action-research approach.

Economic impacts/values of greenspace

Research gaps here include:

- Valuation of the effect of greenspace on property prices in the UK and Scotland – probably a complex subject, given the functioning of the property market but an important one. This might include surveys of prices or properties geographically related to the proximity of greenspace as well as information from surveys of estate agents and solicitors, willingness to pay by prospective purchasers and the characteristics of greenspace that may also have an effect.
- Broader studies of the economic value combining different economic models such as some suggested in para 7.4.2, perhaps attempting to put a global valuation on greenspace in its many dimensions. This may include the use of cost benefit analysis.
- There are large gaps in evidence for the effect of greenspace on inward investment values. This is likely to be a difficult area to research because of the wide range of factors that affect business decisions, for example, as well as problems over sources of data and their commercial sensitivity.
- Absenteeism rates, their costs and the reduction of this by people obtaining health benefits from greenspace is also a gap with further challenges in developing a robust research methodology.

Environment and greenspace

The following gaps were identified:

- Comprehensive research on the effect of greenspace on pollution, air quality, shelter (in the Scottish context), noise, energy consumption and flood mitigation, perhaps tied into a wide-ranging cost benefit analysis (see para 7.4.4).
- More comprehensive assessment of biodiversity values of different types of urban greenspace, especially golf courses, perhaps leading to better planning and design guidance.
- The development, refinement or technology transfer of practical tools for long term evaluation and monitoring of the condition of urban greenspace for biodiversity conservation.
- In relation with the above point, there is potential for developing participatory methodologies for monitoring urban greenspace biodiversity. These could take the form of biodiversity surveys that could involve greenspace users and the wider community. Possibly linked with environmental education and community empowerment programmes, such projects could turn urban greenspaces into focal points for community involvement with the public sphere and promote social inclusion and participation.

Planning and design of greenspace

The research gaps are:

- Perception studies are important in understanding how different people view greenspace. They could expand and develop the methodological approach using innovative qualitative methods (such as ethnographic methodologies) and phenomenological perspectives to the lived experience of greenspace.
- The planning literature is dominated by top-down approaches; there is an obvious gap in the field of well-researched examples of participatory approaches. Methods of evaluating individual projects so as to obtain high quality evidence are needed before this can be satisfactorily achieved, for example, better methods of action research.
- More research is needed to develop practical planning tools, decision support systems and the like for a range of aspects – health and wellbeing assessment, social and community benefits, an economic dimension and application of sets of indicators suited to the Scottish situation, for example quality of life and environmental services, for example,.

Conclusions

This review has covered an extensive area of literature and, taken together with the York report, provides a fairly comprehensive picture of the research evidence for the range of aspects of greenspace covered in the brief. It is clear that the evidence base in all areas is increasing, with a particular focus on health and wellbeing which has significantly accelerated in recent years and is likely to produce much more in the near future.

There are also some surprising gaps in the evidence that found its way through the search and screening process used here. Three areas stand out: community capacity and greenspace, biodiversity values of greenspace and ecological connectivity in urban greenspace. The absence in UK evidence is all the more marked. This may not be as a result of a lack of evidence per se, but possibly robust evidence, published in reputable sources and available through the search techniques used here.

1.0 Introduction

1.0.1 This report presents the findings of a major literature review relating to greenspace and a number of different themes. The review was commissioned by **greenspace scotland** in partnership with SNIFFER and Scottish Natural Heritage and was carried out by staff at the OPENspace Research Centre, Edinburgh College of Art/Heriot Watt University. It forms part of a wider research programme managed by the Quality of Life partnership (greenspace scotland, SNH, NHS Health Scotland, Scottish Government, Forestry Commission Scotland and SNIFFER) who are developing a number of projects which aim to demonstrate the links between greenspace and a range of quality of life issues and policies. The literature review is intended to inform future project development and policy advocacy, as well as providing a resource for a range of audiences interested in greenspace.

1.0.2 The brief asked for a review of recent and current research relating to the links between greenspace and a range of quality of life issues. The reviews were broken down by theme, and aimed to identify gaps in knowledge where relevant.

1.0.3 As the review was built on the existing 'Making the Links' study, greenspace scotland wanted to see an emphasis on critical review of evidence quality, and highlighting of research gaps. The client also wanted the review to examine any evidence on the ways in which greenspace benefits can be maximised for particular themes, drawing on good practice.

1.1 Areas reviewed

1.1.1 In accordance with the brief a specific number of areas were included in the review:

- **Health and wellbeing** (greenspace scotland had already commissioned a critical literature review of the links between greenspace and health and so this review aimed to extend the coverage of this but not to repeat it)
- **Social and community value** of greenspaces (including impacts on education and capacity building, community cohesion, equality and diversity, and civic pride)
- **Economic value/impacts** of greenspaces (including a number of different areas such as the effect on property values, on inward investment, regeneration or the wider economy)
- **Environmental value** of greenspaces in relation to, pollution and air quality, climate, flood effects biodiversity and conservation, etc.
- **Planning and design**, including perceptions of greenspace, and the planning and design of greenspace.

1.1.2 Each of these is broken down into a number of separate themes. These themes emerged by sorting and classifying the literature that successfully passed the screening phase (see Figure 1 below) into logical groupings. In several cases papers could be placed in more than one theme, in which case a judgement was made as to which category was the best fit in terms of the emphasis in way the results were presented. Thus the reader may find that a paper could as easily be located in another area of the report as the section where it is found. See each review section for the themes used.

1.2 Methods

1.2.1 The starting point for the search was the large database assembled in 2004 for the then Office of the Deputy Prime Minister (ODPM), now Department for Communities and Local Government (DCLG). This database, prepared for a research mapping exercise, employed rigorous criteria for the search of literature in the general field of green and public space and contains some 1400 items. These criteria, for items not from peer-reviewed publications, are as follows:

- Are the research aims clear?

- Is there a clear methodology and is it justified?
- Is the analysis clear?
- Are the key conclusions well-founded in the results of the analysis?
- Are the conclusions well related to the relevant literature?
- If there is a qualitative element to the research: is there an appropriate conceptual/theoretical framework and is the analytical approach appropriate to the type of data?
- If there is a quantitative element to the research: is the sample size adequate for confident statistical analysis and is the statistical validity adequate?

1.2.2 The definition of greenspace used for the search covers the following broad areas, taken from the York report (Croucher et al 2007). This was used so that comparison can be made between this review and the existing work in the field of physical and mental health (see Table 1):

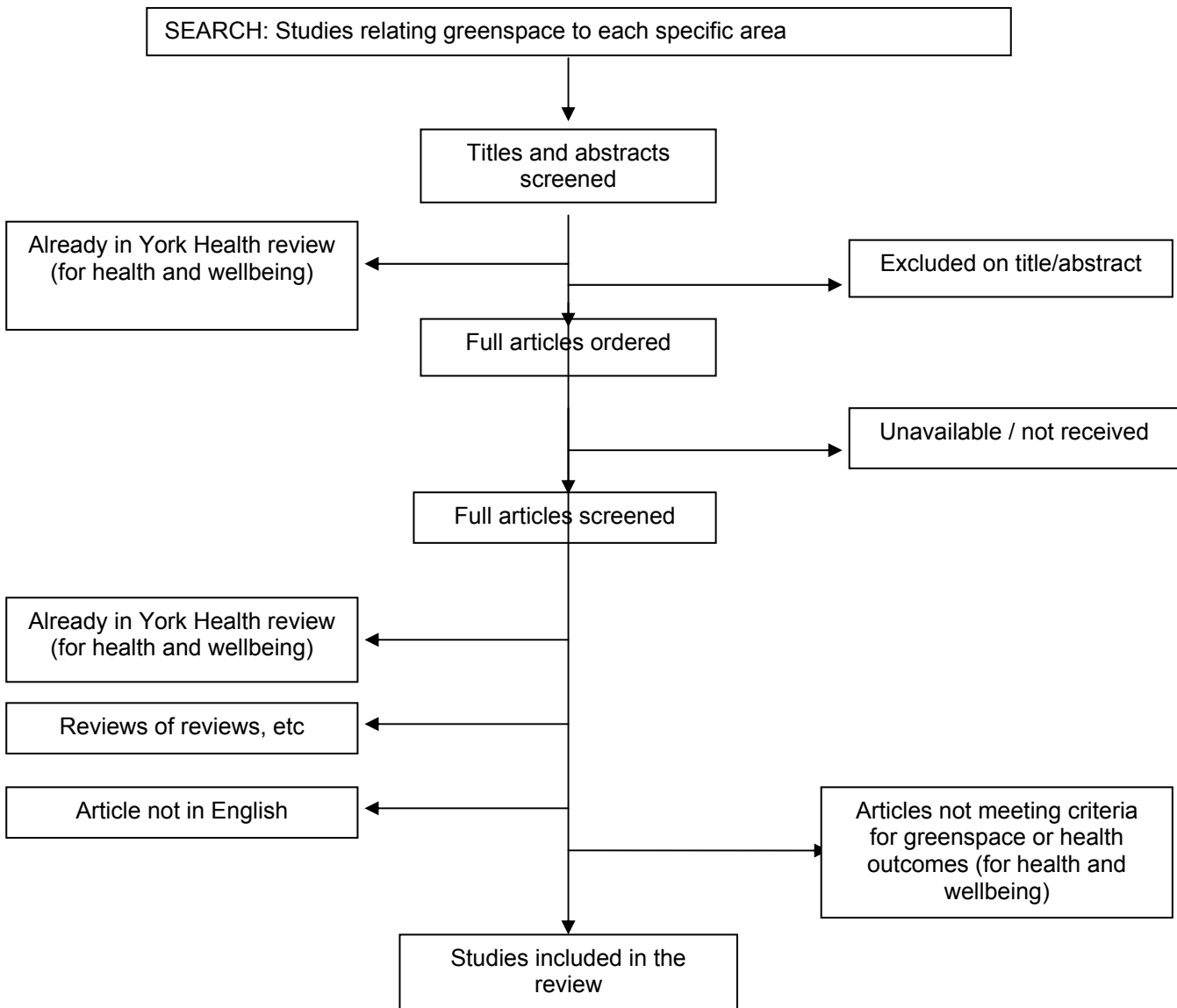
- Public parks and gardens
- Community gardens and allotments
- Urban planting and landscaping
- Cemeteries
- Sports fields
- Green path/routes and trails
- Brownfield sites
- National parks and other wilderness environments (in UK only)

1.2.3 The review considers material from sources that include peer-reviewed literature and also so-called 'grey literature' which meets certain criteria. Slightly different standards were applied to material included in the section on health and well-being where specific evidence of outcomes was desired. This is easier to identify for the field of health and wellbeing compared with some of the other subjects examined in the review.

1.2.4 The search for this review covered the last 10 years 1997 to 2007 (with some additional material from 2008). This meant that the material in the database from the years 1994-1996 could be dropped but that fresh material from the years 2004-2007(8) was needed. An initial 'trawl' of such material was undertaken and a large amount of potential material was thus obtained. Searches were undertaken using several academic search engines such as Science Direct, the Web of Science, ATHENS and Google Academic. The search terms were drawn from those suggested by the client and then using the same structure as for the ODPM/DCLG database structure (see Appendix 1).

1.2.5 The yield from this approach was too large to review in detail so an initial 'triage' process was carried out looking at the titles and abstracts. Those deemed to be irrelevant – on the basis that they offered no evidence of direct linkages, for example, or were too specific to a location that would not be transferable to Scotland, or were largely descriptive of cases – were removed and the subsequent reduced list was broken down by the initial categories. The next phase was that of screening each paper or report. For this the abstract for each paper was obtained and studied to see if it fitted the objectives of the review. If it did it was included and if not it was rejected. The next step was to obtain the papers or reports; some were not available and so were excluded. Each paper was then read and either included or excluded from the final selection. The paper trail for this is available as a set of screening reports in tabular form (Annex 1, a separate document). Once finally included each paper was individually reviewed using a standard procedure and a tabulated form. All the individual reviews are available in a separate document (Annex 2). A flowchart indicating the process of study selection is shown in Figure 1.

Figure 1. Process of study selection



1.3 Structure of the report

1.3.1 The report is structured according to the list of the subject areas noted above (para 1.2.1) and each section is broken down into the sub-themes that emerged from the organisation and screening of the literature. Following an initial breakdown of each field a summary of the papers included in the review is presented. This leads to a discussion of the main aspects uncovered by the review and a summary of the main points that emerged. Following the themed review section the final chapter contains a summary of what has emerged, a discussion of the relevance to Scotland and then an assessment of the gaps in research. The Appendices contain the brief, a description of the main search terms derived from the ODPM/DCLG database and a reference list of all the papers, arranged by the main themes for easier reference. The Annexes contain the record of the screening process (Annex 1) and the individual reviews for each paper included in the report (Annex 2).

2.0 Effect of greenspace on health and wellbeing

2.1 Introduction

2.1.1 Since the review of the effect of greenspace on health and wellbeing is an extension of the York health review (The links between greenspace and health: a critical literature review, Croucher et al, University of York, 2007), the same inclusion criteria were used (Table 1, derived from Croucher's Table 2.1) and those collected by the search which were already reviewed by Croucher et al were left out. Papers were also included if they reported outcomes related to health or wellbeing (levels of walking/physical activity, blood pressure, weight/BMI, measures of psychological wellbeing, quality of life or life satisfaction, assessment of mood/stress levels, etc).

Table 1: Inclusion and exclusion criteria, taken from Croucher et al, 2007

Inclusion criteria	Exclusion criteria
Studies reporting the impact of greenspaces on: <ul style="list-style-type: none"> ▪ Physical health ▪ Health behaviours ▪ Mental health and well-being ▪ Social health 	Studies reporting the impact of greenspace on other topics, for example: levels of pollution.
Greenspace to include: <ul style="list-style-type: none"> ▪ Public parks and gardens; ▪ Community gardens and allotments; ▪ Urban planting and landscaping; ▪ Cemeteries ▪ Sports fields ▪ Green path/routes and trails ▪ Brownfield sites ▪ National parks and other wilderness environments in UK only 	Greenspaces to exclude: <ul style="list-style-type: none"> ▪ Private and domestic gardens ▪ National parks and other wilderness settings outside the UK.
Studies undertaken in developed countries	Studies undertaken in developing countries
Studies focusing on impact of urban greenspaces, and/or greenspaces that are near and/or accessible to urban areas (for example, greenbelt, country parks) Note: Urban settlements defined within Scottish context as settlement with more than 3,000 people	Studies focusing on greenspace in a rural context
Papers reporting evaluations and empirical studies	Papers not reporting empirical studies, for example, editorials, think-pieces, theoretical and methodological discussion papers Papers reporting primary studies that have been previously included in earlier, methodologically robust reviews Theses and dissertations*
Literature reviews on relevant topics with adequate reporting of review methods	Literature reviews not reporting review methods
Papers published in English	Papers published in languages other than English
Papers published since 1990	Papers published before 1990

2.1.2 Following screening of the literature and identifying the final material to be included in the review a number of categories emerged and these formed the structure of the review. These are as follows, with the number of papers included in each section noted:

- Proximity and features of parks, school grounds and public open spaces in relation to physical activity – 13 primary studies and 2 reviews, broken down into sub-sections on children, older people and adults generally (with 1 paper on dog walking)
- Amount/degree of greenspace of neighbourhoods and association with heat stress – 1 paper
- Interventions to promote physical activity – 1 study
- Restorative effects of greenspace – 12 studies (with a subsection on health and viewing landscapes)
- Health benefits of group participation in greenspace settings – 4 items
- Hazards and risks – mainly childhood injuries – 6 papers

2.2 Proximity and features of parks, school grounds and public open spaces in relation to physical activity

2.2.1 The searches for this review identified 13 primary studies and 2 reviews meeting the inclusion criteria that related actual or perceived access to greenspace to levels of physical activity, and that had not previously been reviewed in the York Report on the Links between Greenspace and Health.

2.2.2 Most, but not all, studies found a positive association between the proximity and accessibility of greenspace and amounts of physical activity, with some studies finding a link only in particular population groups or activities.

2.2.3 Evidence collected in previous reviews A recent review by Kaczynski and Henderson (2007) comprehensively summarises evidence from 50 studies investigating environmental correlates of physical activity.

2.2.4 Data on environmental factors and physical activity outcomes were systematically extracted and tabulated, along with any association found. In general, proximity to parks or recreation was generally associated with increased physical activity; in 40% of the studies, all or most of the associations examined between parks or recreation and physical activity variables were positive. Nine of the articles (18%) reported that the associations examined were not significant, while the remaining 20 articles (40%) reported mixed findings, including at least some positive relationships between parks or recreation variables and physical activity.

2.2.5 A slightly older literature review by Owen et al. (2004) summarised evidence from 18 studies investigating environmental influences on walking behaviour. While not all of these studies would meet the inclusion criteria for the present review (some did not specify any greenspace component), most included some measure of perception of overall quality of neighbourhood and many highlighted distance and access to walking trails, etc. Significant association between accessibility and walking was reported by several studies and, overall, access to places like beach and public open spaces, and having a “highly walkable” neighbourhood were found to be significantly related to walking to get to and from places. The environmental attributes found to be associated with walking to get to and from places differed from those associated with walking for exercise or recreation. The review authors note, however, that these associations are limited by the heavy reliance on self-reported data and subjective rating of environmental characteristics, and highlight the need for studies with more objective measures, both of environmental attributes (e.g. by using GIS), and actual user activity.

2.2.6 The following sections examine material which are primary studies; some appear in the Kaczynski and Henderson review.

2.2.7 Children and Young people. This subsection focuses on research looking at children and young people. The studies concentrate on issues of physical activity on problems such as obesity in children. They are dominated by studies from the USA and Australia.

2.2.8 Timperio et al. (2004) identified a gap in the evidence on environmental correlates of walking and cycling among children, and conducted a survey of Australian children aged 5-9 years and 10-12 years and their parents to examine associations between parent's perceptions of the local neighbourhood and walking and cycling among children in the two age groups. Associations between 10- and 12-year-old children's own perceptions of their neighbourhood and walking and cycling were also examined, along with their perceptions of their parent's views. The study found that perceptions of the local neighbourhood may influence children's physical activity. Older children's perceived poor access to parks in their local neighbourhood was related to less walking and cycling. Perceptions of limited access to public transport options and parks or sports grounds were associated with a lesser likelihood of walking or cycling among girls in particular. A limitation in this study was that actual access to and proximity of parks and sports grounds was not assessed, and the authors point out that lack of knowledge of facilities in the neighbourhood may be a barrier to their use.

2.2.9 Two studies used data from a nationwide trial in the United States aimed at slowing the reduction in physical activity levels often seen in teenage girls (Trial of Activity in Adolescent Girls (TAAG)). Cohen et al. (2006) examined the association between park proximity, park type, and park features and physical activity in adolescent girls. They found that the type, number, and specific parks features in a half-mile zone surrounding the home address were associated with girls' non-school metabolic equivalent-weighted moderate/vigorous physical activity (ME-MVPA). Each park in the half-mile buffer was associated with an increase in non-school MW-MVPA by 2.8%, or 17.2 minutes per 6 days of non-school MW-MVPA. The study concluded that adolescent girls who live near more parks, particularly near those with amenities that are conducive to walking and with active features, engage in more non-school MW-MVPA than those with fewer parks. A similar paper by Cohen et al examines this issue in relation to a more general population and appears in the York health review (Cohen, D. A., McKenzie, T. L., et al. 2007. Contribution of public parks to physical activity. *American Journal of Public Health* 97(3): 509-14).

2.2.10 A related study by Scott et al. (2007) examined the relationship of school accessibility on weekends with body mass index (BMI) and physical activity in this population group. The study found that, although there was no relationship between school accessibility on Saturdays and weekend ME-MVPA, the number of locked schools was associated with significantly higher body mass index. Girls with no schools within a half-mile radius of their home registered 10% less weekend MW-MVPA ($p < 0.10$). This amounted to an average of 22 fewer minutes of moderate-to-vigorous activity. While the number of accessible schools with active amenities was not significantly related to girls' MW-MVPA, each additional park within the same half mile distance was associated with almost 3% more weekend MW-MVPA ($p < 0.10$). This latter point supports the authors' suggestion that the lack of correlation between availability of school facilities and physical activity might suggest that the target population does not view their school as somewhere they can exercise on the weekend. The authors found weekend school accessibility to vary widely at different locations nationwide, and note that relationships between school accessibility and physical activity/BMI are confounded by other neighbourhood characteristics, such as crime rate and socio-demographic differences.

