Establishing ecological and social priorities for urban biodiversity conservation and their alignment through green infrastructure planning; a case study in Swindon, UK.

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Abstract

The increasing number of people living in towns and cities across the world places ever growing pressures on, and demands of urban ecosystems. Research indicates that a diminution in the extent, quality and associated functions of urban green networks as a result of development pressure risks decline in urban biodiversity and the potential human benefits to be derived from nature rich urban environments.

Adopting a case study approach, this research investigates ecological and socio-cultural priorities for conserving urban biodiversity and how these perspectives align within the theoretical framework and practice of green infrastructure planning. In doing so the research adds to a limited but growing body of evidence that describes the vital contribution of urban biodiversity to place making and how related policy and practice could better respond.

The research took place in Swindon, UK, a town undergoing continued expansion and regeneration. Broadleaf plantation woodlands, as a widespread habitat and ubiquitous component of the town's urban landscape, provided the venue for concurrent ecological and ethnographic explorations of the biodiverse qualities of place. Field studies of the richness and abundance of woodland dwelling beetles ran alongside observation of, and interviews with residents via regular and extended participation in Swindon's health walks groups.

The findings add to previous research highlighting the significance of the intricate and interlacing network of open spaces forming much of urban green infrastructure as wildlife habitats. Critically, the research also reveals the ways and depths to which common-place 'everyday' nature encountered in such settings is embedded within residents' sense of place.

The findings imply that urban biodiversity conservation goals should place much greater emphasis on local, small and inter-connecting greenspaces often dismissed in planning policy and conservation practice. Establishing such goals within strengthened green infrastructure planning frameworks and founded on a broader definition of urban biodiversity to encompass socio-cultural dimensions,

could realise substantial benefits for environmental, personal and societal well-being.

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Contents

Chapter 1: Introduction

This chapter provides an overview of the context and identified need for this research. Key concepts employed during the study are introduced and the research aims are set out. Approaches to the research alongside justification for their use are outlined and research objectives are stated. A summary of the thesis structure is provided at the end of the chapter.

1.1 Consequences of urbanisation on biodiversity and peoples' everyday contact with nature

1.1.1 Increasing urbanisation

The number of people living in urban areas across the world continues to increase. Population projections indicate that this trend will continue, and that by 2050 more than 6 billion people world-wide will be urban dwellers (UN, 2018). At the same time, the proportion of the world's population living in urban areas is also projected to increase through a process of urbanisation (Farinha-Marques et al., 2011). In the UK, the number of people living in towns and cities is projected to grow from over 82% of total population in 2015, to almost 90.2% in 2050 (United Nations, 2018). These figures equate to an additional 13.9 million people living in urban areas of the UK within the next 40 years.

In comparison with total land area across the world, the proportion of land classified as urban appears relatively small at between 1-6% (Alberti, 2005). Whilst global figures can mask heterogeneity in spatial distribution (Dearborn & Kark, 2010), a sense of proportion in the context of this study can be given by comparing the extent of urban areas to those protected for biodiversity conservation in the UK. In the UK, 15% of total land area is classified as urban (DEFRA, 2011). In comparison, Sites of Special Scientific Interest, those deemed nationally important for nature conservation and protected by law, cover around 8% of the country's land area (Natural England, 2013 a).

1.1.2 Biodiversity as a quality of place in urban settings

The quality of the urban environment and local ecosystems will play an ever more important role as urban populations grow (WHO, 2016). As global populations become increasingly urbanised the planning and management of spaces in which

people live and work in towns and cities becomes more pressing. Concepts such as liveability, environmental quality, quality of life and sustainability are increasingly employed in relation to urban planning (Kamp et al., 2003). The natural environment within urban centres is seen as central to such place quality concepts (Streimikinie, 2015).

Within the realm of natural environment, concepts and associated theoretical frameworks such as ecosystems services, natural capital and green infrastructure have been developed, and continue to be developed, to support evidenced based approaches to planning for future urban growth (Wentworth, 2017). Planning for urban growth and the concepts employed in the context of the natural environment are explored in greater detail in sections 2.4 and 2.5.

Biodiversity conservation is common to such approaches and is described as vital in maintaining and improving critical environmental and socio-cultural functions and benefits within urban settings (Savard et al., 2000). Biodiversity is also discussed in these settings in terms of having intrinsic value beyond that assumed from an anthropocentric perspective. That biodiversity continues to be in general decline and is under increasing pressure as towns and cities grow and regenerate is therefore of particular concern (Elander, 2005; Elmqvist, 2016).

The impact of towns and cities on ecosystems and biodiversity is far reaching and is felt at global and local scales (Dallimer et al., 2012; Alberti, 2005). The demand of urban dwellers on global resources is seen as one of the greatest drivers of global biodiversity loss (Aichi Declaration, 2010). At a local level, ecosystems within towns and cities differ greatly in terms of micro-climate, hydrology, soil modification and nutrient cycling when compared to non-urban areas (Pickett et al., 2001). Urban development is seen to 'fragment, isolate and degrade natural habitats' (Alberti, 2005). Consequently, urbanisation is seen to change biological communities, often described in terms of biotic homogenisation whereby urban conditions favour generalist over specialist species (Concepcion, 2015; Elmqvist, 2013).

Despite, or in some case because of these factors, towns and cities have been described as being places where biodiversity can be complex, unique and 'conservation worthy' (Farinha-Marques et al., 2011). Urban landscapes can be

viewed as a distinctive mix of the natural and semi-natural with habitat combinations and associations not seen elsewhere (Young, 2009). Consequently and as explored further in section 2.1, new approaches to urban biological conservation, and a redefining of the concept of urban biodiversity are called for.

1.1.3 Biodiversity in relation to health and well-being, and environmental apathy

The far reaching extent to which humans benefit from nature *'*beyond material welfare and livelihoods*'* is described by the Millennium Ecosystem Assessment (MEA, 2005). As set out in section 2.2., the socio-cultural, health and well-being benefits arising from people's contact with nature are increasingly discussed in both academic and policy circles. There is however no clear consensus regarding the reasons, for example culturally mediated or evolutionary hard-wired, why contact with nature is beneficial to people. Conversely, a potential disconnection between people and the natural environment as a consequence of urbanisation is often cited as a cause for concern with implications for both societal, personal and environmental well-being.

Following a review and synthesis of research, Russell et al. (2013) summarise that on balance experiencing nature makes people happier and healthier. At the same time they call for a better understanding of culturally mediated 'intangible connections' between people and nature to aid decision making. Likewise, there is a paucity of research investigating the connection between natural qualities of place, as might be usefully represented within the concept of biodiversity, and their impact on quality of life in urban settings (Bell et al., 2017; Brown and Grant, 2005; Jorgenson and Gobster, 2010).

1.1.4 Planning for future urban growth: the role of green infrastructure

The need to understand motivations for conservation and values attributed to biodiversity is a prerequisite of planning for biodiversity conservation in our towns and cities. The characteristics of urban ecosystems make objectives for biodiversity conservation particularly complex, with priorities being derived from both eco-centric and anthropocentric perspectives (Gagnon -Thompson & Barton, 1994). The 'loftiness of ecological goals' needs to be tempered by a pragmatic

approach to deciding what biodiversity is likely to succeed in urban areas, what functions and services are required and for what purposes (Dearborn & Kark, 2010).

Long standing ideas about improving the qualities of, and spatial links between, natural areas and other green spaces for the benefit of people and nature alike are manifest in the concept of green infrastructure (GI) (Benedict & MacMahon, 2000). As explored in greater detail in section 2.5 the concept of GI and the practice of green infrastructure planning (GIP) have been adopted in the context of spatial planning in the UK (Sinnett, 2017; Kambites & Owen, 2006), more broadly across the Europe and internationally (Calvert, 2018; Mell 2008).

A core theme to GI is that of connectivity: predominantly discussed in terms of physical connectivity of places for nature and peoples' physical access to natural areas, but also embracing psychological and cultural dimensions of human-nature relationships. Likewise, multi-functionality is also a central premise to GI planning, which seeks to optimise ecological, natural resource and socio-cultural benefits to be derived from an interconnected network of urban green and 'blue' spaces.

1.2 Research aims and objectives

1.2.1 Aims

Whilst not attempting to develop a fully integrative framework, this research compares two component views of how urban biodiversity priorities may be shaped. In doing so, the research adopts two perspectives:

- an ecological view of the value of urban biodiversity; and
- a people-centred view of residents' attitudes to urban biodiversity.

The consequences for policy and planning related practice are then explored in relation to urban growth and regeneration. The concepts of green infrastructure (GI) and green infrastructure planning (GIP), as used within the UK planning system, are employed as a useful framework within which to apply the research findings.

The research aims are therefore:

1) To ascertain the influence of habitat structure, composition and landscape context on biodiversity in urban settings;

2) To critically examine what determines residents' perceptions of, and values assigned to, nature in urban settings; and

3) To establish the potential of green infrastructure planning to provide a nexus between ecological and social priorities for urban biodiversity conservation.

1.2.2 Study approaches

The research adopts a case study approach, using Swindon (51.56° N, 1.78° W) as a town undergoing continued and rapid expansion. Major green-corridors within urban Swindon provide common venues for both the ecological and socio-cultural elements of the research. The relevance of Swindon as a study area and the rationale for choice of locations are considered in detail in chapter 3.

From an ecological perspective, the research investigates the composition and spatial configuration of Swindon's urban GI and its influence on biodiversity within urban green-spaces. Abundance and species richness of ground beetles encountered within urban plantations woodlands are used as surrogate measures of wider biodiversity. Woodland habitats are a principal habitat maintained in European urban landscapes (Croci et al., 2007; Donnelly & Marzluff, 2004) and therefore considered a useful setting for this research. The functional traits of ground beetles are seen to correlate well with characteristics of 'good indicator species' (Ranio & Niemela, 2003). As explored further in section 3.2, beetles are therefore considered as a useful taxon to study, complimenting research elsewhere often focussed on other taxa (Gagne & Fahrig, 2011). Concepts underpinning island biogeography theory and landscape ecology, as embedded in GIP, are then explored alongside measures of habitat configuration and structural diversity of vegetation.

From a social perspective, the research evaluates local residents' perceptions of and attitudes towards biodiversity in Swindon's urban GI. The work takes a qualitative, ethnographic approach to understand residents' level of awareness of, and attitudes towards local biodiversity developed through their everyday contact with nature. Further qualitative research in this area was considered beneficial in

helping to add new perspectives and complement the more quantitative approaches adopted to date (Jorgenson & Gobster, 2010). A theoretical framework centred on the concept of Sense of Place is adopted for the purposes of the study. Sense of Place (SoP, section 2.3) offers a means to disaggregate the intricate connections between people and the qualities of the spaces which they inhabit and assess how urban residents attach value to the ecological attributes of the areas in which they live.

With reference to a growing body of research and practice in the field of GIP and its application within the case study area, the final part of this study establishes the opportunities provided by GIP, and associated concepts, to integrate ecological and social perspectives of urban nature conservation into policy and practice recommendations.