2.2.11 Another study in the United States examined predictors of physical activity in a population of young (4-7 years) children with BMI \geq 75th percentile (Roemmich et al. 2006). The children's baseline physical activity was measured objectively by accelerometer, and parks and recreational areas within a half-mile radius of the child's home were determined with GIS. Although a main focus of this study was to determine the influence of the child's TV watching environment at home on activity, access to parks and recreational facilities was also included in the model. Univariate correlations using hierarchical regression models to predict total physical activity using percentage park plus recreation area as a predictor revealed that neighbourhoods with increased proximity between homes and a greater proportion of park area are indeed associated with greater physical activity in young children. However, this study focused only on a sub-population of overweight children and the findings cannot be assumed to be generalisable.

2.2.12 In a UCLA Center for Health Policy Research Brief, Babey et al. (2005) summarise findings based on data taken from the California Health Interview Survey (CHIS 2003). CHIS 2003 completed interviews with 4,010 adolescents ages 12-17, drawn from every county in the state and including all ethnic groups, to assess correlation of percent of adolescents engaging in regular physical activity and no physical activity with access to a safe park. The survey results revealed that the percent of teens engaging in regular physical activity is higher when teens have access to a safe park than when they have no access (71.8% vs. 67.3%) and, conversely, the percentage of teens who get *no* physical activity at all is higher among those with no access to a safe park than among those who have access to a safe park (10.3% vs. 6.4%). No significant association was found in teens living in rural areas, thus access to a safe park has a bigger benefit for teens who live in cities. Access to a safe park also made more of a difference for teens from moderate- and low income families.

2.2.13 The main findings raised by this section, even though the number of papers is small, is that available, accessible and safe parks/school grounds that are close to where children and young people live correlate with increased physical activity. What does not emerge from this is how near to residential areas such places should be. Since these studies are not from the UK extra work could be carried out to see if the same results apply here too. This could be based on mixed methods – GIS study of availability and proximity of greenspace to different communities, perceptions of accessibility, safety and how welcome children and young people feel in certain greenspaces (this also relates to some of the aspects covered by the section on social and community values). The use of school grounds at weekends could also be investigated.

2.2.14 Some of the work focused on adolescents but it would be important to examine the whole range of ages of children and young people from different social and economic backgrounds.

2.2.15 Exercise is likely to be associated with other lifestyle factors, so any studies should try to isolate the effect of greenspace features from among these other factors.

2.2.16 Older adults. This subsection focuses on older adults – over 65 years of age. Two of the studies are part of the same ongoing research programme (I'DGO) which is UK based.

2.2.17 Older adults living in the community were the focus of a study by Li et al. (2005) examining characteristics of the built environment related to neighbourhood walking activity. Residents (mean age 74) of residential neighbourhoods in Portland, Oregon were surveyed to assess their level of walking activity, and their perceptions of accessibility of parks and recreational areas. Actual neighbourhood characteristics were measured using GIS technology. A positive relation was found between built environment factors (including green and open spaces for recreation) and walking activity at the neighbourhood level. Older residents of neighbourhoods with high density of places of employment and households, greater numbers of street intersections, and green and open spaces for recreation, were more likely to engage in walking activity.

2.2.18 Older adults were also the focus of two related studies by Sugiyama and co-workers (Sugiyama and Ward Thompson 2008; Sugiyama et al. 2008), this time in a UK setting as part of the I'DGO (Inclusive Design for Getting Outdoors) research project. A cross-sectional survey of people over 65 years of age living in the community or in sheltered housing was conducted to examine what aspects of neighbourhood open space are associated with walking for recreation and for transport by older people. The analyses indicated that the quality of, and access to, open, green spaces in a neighbourhood were associated with longer walking time for study participants. Pleasant neighbourhood surroundings were associated with a 40% increase in odds of achieving more than 1 hour of recreational walking per week. Conversely, "nuisance factors", which includes unattended dogs, dog fouling and youngsters hanging around, discourages older people from walking for recreational purposes. However, although some characteristics of neighbourhood open space were associated with participants' life satisfaction scores and walking activity, there was no significant association between health and neighbourhood open space attributes. Nevertheless, the

findings suggest the possibility that improvements in the quality of and access to neighbourhood natural spaces could contribute to increase the amount of outdoor activity for the older population.

2.2.19 The outcomes of the research reviewed here have suggested positive relationships between the quality of and access to greenspace and walking times among older people.

This is similar to that for younger people from the previous section. So far the research examines limited populations and is mainly carried out by self-reporting but future work yet to be completed will include more quantitative work so that more robust results are to be expected.

2.2.20 Physical activity – walking. This section covers a wider age range of adults, including some older people. The focus is on walking and various aspects of greenspace. One study is from England, the others are from Australia, Belgium, the Netherlands and the USA.

2.2.21 Foster et al.'s (2004) cross-sectional study of adults in England showed mixed results for walking with respect to having a park or leisure centre within walking distance. For both men and women, there were no associations between any of the nine perceptions of the environment and the two walking categories in bivariate analysis. In multivariate analyses, for men, having a park within walking distance was the only environmental variable associated with higher odds of walking ≥ 150 minutes per week (OR = 2.22; 95% CI: 1.18 to 4.35). No other significant associations were found.

2.2.22 Giles-Corti has conducted several studies on the relative influence of individual, social and physical environmental determinants of physical activity and exercise, particularly walking (3 studies cited in the York Health Review). Her data are based on large cross-sectional surveys of healthy, working age adults in Perth, Australia. The study included here (Giles-Corti and Donovan 2003) indicates that walking at recommended levels was associated with having good access to attractive open spaces in the area of the study. Self-reported physical activity and walking was correlated to overall spatial access to attractive public open spaces, beaches, rivers and golf courses. Relative to respondents in the bottom quartile of access to public open space, the odds of walking at recommended levels were 47% higher among those in the top quartile (OR 1.47. 95% CI 1.00, 2.15, P=0.048). While supporting the contention that good access to public greenspaces and recreational areas is positively associated with physical activity levels, results in Perth may be confounded by generally high baseline levels of walking and physical activity compared to other regions and countries (in the 2 weeks preceding the survey, 72.1% of respondents had walked for transport, and 68.5% had walked for recreation), and the higher than average socio-economic characteristics of the respondents.

2.2.23 In an epidemiological survey of walking for physical activity in the United States, Eyster et al. (2003) assessed various attributes of regular and occasional walkers and those who never walk. Thirty-four percent of the population surveyed were regular walkers, 45.6% occasional walkers, and 20.7% never walked. Walkers reported using neighbourhood streets, shopping malls, and parks for walking. For the purposes of this review, the use of parks for walking is most relevant. The study found that more male regular walkers (38.7%) used parks for walking than female regular walkers (33.9%), although the reverse was true for occasional walkers, where 30.7% of female occasional walkers used parks compared with 24.4% of men. People in the younger age categories, regardless of walking status, reported using parks more than people in older age groups. 30% of regular and 23.1% occasional walkers who were white reported using parks for walking. These percentages were substantially lower than those for black and other racial/ ethnic group respondents using parks for walking. More walkers living in urban areas reported using parks than other living environments. Over twice the percentage of occasional walkers living in urban areas (34.5%) used parks for walking compared with only 15.8% of occasional walkers living in rural areas. Similarly, 45.6% of respondents living in urban areas use parks for regular walking, compared with only 19.6% of regular walkers in rural areas. It should be noted that low-income individuals were over-sampled for this survey, thus limiting the generalisability of the findings.

2.2.24 A cross-sectional survey of residents of Maastricht, The Netherlands, was conducted to identify factors of the physical environment that may influence time spent on walking and bicycling (Wendel-Vos et al. 2004). Although no associations were found for attributes of green and recreational space and walking, living in a neighbourhood with sport grounds and or parks close to home was positively associated with time spent on bicycling. However, this may be specific to the Dutch context.

2.2.25 In a study conducted in an urban forest near Leuven, Belgium, Roovers et al. (2002) investigated the interaction between the structural characteristics of the recreation site and recreation patterns. They found that most visitors (48%) had come for a walk, followed by biking (29%), jogging (16%) and horse riding (7%). The overall forest area was viewed positively by respondents, and most gave a positive response to additional infrastructure (especially litter bins). Their analysis of forest users revealed that most visitors (55%) use the car to get to the forest, and that visit frequency and length are negatively correlated and strongly determined by the distance covered from the residence to the forest. This latter factor has implications for the future selection of urban forest sites.

2.2.26 In one of the very few controlled intervention studies included in this report, Parkkari et al. (2000) examined the effects of regular walking during a golf game on various health and fitness indicators in previously sedentary middle aged men in Finland. A group of golfers (n=55) was compared to the same number of age-matched non-golfing controls. At the beginning of the intervention, the golfers were instructed to play an 18-hole round of golf twice a week and to walk rather than ride a cart throughout the 20-week golfing season from May to September. The control subjects were instructed to continue their sedentary lifestyle. Favourable effects on body composition, cardio-respiratory performance, trunk muscle endurance, and HDL cholesterol levels were observed in the golfers compared to the controls. The authors conclude that walking during a golf game is a practical and safe form of physical activity for previously sedentary men. This study was unusual in the thoroughness and breadth of the physical measurements taken.

2.2.27 These studies found rather mixed results, although proximity and quality of greenspace had some associations with walking for some groups. The studies mainly used self reporting of physical activity with some objective measures of greenspace, mainly using GIS. In order to complete the picture between children/young people and older people, more work using more objective measures, such as used in the golfing study, would be very helpful, perhaps focusing around obesity and other major health issues in Scotland.

2.2.28 Given the importance of golf in Scotland, this study is interesting methodologically and also for its potential application. It also shows how targeting intervention at key groups may be successful. There is scope to consider how such approaches could be targeted at other groups known for low levels of physical activity, by designing interventions around activities likely to be of interest, perhaps those with a high social component.

2.2.29 Dog-Walking

As a sub-category in this section, the literature search identified several studies linking dog ownership with physical activity, but only one correlated dog-walking activity with access to greenspace. Cutt et al. (2008) investigated access to public open space with dog supportive features among dog owners in Perth, Australia, and found that neither perceived nor objectively measured access to public open space was a significant factor in whether people walked their dogs. The authors hypothesised that a supportive environment may maintain rather than encourage uptake of dog walking.

2.3 Greenness of neighbourhoods and association with heat stress

2.3.1 One paper in a category of its own reported a study by Harlan et al. (2006), which investigated neighbourhood microclimates and vulnerability to heat stress. A simulation model was used to estimate an outdoor human thermal comfort index (HTCI) as a function of local climate variables collected in 8 diverse city neighbourhoods during the summer of 2003 in Phoenix, (AZ, USA). HTCI is an indicator of heat stress, a condition that can cause illness and death. Greenness of the neighbourhood was expressed as SAVI (Soil-Adjusted Vegetation Index - a measure of vegetation density calculated from remotely sensed data). The study found that places that were less densely settled with some open space and more abundant vegetation were more comfortable environments in the summertime. The correlation between vegetation (SAVI) and HTCI was statistically significant for all eight sites surveyed. While the temperatures occurring in the summer in Phoenix, Arizona (40°C and above) are hardly relevant to a UK setting, the fact that increased vegetation was associated with lower HTCI values is nevertheless interesting, and may be relevant in a UK context given that ambient temperatures regarded as stressful are lower than in habitually hot regions.

2.4 Restorative effects of greenspace

2.4.1 The next major section under the category of greenspace and health examines the restorative effects of greenspace. Restoration, i.e. recovery from illness, stress relief, reduction in anger or anxiety, and increased feelings of well being, and its relationship with natural environments is the focus of much current research in several overlapping fields (psychology, public health, environmental sciences, etc.). The literature survey identified 6 studies meeting the inclusion criteria that fit into this category, and which were not already summarised in the York Health review.

2.4.1 Stress relief. These papers cover the issue of stress relief, part of an increasing area of interest in recent years.

2.4.2 Hansmann et al. (2007) interviewed park users in a large forest park in Zurich, Switzerland, to assess the restorative effects and stress relief afforded by physical activities the park. Participants were questioned as to their pre-visit headache and stress levels and how they felt at the time of the survey (i.e. after spending some time in the park). The results showed significant decreases in headaches (but the sample number was low for this part of the survey), and a significant reduction in self-rated stress levels associated with the park visit. Positive effects increased with length of visit, and individuals practising sports (e.g., jogging, biking, playing ball) showed significantly higher improvements than those engaged in less strenuous activities (e.g., taking a walk or relaxing). Interestingly, participants were also asked about their belief in the restorative potential of the forest; a large majority of participants indeed believed in the health benefits of visiting forests and parks. The authors conclude that their findings support previous research on how exercise in greenspaces promotes wellbeing and recovery from stress.

2.4.3 A questionnaire study was conducted by Gidlof-Gunnarsson and Ohrstrom (2007) in urban residential settings with high road-traffic noise exposure in Sweden, to examine whether perceived availability to nearby green areas affects various aspects of wellbeing in two noise-condition groups (those whose apartments have access to a "quiet" side versus those which do not). The results showed that both availability to nearby green areas and access to a quiet side significantly decrease long-term noise annoyance; however, the values of the effect sizes indicate that the influence of the two independent variables on noise annoyance is modest. Better availability of green areas is associated with a higher amount of residents (%) walking and exercising in the neighbourhood every day or once/few times each week, and the results indicate that residents with no access to a quiet side of the dwelling benefited most by availability to green areas. Better green area availability was associated with less symptom prevalence regarding being "very tired", "stressed", and "irritated/angry". Although the authors did not specifically examine how the residents perceived the soundscape in the green areas, they note that "better" green-area

availability was linked to a higher percentage of residents hearing natural and human sounds (birdsong, children playing) when they were outdoors. This may indicate that there exist a (positive) soundscape in the nearby neighbourhood (potentially in the nearby green areas) that is not dominated by road traffic noise.

2.4.4 In a somewhat related approach, Song et al. (2007) analysed the potential restorative effects of parks and other recreational facilities on "traffic stress", i.e. stress due to high traffic volume, involvement in accidents, etc in Los Angeles. Traffic stress was found to be negatively correlated with gender, age, education and social support, positively correlated with employment and acculturation and uncorrelated with income. The association between traffic stress and general health status was amplified by vehicular burden and major streets but dampened by the ratio of green parklands and the association between traffic stress and depressive symptoms appeared less in neighbourhoods with a higher green parkland ratio. Two factors limit the generalisability of these results: neighbourhoods in this study had a low average green park land ratio (4%), and the target population was exclusively Chinese-American. The authors acknowledge this limitation, but note that respondents' general health scores (mean = 70.4) were similar to those of US national norms (mean = 72.0).

2.4.5 These three papers all identified positive associations of stress relief with different types of greenspace. However, all were based on self-reported data. Two were European and one was from America, which studied a single ethnic group – Chinese Americans. **This subject is well-covered in the York report where some major robust studies were reviewed, including a large one from England. These provide fairly strong evidence in support of the links between greenspace and stress reduction.** There are no studies from Scotland to date.

2.4.6 Happiness and aggression. This could be considered a specific aspect of restoration which is more targeted at emotional state rather than stress. Positive mood can be associated with happiness, while some negative emotional states include feelings of aggression. Five papers are included in this section, which is a rather mixed collection.

2.4.7 Bodin et al. (2003) assessed the moderating effect of environment on attentional and emotional restoration in a small sample (n=12) of habitual runners. This study (conducted in Sweden) measured self-reported emotions and behavioural measures of attention before and after each of two 1-hour runs in each of the two environments (urban and rural). While the runners preferred the park over the urban environment and perceived it as more psychologically restorative, and indeed declines in anxiety/depression and anger from pre-test to post-run were significant, no greater emotional (or attentional) benefits came from running in the park versus the urban environment. This was one of the few studies in this group not to show a positive association of greenspace with restorative effects, but the extremely specialised study population may explain this finding, as regular runners derive emotional benefit from running per se, and environment may play less of a role.

2.4.8 Chiesura (2003) investigated urbanites experience of nature in the Vondelpark, Amsterdam. It was found that the main reasons people mentioned for visiting the park was to relax and to listen and observe nature. Age differences were found in relation to the motives of the visit. While sporting and meeting other people apply to the youngest age-categories, the motives—relax, stay with children and contemplating nature—were preferred by adult and elderly visitors. The feelings of "freedom" and "unity with nature" are the most frequently mentioned feeling evoked by nature. People perceive the feelings and the emotions evoked in the park as very important contributions to their well being. Direct benefits are perceived in terms of regeneration of psychophysical equilibrium, relaxation, break from the daily routine, and the stimulation of a spiritual connection with the natural world.

2.4.9 Chiesura (2004) reported some results of a survey conducted among visitors to an urban park in Amsterdam. Those surveyed described feelings of freedom, happiness and luck associated with being in the park, and these were rated as being very important for their daily feeling of well

being. Most people said they visit the park primarily because they want to relax. The majority of respondents indicated dissatisfaction with the amount of urban green currently present in the city. Although lacking hard data, the results of this survey are in general agreement with the perception of urban greenspace as restorative elsewhere in the literature.

2.4.10 In a study carried out by Hartig et al. (2003) in Sweden, the experimental design crossed an environmental treatment condition (natural, urban) with a pre-treatment task condition (task, no-task), and measured blood pressure (BP), emotional and attentional outcomes in response to the 4 treatments. At 20 min into the treatment (and so 10 min into the walk), BP declined in the natural environment but increased in the urban environment. However, after the 30-min mark the trends for all four groups converged, thus the subjects in the nature reserve did not have substantially lower average BP values for the walk period as a whole. Thus, although change in BP during the walk initially indicated a restorative advantage of being in the natural environment, the environmental effect had largely dissipated by the postwalk.

2.4.11 Overall happiness (OH) scores reported on the walk and pretest-to-postwalk change in positive affect and anger/aggressiveness were sensitive to the environment and task manipulations. The greater OH of no-task subjects on the walk in the nature reserve, and the greater pretest-to-postwalk increase in positive affect and decline in anger/aggression, offer support for the nature restoration hypothesis. The no-task subjects showed greater positive affect increase in the natural environment than the task group, whereas in the urban environment the task and no-task groups showed similar declines. Subjects reported a decline in attentiveness during the experiment, an effect not modified by environment or task condition. Interestingly, gender differences were observed in perceived sadness of the subjects. On average, men in the task group became less sad in the urban environment and sadder in the natural environment, with the opposite pattern seen in "no task" men. In contrast, women in the task group became sadder on average in the urban environment and less sad in the natural environment. No-task women showed similarly small average increases in sadness in the urban and natural environments.

2.4.12 Kuo and Sullivan (2001) focused on an urban public housing complex in Chicago, and tested the hypothesis that nearby nature reduces the propensity for aggression. Long-term female residents of the apartment complex were interviewed. The authors found that levels of aggression and violence were significantly lower among individuals who had some nearby nature outside their apartments than among their counterparts who lived in barren conditions, and that residents living in greener settings demonstrated reliably better performance on measures of attentional functioning. When attentional functioning was controlled for in a regression between greenness and overall aggression, greenness was no longer a significant predictor ($\beta = -.13$, $p = .11$, $R^2 = .09$, $F = 6.5$, $p < .0025$) thus indicating that attentional restoration could be the sole mechanism underlying the nature-aggression relationship found. The authors invoke attention restoration theory (S. Kaplan, 1995; *J Environ Psychol*, 15, 169-182) as providing the best explanation for the link between nature and aggression.

2.4.13 In all of these studies, greenspace was positively associated with feelings of happiness and in two of them a reduction in aggression was noted. One study (that by Hartig) is notable for having used objective measures (blood pressure) to capture mood changes. The York report also notes similar findings but does not specifically separate this subject from a more general coverage of mental health in a wider sense.

2.4.14 Children. In this sub-section a number of papers are found to focus specifically on issues around mood, attention deficit disorder and self-discipline in children.

2.4.15 In another study by the same group, and at the same housing scheme in Chicago as described in the last paper of the previous sub-section, Taylor et al. (2002) examined relationships between near-home nature and self-discipline in children aged 7-12 years. The study tested for possible links between near-home nature and children's capacities for concentration, impulse inhibition, and delay of gratification. The authors were particularly interested in whether any effects

of nature might be moderated by gender. Findings for boys stood in striking contrast to those for girls. Whereas girls showed significant, positive relationships between near-home nature and each of the outcome measures, boys showed no significant relationships between near-home nature and any of the outcomes. The authors conclude that for girls, greenspace immediately outside the home can help them lead more effective, self-disciplined lives but suggest that perhaps more distant greenspaces are equally important for boys.

2.4.16 The same authors also conducted a study, also in Chicago, in a very specific group of children - those diagnosed as having Attention Deficit Disorder (ADD). In this work, Taylor et al. (2001) surveyed parents of children with ADD regarding their child's attentional functioning after activities in several settings. The results showed that the greenness of their play setting was related to symptom severity; ADD symptoms were milder for those children with greener play settings. Children who played in windowless indoor settings had significantly more severe symptoms than did children who played in grassy outdoor spaces with or without trees. The authors comment that their survey extends the validity of attention restoration theory from adults with normal attentional functioning to children whose attentional functioning is compromised.