1.2.3 Research objectives

The objectives of this study in relation to the aims are:

Aim 1. To ascertain the influence of habitat structure, composition and landscape context on biodiversity in urban settings.

> Objective 1.1: To select comparable woodlands that differ in urban landscape context and describe their structure and composition;
>
> Objective 1.2: To survey ground beetles in each urban woodland;
>
> Objective 1.3: To relate beetle species richness, community composition, and abundance to the composition and spatial configuration of Swindon's urban woodlands.

Aim 2. To critically examine what determines residents' perceptions of, and values assigned to, nature in urban settings.

> Objective 2.1: To identify a social group that engages with urban green space in differing urban landscape contexts and in close association with woodlands selected for objective 1.1;
>
> Objective 2.2: To adopt a triangulated approach to elicit residents' perceptions of, and values assigned to, nature within urban green spaces;

Objective 2.3: To utilise a sense of place framework to evaluate the contribution of nature encountered within Swindon's urban green space to the value residents assign to these areas.

Aim 3. To establish the potential of green infrastructure planning to provide a nexus between ecological and social priorities for urban biodiversity conservation

Objective 3.1: To synthesise the potential role of green infrastructure planning as a basis to integrate ecological and social perspectives in urban settings;

Objective 3.2: To provide a mechanism through which both ecological and social benefit can be delivered in urban settings and provide recommendations for policy and practice.

1.3 Thesis Structure

Chapter 1, here**,** provides the context and identified need for this research. Key concepts employed during the study are introduced. The research aims, objectives and questions addressed are set out. Approaches to the research are outlined alongside justification for their use.

Chapter 2 further defines the scope of the study and presents an in-depth exploration of the concepts used in the context of previous research and associated literature. Biophysical and socio-cultural aspects of planning for urban biodiversity are investigated.

Chapter 3 sets out the methodologies followed, and justification for their use, for both the ecological and social strands of the research. The ontological and epistemological stances employed for the study are established in advance of the consequential approaches to the investigations.

Chapter 4 describes the methods used to investigate biodiversity as represented by beetle species assemblages in relation to urban woodland habitat structure. Results are examined and discussed in the context of planning for urban growth and development.

Chapter 5 describes the methods used to investigate urban residents' sense of place with regard to biodiversity encountered in 'everyday' settings. Results are examined and discussed in the context of planning for urban growth and development.

Chapter 6 pulls the research findings together in the form of a synthesis. Discussion centres on the merits of green infrastructure planning as a means to align ecological and social priorities in place making. Conclusions are drawn and recommendations made for consideration in policy and practice, alongside implications for further research.

Chapter 2: Examining biophysical and sociocultural characteristics of urban green spaces in relation to biodiversity conservation

This chapter defines the scope of the study and presents an in-depth exploration of the concepts used, in the context of previous research and associated literature. Both biophysical and sociocultural aspects of planning for urban biodiversity are investigated. Key concepts employed in this research such as those related to biodiversity and human benefits of nature in urban settings, valuing nature and sense of place, landscape ecology and green infrastructure planning are scrutinized.

2.1 Biodiversity conservation in towns and cities

The complex nature of biodiversity in towns and cities can be seen in relation to processes, e.g. nutrient cycles, hydrology, climate, soils, disturbance and the complexity of habitat types and wildlife communities (Alberti, 2005). Urban habitats are unlikely to fully replace the functionality of natural remnant habitats, and conservation efforts, focusing on priority habitats and species more typical of wider rural settings may have limited success (Rosenzweig, 2003). Rather, urban nature may be characterised by a combination of native species, introduced and invasive species often forming ‘novel communities’ (Blaustein, 2013) or ‘unlikely recombinant communities’ (Angold et al., 2006) and manifest in ‘novel ecosystems’ (Kowarik, 2011). There is need therefore for a broader approach, and one which encompasses the whole range of urban nature rather than an exclusive focus on native species. Such a focus risks ignoring the benefits of ‘other urban nature emerging on profoundly altered sites’ (Kowarik, 2011).

Moreover, some of the underlying concepts and theoretical approaches to conservation are considered a poor fit in the urban context (Pickett et al., 2001). Principles of island biogeography have been extensively used in conservation biology to describe a predictive relationship between species distribution and the size and distribution of remnant habitat patches within fragmented landscapes (Franklin & Lindenmayer, 2009). Habitat isolation and fragmentation in urban areas are typically large and variable and an extensive review of previous research carried out by Prugh et al. (2008) has shown that habitat patch area and isolation are poor predictors of occupancy for most species. Such findings support

the proposition that the complexity of urban areas precludes simple cause-effect relationships (Werner, 2011) such as those led by an expectation of patch size-species correlations (Spellerburg et al., 2000).

Further difficulties arise in distinguishing between habitat patches and surrounding land-use in urban areas. The model presented by island biogeography is one that describes fragmented, wildlife accommodating habitat patches isolated within a sea of more hostile land-use. In towns the homogenising effects of urbanisation (Alberti, 2005) creates a situation whereby land-use around areas considered as patches may be hospitable and provide suitable conditions for patch dwelling species to live and reproduce. Hence, the notion of a patch/non patch dichotomy appears less relevant in urban settings (Prugh et al., 2008; Franklin & Lindenmayer, 2009; Norton, 2019). Moreover, species which have persisted in highly fragmented urban landscapes may be considered to be the ‘survivors’ and may be more typically able to persist in non-patch areas (Prugh et al., 2008). Issues of scale also become apparent when looking at habitat patches across an urban mosaic: what may appear as a patch when looked at a local scale, say over several hectares, will disappear into the background mosaic when viewed over the full extent of a townscape.

It has been suggested therefore that conservation of habitats and species in fragmented landscapes would be better assessed through improved understanding of landscape configuration and vegetation diversity (Spellerburg, 2010) and through the application of landscape metrics as a means to describe the composition and spatial configuration of urban landscapes (Alberti, 2005).

2.1.1 Consideration of scale

Cities and towns may broadly be considered at three scales. At a regional scale, urban areas as a whole can be thought of in terms of their integration with a more natural surrounding landscape, described by Werner (2011) as the ‘embedded city’. At this scale the town may be seen for example as a potential refuge for wildlife, the nature of which is shaped by the surrounding landscape and the legacy of that landscape within the urban area. Within the confines and across the extent of an urban area, the make-up of the urban mosaic, that is the complex arrangement of built and semi-natural features may be thought of as a coherent

whole described as ‘within city’ by Norton et al. (2016). At a local scale, much research is focussed on individual sites or patches and ecological interactions within them (Werner, 2011).

Likewise, urban biodiversity conservation needs to be considered at multiple and appropriate spatial scales (Franklin & Linden-Mayer, 2009; Young et al., 2009) for example, from a single feature such as a tree to a landscape scale over several thousands of hectares. Whilst the recent shift in planning for biodiversity has emphasised the need to develop landscape scale approaches, at the same time, the importance of the fine detail of urban habitats has been noted (Mark et al., 2009). Goddard et al. (2008) report that scale of ecological sampling can ‘confound ecological patterns and research at multiple scales is needed to take into account scale dependency of taxa’. Similarly, Norton et al. (2016) call for greater adoption of hierarchical patch dynamic models, in further research on urban ecological systems. To support better decision making it has also been suggested that landscape management frameworks and scales of ecological patterns need to be better aligned (Borgström et al., 2006). A recent attempt to overcome such scale mismatches may be seen in the formation of Local Nature Partnerships in England which are seeking to take a landscape scale approach to improving the natural environment beyond the administrative boundaries of local authorities (Natural England, 2013 b).

2.1.2 The importance of the urban matrix

There has been much research focussed on the biodiversity and ecology in towns and cities across the globe. A literature search of urban ecology studies yields many thousands of journal papers spanning the globe and often dealing with specific aspects of a range of taxonomic groups and urban land-use typologies. There has however been a call for a greater understanding of the interplay between the landscape matrix and patch effects (Angold et al., 2006) and few studies have investigated the link between urban biodiversity and the extent and configuration of the urban matrix (Werner, 2011 citing Hodgkinson, p.236).

The matrix in towns and cities, that is the interweaving network of green-space and built environment, forms the fabric of a complex habitat mosaic. Small green-spaces, verges, gardens, open spaces, transport corridors, scrub land typically

make up the constituent parts. Several studies point towards the importance of matrix landscape elements for particular species, for example heathland studies in the UK demonstrate the importance of structural diversity of surrounding vegetation on heathland ecology (Webb, 1984); the role of adjacent matrix to remnant urban woodlands affecting the breeding of Great Tits (*Parus major*) (Hedblom & Söderström, 2012); the permeability of the urban matrix shown to be important for movement of sugar gliders *(Petaurus breviceps*) in Melbourne, Australia (Caryl et al., 2013); the importance of ecological corridors within the matrix for the movement of garden shrews (*Sorex* and *Crocidura* species) (Vergnes et al., 2013) the persistence of racoons (*Procyon lotor*) in of the urban matrix of Baltimore in areas of little natural habitat (Gross et al., 2012).

It has been suggested that prioritising conservation efforts across the urban matrix may provide better conservation returns than manipulating the size and configuration of remnant habitat patches (Franklin & Linden-Mayer 2009; Norton, 2016). Two functions of the urban matrix that is living space and permeability (or conversely resistance) for animals and plants are considered important in terms of planning for biodiversity conservation (Werner, 2011).

2.1.3 Challenges of defining biodiversity

Before going further, it is important to set out what is meant by biodiversity and how the concept is varyingly adopted in biodiversity conservation research.

The term biodiversity, as a contraction of biological diversity, was first adopted in literature in the mid to late 1980s and has been attributed, amongst others, to Wilson's work on biophilia (Haila & Kouki, 1994). Biodiversity has since been defined as 'the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems' (Convention on Biodiversity). The etymology of the term biodiversity is usefully described by Elander et al. (2005) who summarise its emergence relating initially to species or genetic diversity to an increasingly complex 'umbrella concept' characterised at the three levels of organisational structure: genetic (gene, chromosome, genome), taxonomic (species, genus, family), and ecological (population, community, ecosystem) (Spellerburg et al.,

2000). In interpreting and explaining its significance however, the term biodiversity has been described as vague, political, abstract, popular, complex, context and scale specific (Haila 1994; Hamilton, 2005).

Sarkar (2005) describes the philosophical and practical challenges in understanding the concept of biodiversity in the context of biological conservation. Sarkar, in common with other research invokes a medical analogy to help characterise an essential relationship between biodiversity and the practice of conservation biology. Sarkar describes for example a focus on endangered species being analogous to emergency medical intervention, whilst biodiversity conservation practices would be better focussed on preventative practices.

At one level biodiversity is a simple term describing the observation that ‘natural entities appear diverse’ (Haila & Kouki, 1994, page 7). The disciplines of conservation biology and ecology most often consider biodiversity at the species level (Colwell, 2009) with biodiversity often being synonymous with concepts of species richness or species diversity (Hamilton, 2005). Both species diversity and biodiversity have however been described as non-concepts or umbrella terms without clear relationship to ecological function (Haila & Kouki, 1994; Hamilton, 2005). Saille (2006) illustrates the concern with respect to defining targets for biodiversity conservation in woodland habitats. Saille (2006, citing Ormerod, 2003, page 11) argues that biodiversity conservation objectives should seek to develop ‘a functioning woodland community with the full range of natural processes and associated structural diversity present’ rather than being driven by measures of species and habitat diversity alone.

In considering biodiversity conservation, and of particular relevance to this research, Farinha et al. (2011) also set out broader definitions for the concept of biodiversity accounting for socio-economic, aesthetic, cultural and ethical values. In tandem, the concept of urban biodiversity, although recently challenged (Blaustein, 2013; Francis et al., 2013), is seen to require a shared definition as proposed by Muller (2010): ‘the variety and richness of living organisms (including genetic variation) and habitat diversity found in and on the edge of human settlements’.

2.2 Urban nature, health, well-being and environmental apathy

2.2.1 Reported benefits and shortfalls of human contact with nature in urban settings.

The readily available opportunities provided by urban green spaces for people to have contact with nature on a regular basis is often cited as a primary motivation to conserve urban biodiversity (Kowarik, 2011). The benefits of such contact appear two-fold: relating to improvements to health and well-being (Goddard et al. 2008; Brown & Grant, 2005; de Vries et al., 2003) and as means to educate and raise consciousness of the value biodiversity and thereby foster pro-environmental behaviour within the general populace (Marzluff & Rodewald, 2008; McKinney, 2002; Miller and Hobbs, 2002). Furthermore, civic participation in identifying conservation priorities and achieving publically supported conservation work is seen as increasingly important (Fischer & Young, 2007). Access to nature within an urban setting is seen as important in shaping peoples' understanding of, and attitudes towards, the natural world (e.g. Millard, 2008; Miller & Hobbs, 2002) and 'kindling within them a value for biological diversity' (Marzluff & Rodewald, 2008)

Empirical research has particularly focussed on the influence of being in contact with nature on peoples' psychological well-being and recovery from illness. Such work has, for example, included a study suggesting a positive relationship between nature sounds and stress recovery (Alvarsson et al., 2010). The calming and restorative effects of the natural environment have been described as being essential for good mental health (Natural England, 2012a). Three theories explaining a link between the natural environment and health and well-being have been summarised by Dr William Bird, a UK based general practitioner (2007):

- The biophilia hypothesis which asserts that there is an inherent human need to affiliate with life and lifelike processes (Kellert & Wilson, 1993);
- Attention restoration theory (Kaplan & Kaplan, 1989) which sets out four restorative qualities of experience that are accommodated by the natural environment: being away, fascination, feeling of extent and of the natural environment. Notably, Bird (2007) refers to over 100 studies that support this theory;

- Psycho-physiological stress recovery theory: based on observations of physiological indicators of stress relief responses of exposure to the natural environment. The theory assumes this response is based on inherent reflexes centred within the limbic system part of the brain (Ulrich, et.al, cited by Bird, 2007).

The benefits people derive from nature are also being increasingly described in terms of cultural ecosystems services (CES) within a wider framework including other ecosystems services: provisioning, supporting, and regulating. CES are described as 'those providing the non-material benefits people obtain from ecosystems though spiritual enrichment, cognitive development, reflection, recreation and aesthetic experiences' (Millennium Assessment, 2005). Typically characterised as intangible, the physical, emotional, and mental benefits derived from CES have been described as 'subtle and intuitive' in nature (Milcu et al., 2013 citing Kenter et al., 2011 pg. 43), a relationship extensively referred to in academic and non-academic literature in terms of nature 'connectedness'.

Connectedness with nature

Connectedness with nature has been described in psychological research as the degree to which people feel a part of nature rather than feeling separate to nature or 'the extent to which an individual includes nature within his/her cognitive representation of self' (Mayer & McPherson Frantz, 2004). That such connectedness has a biological, implicit, unconscious basis (Vining et al., 2008) is reflected in a number of theoretical hypotheses relating health and well-being to contact with nature. In setting out their biophilia hypotheses, Kellert and Wilson (1993) describe an evolutionary grounded relationship between human and non-human life as being fundamental to living a fulfilling life as reflected in research describing attention restoration theory (Kaplan & Kaplan, 1989) and psycho-physiological stress recovery theory (Ulrich, et al., cited by Bird, 2007 p9).

The amount of time spent in what is perceived as natural environments has been shown to influence affinity with nature and an inverse relationship between the degree of separation of people from nature and their contact with nature is suggested (Vining et al., 2008). Experiences of places is therefore seen to

influence nature connectedness. A growing disconnection between people and nature as a consequence of urbanisation is often cited as a cause for concern in relation to the human wellbeing and environmental apathy amongst individuals and society more generally (Miller, 2005; Shwartz et al., 2014; Hartig, 2013). A number of concepts have been used to describe and explain a growing disaffection and apathy towards nature particularly associated with urban environments (Miller, 2005). 'Shifting baseline syndrome' (Pauly, 1995) describes a generation to generation acceptance of continually degrading ecosystems which become the perceived normal state of nature. SBS is manifest in individuals as a psychological condition of 'environmental generational amnesia' (Kahn, 2002) whose root cause is an impoverishment of the richness of the natural environment. Similarly, Miller (2005) describes the basis of an estrangement from nature or 'extinction of experience' (Pye,1993), in terms of a downward spiral of disaffection and apathy towards the natural environment, as a result of biological homogenisation associated with urban areas and increasingly sedentary lifestyles. Particular emphasis is placed on childhood experiences in the context of increasing urbanisation (Miller, 2005).

The importance of childhood experience

A growing body of research describes a profound and positive effect that contact with nature can have on the physical and mental well-being of children (Strife & Downey, 2009). Furthermore, extensive reviews such as those carried out by Charles (2012) and Faber et al. (2006) summarise a myriad of ways, physical, emotional, cognitive and socio-cultural, in which experiences of nature can support childhood development. The range of personal and socio-cultural benefits to be derived from such experiences and described by such research is seen as far reaching and covers (Strife & Downey, 2009; Charles, 2012):

- Improvements to physical health
- Mental and cognitive health, emotional well-being
- Cognitive capacity
- Motor functioning
- Attention functioning
- Improved academic performance

- Social interactions, community trust and perceptions of safety
- Language development, social and collaborative skills
- Fostering pro-environmental behaviour.

Conversely, a rapid decline in childhood experiences in nature has been described as a consequence of more sedentary lifestyles, less time spent outdoors, a lack of structured programmes in nature, greater media orientation, and parental fears regarding safety (Pretty et al., 2009; Strife & Downey, 2009; Kellert, 2005; Faber Taylor & Kuo, 2006; Charles and Louv, 2009; Chawla, 2006). Strife and Downey (2009, citing Kellert 2005) suggest that children disproportionately suffer the long term developmental consequences of limited contact with nature with implications for health later in life. Contact with nature throughout various stages of childhood development is hypothesised in research by Pretty et al. (2009) as being a necessary component of a healthy 'life pathway'. In such a model, those more connected with people and society, engage with natural places and eat healthily are seen to lead to longer as well as better quality of lives.

Particular importance is placed on middle childhood, 6-11 years old (Kellert, 2005) equivalent to the second age childhood, 6-12 years old described by Pretty et al. (2009). Both pieces of research describe this as a critical period of cognitive and emotional development during a time when children start to explore *'explore their environments to make memories and develop cognitive capacities'.* The importance of the local environs beyond the immediate home is emphasised as is the opportunity afforded by local spaces for 'spontaneous and unplanned contact with nature'. Locality is also important is providing opportunity for regular contact with nature, research having shown that whilst memorable individual experiences or 'occasional immersions in nature' (Kelly, 2006), can be valuable and more time spent in nature is associated with a closer connection to nature (Richardson, 2015; Strife & Downey, 2009). Moreover, lack of regular positive experiences in nature has been shown to foster what might be considered as negative emotions of fear, discomfort and dislike of the natural environment (Bixler & Floyd, 1997).

Most of the research in this field stems from developed countries particularly in the US, UK, Canada, Australia, Germany, the Scandinavian countries, and Japan

(Charles & Louv, 2009). There are indications however of consistent patterns of findings across a range of research settings and disciplines (Faber Taylor & Kuo, 2006). Moreover, the effects of nature experience are evident irrespective of socio-economic and socio-cultural backgrounds (Strife & Downey, 2009). Whilst further research is called for, the sentiment is that 'we can continue to assume, just as they need good nutrition and adequate sleep, children may very well need contact with nature' (Faber Taylor & Kuo, 2006).

2.2.2 The role and perception of biodiversity

A contributing factor attributed to a reported growing disconnection between people and nature as a consequence of urbanisation is the process of biotic homogenisation associated with urban environments (McKinney, 2006; Alberti, 2005). As a consequence of such homogenisation, ' biological poverty' has been described as occurring when urban citizens experience below-average levels of native species diversity on a daily basis (Clergeau et al., 2002 cited Farinha-Marques et al., 2011 p. 253). However, such understanding remains limited and the reasons that contact with nature is of benefit to people remain unclear (Bell et al., 2017, Dallimer et al., 2012, Southon et al., 2018). There has therefore been a call for a better insight into how people perceive, value and respond to urban biodiversity to better guide conservation efforts (Bell at al., 2017;Christmas et. al., 2013; Fischer and Young, 2007). Clark et al. (2014) argue that a better understanding of the relationship between biodiversity change and human cultural values could have profound importance for both biodiversity conservation and health.

There have been few studies on the components of, or mechanisms by which, the qualities of naturalised green-spaces impact on quality of life (Brown & Grant, 2005; Jorgenson and Gobster, 2010). In addition, research evidence on the effects of people's exposure to green-space is not consistent and causal pathways have been inadequately considered in research to-date (Lachowycz & Jones, 2013).

Dean (2011) undertook a systematic review of studies which have sought to show relationships between biodiversity and mental health. At the time, Dean found a single study by Fuller et.al (2007) carried out in Sheffield, which specifically sought to explore the link between psychological well-being and biodiversity as a

component part of the landscape. Subsequently, Dallimer et al. (2012) carried out similar work to that of Fuller, again in Sheffield. Both Sheffield studies describe the correlation between a person's sense of well-being and biodiversity, the latter as measured by species richness in urban green-spaces. The Sheffield studies followed a quantitative approach utilising two theoretical frameworks: sense of place framework (Dallimer citing Altman & Low 1992, pg. 50) and cognitive restoration theory (following Kaplan & Kaplan, 1989) as the basis for assessing psychological well-being. Whilst contradictory in part, both pieces of research i) indicated that there was a positive correlation between perceived species richness and well-being and ii) highlighted the importance between perceived and actual species richness as a key area to address through further research. A more recent study by Chang et al. (2016), cite work indicating that beyond a certain level of naturalness, self-reported well-being may begin to diminish. They go to employ assessment of physiological 'biofeedback' in response to a range of semi-natural settings: facial muscle tension, heart rate variability, and blood volume pulse. Whilst finding no negative responses to changes in biodiversity, they also report that physiological responses remain unchanged with increases in biodiversity.