2.4.17 In a study on Finnish children aged 8-9 or 12-13, Korpela et al. (2002) explored the relationships between restorative experience, self-regulation, and children's place preferences. Natural settings did not predominate among these children's favourite places and the study found no evidence that children associate cognitive restoration and relaxation with natural settings in particular, although there was evidence for self regulation strategies in connection with favourite places in general.

2.4.18 A paper by Whitehouse et al. (2001) focused on a garden that had been established for a children's hospital in San Diego, to determine whether the garden was meeting its goals of reducing stress, restoring hope and energy, and increasing user satisfaction. Of the survey respondents who knew of the garden's existence and had used it (n=52), the vast majority reported positive mood changes as a result of visiting the garden.

2.4.19 These studies offer mixed results, partly because they look at some rather different issues, even though the general theme is the same. There seem to be some gender differences in one study which could be worth exploring further. None of the studies is from the UK. Nothing specific on this can be found in the York report, which suggests that there is potential for more work in this area, especially in the way that children at risk can be helped by more use of greenspace, either as part of their everyday experience (which links to issues of play freedom discussed in the later section on social and community values) or in special programmes, such as in the treatment of attention deficit disorder, aggressive behaviour, poor discipline and performance at school etc.

2.4.20 Health effects of viewing landscapes. The next subsection changes from direct experience of nature/greenspace to indirect exposure through looking at landscapes. Four studies and one literature review were identified dealing specifically with the topic of the health effects of viewing *images* of different types of landscapes, which could be thought of as a specific subset of the restoration studies described above. As Verlarde et al. (2007) point out, links between landscape and health have been observed for a long time in many different cultures and societies and, as outlined above, there is a growing literature on the beneficial effects of "healing gardens" and "therapeutic" natural spaces.

2.4.21 In their extensive review of the literature, Verlarde et al. (2007) explore the types and range of landscapes used in environmental psychology studies, and the evidence of health effects related to viewing these landscapes. They point out that environmental perception is clearly multi-sensory, and not restricted to vision. However, vision is by far our most important sense in terms of yielding information about outdoor environments. How these visual cues affect various aspects of health and wellbeing was the focus of the review. Landscape categories and comparisons used in the included studies varied (e.g. range of greenery, nature vs urban, landscape vs no view, and sub-categories of nature and/or urban). Approximately half of the studies reported in the review were

conducted using images of landscapes (from a window, a video, and a photograph, etc.) but no exposure to real landscapes. The remaining studies were based on activities in real landscapes where the differences in treatment were the landscape type where activities were performed. The main health aspects of exposure to landscapes related to reduced stress, improved attention capacity, facilitated recovery from illness, amelioration of physical well being in the elderly, and behavioural changes that improve mood and general wellbeing. The identified health effects fall into three main types: firstly, short-term recovery from stress or mental fatigue (psychological); secondly, the physical recovery from an illness or reduced incidence of physical illness; and, thirdly, a long-term behavioural change and an overall improvement in wellbeing (increased social interaction and reduction of aggressive behaviour). Most of the health findings related to the urban/nature and landscape/no-landscape comparisons, where views of nature were found to provide greater positive health effects compared to urban views. Interestingly, the negative effects of viewing landscapes with no natural component were also collated in this review, showing in most cases the opposite trend as for natural views.

2.4.22 Several studies examined the influence of the immediate surroundings and views from public housing complexes in the United States on various measures of health, wellbeing, and satisfaction. Kaplan (2001) looked at correlations between what was visible from apartment windows (various types of views including natural - farmland, woods - and built elements - parking lots) and residents' feelings of satisfaction and general wellbeing (public housing in Ann Arbor, MI). The survey showed that having nature in the view from home played an important role with respect to both the satisfaction and the wellbeing measures. However, built components significantly detracted from residential satisfaction but did not affect wellbeing. Distinctions could be made between different types of natural views: views of gardens and flowers were important to satisfaction and effective functioning. Views of trees, by contrast, were more pertinent to the sense of being restored and having one's directed attention intact.

2.4.23 A short presentation published by the Countryside Agency (Hine, undated) presents some data on the effects of viewing different types of landscapes in an experimental setting in which 100 subjects exercise on a treadmill for 20 minutes while viewing different types of landscapes. While this is not a full report, the limited data presented indicate that blood pressure declined most if subjects were exposed to pleasant rural views and increased relative to the control situation (no view) with unpleasant urban scenes. The additional effect of concurrent exercise was not presented in this short report.

2.4.24 Van den Berg et al. (2003) undertook research in the Netherlands by showing people disturbing films, followed by a video of a natural and/or built environment, and then measured the potential restorative effect of the various images. Participants who viewed natural environments, as compared to participants who viewed built environments, showed significantly greater restoration on all five affective measures (depression, anger, tension, overall happiness, overall stress), and marginally better concentration.

2.4.25 In another experimental study in Norway, Laumann et al. (2003) tested the hypothesis that exposure to nature stimuli restores depleted voluntary attention capacity and affects selective attention. Before viewing a video of either a natural or an urban environment, 28 subjects first completed a proof-reading task to induce mental load and then performed Posner's attention-orienting task. While subjects who watched a video depicting a natural environment had significantly lower heart rate measured as the difference from baseline than subjects who watched a video of an urban environment, viewing the nature video compared to the urban video elicited less attentional selectivity, with the nature group performing significantly slower than the urban group on some measures of attention.

2.4.26 This subject is not covered in the York report as a specific topic, although there is some material on landscape preferences that could be seen to overlap. **The studies showed that viewing real or simulated natural (or non-urban) landscapes contribute to positive moods and actual restoration from stress.** The reviewed studies are from a range of locations, one from

the UK. In connection with studies on physical accessibility of greenspace there is scope for further evaluation of what might be termed “visual access” as well, perhaps as a surrogate or alternative experience for those people unable to visit greenspace in person. There may also be scope to explore any links between the positive effects of being able to view greenspace with its effect on housing price (see the section on Economic values of greenspace).

2.5 Health benefits of activities in greenspace settings

2.5.1 Several papers reported on the benefits to both physical and mental health of participation in activities in greenspace. In some cases, mental health benefits to subgroups of the population suffering from mental illness or depression were demonstrated, in others the potential psychological health benefits to the wider population were emphasised.

2.5.2 Evaluation of a project specifically aimed at the mentally ill in the community of Thames Chase Community Forest in Essex was reported by McGeeney (2004). The aim of the programme was to break down barriers to accessing the green environment for mental health users and to encourage them to gain therapeutic benefits from being outdoors. Participants [a selected group of mental health users, from the over 65s and severely mentally ill in the community and their occupational therapists (10 over 65s, 11 under 65s)] were offered a weekly two-hour session preceded by a lunchtime meeting, with the sessions including a range of activities designed to make the countryside appealing and interesting (bird watching, the medicinal and folklore use of plants, creating things from natural objects and conservation work). Although the data in the report is very limited, feedback from participants, their occupational therapists, and programme staff indicated the success of the project, with people saying they felt emotionally better for being taken into nature and shown things of interest. Overall everyone was very pleased with the programme and said that they enjoyed it a great deal: “Great satisfaction from all the sessions.”

2.5.3 In their 2005 book "Health, Well-Being and Social Inclusion - Therapeutic Horticulture in the UK", Sempik et al. provide a comprehensive description of the rationale, history and current status of social and therapeutic horticulture (STH) in the UK. Drawing on the results of a survey of over 800 horticulture and gardening projects throughout the UK, and in-depth case studies and interviews with vulnerable adults who use horticulture and gardening as a form of therapy, the book highlights the benefits of STH. Various case-reports describe improvements in mental health status or mood. Overall, 55% of interviewees stated large improvements in physical health and 26.4% feel fitter as a result of STH participation.

2.5.4 Pretty et al. (2007) sampled participants in 10 case studies in the UK focusing on green exercise (walking, boating, fishing, mountain biking, horse riding, woodland activities, conservation) to assess the psychological benefits of participation. They found that green exercise led to a significant improvement in self-esteem and total mood disturbance, with scores for anger-hostility, confusion-bewilderment, depression-dejection and tension-anxiety all improving post-activity. A limitation of this study was that the participants had already chosen to conduct these green exercise activities and were, therefore, drawn from a generally healthy and active part of the population at large.

2.5.5 Another aspect relevant here is the potential benefit to the participant of civic environmentalism. Townsend (2006) defined "civic environmentalism" as "voluntary communal actions undertaken to promote ecosystem sustainability, typified by membership of a 'friends of parks' group". In her 2006 paper "Feel blue? Touch green!", Townsend presents a summary of four civic environmentalism projects in Australia. Qualitative data gathered from these projects reinforces the intuitive view that belonging to an environmental group and taking part in the associated activities benefits the individual as much as the environment. The paper reports group members' perceptions and comments on a wide range of benefits relating to physical health, mental health, social health, human relationships, and feelings of meaningful occupation, to opportunities for contact with nature, creative expression, and making a positive contribution to human society.

2.5.6 One of the four projects also yielded some quantitative data on some health outcomes. "Trust for Nature" (TfN) is a community-based conservation organization that focuses on the protection of private land of high conservation value in the state of Victoria, Australia. Fifty-one TfN group members were questioned about their health, wellbeing and social capital and the data obtained were compared to data collected from 51 local community members (matched for age, gender and locality) who were not involved in conservation groups. General health scores were better in TfN members compared to controls, and the number of annual doctor visits was lower. The eponymous "Feel blue? Touch green!" was undertaken to explore the specific potential of nature-based activities for promoting health among people suffering from depression, anxiety and related social isolation. Self-selected participants undertook at least 10 hours of supported hands-on nature-based activities, with the impacts of the experience on the health and wellbeing of participants being evaluated. The finding of this ongoing study so far indicate that the improved mental health outcomes also relate to increased physical activity associated with project involvement. Townsend concludes that civic environmentalism has the potential to promote health, wellbeing and social connectedness for individuals and the wider population, as well as for groups with identified health vulnerabilities.

2.5.7 These studies contain evidence of different quality, although several are from the UK. The physical and mental health aspects can also be linked to some aspects of the sections on social and community values discussed next. There is scope for more work to improve the evidence base for the benefits to health of specific activities.

2.6 Hazards and risks associated with greenspace

2.6.1 The York Health review briefly describes six papers exploring hazards and risks associated with greenspace (risk to park workers of blood-borne diseases from discarded syringes, Lyme disease from tick bites, health risks associated with bird droppings, and health risks from sun exposure). Our literature search identified several related topics (e.g. levels of canine intestinal parasites and the possible associated health risks, exposure of children to toxic elements in playgrounds, etc), but few met the inclusion criteria for health outcomes - most were descriptive or risk assessments rather than demonstrating actual effects. A study (Buijs 1997) that did report data on *Toxocara* seropositivity in relation to use of public playgrounds found no association between *Toxocara* seroprevalence and assumed risks, i.e. contact with pet animals and public playgrounds. One area where defined health outcomes were reported was in the association between neighbourhood/playground characteristics and injuries to children sustained in playgrounds and parks. Six studies in this field met the inclusion criteria, albeit with limited relevant data in some cases.

2.6.2 *Neighbourhood and park characteristics associated with childhood injuries* Six studies emerged from the screening to deal with safety and injuries to children from playing in parks and play areas.

2.6.3 Kendrick et al. (2005) reported results from a cohort study comprising 1717 families (2357 children aged 0-7 years) registered at 47 general practices in Nottingham (UK). Multi-level Poisson regression examined relationships between electoral ward (neighbourhood), family and child characteristics and medically attended injury rates. The A&E attendance rate was higher in wards with a higher number of parks and play areas per 1000 children under 5 (possibly due to greater exposure to hazards within parks and playgrounds or on the journey to parks and playgrounds), but family characteristics were found to be more important in determining A&E attendance rates. The authors acknowledge that parks or play areas per 1000 children is a poor measure of exposure. Although the results are indicative of an association, the specific relationship between park density and injury rate would have to be examined in a study designed for that purpose, which this was not.

2.6.4 Most of the studies in this section looked specifically at the safety of different types of playground surfaces and equipment. LaForest et al. (2000) collected data on the severity of fall

injuries on sand or grass in playgrounds in Montreal, Canada. Although many of the injuries were sustained in a residential setting (and thus are not relevant for this review), the overall adjusted risk of fractures and head injuries and of other relatively severe injuries was 1.7 times greater on grass than on sand. The study concludes that that grass is not a good protective surface beneath play equipment.

2.6.5 Ball (2004) conducted a retrospective analysis of injury and fatality statistics associated with playgrounds in the UK. Most playground equipment related injuries occur in public playgrounds and parkland, but the risk of serious injury in UK playgrounds is actually small. Although impact-absorbing surfaces (IAS) have been implemented in many UK playgrounds in recent years, there is no apparent trend in injury cases.

2.6.6 In another UK study, Mott et al. (1997) found, not surprisingly, that rubber or bark surfacing is associated with a lower rate of injuries than tarmac or concrete surfacing in playgrounds. The authors believe the type of surfacing, the type of equipment and the height of equipment are the most important factors affecting the safety of children in public playgrounds. This was borne out by the results of a study by the same authors, in which they assessed whether playground improvements decreased injury rates (Sibert et al. 1999). Following changes to playground surfaces and equipment (greater depth of bark (600 mm instead of 300 mm) and replacement of monkey bars with rope climbing frames), injury rates in improved playgrounds were significantly reduced.

2.6.7 A study by Petridou et al. (2002) comparing injury rates in public and private playgrounds in Athens, Greece, found that the risk of injury was 2.2 times higher in public than in private playgrounds. The more serious consequences in public playgrounds appear to reflect the greater height of equipment, harder ground surface and poor maintenance (e.g. unsmoothed edges) encountered in many public playgrounds compared with most private ones (it should be noted that private playgrounds here included indoor establishments associated with fast-food restaurants, supermarkets, etc.).

2.6.8 Nixon et al. (2003) determined the frequency of use of play equipment in public schools and parks in Brisbane, Australia, and estimated an annual rate of injury per use of equipment. The annual injury rate for the 16 schools and 16 parks under observation was 0.59/100 000 and 0.26/100 000 uses of equipment, respectively. The authors conclude "The low overall rate of injuries/100 000 uses of equipment in this study suggests that the benefit of further reduction of injury in this community may be marginal and outweigh the economic costs in addition to reducing challenging play opportunities." This latter point was also made by Ball (2004), who raised the point that "safer" playgrounds may alter risk factors by encouraging riskier play activity, or displacing children to other, more high risk, locations in their search for stimulating play opportunities.

2.6.9 The studies described here clearly show how the way that issues of risk and safety in relation to physical injury and play areas are dealt with in design, for example, have an effect on rates of accidents. There is an interesting comment in the Nixon paper about the need to balance of lowering risk with reducing play values. This is an area where there is scope for more research – how to increase play values and also how increases in self-reliance and improvements in key motor skills such as suppleness, agility and balance affect activity types and levels in later life, such as maintaining a habit or undertaking physical exercise.

2.7 Summary of key points – effects of greenspace on health and wellbeing

2.7.1 As noted in the summary for each subsection in this section, there is increasing evidence for positive associations between greenspace and physical and mental health. The findings are in line with those of the York report, although this review has found material not covered by that study and does not cover some subject areas found there because nothing new that met the inclusion criteria came up in our search.

2.7.2 The key findings worth emphasising are as follows:

- The proximity and accessibility of greenspaces in relation to residential areas appears to affect the overall levels of physical activity/exercise. This is true of children and young people (the subject of one sub-section), older people (receiving special study at present) as well as generally for all age groups. Some studies show stronger associations than others.
- Many of the studies are based on self-reported data, which limits the value, although some of the studies on adolescent girls use objective data.
- Although not especially relevant to Scotland, greenspaces reduce the heat island effect which can help in turn to reduce heat stress among vulnerable people, such as older people, during the summer.
- Physical exercise in greenspaces is generally positively associated with promoting wellbeing and recovery from stress. However, only limited numbers of studies use objective measurements, such as blood pressure monitoring, to assess this: the rest use self-reported data.
- There is evidence that some behavioural or emotional problems in children, such as attention deficit disorder, can be improved by exposure to greenspace.
- Being able to view greenspaces also seems to have positive effects, especially on stress reduction or restoration. The studies also include some carried out using pictures rather than real landscapes, so that the evidence may be contradictory and need strengthening.
- Promoting active exercise of a specific type in at-risk groups such as sedentary men is strongly supported by the evidence from one robust study. This relates to golf, a very pertinent subject in Scotland. This is potentially an interesting approach if it could be applied to other at risk groups.
- Health benefits and social/community benefits may be linked when people participate in communal or group activities in greenspace. Whether there is something specific about performing such activities in greenspace, or whether it is the group activity itself, regardless of where it takes place, is not fully tested but potentially of great interest.
- Safety aspects of greenspace covered here (as opposed to those reviewed in the York report) relate to children's play, where the need for safety has to be balanced against the need for challenging environments to stimulate children and to help them develop motor skills. This is a subject that is becoming more important but lacks any research on the challenge side of the equation.

2.7.3 This summary demonstrates that solid evidence of a high quality remains somewhat elusive (at least according to the inclusion criteria adopted for this review) and there are still degrees to which the evidence is conclusive or inconclusive in many areas, even with the best evidence. There is almost no evidence based on Scottish data, although it is unclear as to the degree to which Scotland differs from England in terms of the demographic or urban issues of relevance here.

2.7.4 The papers not only reflect recent policy concerns but also trends in research. Much of this remains in development and more evidence in all areas is likely to emerge in the near future.

3. Social and community values of greenspace

3.1 Introduction

3.1.1 This section looks at a range of issues that may also be generally linked to health and wellbeing but are more associated with aspects of social or community cohesion, especially in areas where this is often a problem, such as areas of low income, poor housing and other aspects of deprivation and where the environment may also be of poor quality. Some of the topics are addressed in the York report. 132 articles were screened of which 44 were included in this review. Some included in the York review on the basis of the evidence for health were included here because of the emphasis on social and community values. They addressed the topics listed below:

- Effects of the physical environment on the coping strategies of people living in urban public housing: 4 papers
- Access to greenspaces and social inclusion/equality: 4 papers
- Gender differences related to public parks and recreation settings: 2 papers
- Greenspace, children and youngsters: perceptions, uses, effects: 10 papers
- Inequality and social cohesion including ethnic groups: 7 papers
- Ageing and environment: 3 papers
- Safety and danger in greenspaces: 3 papers
- Community involvement and community landscapes: 6 papers
- Social values of urban residents and strategies/tools for urban sustainability: 2 papers
- Community gardens, gardens, and social dimension of sustainable development: 2 papers
- Development of research methodology: 1 paper

3.2 Effects of the physical environment on the coping strategies of people living in urban public housing

3.2.1 A series of papers by the team of Frances Kuo consider the subject of urban public housing in Chicago and a number of different factors relating the environment to a range of social and community issues.

3.2.2 Kuo & Sullivan (2001) examined the relationship between vegetation and crime for 98 apartment buildings in an inner-city neighbourhood using data from crime reports. Results indicate that although residents were randomly assigned to different levels of nearby vegetation, the greener a building's surroundings were, the fewer crimes reported. This pattern held for both property crimes and violent crimes. The relationship of vegetation to crime held after the number of apartments per building, building height, vacancy rate, and number of occupied units per building were accounted for.

3.2.3 Kuo (2001) also tested whether the availability of green views and nearby greenspaces in poor inner-city neighbourhoods enhances residents' effectiveness in coping with poverty. The findings demonstrated that individuals who had some nearby vegetation were significantly more effective in managing their major life issues than were their counterparts living in barren environments. Furthermore, as would be predicted if this relationship were mediated by attention: residents living in greener settings demonstrated reliably better performance on measures of attention; IMMI scores of effective life functioning were directly proportional to attentional performance; the relationship between vegetation and life functioning scores became non-significant when attention was controlled; and the relationship between attentional performance and life functioning scores remained robust when vegetation was controlled.

3.2.4 Sullivan, Kuo, & DePooter (2004) investigated whether the amount of vegetation in a space is related to its use, the number of people engaged in social activities, and the proportion of social activities. The results showed that on average 83% more individuals engaged in social activity in green versus barren spaces. Moreover, for females, greener spaces were found to support proportionately more social activity than more barren spaces. However, the location of the spaces examined (front, back, or side of the apartment building) was not related to the amount of social activity observed. There was no significant relationship between green cover and the use of outdoor spaces for teens. The results showed that more individuals engaged in social activity in green versus barren spaces.

3.2.5 Coley et al. (1997) investigated the influence of availability of nature on the use of outdoor public spaces and social cohesion in public housing developments in Chicago. This study demonstrated that the presence of trees has an important impact on social cohesion in public housing developments and on residents' use of outdoor space. People in different housing developments showed different patterns of use of natural settings. The presence of trees may contribute to the social cohesion of communities via a variety of mechanisms: increasing face-to-face contact, increasing residents' satisfaction with their neighbourhoods, enhancing residents' social functioning. The presence of people in outdoor spaces could also help to make the area much safer.