Other work by Qui (2013) used the theoretical framework proposed by Kaplan and Kaplan (1989) to assess perceptions of biodiversity and aesthetic preferences of visitors to an urban green-space in Helsingborg, Sweden. Their research evaluated the relative importance of two visual aspects of landscape: spatial configuration and content. Whilst people were able to distinguish biodiversity, the Helsingborg study showed no link between biodiversity and aesthetic preference. Likewise, subsequent work by Hoyle et al. (2018) found diversity in colour within urban meadows to be a driver of human aesthetic response rather than plant species diversity per se.

"G*ross structural habitat heterogeneity*" of the urban landscape is suggested by Fuller at al., (2007) to potentially be the primary means by which people detect biodiversity. This view is emphasised by Jorgenson and Gobster (2010) who suggest there is considerable support through other research for a 'structural heterogeneity hypothesis'.

Such a hypothesis infers the importance of scale in peoples' perceptions of biodiversity. Whilst biodiversity may be studied at many spatial levels, from the gene to landscape scale, it is difficult for people to relate to phenomena at scales beyond their direct experience (Gobster et.al, 2007). Gobster et al., stress the importance of the 'human perceptible realm' as it is at this scale that landscape perception becomes a key process for connecting humans with ecology and is important therefore in understanding the relationship between aesthetics and ecological qualities of the landscape.

2.2.3 Understanding health and well-being

Similar and analogous to the need to better define the concept of biodiversity (section 2.1.4) in the context of this research, so too the need to set out dimensions of health and well-being.

The concepts of 'health' and 'well-being' are often used concurrently with limited exploration in both academic and non- academic literature of their definitions, component parts and inter-relationships. For the purposes of this research, the World Health Organisation's definition of health (WHO, 1948) is adopted alongside the Stiglix Commission's definition of subjective well-being (2009).

Human health has been defined as 'a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity' (WHO, 1948). Explicit within this definition is that social as well as biological and psychological factors need to be considered when addressing health related issues (Tzoulas et al., 2007). Whilst the WHO definition is not without detractors it has been widely adopted and little adapted over the past 60 years (Huber et al., 2011).

Well-being is a concept widely used in academic research and practice in fields as diverse as health care, industry and economics, sociology and anthropology (Smith, 2010). Likewise, a plethora of academic research seeks to relate well-being to biodiversity conservation (Tzoulas et al., 2007). Well-being has been described as a 'dynamic concept that includes subjective, social, and psychological dimensions as well as health-related behaviours' (Siefert & Shaw, 2013). The UK's Millennium Ecosystem Assessment uses a broad definition of 'well-being encompassing material security, personal freedoms, social relations

and physical health (MA, 2005). As well as improvements to well-being being seen as worthy in their own right, such improvements are seen as instrumental to other outcomes including contributions towards human health and vice versa (Dept. of Health, 2014). Two dimensions of wellbeing have been described: objective and subjective. Objective wellbeing is based on assumptions about basic human needs and rights, including aspects such as adequate food, physical health, education, safety (Dept. of Health, 2014). Variables such as income and education level, access to healthcare have been used as measures of objective well-being (Smith, 2010; Dolan et al., 2011). Subjective wellbeing (SWB) is generally described as how people think and feel about their own wellbeing (Dolan et al., 2011). A widely adopted definition of SWB is provided by the Stiglitx Commission (2009) which states that 'subjective well-being encompasses different aspects: cognitive evaluations of one's life, happiness, satisfaction, positive emotions such as joy and pride, and negative emotions such as pain and worry'. Measures of subjective well-being are being increasingly used to develop, monitor and appraise public policy (Dolan et al., 2011).

2.3 Valuing Nature and Sense of Place

2.3.1 Ways of valuing nature and biodiversity

To help guide environmental policy and decision making, there has been a drive to measure the value of biodiversity in terms of market or non-market economic benefits through approaches such peoples' willingness to pay or contingent valuation methods (TEEB, 2007). However, the 'plurality and incommensurability' of the values which can be ascribed to nature raises questions over such natural capital approaches (Stratford, 2013). The challenges of doing so are compounded by problems arising in that the concept of value, as applied in social science and psychology disciplines, and its relationship to other terms employed such as normative beliefs, attitude, and opinion is contested (Bergman, 1998; Vaske & Donnelly, 1999). A plethora of terms used within value domain is seen as confusing (Seymour et al., 2015) and act to hinder research (Parks & Guay, 2009).

Despite these reservations, a better understanding and integration of social values with ecological and economic evaluations of nature and natural resources in

particular places is increasingly called for (Christmas et al., 2013; van Riper et al., 2012). The UK National Ecosystem Assessment (UK NEA, 2013) recognised the need for a better understanding of non-use, shared cultural and plural values ascribed to nature. The UK NEA subsequently set out a programme of research to include comparisons of monetary and non-monetary valuation methods and involved using a range of deliberative techniques and multi-criteria analysis. The importance of understanding the values that people and communities associate with place has been described as central to guiding communication and decision making in the field of natural resource management (Sherrouse et al., 2011; Seymour et al., 2010). As such and in the context of urban forests, Steenberg et al. (2019) call for greater integration of societal values into ecosystem based management models. Likewise, research utilising ecosystems service frameworks has started to address the role of culturally assigned values as mediators of health and well-being benefits in relation to human contact with nature and natural environment (Clark et al., 2014).

The roles of values as pre-cursors to pro-environmental behaviours are also cited extensively in social science research related environmental issues (Gatersleben et al., 2012). Conceptual models have been employed across research disciplines to understand such links between people's values and behaviour. Various models based on cognitive hierarchy theory (CHT) have been used extensively in studies related to environmental issues (Vaske & Donnelly, 1999).

Such value-attitude-behaviour concepts and their inter-relationships as represented in research and grey literature relating to nature conservation, natural resource management and ecosystems services based models are considered in greater depth in Chapter 5 and Appendix 1.

2.3.2 Understanding sense of place (SoP)

The notion of SoP first emerged in the 1960s-70s (Kudryavtsev et al., 2012) and the geographer, Yi-Fu Tuan's work, describing how 'space' becomes 'place', is often cited as seminal. Multi-faceted, complex and difficult to define, SoP is a term that 'encompasses the meanings and attachments that places hold for people' (Semken & Freeman, 2008). Research on the concept of place is multi-disciplinary

and diverse approaches have been adopted from biological, social, geographical, religious, the arts and resource management perspectives (Forristal et al., 2012). An indication of the breadth of place research can be seen from a cursory view of webpages dedicated to research on place and space (Janz, 2014). Accordingly, varying epistemological and ontological stances have been adopted in studies of human-place interactions (Kudryavtsev et al., 2012; Williams & Patterson, 2007; Kyle & Chick, 2007). Reflecting such breadth of research, there has been a call for a *'*need to clarify the multiple and competing paths for place research easily obscured in the heap of similar-sounding place concepts*'* (Williams & Patterson, 2007).

Despite inconsistent use of terms and associated 'chaotic' literature (Kudryavtsev et al., 2012; Jorgensen & Stedman, 2011), SoP can be seen as a three component view that weaves together physical environment, human behaviours, social and psychological processes (Stedman, 2003). Many researchers describe SoP as a combination of two complimentary concepts: place attachment and place meaning (Kudryavtsev et al., 2012; Semken & Freeman, 2008). Place attachment is described as a positive bond that develops between groups or individuals and their environment (Altman & Low, 1992). Place attachment has also been conceptualised in terms of concepts of place dependency, the *'*potential of a place to satisfy an individual's needs by providing settings for his/her preferred activities' (Jorgensen & Stedman, 2001), and place identity: the extent to which a place becomes a part of personal identity (Proshansky et al.,1978).

In the context of place theory, Low and Altman (1992) stressed the centrality of 'affect, emotion and feeling' in human-place interactions but also recognised the roles of cognition and practice. A similar tri-partite conceptualisation was followed by Jorgensen and Stedman (2001) who set out cognitive, affective and conative components of SoP. Conceptualising SoP, grounded within attitude theory (the inter-relationships between SoP and value-attitude-behaviour theory are described further in appendix 1), Jorgensen and Stedman (2001, 2006) correlate place attachment with the affective realm, place identity as primarily cognitive and place dependency as conative. Differentiating between the cognitive, affective and cognitive domains, Jorgensen and Stedman suggest, 'will better reveal the

complex relationships between the experience of a place and attributes of that place*'.*

2.3.2.1 Sociocultural and biophysical influences on sense of place

Research literature sets out a debate between sociocultural and biophysical influences on SoP. Stedman (2003) suggests that SoP research has neglected the role of the physical environment, instead favouring social constructions. From a sociocultural perspective, 'space' only becomes 'place' when endowed with [socially constructed] values (Tuan 1977 cited Stedman, 2003 p. 672). As such, single spaces can encompass multiple 'places' and a particular locality can hold divergent meanings for different people (Gruenewald 2003, cited Semken 2005 p 149). However, the role of the biophysical environment in place-making has been described extensively and Stedman (2003) asserts that landscape characteristics matter and that they underpin the component concepts of SoP. Thrift (1993) also describes a link between the physical environment and the embodiment of place. Using an example of the sensorial experiences encountered on a walk in the countryside, Thrift describes how place consists of *'*the push and pull of walking up hill and down dale, the sound of birds and the wind in the trees, the touch of wall and branch, the smell of trampled grass and manure*'.*

It is not the intention here to detail the debate between sociocultural and bio-physical influences on SoP. However, in the context of this research it is noteworthy that such debates have exposed a gap in research whereby the physical, ecological attributes of the landscape encompassing communities has received little attention and that 'only on rare occasions' have sociologists looked at residents' attachments to physical/ecological attributes of place (Beckley et al., 2007).

On the assumption that it is possible to do so, and there are means to (quantitatively) measure degrees of place attachment, Beckley et al.(2007) set out a theoretical proposition to disaggregate ecological and sociocultural attributes of place. Whilst the epistemological and ontological bases of such an approach have been questioned (Williams & Patterson, 2007), the hypotheses proposed by Beckley, provide useful areas for research to explore: the role of changing

environments, issues of scale (e.g. home, neighbourhood, region), length of residence, cultural differences and knowledge of place. Similarly, Kudryavtsev et al., (2012) summarise experiential factors that a) may influence place attachment such as frequency, length of encounter and active engagement and b) shape place meaning through first-hand experiences and learning from written, oral and other sources.