3.2.6 These papers all refer to a specific type of urban area with a specific ethnic and social context, in Chicago. While the results appear robust there are questions over the applicability of the results to Scotland or the UK. In Scotland there are problems of poor environments in public housing areas but there are fewer ethnic issues. The methodology is interesting and there is scope to see whether, in the Scottish climate as well as social situation, similar results or associations could be found.

3.3 Gender differences related to public parks and recreation settings

3.3.1 This section looks at gender differences, in particular, the perceptions and use of greenspaces by women, the two studies being by the same team.

3.3.2 Krenichyn (2006) described women's patterns of physical activity in a park in New York and found that the physical space not only accommodated physical exercise but its aesthetic elements were also highly valued. In particular, the park offered a more 'smooth' and 'continuous' workout than streets and sidewalks, where activity was frequently interrupted as these women negotiated obstacles and dangers such as traffic, traffic signals, or car doors opening suddenly. Prospect Park also seemed safer and more 'controlled' than the streets; the aesthetic elements of the park were important for the women interviewed. They spoke about qualities of the park related to nature, the outdoors, and greenery. The park was 'locally and conveniently located' but was quite different from more remote outdoor settings like 'the country.'

3.3.3 Krenichyn (2004) also studied women's experiences of physical activities in Prospect Park, NY in an earlier study. Women found enrichment and support for both relationships and activities among family, friends, acquaintances, and strangers in the park, which provided feelings of safety and enjoyment. The presence of others and chance meetings in the park also provided emotional social support and more long-term affiliations to support athletic interests such as team sports.

3.3.4 This short section of two related papers nevertheless picks up a number of interesting aspects – the atmosphere, the sense of safety and the rich social environment. Given the concerns about safety expressed by women in the UK and mentioned in the York report, it would be valuable to take this subject forward. In Scotland, with its long winter nights, the issue of safety and comfort applies to everyone, but is especially relevant for women.

3.4 Greenspace, children and young people: perceptions, uses and effects

3.4.1 In this section some aspects of the use of greenspace by children are examined. There are many papers looking at this field, reflecting the current level of interest in the subject. The section is divided into three subsections looking at perceptions, environment and behaviour and play.

3.4.2 *Perceptions of greenspace and living environment* This subsection looks at two papers by the same team, looking at how children relate to and perceive their environment, including greenspaces.

3.4.3 Kyttä (2004) examined the interrelationship between the degree of children's independent mobility and the way affordances (a property of the perception of the environment in terms of "what it affords") in the context of the child-friendliness of the environment in Finland and Belarus. The focus was on the question of how these two are related to one another in different environmental contexts. For this purpose, Kyttä constructed a model based on the idea that the co-variation of independent mobility and the actualization of affordances define 4 types of children's environments: "Bullerby" (the ideal environment), "Wasteland", "Cell", and "Glasshouse". The opportunities for the actualization of affordances vary in these 4 environments. The Bullerby type of setting was the most prominent in the Finnish communities whereas the Cell, Wasteland, and Glasshouse were the most common type in the Belarussian communities. The proportion of Bullerby types decrease as the degree of urbanization increased. This shows that the level of urbanization affects the actualization of affordances through mobility licenses.

3.4.4 Korpela, Kyttä and Hartig (2002) looked at the role of restorative experience and self-regulation in the formation of place preferences by Finnish children. There were no statistically significant associations between age or gender and type of favourite place, nor was a particular type of favourite place named disproportionately often, independent of age and gender. One-third of the children reported using their favourite places for emotion-regulation. Use of the favourite place for restoration and emotion-regulation did not necessarily imply visiting the favourite place alone; however, 12-13-year-olds were more likely than the younger age group to visit the favourite place with friends. Most of the parents did not know their child's favourite place. Neither natural nor residential settings predominated among the children's favourite places in this study.

3.4.5 These two Finnish papers use an interesting approach, that of affordances, in the examination of how children relate to their neighbourhoods. **This method has not been applied in the UK and could help to highlight how children identify themselves with particular places and forge a place attachment.** This could also be related to play spaces in a neighbourhood of which greenspaces form a part.

3.4.6 *Environment and behaviour* The next subsection builds on the theme of place preferences and perceptions and relates this to children's behaviour.

3.4.7 Wells (2000) examined the effects of nature on the cognitive functioning of children in low-income families in a housing environment in Michigan, USA. It used a longitudinal design where children's cognitive functioning (i.e., attentional capacities) was assessed at 2 times (pre-move and post-move) and explored whether changes in cognitive functioning can be associated with changes in naturalness of the home. The new home environments did have significantly more natural character than the original housing. Results indicate that children whose homes improved the most in terms of greenness following relocation also tended to have the highest levels of cognitive functioning following the move. The change in the naturalness of the home is a statistically significant predictor of the post-move attentional capacity. The naturalness change score explains an additional 19% of the variance in post-move attentional capacity, beyond the 50% of the variance explained by pre-move attentional capacity. The findings suggest that the effects of natural elements within the home environment have a profound effect on children's cognitive functioning.

3.4.8 Min and Lee (2006) examined the relations between use and importance of a neighbourhood setting in South Korea to identify core behaviours in the setting most relevant to the children's place-space distinction and the formation of such important places. The distinction between 'places' and 'spaces' occurs at several different levels. It first can occur at a larger scale between the 'outside' world and 'within-neighbourhood' world. At lower levels, this type of distinction can apply between indoor settings and outdoor settings. Village children had greater interest in outdoor rather than indoor settings. They seemed to find many of their valued places in neighbourhood outdoor settings such as designated play areas and developed parks. Settings children mention to be important to them are utilized more often (about twice as much) than their counterparts. In these settings, a variety of behaviours take place, incorporating more intentional activities (as opposed to transient, short-lived ones), encouraging group behaviours (as opposed to single-person activities), and providing children with a sense of their own territorial play area.

3.4.9 Wells and Evans (2003) examined nearby nature as a buffer of the impact of stressful life events on the wellbeing of children in rural New York state, with two standardized measures of psychological distress (maternal report) and global self-worth (child self-report). The results of this study suggest that the presence of nearby nature moderates or buffers the impact of life stress on children. The psychological effects of stressful life events such as family relocation, being picked on or punished at school, or being subject to peer pressure varied depending on the amount of nearby nature to which the children, aged 6 to 12, had access. This moderating effect occurred with both dependent measures - parent-reported psychological distress and children's own reports of global self-worth. Together, these results offer evidence of the potential for nearby nature to moderate the impact of life stress on children. Stressful life events have less impact on psychological distress under *high nature* conditions than under *low nature* conditions.

3.4.10 Bixler and Floyd (1997) examined the relationships between Texan adolescents' fear expectancy, disgust sensitivity, desire for modern comforts and preference for wildland and build environments. Self-reports of negative perceptions of wildland environments were related to lower preference for wildland environments and activities and, to some degree, positively related to preference for indoor environments and activities. These relationships were found with this predominantly rural and suburban sample, in contrast to the assumption, stated in popular writings, that it is urbanites who tend to react negatively to natural environments. They concluded that, even at adolescent age, negative perceptions of wildlands are already playing a role in recreational preferences and future occupation choices.

3.4.11 This subsection on aspects of environment and behaviour produces some contradictory evidence in relation to adolescents and wild places, although it is unclear how wild places are defined. Aspects of cognitive behaviour associated with green areas are also interesting. Although this somewhat disparate set of papers points in the direction of greenspaces being valued by children and part of the way in which greenspace can help them develop and cope with the stresses of growing up, it would be interesting to explore the effect on children of not being able to explore their neighbourhood by themselves, nor to play there.

3.4.12 Children's play. In this subsection some areas of children's play in greenspaces are examined. They mainly cover freer types of play in a range of environments, or the use of natural materials in play. None deal with play in organised play areas.

3.4.13 Herrigton and Studman (1998) tested the hypothesis that the installation of natural material/landscape elements into the existing schoolyards in Iowa, USA, would offer additional types of child development (i.e. social, emotional, and cognitive). In general, the findings indicated that the permanent interventions like the vegetative rooms and stepping stones received longer bouts of interaction. They concluded that the link between how a child develops socially, physically, emotionally, and cognitively, and the characteristics of their outdoor environment is crucial for identifying processes and methods that will produce quality outdoor environments for children.

3.4.14 Veitch, Bagley, Ball and Salmon (2006) investigated parents' perceptions of individual, social and physical factors on their child's active free-play in Melbourne, Australia. Overall, the findings suggest that opportunities for outdoor play and independent mobility may be quite limited for many children. The issues that parents considered to have the most impact on their child's active free-play included: safety concerns; the child's level of independence; social aspects; attitudes to active free-play; facilities at parks/playgrounds; and environmental/urban design. Children living in *courts or culs-de-sac* appeared to have greater autonomy for active free-play because parents perceived their court to be a safe place for children to play and, as such, courts were used regularly as a play area. There was a high level of concern among parents from low socio-economic status (SES) areas regarding teenagers loitering in parks and other public open spaces. Children's opportunities for active free-play were impeded by parental safety concerns mainly regarding fears of strangers, teenagers/gangs, and road traffic. Children with limited independent mobility (limited ability to walk or cycle around neighbourhood unaccompanied by an adult) are restricted in their ability to access public open space and consequently are dependent on their parents having the time and motivation to take them to places to play. Parents indicated that their child was much more likely to play outdoors if he or she had friends or other children their age to play with.

3.4.15 Bixler, Floyd, and Hammit (2002) investigated the relationship between frequency of childhood play in different physical environments and environmental preferences in the USA. Results suggest that childhood play influences later interest in wildlands, environmental preferences, outdoor recreation activities, and occupations in outdoor environments. Respondents reporting having played in wild environments had more positive perceptions of natural environments, outdoor recreation activities, and future indoor/outdoor occupational environments. Although environmental attitudes and activism were not directly measured, there is little indirect evidence among the results for a relationship between childhood play in wildlands and environmentalism. No significant differences were found for preferences for environmental sciences activities conducted in schools. They concluded that childhood play in wildland environments is related to environmental competencies and preferences but not necessarily an intellectual interest in environmental sciences or environmentalism.

3.4.16 Bell et al (2003) explored the uses and meanings of woodland by children and teenagers in Central Scotland. They found that woodland is important for children and teenagers, though to different degrees and at different times in their development. Late teenagers/young adults pose a challenge to adult hegemony of public place; they are seen as troublemakers and excluded or marginalised as a result. This study also underlines the key role that childhood experience plays in people's relationship with place. Three elements stand out from this research: the tensions between parents and children in terms of protection versus the need to play freely; the tensions between different age groups of children/teenagers over their desires to use woodlands for play and social activities; and the tensions between adults and children/teenagers over the kind of activities falling into the categories of use and abuse.

3.4.17 These four papers on play relate in some ways to the aspects on place identity in the previous sections and in two cases the issue of parental/adult concerns on the freedom of children and teenagers is examined from the point of view of safety and also what activities count as play. The role of natural materials in schoolyards could receive more attention. **This perhaps supports the growing evidence that link children's early patterns of association with, and use of, greenspace with later adult habits.**

3.5 Inequality and social cohesion

3.5.1 This section covers somewhat similar aspects to that on social inclusion but it focuses more on issues of cohesion amongst and between different groups such as those defined by ethnicity, age or disability. This is about the role that greenspace can play as a stage for different social groups to come together and interact while they otherwise may live, work and participate in leisure in different places where they are unlikely to interact.

3.5.2 Ravenscroft & Markwell (2000) examined the extent to which the provision of parks promoted social inclusion among urban youth in Reading in the UK. They found there was a consistently greater percentage of black and Asian park users than the proportion of ethnic minority residents in either the town or the neighbourhood of the parks. There was a high correlation between the location of people's homes and the parks that they use. Over half of those interviewed took less than 5 minutes to reach the park, while over 90% took less than 15 minutes. While there is some evidence of mixed ethnicity (certainly involving Asian and white youths) in the large parks, usage of the neighbourhood parks displays a greater degree of apparent segregation. Although Black and Asian youths account for a disproportionate number of park users – and also spend longer in the parks than their white counterparts – black youths in particular tend to experience lower levels of user satisfaction than either white or Asian youths. The lower levels of satisfaction recorded for young black people largely reflect their concerns about their personal safety. The fact that most of the ethnic minority usage takes place at the least satisfactory sites indicates that elements of exclusion may still operate, despite the overall usage patterns.

3.5.3 Gobster (1998) conducted a case study of Warren Park in Chicago to show that it serves a counter example to *green wall* thesis – the idea that parks form barriers between and segregate different communities on either side. He found that the Warren Park case study stands as a counterexample showing that reductions in amenity values do not necessarily follow when parks form boundaries between diverse neighbourhoods. Even though Warren Park conforms to the definition of a boundary park, it appears to be successful in serving diverse neighbourhood residents. This conclusion was based on comparing the proportion of park users from different groups to the proportion of their populations in the nearby neighbourhoods, estimating use levels and the presence of different social and activity groups within the park, and looking at the kinds of interactions that take place between individuals who are from different racial and ethnic groups.

3.5.4 Surprisingly few papers addressed the specific use of greenspace by different ethnic groups, given that agencies such as Black Environmental Network (BEN) have highlighted the general lack of information and focus on ethnic community environmental participation. A BEN report by J.L Wong describes the creation of a space within a park after consultation with local ethnic communities. The Mughal garden (designed based upon the underlying principles of Mughal architecture) appears to be appreciated and well used by the local Asian community, e.g. (from the report) "Every day at 8.30 in the morning you can witness over 50 ethnic minority women walking for health in Lister Park."

3.5.6 A study by Tinsley et al. (2002) addressed differences in use and perceptions of parks by different ethnic groups. Visitors to a large urban park (Lincoln Park, Chicago, IL) were interviewed to determine their reasons for being in the park, the social context of their visit, and the types of psycho-social benefits they associated with park visits. The survey found that Caucasian park users visited the park less than three or four times a week and more than once a week. The Asian park users visited the park, on average, between once a week and once a month, and the African-American and Hispanic park users reported that they averaged one visit a month to the park. African-American park users were more likely to visit the park with their friends while Caucasian park users were more likely to use the park alone or with a member of their immediate family. African-American respondents rated pleasure seeking, personal self-enhancement, and exercise as more important psycho-social benefits than Hispanic and Asian park users while the Caucasians rated exercise as a more important benefit than did these groups. All ethnic groups reported a sense of immediate pleasure and the opportunity to engage in simple, non-challenging activities without the need for complicated planning or the necessity of a long-term commitment. All four

ethnic groups reported that Lincoln Park provides a wide variety of psychosocial benefits to older Chicago dwellers, with specific differences in self-reported benefits being largely explained by individualist (Caucasian) and collectivist (other groups) cultural orientations.

3.5.7 Lee and Scott (2002) examined the extent to which socio-economic status, race, and gender comprise three indicators of outdoor recreation behaviours in parks in Texas. All independent variables – socio-economic status, race, age and gender - show a significant relationship to recreation participation away from home as well as in recreation close to home. The results also support the hypothesis that elderly females from minority ethnic groups with low educational achievement and low income are the lowest users of parks while young educated higher income white males are the most frequent visitors. Age was the most important factor in explaining people's outdoor recreation participation away from home, close to home, and state park visitation.

3.5.8 Cohen, Inagami, & Finch (2008) explored an area in Los Angeles to examine which social and environmental features were associated with personal reports of collective efficacy (the ability or effectiveness to work together or interact positively). Generally, the presence of parks was a positive feature while the presence of shops selling alcohol was a negative feature. They concluded that certain environmental features set the stage for neighbourhood social interactions, such as parks, which were positively associated with collective efficacy. Altering these environmental features may have greater than expected impact on health.

3.5.9 Gobster (2002) examined outdoor recreation use patterns and preferences among a racially and ethnically diverse clientele in Chicago's largest park. Results showed that park users from minority ethnic groups came from farther away to use the park, more often came by car, used the park less frequently, and were more likely to visit in large, family-oriented groups than white park users.

3.5.10 Germann-Chiari and Seeland's (2004) research goal was to analyse the potential of urban greenspaces to provide opportunities to integrate different groups, such as youths, elderly people, and foreigners. A comparison between Geneva, Lugano, and Zurich showed that Geneva has the best opportunity to make the most of the social integrative potential of its available greenspaces. They concluded that where social segregation is often responsible for tensions and conflict, where social change, loss of employment opportunities and value orientation creates ghettos, it is time to mobilise the potential of greenspaces as platforms for social encounter.

3.5.11 Seeland and Nicole (2006) focused on disabled users' perceptions of a park in Germany, and on the parks' potential for providing more of the amenities and services that encourage social inclusion of visitors with disabilities. A striking result is that most disabled users indicated they would refuse services meant to improve their social inclusion as visitors to the island because they felt stigmatised by these services. So-called "weak users" (the researchers' term) by contrast, favoured more active use of the park and were more ready to accept services to ease their handicap. This survey indicates that disabled users have their own views and outlook on what they need and want park and landscape architects to do for them.

3.5.12 Sugihara and Evans (2000) examined the role of design characteristics of a residential retirement community in the USA in fostering place attachment and social support to elderly residents who had recently relocated. Residents who live closer to the activity centre, those whose residences enhance the probability of unplanned social encounters, and those whose homes are near a gardening space report greater place attachment to their community. Walking distance from individual cottage units to the main activity centre of the residential retirement community, functional distance, and the placement of outdoor gardening areas all reveal small but statistically significant correlations to place attachment.

3.5.13 Kweon et al (1998) investigated the contribution of urban greenery to the social integration of older adults with their neighbours in deprived, public housing communities in Chicago. They concluded that exposure to common greenspace is associated with social integration, a key

component of wellbeing and recommended that modest improvements in wellbeing can be achieved through creating neighbourhood settings that support the formation of social and community ties, with, among others, the provision of greenspace.

3.5.14 This diverse collection of papers show different findings that are difficult to synthesise together. **There are clear patterns in some places of common greenspaces – be they parks, gardens or communal spaces in housing – facilitating the formation of social and community ties and also fostering place attachment.** Other studies show some tendencies for segregation between some communities. None of these studies on specific locations is from the UK or Scotland and so it is difficult to determine whether the same results would be found here.

3.6 Perceptions of safety and danger in greenspaces

3.6.1 This section looks at some aspects of greenspaces and the perception of safety and danger, especially in terms of design.

3.6.1 Jorgensen, Hitchmough and Calvert (2002) examined the relationship between spatial arrangement and vegetation structure by surveying residents in one area of Sheffield using pictures of different types of vegetation. Findings showed that more open woodland spaces were considered safer than closed ones, that whereas sparser vegetation is preferred in close views, denser vegetation is preferred when viewed from a distance and that naturalistic shrubby edge treatments were considered unsafe relative to less dense treatments. They concluded that spatial arrangement was not related to preference and the significant determinant of preference was edge treatment.

3.6.4 Herzog and Chernick (2000) investigated perceived tranquillity and perceived danger in urban and natural settings in the USA using university students as subjects. The purpose was to investigate perceived tranquillity (theoretically a combination of moderate fascination and aesthetic pleasure) and perceived danger in urban and natural settings. Tranquillity was rated higher in natural than in urban settings, and the reverse was true for danger. Part of this was accounted for by “setting care” by which is meant maintenance of the area involved.

3.6.5 Jorgensen, Hitchmough, & Dunnett (2007) evaluated residents’ perceptions of the aesthetic and safety aspects of woodland at Birchwood in Warrington. Findings show that urban dwellers often hold ambivalent feelings towards naturalistic or wilderness-like urban greenspaces. Woodland in the local area figured prominently amongst the residents’ favourite places, although some feared that they would be the victims of physical or sexual assault, or of robbery or intimidation from groups of young people in the woodland, and women felt particularly vulnerable. The implications for planning, design and management with ecological woodland are explored: urban dwellers should be able to choose their preferred way of interacting with the woodland, residential settings should accommodate a wide variety of user needs, and the vegetation on and around the streetscape should be proactively managed in consultation with the community.

3.6.6 Kuo et al. (1998) investigate inner-city residents’ responses to the incorporation of trees and grass in their neighbourhoods, addressing especially the possibility of safety concerns (in Chicago). Contrary to predictions made by law enforcement officials and some housing managers, residents’ responses indicated that basic landscaping would be very welcome. As far as residents were concerned, the greener the space the better. At the same time, there are multiple indications that residents feel safer when views are not blocked. Together, these findings suggest that the most promising tree configurations are dense yet maximise view distances. Tree planting and grass maintenance may be a cost-effective, viable step in addressing many of the ills plaguing inner-city neighbourhoods. The three general recommendations of this study were: (a) the greener the better, (b) maintain view distances for sense of safety, (c) involve residents in all phases of greening efforts.

3.6.7 This section shows that there are no clear patterns of perception of safety, with some studies showing apparently clear results (natural safer than urban) and others more ambivalent findings, especially regarding woodlands. This may reflect cultural differences. Design issues also emerged, with some fairly clear design guidance on layout. This is clearly an area with a lot more potential for research using larger sample sizes and different types of area.

3.7 Gardens

3.7.1 This small section focuses on gardens and their role and value, ranging from the provision of food to strong wellbeing aspects.

3.7.2 Ferris, Norman and Sempik (2001) carried out a survey of a range of community gardens and develop a typology of types of gardens – leisure, child/school, entrepreneurial, crime diversion, healing/therapy, and neighbourhood pocket parks. This descriptive study showed that urban greenspaces and community gardens can be linked to sustainable policies and used to promote environmental equity.

3.7.3 Gross and Lane (2007) examined the meaning of domestic gardens and of gardening at different points in the lifespan in the south Midlands of England. In childhood, the garden is experienced as a place to develop social relationships with peers, siblings and nature, largely through imaginative and active play. In late adolescence and adulthood, it is experienced as an occasional place to escape to. In late adulthood, the concept of retreat assumes a different meaning. The garden can come to reflect individual limitations and changing abilities or a retreat from a public role.

3.7.4 Armstrong (2000) documented the characteristics of community garden programs in New York to identify those that may be useful to facilitate neighbourhood development and health promotion programs. The most frequent reasons for participating in gardens were: access to fresh foods, to enjoy nature, and health benefits. Gardens in low-income neighbourhoods (46%) were four times as likely as non low-income gardens to lead to other issues in the neighbourhood being addressed – mostly due to organizing facilitated through the community gardens. Many of the community gardens seemed to facilitate improved social networks and organizational capacity in the communities in which they were located, especially in lower income and minority neighbourhoods. Gardens seemed to provide a symbolic focus for some neighbourhoods, which increased neighbourhood pride and the aesthetic maintenance of neighbourhoods. They concluded that community gardens involve important health promotion characteristics in minority communities, such as social support, informal networking, and promotion of community organization programs.

3.7.5 This small section highlights the importance of gardens as both personal and shared spaces with a range of values. It would be worth exploring how gardens – as private or public/community spaces – function in different areas, such as private gardens in suburbs, shared private gardens in cities or community gardens and allotments elsewhere. Gardens form a large proportion of greenspace, yet little has been researched on them.

3.8 Summary of key points – social and community values of greenspace

3.8.1 This wide ranging section has explored the literature in relation to different aspects of social and community values of greenspace.

- Many studies examined the link between greenspace and people's health and well-being. Disadvantaged urban places, such as public housing settings have received special attention. Social aspects, such as social cohesion, are associated in the case of certain sections of society who may feel excluded for one reason or another with an overall sense of wellbeing..
- Individuals who have some nearby vegetation or live closer to greenspace seem to be more effective in managing major life issues, coping with poverty and performing better in cognitive tasks. This applies to both adults and children, especially those living in difficult social or economic circumstances.
- Greenspace and vegetation provide different benefits to urban dwellers in diverse ways. For children, the research findings show a clear pattern of cognitive and social benefits. For older people, there is a connection with place attachment. Some of the findings relate to specific locations, mainly non-UK and there may be problems in transferring the application of the results to places with different social and environmental conditions, such as Scotland.
- Amount of vegetation (e.g. tree density) is not necessarily correlated with lack of safety or crime, as has been previously stated in some studies. The whole area of safety and design of greenspace is still open for much more research as the evidence to date is contradictory and may depend on many local factors, given the way the research has been conducted to date, with small groups of respondents in specific local areas.
- In terms of research methods, most studies are based on correlational designs and the findings cannot support cause-and-effect conclusions. Several studies are descriptive and based on case-studies. This opens up the scope for further work with more attention to cause and effect relationships.
- In theoretical terms, the concept of affordances has been used to guide some of the empirical studies. This is noted when there is a concern in determining how greenspaces can affect well-being in a wider sense. There is scope to develop this approach in further research.
- In relation to practice and application – many studies tried to link research and design by showing how the research findings could inform design. However, this is not done in a systematic way and the guidance may be location specific. There is scope for more research and development in this area.
- Issues of gender, ethnicity, ageing and disability have received limited attention and some of the studies undertaken do not have a strong methodology. This needs to be improved if further research is to be robust and taken seriously.
- Greenspaces are perceived differently by different age groups (see comments on Gross and Lane's study) but this is not considered in practice to any large extent. As people move from one life stage to another and use greenspaces differently then their needs will change but so far this has not been considered.
- Some studies which are methodologically quite robust may not be transferable due to the specific social or economic situation of the study location.
- There is some evidence that greenspaces do actually promote social cohesion amongst and between different groups in different places, such as parks and gardens. In a multicultural society of increasing demographic complexity this is worth further exploration.

4. Economic value and impacts of greenspace

4.1 Introduction

4.1.1 Fifty three papers were screened from the initial collection, out of which 26 were deemed relevant. The bulk of reviewed literature consists of hedonic pricing and contingent valuation studies, with cases drawn from the USA, the Netherlands, Spain, Finland, China and New Zealand. The initial search included a range of terms, such as economic regeneration, inwards investment and tourism but failed to identify any research that would meet the inclusion criteria. This is itself a considerable gap in research. In this section the themes of the research, such as property values and greenspace, are also strongly connected to the methods used, so the organisation is slightly different compared with other sections.

4.1.2 The papers included in the review comprised:

- 1 review of ecosystem services conferred by green space, introducing the concept of green GDP (Boyd 2007)
- 1 review of economic valuation methods (Bräuer 2003)
- 1 meta-analysis of 30 studies that tested the 'proximate principle' in the case of urban parks in North American cities (Crompton 2001)
- 14 hedonic pricing studies, exploring the perceived value of green space reflected in property prices in the vicinity
- 7 contingent valuation studies, exploring willingness to pay for various types of green space
- 1 travel cost demand survey in national forest areas of the Apalachicola River region, Florida, USA (Shrestha, Stein and Clark 2007).
- 1 study of local economic and environmental governance in England (Jonas and Gibbs 2003)

4.2 General approaches to the use of economic valuation for greenspace

4.2.1 This first section comprises two papers looking at some general aspects of how to evaluate economic aspects of greenspace, especially in terms of biodiversity and ecosystem services.

4.2.2 Boyd (2007) reviews non-market benefits of nature and introduces the concept of green Gross Domestic Product (GDP) to describe and evaluate them. He suggests that green GDP, the sum of ecosystem services that determine the beneficial products of nature, could be used to judge the effects of public policy. Ecosystem services are defined by economic principles and assessed on the basis of welfare, rather than input-output values.

4.2.3 Bräuer (2003) studied the use of economic evaluation for biodiversity conservation. He concluded that economic evaluation provides a useful methodology to integrate environmental goods in the political decision making process. Money links environmental goods with the economic world and promotes the acceptance of biodiversity conservation by showing its benefits. Most biodiversity conservation programmes are suitable for economic evaluation. It can only help to examine whether environmental policy meets the preferences of the public but fails to offer any information about environmental impacts or quality.

4.2.4 This section suggests that a number of approaches exist which are becoming more robust and applicable. These could be evaluated and developed further as tools, for example, for households or local authorities.

4.3 Meta-analysis

4.3.1 This section contains one paper looking at a metanalysis of other work. This is a useful approach to obtain a larger picture from a lot of smaller research.

4.3.2 In a meta-analysis of a number of empirical studies Crompton (2001) looked at the impact of parks on property values in the USA. He concluded that 20 out of the 25 reviewed studies suggested the proximate principle (i.e. that proximity to urban parks increases property values); (4 of the 5 non-supportive studies were found to be methodologically flawed). The proximate principle was also found to apply in rural areas. The park's design, maintenance and visibility affected proximate values. He suggested a general guideline of a proximate value increase for properties facing or close to parks to be 20%. The proximate effect appeared to extend from 500-2000ft or more in the case of large parks.

4.3.3 This approach might be fruitful in the UK in order to try to strengthen the evidence from a larger range of studies, if such studies exist.

4.4 Property values and greenspace: hedonic pricing studies

4.4.1 This set of studies use property price datasets to test various formulations of the '*proximate principle*': the positive effect of greenspace on property values in the vicinity, because, according to the theory, it reflects buyers' valuation of greenspace amenities. Most hedonic pricing studies refer to North American cases; a few studies from Finland, the Netherlands, Spain and China were also reviewed. Evaluated green space types ranged from urban parks, urban forests and conservation areas to agricultural and derelict land.

4.4.2 North America

Cho, Poudyal and Roberts (2007) used hedonic valuation modelling to determine the spatial variation in amenity values for both quantity and quality of contrasting types of open space (evergreen and deciduous forest) in the housing market in Knoxville City and Farrangut Town, Tennessee, USA. They found that proximity to mixed forest is valued significantly more than proximity to homogeneous forest patches, while proximity to deciduous patches is negatively valued. Residents of a neighbourhood value a continuous forest tract more than one where the same amount of forest area is in fragmented and isolated patches. Forest patches are valued in the rural-urban interfaces but exercise negative effects in the urban core area, possibly because larger forest blocks are more valued in the Urban Core area where land is dominated by impervious surfaces and buildings with little vegetation. A gradual decrease in the positive value of larger forest blocks as one moves away from the city centre was noted in this study.

4.4.3 This research demonstrates that amenity values of different open space features vary according to degree of urbanisation and concludes that real estate developers and city planners can preserve or enhance housing value by considering the size, spatial configuration, and species composition of open space in residential neighbourhoods.

4.4.4 Georghehan, Waigner and Bockstael,(1997), in a study of spatial landscape indices in a hedonic framework, carried out an ecological economics analysis using GIS in and around Washington DC. They found that in general, more open space increased the selling price at a neighbourhood scale but decreased it at a regional scale (agricultural land, forest). Increases in diversity and fragmentation were not generally valuable features, although they were highly valued in almost all urban Washington DC suburbs and where rural land predominates. They concluded that the nature and pattern of land uses surrounding a parcel have an influence on its price. The effect of landscape features on parcel price is different, depending on whether the parcel is in an urban, suburban or rural area.

4.4.5 The same authors also looked at the value of open spaces in residential land use in Maryland in 2002. They found that individuals value permanent open space in their residential choice. The value of permanent open space is capitalised not only in individual farmland prices, but also in the surrounding residential land prices. This can lead to an increase in land tax revenue from the parcel, yielding a return on the land preservation investment, which could be targeted to finance other conservation investments, or local government.

4.4.6 In another study from Maryland, Irwin (2002) looked at the effects of open space on residential property values. She found that surrounding open space significantly influences the residential sales price of houses. Different types of open space had differing effects. Spillover effects from preserved open space were significantly greater than those associated with developable farmland and forest. She concluded from this that the public's demand for open space preservation is motivated more by the fact that open space implies no development rather than being driven by particular features of open space landscapes. Specifically, significant additional benefits were estimated to accrue to neighbouring residential properties given a marginal change in the landscape from any of the developable open spaces to preserved open space uses. The benefits of preserving any particular piece of open space were a function of the number of residents within the neighbouring area, their preferences, and the relative scarcity of open space in the region.

4.4.7 From Portland, Oregon, Lutzenhisher and Netusil (2001) examined the effect of open spaces on a home's sale price. They found that natural area parks have the largest statistically significant effect on home sale price. Golf courses, specialty parks/facilities and urban parks were also found to have a statistically significant effect. Park size and distance from the home have statistically significant effects on home price. They concluded that all open spaces in Portland have a statistically significant positive effect on home sale price, although this effect varies with park type and distance from home. Natural area parks were estimated, on average, to have the highest statistically significant effect; this effect also has the longest reach: up to 1500 feet.

4.4.8 In a study in Boulder Colorado, Riddel (2001) applied a dynamic approach to estimating hedonic prices for environmental goods to open space purchase. She found that an active open space purchase programme was responsible for higher house prices, a modest amount of commercial and residential expansion, and a drop in the average wage. One important outcome of the Boulder open space purchase program has been leapfrog development of areas outside the greenbelt. She noted the limitations of applying cross-sectional methods such as the hedonic property method when environmental quality trends are the focus of the investigation. Significant lags in the incorporation of resource values combined with the potential endogeneity of the environmental good provision may lead to erroneous inference regarding the market effects of a trending non-market good.

4.4.9 Shultz and King (2001) used census data for hedonic price estimates of open space amenities and land use in Tucson, Arizona. They found that proximity to the large protected natural areas, golf courses, and Class II wildlife habitats, as well as the percentage of vacant and commercial land use, positively influences housing values. By contrast, proximity to undeveloped and neighbourhood parks, Class I wildlife habitats, as well as percentages of industrial land use and high levels of housing density, negatively influences housing values. Among the open space amenity variables, neighbourhood parks had the greatest relative influence on housing values, followed by Class II river/wash habitat, regional/district parks, and large protected natural areas.

4.4.10 In North Carolina, Smith, Poulos and Kim (2002) looked at ways of treating open space as an urban amenity. They looked at different types of open space and found that golf courses are desirable open space amenities. Greater distance from golf courses reduced adjusted prices and was statistically significant. Proximity to vacant land also has a positive effect on property price, whereas proximity to agricultural and forested land had a negative effect in this study. They considered the reason for this to be the effect of anticipated changes in use (development) that would make proximity to these locations less likely to provide open space amenities in the future. Public parks did not provide the same types of amenities as golf courses or vacant land. They concluded that the results confirm the importance of private open space for residential home values. The estimated effects of golf courses and private vacant land suggest they may well be associated with open space amenities. The effects of land uses that contribute to open space also change as the overall density of land uses change.

4.4.11 Europe - in Europe, there are studies from the Netherlands, Spain and Finland

4.4.12 In the Netherlands, Luttik (2000) examined the value of trees, water and open space as reflected by house prices. He found that the impact of green areas was ambiguous; in many cases, the hypothesis that a green structure attracts a premium had to be rejected. The effect of water bodies and open space could be demonstrated in almost every instance. Attractive landscape types were shown to attract a premium over less attractive landscape types (such as monotonous arable landscapes). The most influential environmental attribute was the presence of water features. Greenspace in residential areas was shown to attract a premium in a number of cases. He concluded that these findings advocate the preservation of existing green areas in residential areas and creation of green areas in new urban developments. It proved to be much more difficult to demonstrate the effect of a park or a recreational area bordering the residential area. Attractive regional features were demonstrated to have a considerable impact on house price.

4.4.13 In Spain, Morancho (2003) carried out a hedonic valuation of urban green areas. She discovered that house price relates inversely with the distance that separates it from an urban greenspace. Nevertheless, though being significant, this effect seems to be rather small compared with the influence of other variables such the living area of the dwelling or its status with respect to official protection regulations. She concluded that as far as environmental variables are concerned, only the distance from a green area is significant.

4.4.14 Finland has produced two hedonic studies from the same research team headed by Tyrvaïnen. Some contingent valuation studies are also reported (see next section). In the first study (1997) property age and distance to the town centre seemed to be the strongest explanatory variables for apartment prices. The environmental variables were all significant at the 5% level, except distance to wooded recreation areas, which was significant at the 10% level. On average, increased size of the property and the amount of forest in the housing area, as well as its nearness to watercourses and recreation areas, increased apartment prices. In contrast, forest parks had a negative effect on prices. In this particular case, a change by building in the recreation area would decrease the total value of apartment prices in the district by approximately 7%. She concluded that the results show that the environmental variables, with the exception of direct distance to the nearest forested park, had a significant positive influence on apartment price. This study suggests that the effect of urban forest on property prices is nonlinear rather than linear.

4.4.15 Tyrvaïnen and Antti (2000) also examined property prices and urban forest amenities in Finland. They found that a 1 kilometre increase in the distance to the nearest forested area lead to an average 5.9 % decrease in the market price of the dwelling. Dwellings with a view on to forests were on average 4.9 % more expensive than dwellings with otherwise similar characteristics but no view. They concluded that by comparing urban forest benefits with the provision and management costs of the areas could serve as a tool in the formulation of appropriate urban land-use policy. The estimates would also help in justifying the improvement of degraded environments.

4.4.16 China Three hedonic valuation studies from Chinese cities highlight some of the differences between rapidly expanding cities of Asia and Europe and North America in the ways greenspace is appreciated.

4.4.17 Jim and Wendy (2006, 2007) investigated the position of outdoor environmental quality in house-buyers' preferences and assessed monetary values attributed to environmental externalities by the hedonic pricing method in the city of Guangzhou. They found that the most important home-buying motive was improving the living space, followed by increasing floor area of the dwelling unit. Environmental elements within and around residential precincts were accorded seventh and eighth ranks, below price, security, quality of public transport, etc. The internal environment was found to be somewhat more important than the external one in residents' choice. Proximity to water bodies was also more important by contributing to in situ quasi-public greenspaces and in so doing secured an implicit value. Greenspace was ranked first inside residential grounds and second around but only if it could be used by residents. However, greenspace around the residential area

but not open to the public was accorded the lowest rank. The ecosystem services and visual benefits of such inaccessible spaces were valued but at a relatively low level. Housing environmental attributes imposed both positive and negative effects on price.

4.4.18 Similarly, a GIS-based hedonic pricing study in Jinan City, China (Kong, Yin and Nakagoshi 2007) evaluated the implicit, non-market price benefits from urban greenspace on house prices. This study also found that various types of public greenspace with varying attributes differ in their impact on housing price. Proximity to scenery forest had a positive amenity impact, raising the house value by 5% for each percentage increase in the size-distance index. People in Jinan prefer to live in a quiet and comfortable environment, with homogeneous land-use in the immediate vicinity of their houses. Properties with a higher percentage of greenspace area within a 300m radius have higher house values, with each percentage point of greenspace adding about 2.1% to the price per square metre. Accessibility to plazas displayed slightly higher significance than accessibility to parks. The authors noted that although residents seem to appreciate green housing districts and easier accessibility to scenery forest areas, there is a serious conflict between the attractiveness of scenery forest to immigrants and protection of scenery forest as source areas for the region's springs, which raises the need for governments to develop policy initiatives to preserve and allocate many more public greenspaces.

4.4.19 The main findings of the hedonic pricing studies are as follows:

- Most but not all studies suggested that proximity to greenspace has a statistically significant effect on house prices.
- Not all types of greenspace had the same effect; depending on local situations certain types of greenspace had a negative effect on house price.
- Often, but not invariably, parks with a natural character have the highest statistically significant effect; this effect also has the longest reach.
- The effect of landscape features on property price is different, depending on whether the property is in urban, suburban or rural area.
- Comparison of studies from North America, Finland, the Netherlands, Spain and China suggests significant differences in the degree to which greenspace is valued, as well as in the relative contribution of other environmental attributes to house price.
- The different types of property market may affect the application of these results to Scotland. However, in all studies sales of houses, not rental, were used.
- The type of greenspace tended to be associated with different countries – the value of water could be said to be characteristic of the Netherlands while forest is very typical for Finland. Golf courses were significant in the USA and are common in Scotland too!
- In the USA, protected areas had a major effect. This may be the case for greenbelt proximity in Scotland but would need to be tested.
- The method is now well established and would be relatively easy to apply in Scotland using house price data.

4.4.20 Results from hedonic pricing studies are often used to demonstrate the economic, alongside environmental and social, good sense of preserving greenspace in an economic environment that tends to favour development. It is argued that the economic benefit generated by rising property values if attractive greenspace remains undeveloped can compensate for loss of income benefits from a reduced amount of development on an area. Furthermore, increased revenue from the taxation of more highly priced private property in the vicinity of greenspace could be used to finance public (e.g. conservation) projects or greenspace management.

4.5 Value of greenspaces: contingent valuation studies

4.5.1 These studies use questionnaire surveys to assess people's willingness to pay (WTP) for goods and services conferred by undeveloped greenspace (USA, Spain), state-owned forests (Finland), and urban greenspace (China, Finland New Zealand). These related to preservation of land or non-market benefits such as recreation. There are many more such studies of recreation but they are not associated with urban areas. In Finland state owned forest can also be found close to where people live as well as in remoter areas, hence the inclusion of a study in this review.

4.5.2 Breffle, Morey and Lodder (1998) carried out a study using contingent valuation to estimate a neighbourhood's willingness to pay to preserve undeveloped urban land in Boulder, Colorado. They found that WTP increased with income, decreased at a decreasing rate with distance, and increased with perceived importance of preserving land. Passive use values are a small but significant portion of the total WTP for preservation of the property under investigation. The best estimate of neighbourhood WTP was greater than what it might have cost to purchase the property from the developer in order to protect it. They conclude that contingent valuation is a flexible policy tool for both government land managers and private community groups concerned about whether to preserve undeveloped urban land.

4.5.3 A couple of studies use contingent valuation surveys to assess the non-market benefits derived from the use of urban parks in Valencia, Spain. The first study (del Sal-Salazar and García Menéndez 2007) focused on the park visitors' willingness to pay for park services and found a very high zero WTP value (79%). The main reason for rejecting introduction of fees for park use was that the respondents felt they already paid too much tax. WTP was found to increase with income and education as expected and to vary depending on which section of the park the interview was conducted in, possibly reflecting different facilities offered by each section, and also the income level of adjacent areas.