2.3.2.2 Urban biodiversity in sense of place research

Whilst the notion of SoP has been employed across a broad sweep of research considering human-place relationships, few studies have considered the role of biodiversity per se. Horwitz et al. (2002) through their studies of aquatic systems in Australia, summarise that biodiversity contributes to a person's attachment to a particular place and becomes part of a person's identity. They go on to say that loss, destruction, or change in a location has the potential to affect an individual's psychological well-being, and challenge a community's identity and image of itself (Horwitz et al., 2002). Work by Fuller et al. (2007), carried out in Sheffield (UK) employed a SoP framework and is one of few studies to seek to explore the link between psychological well-being and biodiversity as a component part of the urban landscape. Subsequently, Dallimer et al. (2012) carried out similar work to that of Fuller, again adopting a SoP framework and again in Sheffield. Both Sheffield studies, contradictory in part, describe the correlation between a person's sense of well-being and biodiversity. Related work by Qiu et al. (2010) used the cognitive restoration theoretical framework proposed by Kaplan and Kaplan, (1989) to assess perceptions of biodiversity and aesthetic preferences of visitors to an urban green-space in Helsingborg, Sweden. Whilst people were able to distinguish biodiversity, the Helsingborg study showed no link between biodiversity and aesthetic preference.

In reviewing SoP in the context of health improvements, Frumkin (2003) states that 'public health needs to rediscover the importance of place' and proposes that contact with nature needs further evaluation before it can be recommended to the healthcare industry, particularly understanding the 'kinds of nature (flowers? trees? animals?) and kinds of contact (viewing? touching? entering?)' of benefit.

2.4 Shifting approaches to nature conservation

Traditional approaches to nature conservation with a focus on particular places or sites of ecological interest are being superseded by those emphasising broader spatial scales and the role of humans in shaping the landscape. A broader shift in emphasis has also been categorised by Mace (2014) who describes a transition between 4 overlapping phases of approaches to nature conservation in the developed world over the past 50 years:

- 'Nature for itself', characterised by foci on wilderness and intact natural habitats, largely beyond human influence
- 'Nature despite people' considering increased impacts of human activity on nature
- 'Nature for people' moving towards ecosystems based thinking of nature as an essential component of sustainable development
- 'People and nature' seeking to integrate the social and ecological in the context of environmental change, resilience and adaptability.

These changes in standpoint can be usefully considered within the discipline of landscape ecology (LE). Whilst there is some debate about its scope (Turner, 2005) landscape ecology (LE) offers a theoretical perspective on the relationship between spatial and temporal patterns of land-use and ecological processes (Wu, 2008). As a rapidly developing discipline the principles of LE have been used extensively in a number of interrelated fields of research: sustainable development (Wu, 2008; Termorshuizen, 2000) natural resource management (Lui & Taylor, 2002), ecosystems services (Muller, 2010), water catchment management (Aspinall & Pearson, 2000), urban and green infrastructure planning (Jim & Chen 2003; Ahern, 2007), and biodiversity conservation (Lindenmayer et al., 2008).

Central to LE thinking are the components of landscape pattern and spatial heterogeneity often characterised by the patch-corridor- matrix model proposed by Foreman and Godron (1981) as adopted widely in biological conservation based research policy and practice (Lindenmayer et al., 2008). In such a model, structural elements of the landscape are conceptualised in terms of [habitat] patches, the landscape matrix, corridors and stepping stones, combining to form ecological networks. An alternative perspective is conceptualised in landscape mosaics, although the latter appears sometimes conflated within the p-c-m model

(Bennet et al., 2006). Table 2.1 summarises constituent parts of the patch-corridor-matrix model. This model has been employed in the UK as a basis of a national biodiversity conservation strategy aimed at halting biodiversity loss (DEFRA, 2011).

Table 2.1 Structural components of landscape as conceptualised in a patch-corridor-matrix model. Landscape mosaic is presented as an alternative perspective

Landscape component	**Summary descriptions**	**Example**	**References**
Patch	Communities or species assemblages surrounded by a matrix with a dissimilar community structure or composition. Characterised by the means of their formation e.g. remnant, introduced, and ephemeral patches. A patch must be defined from the species point of view, but this definition often coincides with a human point of view.	Designated nature areas.	Foreman and Godron, (1981); Driscoll et al. (2013).
Matrix	Extensive land cover with different types of land cover (patches) embedded within it. The matrix includes the extensive land-cover types that patch-dependent species cannot sustainably live in.	Urban development, intensive agriculture.	Driscoll et al. (2013).
Corridor	A corridor can generally be considered to be a linear feature of vegetation that differs from the surrounding	Water course and riparian zones, hedgerows, road verges,	Gregory and Beier, (2013); Hobbs, (1992).

	vegetation but can cover a broad range of spatial extents and contexts. Four types proposed: line, strip, stream and network.	drainage ditches.	
Stepping stones	A series of small patches connecting otherwise isolated patches. A scattered mosaic of habitat fragments or intermediate patches that might facilitate species dispersal between larger patches.	Isolated woodland copses within farmed land.	Baum et al., (2004); Saura et al. (2013).
Landscape Mosaic	Complex, heterogeneous assemblages of patch types, which cannot be simply categorized into discrete elements such as patches, matrix, and corridors.	Urban centres, agricultural, montane meadows.	Bennet et al. (2006); Debinski et al. (2001).

A concept central to landscape ecology, and allied to green infrastructure planning (discussed further in section 2.5) is that of connectivity. From a nature conservation perspective connectivity typically relates to the ability of species to move across landscapes (Lindenmayer et al., 2008). More broadly functional connectivity refers to the degree to which a landscape facilitates the movement of species, people, nutrients, energy and materials (Ahern, 2007; Belisle, 2005). Considered as representing interactions between landscape structure and landscape function (Ahern, 2007) connectivity may be seen as a determinant of the performance of ecological networks. In a review of landscape connectivity studies, Tischendorf and Fahrig (2000) highlight confusion in the way in which the term landscape connectivity is defined, and the multiplicity of means by which connectivity is measured. In extremis, results from some measurements of connectivity may be interpreted in such a way as to conclude habitat fragmentation

could lead to enhancement of habitat connectivity (Tischendorf & Fahrig 2000). In a later review, Kindlmann and Burel (2008) echo similar concerns and call for development of landscape metrics that better 'characterise the landscape with an emphasis on the underlying processes'. In doing so distinction is made between a) *structural connectivity* defined and subsequently measured solely in terms of spatial components of landscape and b) *functional connectivity* which 'consider [s] the behavioural responses of organisms to landscape pattern'. In summarising the two dimensions of connectivity vis-à-vis landscape structure and behaviour of organisms, Kindlmann and Burel (2008) conclude a need to develop relatively simple measures of functional connectivity which consider the behaviour of broad categories of organisms in relation to landscape structure.

Corridors are often referred to within concepts of connectivity and are seen as key components of the 'indispensable patterns' (Forman & Godron, 1981) of ecological networks providing connectivity across landscapes. In summary, corridors are typically described as set out in Table 2.1. The functionality of such corridors within ecological networks however is much contested. Scale and context dependant descriptions of the structural form of corridors abound and clarification of related terminology is called for. Likewise, more detailed analyses of corridor structure including characteristics such as origin, exterior and internal dimensions, structural diversity of vegetation, measures of naturalness and context within a broader matrix are needed to better understand their viability (Cook, 2012).

2.5 Green infrastructure and green infrastructure planning

Green infrastructure (GI) has been described as an essential, vital component within a wider sweep of sustainable development and urban resilience concepts including that of 'healthy places' (Calvert et al., 2018; Sinnett et al., 2018, Staddon et al., 2018). The concept is used in a variety of settings academic or otherwise: with reference to quality of life, urban renaissance, liveability greenways, landscape ecology, urban planning, human geography (Mell, 2009). The multifaceted functions and associated benefits attributed to GI are encapsulated within ecosystem service (ES) based models (Benedict & MacMahon 2002; Calvert et al., 2018). The two approaches may be seen as mutually supportive and complimentary and better synthesis of GI and ES theoretical frameworks has been

called for (Hansen & Pauleit, 2014). Likewise, in seeking to integrate ecology, design and planning, socio-economics, and management practices, landscape ecological approaches are embedded within GI planning are considered particularly relevant to the urban setting (Ahern, 2007; Wu, 2008). Whilst relevant and applied across urban and rural landscapes, green infrastructure planning in the UK can be seen to have its roots, and main areas of application in spatial planning of urban and peri-urban development (Kambites & Owen, 2006; Sinnett et al., 2018).

Many definitions of GI have been developed, sharing common language and purpose (Benedict & McMahon, 2000). Here, a definition is taken from the European Commission (2013):

'Green Infrastructure: a strategically planned network of natural and semi-natural areas with other environmental features designed and managed to deliver a wide range of ecosystem services (in terrestrial, aquatic, coastal, marine environments). In short, the structure enabling healthy ecosystems to deliver their multiple services to people. On land, GI is present in rural and urban settings, and in protected (such as Natura 2000) and non-protected areas.'

In the UK, a more extensive definition is offered by Natural England (2009a):

'Green Infrastructure is a strategically planned and delivered network comprising the broadest range of high quality green spaces and other environmental features. It should be designed and managed as a multifunctional resource capable of delivering those ecological services and quality of life benefits required by the communities it serves and needed to underpin sustainability. Its design and management should also respect and enhance the character and distinctiveness of an area with regard to habitats and landscape types.

Green Infrastructure includes established green spaces and new sites and should thread through and surround the built environment and connect the urban area to its wider rural hinterland. Consequently, it needs to be delivered at all spatial scales from sub-regional to local neighbourhood levels, accommodating both accessible natural green

spaces within local communities and often much larger sites in the urban fringe and wider countryside'

In common with other definitions of GI and their subsequent operationalization in land-use planning, both the EC and UK approaches share common characteristics embedded within the definition of GI and approaches to GIP as shown in table 2.2.

Table 2.2. Characterisation of green infrastructure and green infrastructure planning

GI and GIP characteristic	Dimensions	Example references
Multi-faceted	Wide range of land use typologies, green, blue integrated with grey.	The Landscape Institute (2009) cite 48 GI asset typologies from local to national scale.
Multi-functional	Full breadth of ecosystems services: provisioning, regulating, supporting, cultural. Providing 'natural solutions' alongside the engineered.	Hansen and Pauliet (2014) review multi-functionality within context of ES.
Connected network	Accessibility, habitat and landscape integrity, hydrology. Manage risks associated with increased connectivity.	Connop (2016). Lohmus and Balbus (2015) consider transmission of disease.
Multi-scaled	Hierarchical spatial nesting from sub-regional to community level. Strategic thinking and planning.	Sinnett et al., (2017) describe examples of GI from the micro to landscape scale. Jerome (2017), posits the importance of community level GI.
Inclusive	Community, interest groups, and stakeholder engagement in planning and management.	Kambites and Owen (2006), Jerome (2017).