4.5.4 The second study (del Sal-Salazar and Pau 2008), investigating WTP for the construction of a new urban park, found a positive relationship between WTP and proximity to the site of the projected park: the mean WTP for individuals affected to a greater extent by the project is considerably higher (59%) than that of less affected individuals. The authors concluded that once the park has been provided, the value of adjacent property will increase by improving local amenity values and suggest that the local property-tax system takes into account the fact that households located closer to the park are potentially higher beneficiaries than the rest of the households.

4.5.5 A contingent valuation survey, to estimate the non-market benefits derived from urban greenspace in the rapidly expanding city of Guangzhou, China was conducted by Jim and Chu (2006). They found that parks were the most preferred places for recreation and amenity enjoyment; 97.6% expressed WTP for park amenities. Among socio-economic factors, only income level had a significant positive influence on WTP. Similar to residents in other cities, Guangzhou residents were found to have strong preference for large green sites with a wide range of recreational facilities, high-quality sites with better design and management, and well vegetated sites with high green coverage and mature trees. Guangzhou residents, however, differed in their weak preference for solitude and privacy, water bodies, and birds and other wildlife. The authors concluded that Guangzhou residents are well adapted to a ubiquitously gregarious existence and crowding in the compact city, and pragmatically do not anticipate or demand chances for solitude or privacy in urban greenspaces.

4.5.6 Huhtala (2004) carried out a contingent valuation study of non-market benefits of public outdoor recreation areas in Finland by a telephone survey. It was found that high income and higher education increased the probability of participation in recreation activities. Respondents were least willing to pay for the opportunity to pick berries (85%), to use hiking trails (73%) and to use ski tracks (65%). Some respondents said they would pay something for guide services (38%), lodging/huts (29%) or campfire sites (25%). There was strong support for public funding of recreation facilities and strong rejection of recreation fees. About 33% of the respondents expressed zero WTP. Most respondents were happy with the system in which the costs of

recreation were covered by tax revenues. Implementation of fees might only lead to a shift to recreation areas where no fees are implemented; this would reduce the possibilities of controlling the environmental impact of recreation.

4.5.7 Tyrväinen (1997) carried out an economic valuation of urban forest benefits in two towns in Finland – more clearly associated with the subject of this review than the previous paper. She found that respondents had a positive attitude towards urban forests in both study towns. The three most valued categories of urban forest functions were benefits related to nature (over 40%), social values, i.e. outdoor activities and exercise (32-36%) and benefits attached to climate. The majority of the visitors (60-82%) were willing to pay for the use of wooded recreation areas. The amount of zero WTP varied from 5 to 21%. 50-66% of the respondents were willing to pay something during the following 3 years to prevent the reduction of forested parks in the housing area. Urban forests were seen more as producing multiple benefits than causing negative externalities. The main value was related to nature, which was seen to be more important than physical exercise (jogging and skiing).

4.5.8 Tyrväinen and Väänänen (1998) carried out another study on the economic value of urban forest amenities using the contingent valuation method in the town of Joensuu. They found that the majority of the visitors were willing to pay for the use of wooded recreation areas (64-82% for monthly fees; 69-83% for seasonal fees). A small proportion of the users stated their true WTP as zero. The high response rate and intensive recreational use of wooded greenspaces in the study town indicated high appreciation of urban forests, a general feature in Nordic recreation studies. Most visitors were willing to pay for the use of the forested recreation areas and the number of protest bids was quite low. The level of income did not have an influence on peoples' willingness to pay. This implies that the greenspaces are not a superior good, but an essential part of the everyday life in the study town.

4.5.9 Vesely's study from 15 cities in New Zealand employed contingent valuation to assess the relative importance of benefits and negative effects associated with city trees; to examine the motivations behind city residents' interest in taking care of trees; to investigate the residents' perceptions of the relative position of urban tree supply and demand; to estimate their willingness to pay for the avoidance of a 20% reduction in the number of city trees at the study sites; and, their willingness to volunteer work as a means of avoiding the 20% reduction. This study found that aesthetics registered the highest importance level, with over 90%, closely followed by benefits of nature in the city; habitat for wildlife and fresh air followed closely. The WTP of respondents who are members of environmental organisations was double of those who are not, and the WTP of those households in the lowest weekly income bracket is half of those in the highest weekly income bracket. When asked to consider volunteering work instead of a monetary contribution, 66% of the total sample gave a favourable answer. Vesely concluded that the goal of community support for tree programmes would be advanced by both the reinforcement of benefits and the management of perceived negative effects.

4.5.10 The main results from the review of the contingent valuation studies are as follows:

- WTP increases with income, decreases with distance, and increases with perceived importance of preserving land.
- In the case of state-owned, freely accessible greenspace (forests), most respondents were happy with the system in which the costs of recreation were covered by tax revenues. Fees might only lead to a shift to recreation areas where no fees are implemented.
- Finnish respondents were willing to pay for the use of wooded recreation areas and specialist services (e.g. guided tours).
- More than half of the respondents, in both Finnish and North American studies, were willing to pay to preserve forested parks in the housing area.

- WTP levels in Chinese and Spanish studies tend to be lower than those of North American studies, highlighting the role of local cultural and economic contingencies in the evaluation of greenspace.

4.5.11 These methodological approaches are well-established and in the applications shown from these studies demonstrate that economic values can be ascribed to non-market goods and services associated with urban greenspace. The approaches could relatively easily be applied in Scotland.

4.6 Local governance, economy and environment

4.6.1 Jonas and Gibbs (2003) looked at changing local modes of economic and environmental governance in England in two areas – Cambridge and Waveney. Both areas have witnessed new territorial-institutional developments in relation to environmental policy making, with limited evidence of policy integration at the suburban scale. They concluded that despite the emphasis on local policy integration through sustainable development, the relationship between the economy and the environment in England is a focus of conflict and new territorial-institutional developments. Urban regime theory needs to broaden its focus to include the full variety of interests in local environmental policy and the mechanisms producing new territorial scales of economic and environmental governance.

4.6.2 While broadly relating to economics and the environment this paper is more theoretical in drawing out aspects related to urban governance. However, it identifies the weakness of links between the environment and economy that need to be addressed and are probably relevant to Scotland.

4.7 Summary of key points on economic values and greenspace

4.7.1 This section shows that there are a number of established approaches that have demonstrated that greenspace can have a direct impact on property prices.

- They also show that different econometric approaches provide measures of other economic values of greenspace when recreational use, for example, is a public good not traded in the market.
- What is significant from this review is the fact that the available evidence is very limited to the two main areas noted above. Several aspects where there might be expected to be economic impacts, such as inward investment to an area in part as a result of environmental quality, the values for tourism or savings to the economy as a result of lower absenteeism by employees as a result of better health effects are missing from the research base.
- Some reports can be found claiming an impact on inward investment but these do not place numbers on this impact, nor are they based on research that could meet the inclusion criteria.
- Savings to employers from lower rates of absenteeism is likely to be extremely difficult to calculate, given that the evidence for health benefits is not yet fully conclusive and that the contribution of this to the total picture of absenteeism is probably unknown.
- These issues noted above are key areas where some idea of the economic impact would add greatly to the policy importance attached to providing greenspace.

5. Environment and greenspace

5.1 Introduction

5.1.1 This section examines a broad area that can generally be classified under the heading of environment in the sense of physical and ecological aspects. 50 papers published between 1997 and 2008 were screened. Out of these, 24 were judged to fall within the scope of the review. Six of the selected papers could not be retrieved. What follows is a summary of 18 reviewed publications on benefits of greenspace on environment and biodiversity.

5.1.2 The reviewed publications draw upon case studies from North America, Europe, the Middle East and South and East Asia. The bulk of publications focus on environmental benefits of various types of urban greenspace, at scales ranging from individual trees to urban forests. The main environmental contributions of greenspace identified in the reviewed literature include:

- Pollution mitigation and air quality: 2 papers
- Microclimate and heat island effects: 4 papers
- Quality of the urban environment: 1 paper
- Flood mitigation: 1 paper
- Biodiversity conservation: 4 papers

In addition to these, a corpus of recent research focuses on the following themes, which to an extent overlap with the category 'Planning and design of greenspace' in this review:

- Long term changes in urban vegetation: 2 papers
- Greenspace restoration: 1 paper
- Methodological developments in greenspace monitoring and evaluation: 3 papers

The main points of the review of environmental aspects of greenspace are summarised below.

5.2 Pollution mitigation and air quality

5.2.1 The two studies of this category refer to the contribution of urban vegetation in mitigating atmospheric pollution. Different approaches are used; one is from a cost benefit analysis while the other is experimental.

5.2.2 Bolund and Hundhammar (1999), in their cost-benefit analysis of urban ecosystem services in Stockholm, Sweden, point out that urban vegetation (street trees, lawns, parks, urban forests, cultivated land, wetlands) reduces air pollution, but the level of this reduction seems to depend on the local situation. Coniferous trees have a larger filtering capacity than trees with deciduous leaves; however, coniferous trees are sensitive to air pollution and deciduous trees are better at absorbing gases. In general, vegetation is much better than water or open spaces for filtering the air. Vegetation can also contribute to the mitigation of the urban heat island effect, through evapotranspiration and reductions in energy use for heating and air conditioning.

5.2.3 Wind tunnel experiments by Freer-Smith et al (2002) in the UK evaluated different tree species for their particulate capture capacity. There were significant effects of species on relative deposition velocity (V_{grel}) and capture efficiency (C_p) for both leaves and stems: both V_{grel} and C_p values were always greater to the needles of *P. menziesii* than to the leaves of the four European and the two semi-arid broadleaves species. The common practice of planting screens of attractive low shrubs set in front of deciduous broadleaves and finally to position evergreen conifers at the very back of screens, although designed on the basis of its attractiveness, may also be effective in the removal of particulates from urban air. This can be further improved by subtle changes. Some deciduous species are likely to be of value in particulate removal even when

leafless in winter by virtue of their stem structures. Evergreen conifers will be an important component irrespective of season.

5.2.4 While this section only contains two papers the evidence they provide is quite strong. The design implications of the findings do not yet seem to have been taken up, so there is scope for more work, perhaps on the effects of different plant species suitable for urban environments.

5.3 Microclimate and the heat island effect

5.3.1 This section examines some aspects of greenspace and its role in urban microclimate. While the issue of heat islands is not potentially as relevant to Scotland as other countries, nevertheless there are some issues worth considering.

5.3.2 In situ measurements and microclimatic modelling on streets and courtyards in Tel-Aviv, Israel to determine the cooling effects of shade trees, among other design elements (Shashua-Bar and Hoffman 2004), found that variations in the cooling effect along the sites are explained mainly by the trees shade coverage. The cooling effect of trees depends on the tree shade coverage as well as on the cluster geometry.

5.3.3 Akbari et al. (2001) reviewed a number of previous urban air quality, heat island mitigation and urban microclimate studies in North American cities (mainly in California and Florida) to document the impact of shade trees, cool roofs, and cool pavements on energy use and urban air quality. The benefits included shading of buildings and, in the case of urban forest, ambient cooling by evapo-transpiration, decrease of the wind speed under the tree canopy and shielding of buildings from cold winter breezes. Urban shade trees offer significant benefits by both reducing building air-conditioning, lowering air temperature, and thus improving urban air quality by reducing smog. The authors calculated that, over the life of a tree, the savings associated with these benefits vary by climate region and can be up to \$200 per tree. Urban greening, in tandem with other heat-island mitigation measures, can, thus, reduce up to 20% of the national cooling demand in the USA.

5.3.4 Takebayashi and Moriyama (2007) performed in situ measurements of the water and heat budget of green roofs in Kobe Japan and Found that on the green surface, the sensible heat flux is small because of the large latent heat flux by evaporation, although the net radiation is large. They concluded that although in the daytime net radiation on the green surface is the largest in this study because of the small solar reflectance, the sensible heat flux is small because a large part of the absorbed heat is used for evaporation. The sensible heat flux on the green surface is about 60W/m² lower than that on the concrete slab at its maximum, and the difference is also confirmed in the night.

5.3.5 A recent prognostic modelling study of 9 large cities in different climatic zones (Athens, Hong Kong, London, Montreal, Moscow, Riyadh, Mumbai, Beijing, Brasilia) was carried out by Alexandri and Jones (2008) to assess the potential of green walls and green roofs to mitigate raised urban temperatures. The authors found that both air and surface temperatures lower significantly in all climates examined when walls and roofs are covered with vegetation. The hotter and drier a climate, the more important the effect of green walls and green roofs is for mitigating urban temperatures. Green roofs and walls can improve outdoors thermal conditions not only at street level, but also at roof level, turning these empty urban spaces into potentially usable ones, in the form of super-terrestrial gardens. By covering roofs and walls with vegetation, thermal comfort in the built environment can improve significantly, not only for hot climates, but for cooler ones. The cooling effect of green roofs and walls lead to quite important energy savings. If applied to the whole city scale, green roofs and walls could mitigate raised urban temperatures, and, especially for hot climates, bring temperatures down to more "human-friendly" levels and achieve energy saving for cooling buildings from 32% to 100%.

5.3.6 Cost-benefit analysis of green roof systems in Athens, Georgia by Carter and Keeler (in press) reinforces the above findings: in addition to significant energy reduction, green roofs were found to increase roof life and avoid storm water costs.

5.3.7 As noted in the introduction, heat island effects may not be so relevant to Scotland. However, the urban microclimate is often affected by wind and the sheltering potential of vegetation has long been known in the agricultural and forestry sector and the issue of wind playing around tall buildings is an issue in architecture. In the windy climate of Scottish towns and cities this could be a fruitful line of research.

5.4 Noise reduction and visual intrusion

5.4.1 This section only contains one paper. Bolund and Hundhammar (1999) in their cost-benefit analysis of urban ecosystem services in Stockholm, Sweden also found that soft lawns, shrubbery and dense vegetation can contribute to reduction of noise levels; evergreen vegetation can also shield the visual intrusion of traffic.

5.4.2 This may be known and understood by designers but the evidence available, especially on noise reduction, could be enhanced in relation to different types of vegetation suitable for Scotland.

5.5 Flood mitigation

5.5.1 This section only contains one paper. As Bolund and Hundhammar (1999) point out, the soft ground of vegetated areas allows water to seep through and the vegetation takes up water and releases it into the air through evapo-transpiration. Reduction in surface runoff can reduce the risk of flooding. Wetland plants and animals can assimilate large amounts of the nutrients and slow down the flow of the sewage water, allowing particles to settle out on the bottom.

5.5.2 The idea of using green elements is already applied in the use of sustainable urban drainage (SUDS) but this is a local approach to specific sites or small areas but there is scope for more work at the larger scale, especially in the wetter areas of Scotland.

5.6 Biodiversity conservation

5.6.1 This section presents four studies, none of which is from the UK. This was a surprising finding but is probably because none of the surveys and other studies which may exist came up in the screening either because they were not published in the sources we used or they did not meet the criteria. The included papers deal with a range of issues: bird and other species conservation feature in most. However, the most interesting aspect for Scotland is the level of interest in golf courses and their habitat value potential.

5.6.2 Clergeau et al. (1998) conducted comparative bird abundance and diversity surveys at Quebec, Canada and Rennes, France, to quantify seasonal changes in bird abundance and diversity along a gradient from downtown to rural areas across urban centres. They found that bird diversity decreases with urbanisation, while bird abundance increased with urbanisation as introduced species increased. The highest bird richness is not always in the most natural habitats but often occurs in moderately perturbed ones. The relative spatial and temporal stability of the bird fauna of Rennes is likely to be a reflection of the quality of residential areas surrounding the centre of the city which, because of their high and heterogeneous vegetative component, attract several insectivorous species. In large cities, local habitat features seem more important than the landscape setting of the city. This study highlights the highly dynamic and evolving character of urban ecosystems, dominated by omnivorous species adapted to human behaviour human by-products. Local features (site level) and increasing diversity of vegetation are more important than regional features (landscape level) in structuring urban bird communities.

5.6.3 Mortberg and Wallentinus (2000) surveyed land cover and bird biodiversity at 28 sites within Greater Stockholm, Sweden, to investigate if forest remnants of the city and the system of greenspace corridors could support target species for conservation (red-listed forest bird species) and identify crucial features and properties of the landscape and assess habitat qualities near cities. Although no endangered, vulnerable or rare forest bird species were found breeding within the sample sites, seven forest bird species that are classified as care-demanding on the national red list were recorded as probably breeding.

Forest size is the dominant predictor of the studied species. Connectivity in the form of amount of suitable habitat in the surrounding landscape also seemed to be important. The qualities of the urban and suburban forests were due to both the vegetation and management. Mature broad-leaved forest, mature coniferous forest and moist deciduous forest were types of vegetation that supported the red-listed species. The large natural areas left in between the main transportation routes of Greater Stockholm supported several red-listed forest bird species that were found breeding close to the city centre. The authors concluded that, for species which have increased in the urban and suburban area, but have a negative trend in rural areas, the city parks and forest remnants seem to function as a refuge. Implications for the design of urban greenspace corridors would be to treat mature and decaying trees and patches of moist deciduous forest as a resource, and to conserve large areas of natural vegetation together with a network of important habitats in the whole landscape and in built-up areas.

5.6.4 Hodgkison et al. (2007) surveyed bird, reptile, mammal and amphibian biodiversity and habitat characteristics on 20 suburban golf courses in SE Queensland, Australia. This research demonstrated that, if designed and managed appropriately, golf courses could perform a positive wildlife conservation role in degraded urban landscapes. The principal factor associated with increased abundance and species richness of birds, mammals, amphibians and, to a lesser extent, reptiles was the area of native terrestrial vegetation retained within the golf course boundary.

5.6.5 Biodiversity also depended on habitat shape, configuration, connectivity and diversity. Species richness and abundance were closely associated with habitat complexity, with different vertebrates responding to different structural features. The local abundance and species richness of all vertebrates was also affected by regional environmental factors including the area of adjacent native vegetation, built land and the number of connecting streams. Golf courses and other greenspace areas can, thus provide refuge to species that are disappearing from urban areas. Local densities of these species can be enhanced through small-scale conservation actions that increase the size and structural complexity of native habitat remnants.

5.6.6 A similar methodology was followed by Terman (1997) who assessed the wildlife habitat potential of naturalistic golf courses in Kansas, USA. This study also found that, if managed correctly, naturalistic courses fit well into an emerging philosophy of ecosystem management that recognises the considerable potential of private lands for preserving nature. Golf courses are probably best considered as habitat for the conservation of small organisms (such as birds and small mammals) because of their relatively small size (on average 54 ha). From an ecological point of view, golf courses should be designed to preserve the maximum amount of natural habitat. Remnant patches of historic pre-development ecosystems such as native prairie, woodlands, and marshes should be preserved to the maximum extent possible. Streambank or riparian ecosystems are especially valuable. Leave snags, fallen logs, and other forms of habitat complexity in place if possible. Natural features and microhabitats such as slopes, springs, water falls, ravines, and other complex environmental features should be preserved also. If wildlife is encouraged to inhabit a golf course, it follows that exposure to harmful chemicals should be reduced as much as possible. Naturalistic courses accomplish this end by reducing the areas of managed turf.

5.6.7 Given the importance of golf in Scotland and the amount of urban land given over to golf courses, this is an area where there is potential for further research.

5.7 Long-term changes in urban vegetation

5.7.1 This section contains two studies looking at the longer term impact of vegetation and its management in greenspace . The time dimension is important in any consideration of landscape and greenspace planning and management.

5.7.2 Florgard (2000) studied the long term (from 1972 to 1998) impacts of development on indigenous vegetation in central Stockholm, Sweden, with the aim to develop methods for valuation of indigenous vegetation types as parts of residential areas, to propose changes in the planning process for preservation of indigenous vegetation and methods for the management and treatment of indigenous vegetation. The reaction of the vegetation depends on vegetation type and on distance to development and entrances. Grass-dominated ground cover vegetation is found to be quite invariable. The vegetation areas have not been affected to an extent where their value as recreation areas in the developed areas has vanished. On the contrary, the preserved vegetation is of great value to the local occupants. This study found that habitat changes from development included mean temperature increase by circa 1°C and wind velocity increased for the short period between clear-cutting and house construction. Mean ground water level was not affected, but the difference between flow peaks and lows increased. Content of sulphur dioxide in the air increased due to installation of a heating plant. Most habitat changes were not demonstrated to affect vegetation. Vegetation damage and vegetation succession were found to be a result of the direct impact of construction and from later use such as trampling. Vegetation damage in the preserved areas was normally of limited extent. Long term effects included erosion and redeposition downslope of vulnerable lichens and mosses and soil formation, increase in areas with bare soil and increase in overall tree coverage. The author concluded that the most important phase in the development process is the planning and design phase: during this the most resistant vegetation types can be chosen to be preserved as future green areas, suitable construction methods can be selected and residential and road structures can be developed to minimise future impact on indigenous vegetation.

5.7.3 A long-term survey of indigenous vegetation in Brussels, Belgium by Godefroid (2001) concluded that urban management practices in the second half of this century have disturbed plant distribution and abundance, leading to regression and disappearance of some of species, and also producing new communities composed of alien species. A great deal of plant habitats were progressively transformed into shrubs with, consequently, regression of light plants for the benefit of shade species. The proportion of native species is increasingly reduced by urbanisation while the proportion of alien species increases. Human impact includes eutrophication, drainage, deforestation, soil enrichment with construction rubble and climate warming; conditions that favour exotic species. Rare species can occur within highly urbanised, densely populated zones; nevertheless, most of these rare or endangered species were found in non-protected areas (e.g. wasted lands, cemeteries, railways, public parks, etc.). Although these areas play an important role in maintaining regional biodiversity, they are threatened because their value is ignored by decision-makers.

5.7.4 These studies, looking city-wide, raise some interesting issues about the way in which existing vegetation is treated in planning in Scottish cities and towns, connected to the value placed on it by local authorities, utilities and the public. These examples could provide models for long term monitoring of urban vegetation and its associated values, landscape, social and ecological.

5.8 Greenspace restoration

5.8.1 This section contains one paper. Grayson et al. (1999) reviewed a number of urban wetland restoration studies from a range of locations and concluded that, in urban situations, wetlands are more likely to be restored or created to provide a specific function (or group of functions) such as treatment of water or protection of wildlife, rather than to be restored to some apparently natural state. They suggest that assessment of ecological restoration projects must be on a scientific basis, involving hypothesis testing and comparison with control sites and emphasise the importance of well-defined goals post-project evaluation.

5.8.2 This holds some lessons for many restoration projects undertaken by many different groups, where they are not planned as scientifically as they might be. An evaluation of such restoration projects might be a useful piece of action research.

5.9 Methodological developments

5.9.1 This section focuses on the methods and tools available for evaluating ecological performance using indicators or spatial analysis. Two of the papers are from UK studies.

5.9.2 An example of application of ecological performance indicators for the monitoring of the urban environment, including urban parks, is the work of Whitford et al. (2001) at Merseyside, UK. The authors measure indicators of ecological performance (surface temperature, hydrology, carbon storage and sequestration, biodiversity) at 4 urban sites and customised them for purposes of sustainable urban planning. Measurement revealed striking contrasts between indicators in all four sites, which correlated strongly with affluence and with proportion of greenspace. The more affluent areas showed better performance in all indicators, being generally more green. This research demonstrates that the ecological performance of cities depends crucially on the amount of vegetation cover, especially trees.

5.9.3 De Ritter et al (2004) developed Benefits of Urban Green Space (BUGS), a methodology of urban greenspace evaluation based on mapping of environmental indicators and environmental modelling. Their method, which evaluates a city's potential in terms of greenspace enhancement, develops planning scenarios for the effective implementation of such an enhancement and evaluates the subsequent environmental and socioeconomic impacts, has been tested in several European cities.

5.9.4 Developing tools for ecological monitoring and of greenspace are often based on GIS-assisted spatial analysis methodologies. Young and Jarvis (2001) examined the character of the whole landscape at scales appropriate to the spatial variability of the urban environment at Wolverhampton, UK, with greenspace elements ranging from hedgerows to woodlands and grasslands, by employing a direct measurement of habitat connectivity. This methodology possesses three main advantages over other approaches: through using a ratio approach that is independent of the sample size, different-sized or irregular-sized areas may be compared; it provides a summary of the character of the whole landscape, both linear and non-linear elements, that is lacking in many other connectivity measurements; since there is no limitation as to the direction of connections, a more realistic appraisal of the landscape may be achieved. The authors suggest that measures such as this can identify how landscapes are changing, and in what direction.

5.9.5 Tools to evaluate places and functions are very useful and help not only in planning areas but in demonstrating evidence. More development of such tools would be helpful.

5.10 Summary of key points – environment and greenspace

- Greening urban areas improves air quality and there is some evidence about what types of plants perform best but more is needed.
- Green areas also improve the climate and reduce the heat island effect but this is not so relevant for Scotland, where wind may be more of a factor.
- Green areas can reduce noise pollution and the visual intrusion from traffic, although more specific evidence on how this should be done in order to inform better design guidance could be useful.
- The risk of flooding is lower where there is plenty of urban vegetation to intercept and absorb storm water. Beyond the use of SUDS, the wider impact of sealing urban surfaces in wetter or more flood-prone regions of Scotland needs further work, for example the effects on peak flows in rivers and streams as a result of storm water running off urban surfaces compared with being able to soak into the ground.
- Urban green areas provide a diverse habitat for mainly common bird and animal species. Golf courses seem to be an underused resource in Scotland, where more research could be targeted, especially in how to manage golf courses to increase their biodiversity value.
- The long term planning of urban green areas is necessary for their development and continuing functioning. Maintaining the continuity of greenspace over time is important, not only maintaining the total amount and type at a given time. This has implications for the long term management of greenspaces.
- There is an increasing availability of tools for evaluating the environmental values of green areas. These are very useful for planning and demonstrating values but need to be more widely available, so that sharing practice and communicating to relevant users and also developing or tailoring tools could be valuable..

6. Planning and design of greenspace

6.1 Introduction

6.1.1 This section looks at evidence about aspects broadly connected with planning and design. It starts with how people perceive greenspace in terms of the range of benefits, their attachments to it and its aesthetic qualities. Some aspects, such as safety also appear that were covered under social and community values and others about perceptions that also relate to greenspace and health.

6.1.2 Forty nine publications on physical aspects of greenspace were screened. Out of these, 27 were deemed relevant with the scope of the review. Six of the selected papers could not be retrieved and three went to other sections (health, social and community). What follows is a summary of 19 reviewed publications focused on physical aspects of various types of urban greenspace: greenways, urban parks and urban and peri-urban forests.

The principal research themes included:

- Perceptions of greenspace: 7 papers
- Planning and design of greenspace: 8 papers
- Methodological developments: 4 papers

The main points emerging from the reviewed publications are summarised as follows.

6.2 Perceptions of greenspace

6.2.1 A number of studies focus on perceptions of physical aspects of greenspace. These studies, commonly conducted through questionnaire surveys, overlap with studies dwelling on attitudes towards greenspace, included under the social and community dimensions of greenspace in this review. The classification criterion followed here was that studies of perception and preferences of physical attributes of greenspace were included in this section, whereas studies on use, significance and ideological aspects were included in the Social and community section. However, the distinction is often far from clear cut.

6.2.2 Asakawa et al. (2004) conducted a vegetation and questionnaire survey (675 respondents) at Sapporo, Japan to measure the quality of the inhabitants' relationship their urban neighbourhoods. The five most important factors relating to public perception of urban stream corridors and greenways were recreational use, participation, nature and scenery, sanitary management, and water safety. The main recreational activities in the stream corridors were strolling and relaxation.

6.2.3 Similarly, residents' perceptions of urban greenways forms the focus of a study in Chicago, USA, which uses focus group interviews, in-depth interviews with more than 5000 stakeholders and on site surveys to elaborate on the human dimensions of urban greenways and their meaning and utility for greenway planning (Gobster and Westphal 2004). This study found that the six dimensions held in common across stakeholders and localities were cleanliness, naturalness, aesthetics, safety, access, and appropriateness of development. The cleanliness of the river and its surrounding environment was by far the top concern of Chicago River stakeholders. Naturalness (trees, wildlife, natural areas, and other nature-related attributes) is a key dimension that people relate to in any ecosystem, no matter how urban it is.

6.2.4 De Groot and van den Born (2003) explored images of nature and of the appropriate relationship between people and nature held by residents of a town in the Netherlands. They found that people distinguish between a consistent set of images of nature, such as arcadian nature and wild nature, and between three images of the appropriate relationship of people and nature, namely

mastership of nature, responsibility for nature or participation in nature. These images partly reproduce images articulated in environmental philosophy. The mastership image is only an undercurrent among the respondents, responsibility for nature is the broad mainstream, and the spiritual/romantic image of participation in nature is present as an undercurrent that has gained more strength than the mastership image.

6.2.5 Greenway benefits mentioned most often were aesthetic in nature, while people's concerns focused on two different aspects of safety: *physical* safety - children falling into the river, health concerns; and *personal* safety - the river as a hang-out for youth gangs engaged in criminal activity, a place for drinking and drug use, and as habitat for the homeless. Access emerged as a key dimension in various forms: *physical* access and *visual* access. The idea that new developments should be appropriate to the context was expressed by people across the range of Chicago River settings. These findings point to the multi-dimensionality and interdependence among human concerns about landscapes, in this case an urban greenway. Within these dimensions it is important to recognise that there could be substantial variances by culture and location.

6.2.6 A questionnaire survey of 1500 residents of Trondheim, Norway by Bjerke et al. (2006) measured residents' preferences of urban park landscapes varying in vegetation density and identified background variables and values that influence these preferences. This survey found that scenes with a moderate degree of vegetation receive a higher preference score compared with the most open scenes and to the scene containing the most vegetation. Middle-aged, well-educated, wildlife interested and 'ecocentric' residents express a higher preference for more dense vegetation. The authors conclude that, in order to ensure the needs and outdoor recreation preferences of a broad range of users are met, urban parks should be characterised by a reasonably high degree of compatibility between environmental features and individual needs, motives and actions. Different types of parks should be available and urban green areas should contain a variety of vegetation types.

6.2.7 A similar investigation of the relationship between people, their environment, and the concept of natural capital in two different urban communities in Chicago, USA was conducted by Crow et al. (2006) with the use of photo-survey, questionnaire and tree survey within urban forest. The authors found that a 'green residential atmosphere' was the most important community quality contributing to the residents' appreciation for their town. Attributes contributing to this quality include close proximity of managed natural areas and other open space, presence of mature shade trees, and landscaping using native plants. Perceived benefits of the nearby urban forest included visual, nature-related, utilitarian, and watchable wildlife. Respondents reported receiving the greatest benefit from visual features of the urban forest; perceived annoying features included upkeep problems, excessive shading, and messy features. Although differences in endorsements within and between communities by gender, age, presence of children, education levels and income were apparent, and substantial differences in the abundance, composition, and structure of the urban forest occurred between the two adjacent communities, residents in both communities ranked the presence of a green residential atmosphere as an important community attribute.

6.2.8 To assess levels of acceptance of different types of nature in Haale/Saale, Germany and examine whether different housing conditions, and different quantity and quality of urban nature encourage different behaviours of residents, Breuste (2004) mapped the internal vegetation structure and its use intensity and conducted interviews with 491 residents at the fringe of the residential estates in two areas of the city. The author found that, although people were interested in nature and urban nature in general and made use of urban greenspaces, especially larger city parks, relatively often, irrespective of social group, natural habitats were mainly understood as areas far away from the city. Natural areas within the urban landscape thus remain unrecognised. Residents are not used to valuing urban derelict land and its spontaneous nature as "wild nature". The author recommends that this lack of understanding of "urban wilderness" as additional and valuable aspect of urban greenspace can be addressed through information and education.

6.2.9 Public perceptions of different types of greenspace were also evaluated by Tyrvaïnen (2003), who used forest image evaluation (291 respondents) to determine whether aesthetic and ecological values can be combined in the management of urban forests in Helsinki, Finland. This study showed that pine and birch stands were most preferred; pure spruce stands were the most disliked among the single species stands. Mixed forest stands were less popular than monocultures. The majority of participants preferred managed forests. The most preferred management practice was management of the understorey; the most disliked alternatives were dense and closed forest vistas with abundant undergrowth. Ecological and aesthetic management practices are, therefore, to some extent competitive aspects within urban forest management. Although visitors may appreciate the idea of naturalness, the real signs of natural state, such as deadwood, are not preferred.

6.2.10 Acoustic and visual stimuli rating laboratory experiments on 75 subjects by Carles et al (1999) studied the influence of the interplay between visual and acoustic stimuli on perception of urban, agricultural and natural greenspace. Results suggest an overall preference for natural and rural rather than urban or man-made scenes. Sounds in which voices and domestic animals predominate, like the village, attract a higher rating than urban parks. Coherent combinations of sound and image are more highly rated than the mean of each component stimulus. Natural sounds, particularly of water, help create positive feelings towards the landscape. The most highly rated combination was the sound and image of a stream, while the lowest score was accorded the combination of the stream image and the sound of the busy park. The images of city parks were more appreciated when subjects did not hear their real sound content, evidencing how such landscapes lose quality as the sound environment deteriorates.

6.2.11 This section pulls together a number of aspects which show that people perceive greenspace from many different perspectives but that they also do so in combination, not separately, so that issues of aesthetics are combined with safety for example. This demonstrates the complexity of designing places that meet everyone's requirements. There is a general preference for "natural appearing" greenspace, but its precise character seems to vary from place to place and amongst different cultural and social groups, which has implications for the type of designs that should be developed. There may be cultural differences, for example, between British and Finnish preferences, which mean that care is needed in interpreting the outcomes of some of the research. Scottish urban areas often contain more semi-natural remnants or elements such as hills, rocky places and small water bodies than their English counterparts, the perceptions of which have not been studied to date.

6.3 Planning and designing urban greenspace

6.3.1 This section explores research into planning and designing urban greenspace. This ranges from planning at the city level to the implications of some sort of cooperation between city authorities and local communities in so-called "hybrid landscapes".

6.3.2 A comprehensive review of urban greening projects from many locations by Jim (2004) surveys the limitations to greening in packed city precincts, proposes precautions and preventive measures to forestall greenery degradation and identifies practical alternatives, solutions and opportunities for greenery. The author emphasises that greening could serve as a necessary but not sufficient condition towards urban sustainability; at best, it could only afford a partial answer, and makes the following recommendations for the planning and design of urban greenspace:

- "Gap sites" of remaining greenspace should be guarded against conversion to preserve the high degree of naturalness and wildlife habitats, and to enhance their essential contribution to urban environmental and scenic qualities.
- A database of actual and potential greenspaces graded according to landscape and ecological values should be compiled when developing a management plan.

- Conservation should aim at both physical land area and site quality for plant growth and human enjoyment. The opinions of landscape professionals must not be drowned by development-related demands.
- Community forestry programmes implemented by various cities can actively involve local people and interest groups, largely as volunteers, in a synergistic partnership.
- Rather than a biased preoccupation with greenspace acreage and tree counts, planners could also emphasise the geometry of the green network and quality of the greenery.
- Spatial permeation and connectivity of greenspaces is desired along new roads (amenity strips on roadsides and medians), amenity parcels in roundabouts, and incidental plots.
- A comprehensive green plan is needed with specific recommendations on locations, dimensions, ingredients and functions of greenspaces, to be tailor-made for different land uses and urban habitats.

6.3.3 Quayle and Driessen van der Lieck (1997) discussed the notion of “hybrid landscapes” as community landscapes. Hybrid landscapes are the result of two place-making processes: the ways that traditional public parks and streets are designed and maintained, and the acts of small-scale appropriation and embellishment that lead to the diversity and richness of front and backyards in residential neighbourhoods. The paper also discusses neighbourhoods as familiar, restorative, memorable and beautiful environments. The rules that govern the making of a hybrid landscape are: transferral of control from municipal agencies to the community itself; openness; and smallness or taking small steps. They concluded that the making of hybrid landscapes may not be easy because it challenges established notions about the function and appropriate demeanour of the public realm.

6.3.4 Kuhn (2003) presents two contrasting case studies of planning approaches in two European city regions, Berlin, Germany and Randstad, The Netherlands, each exemplifying a Greenbelt and Green Heart city-greenspace pattern, respectively. Whereas the Greenbelt approach operates in a *monocentric* city and its surrounding countryside, the Green Heart approach operates in a *polycentric* city region. Although the spatial forms of Greenbelt and Green Heart have persisted as concepts during the last decades, the functional definitions of landscapes have been changing substantially. Both are based on notions of a ‘good urban form’. Open spaces have a double role in structuring city regions: they are *connectors* and *separators* of spatial units. Successful approaches of landscape protection in city regions have to consider more carefully the specific local qualities and social uses as a basis for regional design.

6.3.5 The green belt approach to urban greenspace - especially its historical evolution and implementation - is also examined by Tang et al (2007) for the compact city of Hong Kong. In Hong Kong, the green belt had never been intended to be fully restrictive against urban development. Recreation, rather than conservation, was its initial planning emphasis and many types of urban development were always permitted at the beginning. The narrative of prescribing the green belt for conservation purpose is a recent policy, although its implementation remains ambivalent and half-hearted. There are significant spatial variations in the green belt planning objectives and landscape features across the five different sub-regions in the territory. These zoning plans do not have a consistent green belt planning objective. The planning authority was readily receptive to many popular land-use developments such as ‘small house’, ‘house’ and ‘open storage’ uses. The authors, thus, conclude that, in reality, the green belt in Hong Kong is a transition zone that the planners are quite prepared to ‘sacrifice’ for the pursuit of the right development at the right time.

6.3.6 De Soussa (2007) reviewed 10 brownfield remediation projects at Toronto, Canada and interviewed 12 primary stakeholders in order to examine the processes of planning and decision making involved in remediating potentially contaminated urban brownfield sites and converting them into greenspace. The key motivating factor was the conversion of brownfields into ecological habitats, followed by provision of recreational opportunities for under-serviced communities, flood protection and storm-water control. The main project benefits recognised by stakeholders included

creation/expansion of ecological habitat spaces, public and community collaboration and involvement, increasing areas for public recreation and use, models for future brownfield redevelopment. The author suggests that community involvement in the whole redevelopment process is crucial. Greenspace and brownfield inventories need to be established and used in tandem to identify greening opportunities. Potential funding sources may include both public and private interest groups. Municipal departments involved in the administration of parklands should be consulted and involved directly in all greening projects. Greening projects should be encouraged because they tend to revitalise “blighted” neighbourhoods and enhance their economic and social appeal. An appropriate risk assessment method that integrates elements of landscape design with available site remediation technology should be used. Greening projects present greater challenges than other forms of redevelopment in justifying end-use and project funding, but are more easily accepted by affected communities. Funding for all stages of the conversion process as well as for long-term maintenance of the greenspaces, must be actively sought from both the private and public sectors.

6.3.7 The survey of residents’ perceptions of urban greenways at Sapporo, Japan by Asakawa et al. (2004) also made a number of planning and design recommendations. According to the author, the good stream corridor design would include the following: enhancing the ecological environment of the streams; creating recreational circulation systems and making full use of the natural and cultural characteristics of the local areas. The following five points are important planning strategies: making or enhancing the stream buffer; the improvement of stream areas for ecological purposes including maintenance plans concerning biodiversity; making or obtaining new greenspaces or parks along the streams; connecting the streams to other larger natural areas like hills, green areas, etc.; and acquiring and maintaining water quantity. To realize these goals and strategies, public participation in greenway planning is essential.

6.3.8 A further study of urban greenway planning and design is the review of 8 case studies from Brazilian cities (Frischenbruder and Pellegrino 2006). All reviewed cases are related to floodwater control, soil conservation and conservation of biodiversity in the cities. Three cases of greenways at the regional scale show that the main concern of these projects is the creation of connectivity between the remnants of natural patches of vegetation in order to achieve ecological sustainability. Projects at landscape scale allow the application of landscape ecology principles because they focus on heterogeneous land mosaics. This is a critical spatial scale for land use issues and the efficient configuration of an open space system. Projects at the site scale attempt to visualise in the design process the relationship between and distribution of elements in the landscape. This implementation scale is the critical stage at which the expectations of the communities and other agencies involved in the assessment of the projects can be fulfilled. Greenways have thus allowed planners and designers to think of the landscape as a living agent capable of changing the surrounding conditions. Connecting everyone involved in greenway projects and consulting public opinion on the values and advantages of the green open spaces in their neighbourhoods are of fundamental importance. (Note: this paper could have been placed in the section on environmental aspects but is placed here because it deals more with planning issues.)

6.3.9 Breuste’s (2004) study of urban nature (summarised above) recommends that strategies of planning for nature in cities and its surroundings should vary depending on the urban landscape and the social-cultural contexts. The most effective preservation of indigenous vegetation can be rapidly achieved by concentrating on sites of urban derelict land, with low or no necessary maintenance and with high acceptance and usability. This includes biotope types such as wetlands, rivers, streams, woodlands, structured agricultural pastures and meadows.