	Plan in social inclusion and equity. Manage risks of promoting inequality through e.g. gentrification'.	
Cross disciplinary and cross boundary	Ecological, social, environmental, political. Urban-peri-urban- rural. Administrative e.g. planning authorities.	Sinnett et al., (2018). Mell (2008), Kambites and Owen (2006).
Landscape context	Towns and cities embedded within, influencing and being influenced by the wider landscape. Landscape heritage and local distinctiveness.	

Closely allied to landscape ecology, the origins of GI thinking emerge from long held ideas regarding the benefits of connecting natural areas and green spaces for the benefits of people and nature alike: 'A connected system of parks and parkways is manifestly far more complete and useful than a series of isolated parks.' (Law and Olmsted, 1903). Initially arising from policy and practice based work in the United States (Benedict & McMahon,2002), the concept of GI and the practice of green infrastructure planning (GIP) have been widely adopted in the context of spatial planning in the UK and more broadly across the European Union (Kambites & Owen, 2006; Sinnett et al., 2017). Despite such application in practice, and extensive reference to GI in academic and non-academic literature (Sinnett et al., 2017), GI related research is seen to suffer from limited development of, and lacking a distinct, theoretical foundation (Hansen & Pauleit, 2014; Mell, 2009). Accordingly, the concept of GI has been described as a 'broad and elusive' concept (Hansen, 2014) and being diverse in its meaning and functions (Mell, 2008).

Conceptual difficulties are mirrored in practice. Despite the embedding of GI into UK national and local planning policy, a review carried out by Scott et al. (2017)

found weaknesses in the translation of GI policies into practice. Calvert et al. (2018) describe some of the challenges in planning, delivering and managing green infrastructure manifest in an uneven picture across the UK and reflecting similar difficulties in other countries.

Notwithstanding the theoretical and practical challenges, the underlying concepts and intrinsic processes embodied within GIP offer opportunities to integrate the socio-cultural with the ecological in prioritising biodiversity conservation efforts in urban areas: embracing the whole range of urban nature and realising the individual and societal benefits to be gained from nature rich urban environments. GI and GIP therefore provide a useful theoretical framework in which to establish such priorities within rapidly growing towns such as Swindon. As investigated further in Chapter 6, distinction is needed however between:

- GI assets, often considered in practice in terms of primary use (e.g. play areas or road verges);
- GI as a network of multiple land uses, operating at varying spatial scales and embodying the characteristics detailed in table 2.2. and
- GIP as a cross sectoral and integrative approach to prioritising design, establishment and management of GI networks through policy and practice.

2.6 Chapter 2 summary

As reviewed in this chapter, an interdependency of ecological, personal and social values can be attributed to urban green spaces. Broadly accepted approaches to nature conservation founded on principles of landscape ecology may be less applicable to urban settings than to non-urban settings. At the same time, and in the context of growing urban populations, green spaces within towns and cities offer potential for valuable human contact with nature. A better understanding of ecological and people-nature attributes of place and how they interrelate is needed to better prioritise investment in urban landscapes. The following chapters within this study therefore consider these attributes in turn using a case study approach, and set out their inter-relationships using a GIP framework as presented in the final chapter. Prior to doing so, the methodological approaches to the research are established in Chapter 3.

Chapter 3 Study approaches and area

This chapter sets out the methodologies used in this research, and justifies their appropriateness to meet the research aims and objectives. The emphasis is the broad setting and conceptual framework adopted for the research rather than detailed methods, which are described within subsequent chapters. The ontological and epistemological stances employed for the study are established in advance of the consequential approaches to the investigations.

3.1 Swindon Town as a case study

Swindon (Wiltshire, UK) provides a useful case study to investigate biodiversity conservation in a town which is undergoing rapid urban growth and urban intensification. Continued expansion of Swindon reflects national trends of urban growth with the town projected to grow by an additional 22,000 dwellings alongside additional areas for employment and associated infrastructure for the period 2011-2026 (Swindon Borough Council, 2013). The town's population is projected to grow from 220,000 in 2018 to 244,000 by 2028 and then to 260,000 by 2038 (Swindon CCG, 2018).

Swindon's growth and regeneration is to be accommodated through both expansion of the urban area into surrounding countryside, set to cover close to 2000 ha (Wiltshire Wildlife Trust, 2013), and urban intensification with an additional 4500 homes to be built within the existing urban area (Swindon Borough Council, 2013). Figure 3.1 illustrates potential expansion and urban development areas being considered within Swindon's strategic housing and economic land availability assessment (Swindon Borough Council, 2018). The study therefore took place in a town in which the landscape within neighbourhoods is continuing to undergo rapid change, alongside changes in the socio-demographics of local communities.

Clearly, using Swindon as a case study has its limitations. That urban biodiversity is particularly complex and dependent on a broad range of bio-physical, socio-economic, and cultural factors makes comparison across town and cities problematic (Werner, 2011). That said, it seems reasonable to assume that

Swindon as a medium-size English town (ONS, 2013) is not atypical within the scope of this research in its configuration and make-up, and taking into account any peculiarities that may be highlighted through the research, useful parallels may be drawn with other towns in the country.

Since the early 1990s, Swindon has been at the centre, spatially and in terms of governance, of the Great Western Community Forest (GWCF). One of England's 'original' 12 community forests, GWCF was established deliver a comprehensive package of urban, economic and social regeneration in the context of Swindon's continued expansion (ECF, 2019). Subsequently GWCF led on the development of a green infrastructure strategy for the area (Swindon Borough Council, 2011), one of the first to be adopted in England, and supported by academic research (Kambites & Owen, 2006). The town is therefore considered as a rich venue for investigation.

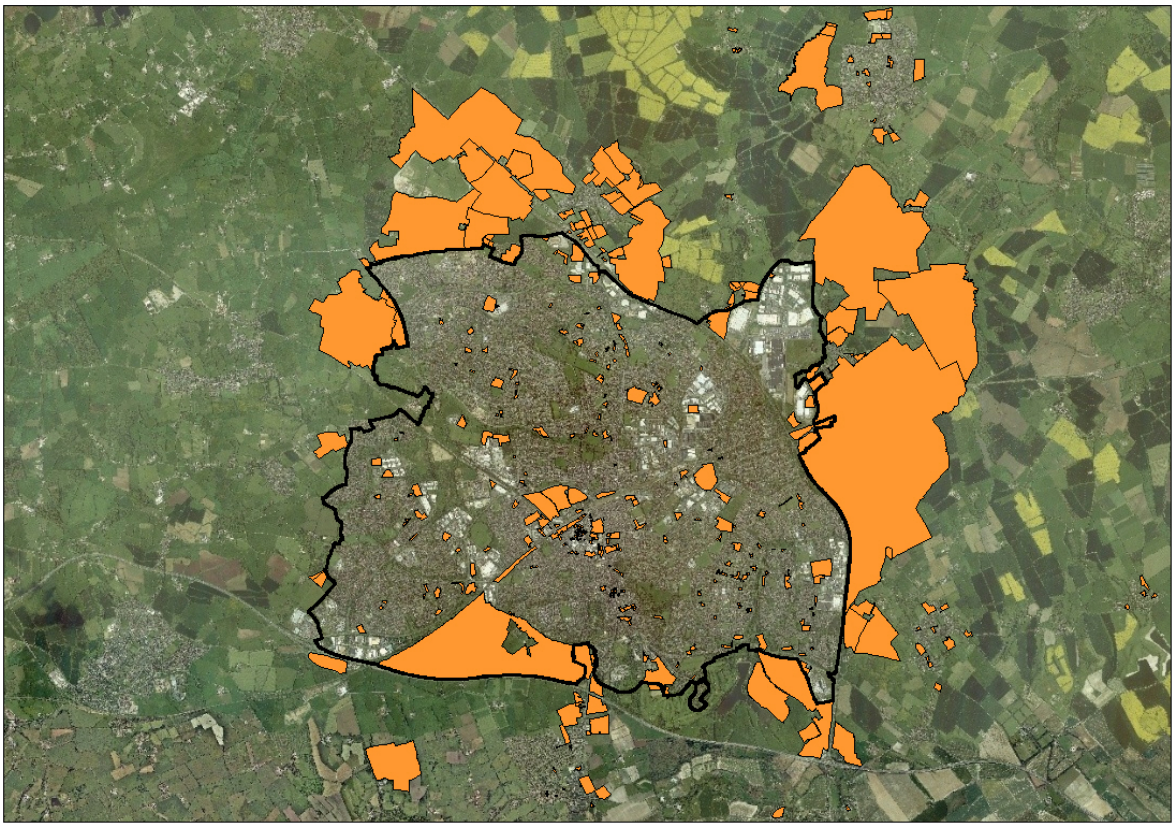


Fig.3.1 Planned expansion and urban densification proposed in Swindon's strategic housing and economic land availability assessment. Orange areas denote land being developed or being considered for development. Source data: Swindon Borough Council, Planning Policy Unit 2018.

3.2 Assessing biodiversity in urban green infrastructures

The study investigated the effects of quality, extent and spatial configuration of habitats on biodiversity, as represented by species richness and diversity in Swindon's open spaces. To address the research objectives within practical constraints required the identification of meaningfully representative habitats within the town, the choice of an appropriate taxon to investigate as a surrogate of wider biodiversity within the habitat, and use of appropriate sampling methods for assessing habitat characteristics and surrogate species assemblages.

3.2.1 Small woodlands as characteristic habitats in urban green infrastructures

Small woods are a widespread habitat within many towns and cities in the UK and further afield in Europe. A review by Pauleit et al. (2005) compared woodland cover across European cities reporting a range from 1-27%, recognising distributional differences across urban and urban fringe settings. Estimates of tree canopy cover reported for over 300 UK towns and cities range from 3% to 45%, for Swindon the reported figure being 8% (Doick, 2018). Despite a low figure in comparison with other UK towns, 8% canopy cover equates to 350 ha and the extent of woodland cover across urban Swindon is illustrated in figure 3.2:

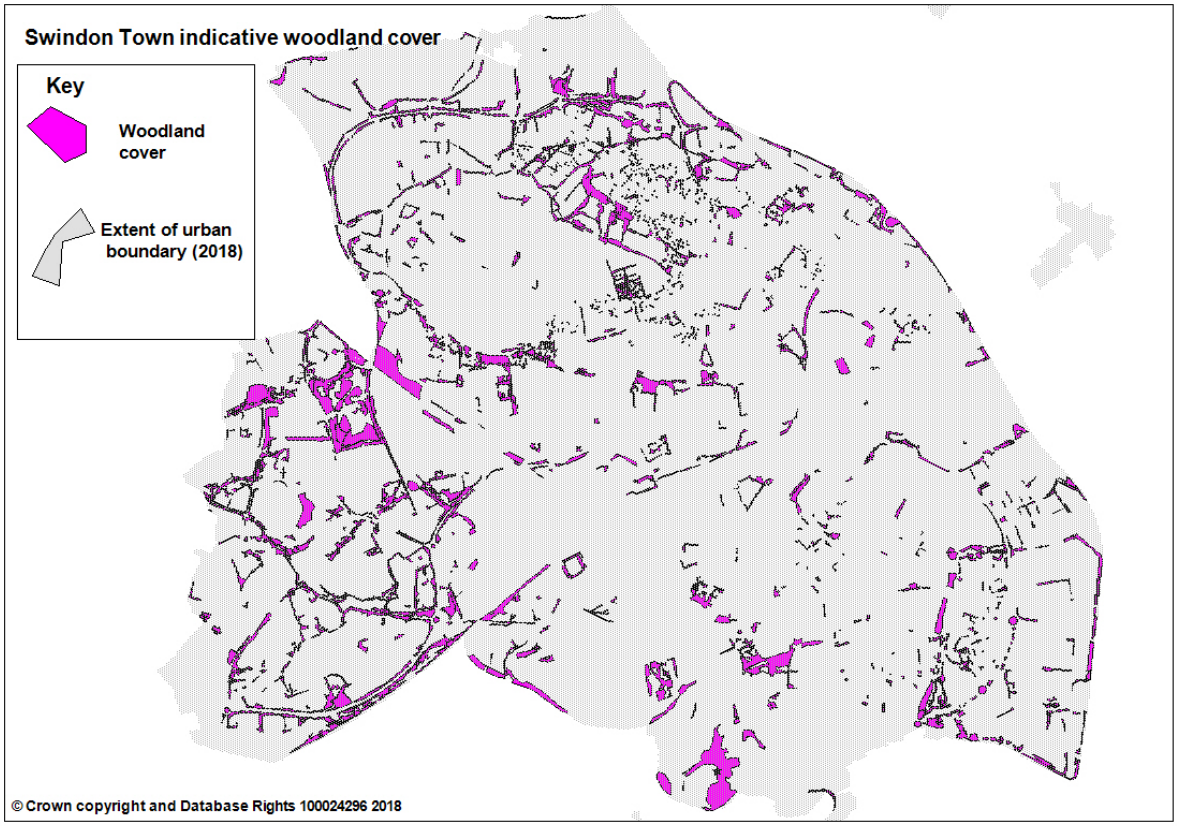


Figure 3.2. An overview of woodland cover across urban Swindon. Source data: Great Western Community Forest (2019); Swindon Borough Council (2018).

In the context of this study small woodlands are seen as a particularly relevant habitat to investigate, not only given their extent and prevalence within urban settings but also given that they:

- Exhibit variation in, and thereby allow for comparisons of, spatial characteristics such as size and configuration;
- Are relatively distinct and homogenous in vegetation assemblage, allowing for comparison of similar woodlands in different settings;
- Are extensive areas where people have access to nature (Shannahan, 2015);
- Have been described as multifunctional and integral components of green infrastructure (Forestry Commission, 2014).

Small, broadleaf plantation woodlands as a characteristic habitat within the case study area were therefore chosen as the venue to address aim 1 of the study and

as described in detail in Chapter 4: to ascertain the influence of habitat structure, composition and landscape context on biodiversity in urban settings.

3.2.2 Use of surrogates in biodiversity conservation and choice of taxon for study

Knowledge gaps, technical and resource difficulties require that surrogate measures are adopted as representatives of environmental conditions and species assemblages (Caro, 2010). There is a long history of both abiotic and biotic measures being used as surrogates of habitat and system conditions (Caro, 2010). Use of surrogates across various disciplines and in varying contexts is dealt with extensively in academic literature. Surrogates are split broadly into two categories described by Grantham et al. (2010) as taxonomic and environmental, or by Rainio and Niemela (2003) as ecological and environmental.

Putting aside conceptual difficulties of defining biodiversity (section 2.1.4) the challenges of carrying out satisfactory assessments of biodiversity across varying scales are well catalogued in academic literature. Various estimates of the limitations of our knowledge of biodiversity on earth have been made. Larsen et al. (2017) report estimates of species richness on earth of between 1 and 6 billion, revising previous estimates of 11 million or less. In comparison, the number of formally described species is estimated as 1.5 million (Larsen et al., 2017). Beyond species richness, Hortal et al. (2015) set out the categorisation of knowledge gaps as they relate to biodiversity data: species taxonomy, species distribution, abundance, evolutionary patterns, species traits and biotic interactions.

Practical constraints, taxonomic, logistical and cost (Hortal et al., 2015) on providing complete inventories of biodiversity for even localised studies require the use of surrogates to guide conservation practice (Larsen, 2012). Bergeron (2012) describes the development of effective surrogates as ‘our only hope’ in guiding the practice of conservation planning. Often employed are surrogate species that is, ‘species used to represent other species or aspects of the environment to obtain a conservation objective’ (Caro, 2010; Wiens at al., 2008 cited by Caro, US Fish and Wildlife Service) or ‘indicators of general biodiversity’ (Sakar, 2005). Other often

analogous terms employed in academic research and conservation practice (Wiens et al., 2008; Caro, 2010) include ‘indicator groups’ (Larsen, 2012), ‘bio-indicators’ and ‘proxies’ (Jones & Leather, 2012). Favereau et al. (2006) set out 5 categories of surrogate species typically adopted: flagship, focal, indicator, keystone and umbrella. Caro (2010) however summarises a lack of clarity in uses of terms such as umbrella species and flagship species; how they differ and where they overlap.

Whilst there is much academic debate on the use and limitations of surrogate species there appears some consensus on the general characteristics of what makes a good choice (Rainio & Niemela, 2003):

- taxonomically and ecologically well understood;
- easy and cost effective to monitor;
- show strong relationships with beneficiary species, communities and ecosystems;
- occur in a range of environments and conditions;
- sensitive to changes in environmental conditions; and
- show specialisation to certain habitat types.

In the context of this study it is interesting to note that useful characteristics of ‘good’ surrogates listed do not include those relating to perception of biodiversity by non-specialist audiences.

3.2.2.1 Beetles as surrogates

Beetles have been described as ‘excellent model organisms for research on ecological and conservation’ (Kotze et al., 2007). Carabids (ground beetles) in particular have been described as good indicators of environmental change (Fujita, 2012) and have been used extensively as environmental and taxonomic bio-indicators in international research (Ranio & Niemela, 2003; Niemela, 2001; Cameron & Leather, 2012) amongst others: forestry practices, climate and climate change, habitat fragmentation, sustainable forest, habitat change, habitat quality, and agricultural production.

In a review by Niemela and Kotze (2009) beetles are described as playing an important role as indicator species in relation to environmental pressures of urbanisation. Studies have shown compositional changes in species assemblages and traits along gradients of urbanisation (Magura et al., 2013; Tothmeresz et al., 2011). Sensitivities of beetles to environmental pressures can be seen at both habitat and landscape levels (Do et al., 2014 citing Koivula). In a comparison of birds' and beetles' response to urbanisation, Gagne and Fahrig (2011) propose use of a wider range of taxa as a focus of research in the urban matrix.

In common with other invertebrates, ground beetles can be characterised in relation to their dispersal abilities (Verges et al., 2013). For example, experiments with the flightless woodland carabid *Abax parralelepipedus* show this species to be a 'low disperser' with a mean distance in movement less than 2 m in 48 hours (Vergnes et al., 2013). In a systematic review of research, Brouwers et al. (2009) summarise the mean daily movement distances of 20 woodland ground beetle species. Reported rates range from 0.6 m/day to 18.4 m/day. Movement rates can be used as predictors of how fast and how far a species can move through a habitat or landscape (Brouwers citing Walters et al., 2006) and thereby offer a measure of dispersal ability.

Consistent with previous research, Vergnes et al. (2013) found within site habitat fragmentation of urban woodlands to be a major factor in determining survivability of the woodland carabid *Abax parralelepipedus*. Sensitivity to fragmentation was largely explained by beetle morphology and observed low movement rates. Other contributing factors may include localised path trampling, pollution, barriers to movement and interactions with other species.

Ground beetles have also been characterised in terms of their habitat associations with lower numbers of beetles found outside their preferred habitats. Niemela and Halme (1992) describe four such distributional types of carabid beetles: generalists, field species, species of open habitat and forest species. Inconsistencies are however apparent with some species referred to as generalists, elsewhere being referred to as field species (Wallin & Ekbom, 1998). Such differences may be explained by context dependency of species assemblages (Vergnes, 2013) such as interactions with other species, behavioural

changes in response to prevailing habitats (Wallin and Ekbom, 1998) and other abiotic influences including elevation and exposure to sunlight (Bergman, 2012).

In summary, beetles, and in particular ground beetles (Caribidae) are seen to be a widely adopted taxon in environmental research, have been described as exhibiting the characteristics of a good surrogate species (as listed in section 3.2.1) and are therefore considered a valid and useful taxon for application to address aim 1 of this study as set out in Chapter 4: to ascertain the influence of structure, composition and landscape context of habitats on biodiversity in urban settings.

The limitations of beetles (alongside other invertebrates), as surrogates when considering peoples' perception of biodiversity is discussed further in Chapter 6, section 6.2.

3.3 An ethnographic approach to understanding residents' sense of place

The research aimed to investigate the influence of biodiversity encountered in Swindon's local open spaces on residents' sense of place. Based on a review of literature the study adopted a 'narrow and deep' approach, amongst a group of residents who are purposefully 'immersed' in nature through their activities, to examine the way people relate to nature in their locale.

3.3.1 Approaches to sense of place research.

SoP research has adopted varying epistemological and ontological stances reflecting the breadth of disciplines for which it has been employed. However, a review of ecology-related health and well-being research carried out by Jorgenson and Gobster (2010) suggests the majority of studies in this area follow quantitative, positivistic based approaches. Of the studies using descriptive or narrative approaches, topics were described by the review as being far ranging and showing little consistency in themes reported. Only a single piece of research, employing an ethnographic approach was singled out: that of Head and Muir (2006) used to study gardeners and their gardens in Sydney Australia. Otherwise, explicit green-space measures are seen to be largely absent form qualitative research (Jorgensen & Gobster, 2010). Notably, the few studies highlighted which

have specifically considered peoples' perceptions and responses to urban biodiversity (Dallimer, 2012; Qiu et al., 2010; Fuller, 2007) have followed quantitative approaches.

This research here was structured around the theoretical SoP framework described by Jorgensen and Stedman (2006): linking cognitive, affective and conative components of attitude-behaviour theory to the principle and complimentary concepts of place meaning, place attachment and place dependency embodied within SoP.

A qualitative, ethnographic approach founded on a constructionist epistemology and interpretivist theoretical perspective was followed:

- Reflecting that SoP is a product of the interactional processes involving the individual, the setting and their social worlds (Kyle & Chick, 2007);
- Given that the limited amount of research to-date describing the link between biodiversity per se and peoples' responses to urban nature has followed predominantly quantitative approaches and has also yielded somewhat contradictory results;
- Responding to calls for more integrative approaches and adoption of different epistemological positions to be used within the field of urban ecology: to help fill the gaps specifically to do with human values and the '*richness of the everyday world*' (Mugerauer, 2010; Pickett et al., 2008);
- Considering that shared values, rather than those of individuals alone, guide concerns for nature. Accordingly, it has been suggested that qualitative, interpretive techniques should be used to aid a better understanding of collective values (Fish et al., 2011).