6.3.10 In their evaluation of a greening aid project in St. Petersburg, Russia, Nilsson et al (2007) make a number of suggestions regarding best practice in the planning of urban greening: donors, beneficiaries and project partners should agree on a set of clear objectives and outputs at the start of the project. Urban greening projects should apply an integrative approach, focusing on different benefits from greenspace and strategic, as well as more operational, activities to ensure project viability. Projects should be based on local needs and adhere to local conditions as well as build on

local expertise and capacities. All key stakeholders need to be involved throughout the project, however, difficult this may be. Sufficient resources should be committed to provide a sound basis for achieving the project objectives. It is necessary to look at the city as a whole, of which urban green areas are a part.

6.3.11 Florgard and Forsberg (2006) explored the use of patches of remnants of natural vegetation by Stockholm residents. They found that children and young people use urban natural areas more than adults; children's use extends into small areas of natural vegetation even if the remaining vegetation is trivial and subjected to wear and tear. The authors conclude that areas with remnant original vegetation in cities have a recreational value, as well as other values, and this needs to be taken into consideration in the planning and design process.

6.3.12 This section points out several key themes: green structure planning needs to take into account the urban morphology – a green belt is suitable for a mono-centric city form such as Edinburgh (perhaps with the blue belt too) while a green heart approach may be more suitable for a poly-centric city such as Glasgow and its neighbouring towns. There is also a theme about public participation in planning of green structures and how this could inform the better functioning of elements like greenways – and then possibly improve the accessibility of greenspace as a result, so yielding, for example, greater health and wellbeing benefits. Good planning also enhances ecological functioning and the value of flood mitigation of biodiversity as noted in the previous sections.

6.4 Methodological developments: decision making and monitoring approaches and tools

6.4.1 This section evaluates research into approaches and tools designed to lead towards better planning and evaluation of decision making. The papers range from those about landscape ecology to a series about the use of GIS tools.

6.4.2 To demonstrate how landscape structure can be used to assess the viability of urban ecological networks, Cook (2002) applied structural analysis of urban landscape elements (patches, corridors and networks) in Phoenix, Arizona (USA). This methodology was developed to guide implementation of an ecological network plan aimed at increasing overall ecological value. Improvement strategies can include re-vegetation of disturbed sites, creating artificial or synthetic corridors or patches, expanding buffers by extensifying adjacent land uses, and others. Optimal patch naturalness adjustments include increases in area covered by native vegetation, reduction of area with paving, compacted or eroded soils, and site adjustments to improve flows (i.e. removal of obstructions or barriers) to return site functions to a more natural condition.

6.4.3 Randall et al (2003) developed a GIS-based decision support tool for the generation and evaluation of 'neighbourhood greening' alternatives for conventional suburban development. Their methodology aims to increase the number of natural areas within suburban neighbourhoods, encourage more natural landscaping techniques for private yards and gardens, provide conventional greenspace for recreation and aesthetics and add a productive component to greenspace areas. This methodology has several advantages: given that the extension is ArcView based, it is a no-cost download addition to a comparatively affordable GIS software package; the operation of the extension does not require an inordinate amount of time to generate results and is simple to carry out. Being a decision support system, the extension provides considerable opportunity for the user or participant in a public meeting to define the character of created scenarios for neighbourhood greening. The potential benefits evaluated with the aid of this tool are conveyed to users in units readily understood by the general public. The NG extension includes a prototype location-allocation algorithm used to determine the most appropriate locations for community garden facilities. The street tree planting algorithm in the NG extension provides the opportunity to plan the refurbishment of residential streetscapes and the neighbourhood greening methodology strives to promote principles of sustainable community design.

6.4.4 A GIS-based surveying methodology was also used by Atwell (2000) to evaluate vegetation cover in selected urban areas in Denmark and to discuss the land area potentially available for supplementary planting in urban zones. This method allows integration of environmental information into the strategic planning and decision-making process. It is especially useful in ensuring that complex environmental information does not deter the overall purpose of developing a planning strategy to enhance the sustainability of the urban environment. Moreover, it offers a tool for targeting greening efforts, as it creates an overview of zones or land-use categories lacking woody vegetation and highlights best-practice zones.

6.4.5 Van Herzele and Wiedemann (2003) developed an integrated indicator that facilitates monitoring of urban greenspace provision against quantitative and qualitative targets, comparison between cities and city parts, assessment of the effects of future policy scenarios and identification of locations where action is required. Indicator development was guided by five principles: “citizen based”, “functional levels”, “preconditions for use”, “variety of qualities”, and “multiple use”. This monitoring and decision making aid was tested in Antwerp, Ghent, Aalst and Kortrijk, Belgium.

6.4.6 Tyrväinen, Mäkinen & Schipperijn (2007) aimed to develop a tool (a version of soft-GIS methodology) to measure the social values of residents in relation to woodlands and greenspaces and to inform decision-makers and planners in an appropriate map form. In general, residents appreciated the relatively sparsely built city structure and strongly disapproved of the infilling of existing housing areas. . The tool seems to be useful to bring the values of residents into the decision-making process.

6.4.7 These tools relate to some extent to the assessment tools noted in the Environment and greenspace chapter and help the planner to improve the way that greenspaces are incorporated into the urban structure. None of them are UK examples, suggesting that either none exist in the UK or else that they have not been written up and presented in terms that evaluate their effectiveness.

6.5 Summary of key points – planning and design of greenspace

- Naturalness is the principal physical attribute of greenspace appreciated by stakeholders. Understandings of naturalness, however, vary across as well as within different societies, and do not necessarily accord with ecological complexity of greenspace habitats. This suggests that there is a need for a Scottish study of perceptions and preferences of urban greenspaces to inform planners and designers.
- Greenspace projects should be embedded in their landscape, ecological and social context; this varies from place to place and so locally relevant knowledge needs to be developed.
- Greenspace design should aim to enhance the ecological functions of greenspace habitats. Different models can be adopted and tools are potentially available to help evaluate how well they function.
- Greenspace planning and design should aim to produce spaces which are attractive and accessible to people; guidance on how best to do this and appropriate tools are needed.
- Greening projects should be evaluated with clearly defined criteria for their ecological and recreational benefit; again, requiring a good set of tools to measure efficiency and benefits.
- Planning should be as participatory as possible – there is increasing evidence that places developed with the active participation of local people meet their needs better and help people develop place attachment as borne out by the evidence presented under the section on social and community aspects.

7. Summary, conclusions and identification of research gaps

7.1 Introduction

7.1.2 This review has been structured according to a number of themes and sub-themes. However, many of them relate to each other or overlap, so it comes as no surprise that some evidence, for example about access to greenspace is discussed in one section while something else, perhaps about planning for access, is discussed in another. Nevertheless, some means of structuring the review is necessary. In this section the main findings from each of the sections are brought together and some of the overarching themes to emerge from this are drawn out. This leads to some conclusions and the identification of gaps where future research might be targeted.

7.1.3 It is important to remember that this summary is based on the literature reviewed, together with some cross-references to the York report for the section on health and greenspace. The literature reviewed had to meet quite stringent criteria for inclusion so that other types of evidence, perhaps with less well-defined outcomes is missing. Policy should be based on robust research with clear conclusions and recommendations, which is what is aimed for here. This means that some of the conclusions may ignore some evidence that did not find its way into the review and some of the research gaps may not appear as big if other evidence of a less robust nature was to be included.

7.1.4 The review has covered the following themes:

- Effects of greenspace on health and wellbeing
- Social and community value of greenspace
- Economic value/impacts of greenspace
- Environment and greenspace
- Planning and design of greenspace

Rather than repeating all the summary points from each preceding section, this chapter aims to identify the most important points and those where the research gaps are most obvious, suggesting also how such gaps might be addressed.

7.2 Effects of greenspace on health and wellbeing

7.2.1 As the York report notes, there is clear evidence for a positive relationship between greenspace and health. This points in several directions: to the proximity of greenspace having an effect on levels of physical activity of all age groups of people; on physical exercise in greenspace having a positive effect on promoting wellbeing and recovery from stress; on exposure to greenspace helping restoration from stressful situations and behavioural or emotional disorders in children. The weakness lies in the understanding of the mechanisms – the studies find associations, correlations or linkages but no cause and effect relationships. Moreover, the evidence comes from a range of types of data and indicators, some much less objective than others – the preponderance of self-reported data in many studies being a case in point. One study on promoting exercise in sedentary males seemed to show a good result based on objective data but one study is not enough.

7.2.2 The possibility of viewing greenspace and obtaining a benefit is identified in the evidence but, as before, the mechanism is unknown. However, the methods used in the research may be a problem for the quality of the evidence, for example the use of photographs of nature rather than views of real nature.

7.2.3 The York report identified the fact that access to greenspace does not appear to be a key variable for explaining levels of physical exercise. We found that the evidence of proximity noted above does appear to strengthen the evidence base, as does the walkability of the neighbourhood.

7.2.4 Greenspace may offer benefits where the urban climate is a problem; the research reviewed here mainly concerns heat stress due to the heat island effect. However, heat stress is not at present an issue for Scotland..

7.2.5 There are links between health and social/community benefits when people participate in communal activity but it is unclear to what extent the greenspace itself is a factor.

7.2.6 The only aspect of safety and greenspace covered in this review concerned children's play. This found a tension between the need for safety on the one hand and creating challenging play spaces on the other.

7.2.7 This summary leads towards identifying a number of gaps in the evidence and potential areas for further research:

- The need to test more widely the issue of proximity, accessibility and type of greenspace for different age, social, economic and ethnic groups. This suggests a large-scale project using mixed methods including recording activity levels and a conjoint-type choice experiment to test the trade-offs amongst different factors, similar to work being undertaken in the I'DGO project at OPENspace.
- Some work of an applied nature to target key at-risk groups, similar to the project on sedentary middle-aged men and golf could be carried out. Given the significance of golf in Scotland this subject could be an important area for exploration as part of such work.
- The impact of views to greenspace could be significant but more work in a range of locations is needed to be able to capture enough data to form a definitive view of the evidence.
- More work on the role of greenspaces in promoting increased health and wellbeing through community activity is needed, in order to be able to isolate the role of greenspace from other aspects, such as social integration.
- More research is needed on how to design play areas which, while being safe, contain more challenge and play value. This could include exploring attitudes to risk, measuring the different benefits of play for different ages and in different environments and play with natural materials and elements. This is a complex and challenging area but an extremely valuable one.

7.3 Social and community values of greenspace

7.3.1 In a similar way to the evidence on greenspace and health, key social and community aspects, such as social cohesion, coping with major life issues in deprived areas, cognitive and social benefits in children emerge from the evidence as being positively linked with greenspace. However, very few studies are from the UK and so there are significant questions over their applicability. Conversely, there is little if any evidence of a robust nature on community capacity, although the study described in the section on greenspace and health and wellbeing involved this aspect to some degree.

7.3.2 The area of safety and fear of crime in greenspace has received attention in recent years but the scale of the studies means that they are unlikely to be generally transferable. Key areas relate to perceptions by different social groups, greenspace layout, design and management.

7.3.3 Some areas of research receive less attention than others in this field, notably gender, ethnicity, disability and ageing. Not only is more research needed but the methodologies of

research need to be strengthened; and existing research which has been undertaken with more robust methodologies may not be transferable.

7.3.4 Gaps in research which could fruitfully be pursued are as follows:

- Since the social benefits of greenspace appear potentially quite large, there may be merit in undertaking studies in particular deprived areas of Scottish towns and cities, perhaps alongside or integrated into planning and design projects aimed at improving the environmental quality of deprived areas. The methods could be borrowed from the robust American studies or specific methodologies could be developed.
- More work on the relationship between fear, safety, crime and greenspace is needed. This could involve using a large sample from different areas, combining both qualitative and quantitative approaches, with correlation between perceptions and data from crime reporting etc, and linked to different measurable characteristics of greenspace.
- Since greenspaces are used differently by people as they move from one life stage to another, a means of assessing this – “life-stage analysis” – could be developed as a valuable, practical tool for planners and designers.
- Transferring research findings into practical design guidelines is also an area that needs a lot more work, although it is not original research per se.
- Gardens are an under researched subject. More research could be undertaken on how they function as private or public/community spaces in different areas, such as private gardens in suburbs, shared private gardens in cities or community gardens and allotments elsewhere. This would suit an action-research approach.

7.4 Economic impacts/values of greenspace

7.4.1 This section is notable for the presence of major sets of projects on valuing greenspace in relation to property prices and/or recreational values. However, the studies are all from non-UK locations where property market considerations, cultural and social contexts as well as attitudes to greenspace may be very different from the UK or Scotland.

7.4.2 The economics of greenspace are overwhelmingly dominated by approaches that treat greenspace as set of measurable goods and services that are amenable to allocation of price. Appealing to economists, planners and a number of conservationists (for providing arguments for the preservation of greenspace as a valuable economic entity), these approaches are, nevertheless, reductive and unable to account for the myriad of landscape functions, ecological as well as ideological, that are difficult to single out let alone quantify. There is an obvious deficit of alternative approaches to the economic impact of greenspace – approaches in which the social values of greenspace can resonate. The diverse perspectives contributed by ecological economics and economic anthropology are particularly relevant to the economics of greenspace. These perspectives are, so far, largely unexplored.

7.4.3 Other economics benefits, such as the effect on inward investment, business relocation or the value of reduced absenteeism are virtually absent from the evidence, at least at a level of evidential quality that would lead to their inclusion in this review.

7.4.4 Research gaps here include

- Valuation of the effect of greenspace on property prices in the UK and Scotland – probably a complex subject, given the functioning of the property market but an important one. This might include surveys of prices or properties geographically related to the proximity of greenspace as well as information from surveys of estate agents and solicitors, willingness to pay by prospective purchasers and the characteristics of greenspace that may also have an effect.

- Broader studies of the economic value combining different economic models such as some suggested in para 7.4.2 above, perhaps attempting to put a global valuation on greenspace in its many dimensions. This may include the use of cost benefit analysis.
- There are large gaps in evidence for the effect of greenspace on inward investment values. This is likely to be a difficult area to research because of the wide range of factors that affect business decisions, as well as problems over sources of data and their commercial sensitivity.
- Absenteeism rates, their costs and the reduction of this by people obtaining health benefits from greenspace is also a gap with further challenges in developing a robust research methodology.

7.5 Environment and greenspace

7.5.1 The benefits of greenspace to the urban environment are, in general, quite well developed in a range of areas including air quality, climate, noise, flood mitigation and biodiversity. However, the studies that are robust enough to be included in the review are largely from outside the UK and so may not be applicable or relevant, for example, climate studies tend to focus on the heat island effect.

7.5.2 An interesting area to emerge was in relation to biodiversity and golf courses – a significant element of Scottish urban greenspace but apparently with no Scottish research that found its way into the robust evidence base..

7.5.3 The long term management of greenspace also featured as an important area as did sets of tools for evaluation and monitoring. These may be tools that are readily useable but they may need modification to make them applicable to Scottish conditions.

7.5.4 The identified gaps in research are as follows:

- Comprehensive research looking at the combined effect and interactions of greenspace on pollution, air quality, shelter (in the Scottish context), noise, energy consumption and flood mitigation, perhaps tied into a wide-ranging cost benefit analysis (see para 7.4.4 above).
- More comprehensive assessment of biodiversity values of different types of urban greenspace, especially golf courses, perhaps leading to better planning and design guidance.
- The development, refinement or technology transfer of practical tools for long term evaluation and monitoring of the condition of urban greenspace for biodiversity conservation.
- In relation with the above point, there is potential for developing participatory methodologies for monitoring urban greenspace biodiversity. These could take the form of biodiversity surveys that involve greenspace users and the wider community. Possibly linked with environmental education and community empowerment programmes, such projects could turn urban greenspaces into focal points for community involvement and promote social inclusion and participation.

7.6 Planning and design of greenspace

7.6.1 The different sections under this subject raised several interesting issues. Perception of greenspace is vital for understanding how people relate to it and there is a lot of evidence about this from other countries but not from Scotland. The methods vary: some are more robust than others. Perceptions include many different aspects – aesthetic, safety, functionality and so on which combine together in complex ways to produce the overall perception of each user about a particular greenspace.

7.6.2 This section also found evidence supporting the value of projects embedded in the local context. Evaluation and planning tools are valuable as planning and design aids, not only for biodiversity but for all other functions.

7.6.3 There is also increasing evidence that planning greenspace should be as participatory as possible – the development of place attachment can be linked to positive social and community benefits.

7.6.4 The gaps in research in this area are as follows:

- Perception studies are important in understanding how different people view greenspace. They could expand and develop the methodological approach using innovative qualitative methods (such as ethnographic methodologies) and phenomenological perspectives to the lived experience of greenspace.
- The planning literature is dominated by top-down approaches; there is an obvious gap in the field of well-researched examples of participatory approaches. Methods of evaluating individual projects so as to obtain high quality evidence are needed before this can be satisfactorily achieved, for example, better methods of action research.
- More research is needed to develop practical planning tools, decision support systems and the like for a range of aspects – health and wellbeing assessment, social and community benefits, an economic dimension and application of sets of indicators suited to the Scottish situation – quality of life, and environmental services, for example.

7.7 Conclusions

7.7.1 This review has covered an extensive area of literature and, taken together with the York report, provides a fairly comprehensive picture of the research evidence for the range of aspects of greenspace covered in the brief. It is clear that the evidence base in all areas is increasing, with a particular focus on health and wellbeing which has significantly accelerated in recent years and is likely to produce much more in the near future.

7.7.1 There are also some surprising gaps in the evidence that found its way through the search and screening process used here. Three areas stand out: community capacity and greenspace, biodiversity values of greenspace and ecological connectivity in urban greenspace. The absence in UK evidence is all the more marked. This may not be as a result of a lack of evidence per se, but possibly robust evidence, published in reputable sources and available through the search techniques used here.

APPENDIX 1: Search terms used in the ODPM/DCLG database

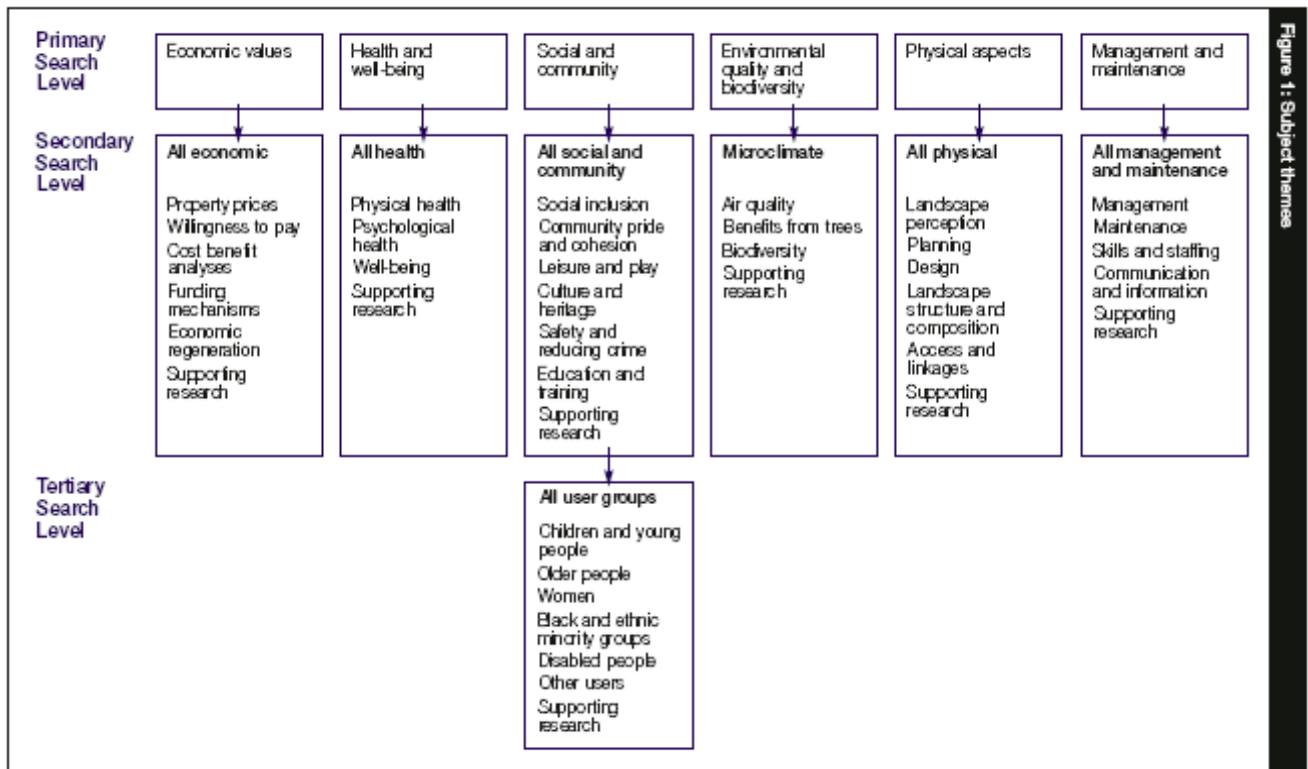


Figure 1: Subject themes

APPENDIX 2: References

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