In seeking to understand the role of nature within the complexities of human-place relationships, field work entailed collaborative approaches between the researcher and research participants. The aim to get a subjective 'insider's view' was dependent on being able to build trust, establish legitimacy and the appropriate positioning of the researcher within the 'field' (Brewer, 2000). The methodology therefore followed a progressive process from passive initiation, to more involved

techniques (e.g. interviews and group discussions), and eventually to exiting the field of research.

In developing such an ethnographic approach, the need to continually analyse and evaluate the implications of the researcher's own opinions and actions was critical. As described by Smith (1988) in relation to participant observation and personal reflexivity: 'As analysts live local activity, they become part of the local place. As much of what a study is to reveal will be etched into the self as will be written in a notebook and by reflecting on self…the participant observer can begin to analyse the social world in he or she is immersed*'.*

3.3.2 Choice of study area and cohort

Swindon's health walks groups were chosen as the venue for an ethnographic based approach to address one of the research aims. The health walks programme in Swindon, forms part of the England-wide Walking for Health Initiative (WHI). The WHI promotes three-fold benefits of group walking: improvements to physical and mental health and social well-being (Walking for Health, 2019). From a cursory review of local WHI websites it is apparent that the natural environment, in terms of attractiveness and accessibility, provides the back-drop for many if not most health walks programmes. For example, the UK National Health Service promote walking in towns and cities which 'offer interesting walks including parks, heritage trails, canal towpaths, riverside paths, commons, woodlands, heaths and nature reserves*'* (NHS Choices, 2012). This is consistent with comments from Dr William Bird, who as a general practitioner established the first health walks programme in the UK, and who has stated that 'the success of walking for health is directly linked to the natural environment' (Walking for Health, 2014).

The act of walking in itself has been described as being instrumental in the construction of place meaning and that even short trips e.g. to local shops can be a time for reflection, exploration and exercise (Ingold & Vergunst, 2008). Pink (2008) drawing on Michel De Certeau's work on the 'practice of everyday life', asserts that the role of urban walking in place-making is clearly established. Ethnographic studies carried out by Ingold and Lee (2008) in Aberdeen, UK, recruited residents who used walks diaries as a means to explore place meaning.

Through this work Lee suggests that ‘the walk’ or walking itself draws together aspects of place and biography and that a health walks leader as a participant in the studies did not ‘draw simple boundaries between health and other outcomes of walking’. Similarly, Lund (2012) describes how person and landscape merge through the activity of walking. Earlier, ethnographic based work by Lund and Lorimer, on observations of hill walkers in Scotland describes how ‘Ultimately, by moving and interacting with hill-walkers, we ensured that our ideas emerged out of, and were re-worked and enriched through direct embodied experience’ (Lorimer & Lund, 2006 cited Pink, 2008 p. 246).

Initial discussions between the researcher and Swindon’s Health Walks Coordinator highlighted the characteristics of the walking groups considered particularly relevant to this research. Consequently, the groups were considered a useful cohort for study because:

- The premise of the groups is closely aligned to the theoretical framework for this research;
- Activities take part in a setting relevant to the research and are amenable to participant observation;
- Whilst age range is limited the groups are mixed gender and comprise residents from different areas of the town, and varying time-spans of residency;
- The groups provide an open and accessible forum for discussion.
- The age of the researcher is similar to that of participants, allowing for easier access and integration;
- The walking routes vary from the urban centre to more suburban/greener areas, encountering a range of green infrastructures;
- Some participants are known to join more than one group and thereby experience different areas of the town; and
- Attendees are known to have particular motivations for participation and therein opportunities for identification of key informants/ purposive sampling.

The health walk groups were therefore considered a valuable cohort to address aim 2 of the study as detailed further in Chapter 5: to critically examine what determines residents' perceptions of, and values assigned to, nature in urban settings.

3.3.3 Triangulation of methods

Triangulation is a widely adopted approach in qualitative research involving the use of multiple data sources to develop a comprehensive understanding of phenomena (Patton, 1999). In doing so, triangulation of methods in social research seeks to validate, enrich, explain and refute findings (Carvalho & White, 1997). Therefore, allowing for triangulation, the methods adopted in this research (detailed in section 5.2.6) involved:

- The researcher as participant observer;
- Guided conversations and semi-structured interviewing; and
- Photo-elicitation techniques involving geo-located photographic recording by participants.

Participant observation has been widely used as a means for collecting data about people and cultures in qualitative sociological research Kawulich (2005). Gold (1958) sets out a typology of participant observer (PO) roles categorising the extent to which the researcher becomes embedded within the social setting in question*: the complete participant*, *the participant as observer, the observer as participant and the complete observer.* The role adopted for the purpose of this research is best described as that of the complete observer: taking an insider's role over an extended period as an enrolled and regular participant in the health walks. In taking such an approach, the construction of a 'working identity' with both gatekeepers and participants, and the management of the 'personal front' by the researcher are considered important (Hammersley & Atkinson, 2009). It is helpful in this respect that the researcher was within a similar age group to participants, had good knowledge of the areas in which the walks take place, was experienced in community based work and was familiar with the purpose of the health walks programme. Whilst these factors may be advantageous in establishing

relationships and a sense of mutuality, they may also present challenges regarding self-disclosure and bias. It was therefore important for the researcher to monitor and manage working identity as the research progressed. To aid this and as used in this study, Somekh and Lewin (2005) recommend the keeping of a research journal, including notes on the researcher's own thoughts, feelings and assumptions as the research progresses.

The importance of group discussions and deliberation was also reflected in this study. With regard to the latter, the UKNEA (2013) notes that 'people may need to form values through deliberation with others. Deliberative processes can inform values, as well as bring out the communal and cultural transcendental values, beliefs and meanings that shape individual values.' Fischer and Young (2007) on research of public perception of biodiversity-related issues, also note the importance of group discussions to examine the joint constructions of meaning.

Semi-structured interviews were chosen, rather than more formal structured methods of data gathering. The empathy and rapport sought through PO work, naturally led to selection of semi-structured interviews and guided discussions as valid methods. Such approaches are seen to be closely associated with related PO studies and have the advantages of being respondent led, flexible, allow the interviewer to check understanding, and empowering respondents (Brewer, 2005). In addition, as described further in Chapter 5, whilst the research wasn't overly sensitive in nature, interviewees were seen to be comfortable in sharing sometimes personal feelings and recollections pertinent to the study. Walking interviews per se, as carried out in this study are being increasingly used to investigate relationships between 'self and place' and have the advantages of 'helping to reduce the power balance' and in 'encouraging spontaneous conversation' (Kinney, 2017).

The third strand to the triangulation of methods, photo-elicitation, adopted a similar approach to that described by Dandy and Van der Wal (2011) who employed field based interactive photo-elicitation techniques together with group discussions to capture participants' preferences for woodland landscapes. They reported on the rich and cost effective manner by which that such methods can capture stakeholder landscape preferences. Photo-elicitation, described as 'the use of

photographs in conjunction with qualitative interviewing', is 'a long-established method in visual sociology' (Hogan, 2012). As reported by Jorgensen and Gobster (2010), research into the potential links between health and well-being and the ecology of urban green-spaces has often employed scenario manipulation approaches whereby the researcher provides visual images, sometimes digitally manipulated, for participant evaluation (Kaltenborn & Bjerke, 2000). In contrast few studies have used on-site 'visitor employed' photography (Qiu et al., 2013) or participant, 'native image making' techniques as described by Bignante (2010). Fewer studies still have based such approaches on qualitative methods, a notable exception being that of Dandy and Van der Wal (2011).

3.4 Research ethics and legality

3.4.1 Beetle surveys

Whilst the research employed destructive sampling techniques in part, the location, sampling intensity and methods employed for beetle and vegetation surveys were considered both legal and ethically justifiable.

The researcher is an experienced field worker and relevant codes of conduct and legislative requirements were followed. No undue environmental damage was expected or resulted as a consequence of the research.

The habitats surveyed were purposefully selected to be broadleaf woodland plantations with a limited age range. An initial review of potential woodland survey sites ruled out any locations of noted habitat value either statutory or of policy merit i.e. no sites of special scientific interest or local wildlife sites. Moreover, a data search of biological records held by the local authority did not flag up the presence of legally protected species or species of note within or in close proximity of the sites surveyed.

Sampling for beetles only took place over a limited period, sufficient to provide statistically meaningful data and to represent the annual seasonal cycle in beetle population activity.

Pitfall traps are a widely accepted and extensively used sampling method for ground dwelling invertebrates. The use of ethylene glycol, a commonly used 'killing fluid' for pitfall traps was ruled out on the basis of it being an attractant and

also being toxic to mammals. The latter was considered particularly important in an urban setting where domestic pets are prevalent. Propylene glycol diluted to 50% with water was used as a substitute for ethylene glycol, considered as non-attractive and non-toxic, to limit unintended bi-catch and to avoid risk to domestic pets (Oboyski, 2007). Following standard practice, pitfall traps were covered using a piece of wood and to limit bi-catch and scavenging (Lange et al., 2011).

3.4.2 Ethnographic study of health walks

The research was intended to be non- covert and was not considered to be in a particularly sensitive or controversial area of study, or likely to involve psychologically intrusive questioning. However, ethical considerations were paramount, particularly given the extended period over which the research took place and the extent to which the researcher entered into the (albeit limited) social arena of the participants.

Issues of confidentiality and anonymity were addressed throughout the research, from recruitment of participants and gatekeepers, handling and safe storage of data, to exiting the research field and presentation of written reports. Practicalities including the seeking of informed written consent from all participants, use of coding to ensure field notes and reports were anonymous, and limited use of personal identifiers such as age, gender, and area of residence.

Prior to undertaking this study, ethical considerations including consent, data protection, confidentiality and risk management were fully addressed via the University of Gloucestershire's Ethical Research Committee (UoG, 2015).

3.5 Chapter 3 summary

Using Swindon town as a valuable case study, the research identified urban woodlands as an extensive and representative habitat for investigation within the town's green infrastructure network. Ground dwelling beetles were chosen as an appropriate taxon to act as a surrogate to assess biodiversity within the woodlands as detailed in Chapter 4.

The woodlands selected for ecological surveys also provided much of the setting for, and green infrastructure used by, 2 of Swindon's health walk groups. The latter

were selected as the study cohort given the close alignment of both their location and their stated purposes with the aims of the research as detailed in Chapter 5.

Thus, chapters 4 and 5 investigate ecological and social dimensions respectively, and separately, of the same urban settings. Chapter 6 then goes on to synthesise these biophysical and socio-cultural components of place to aid priority setting for nature conservation in the context of urban growth and regeneration and in the context of green infrastructure planning.

Chapter 4. Assessing biodiversity in small urban woodland plantations

This chapter describes the methods used, results and findings to address a stated aim of the research:

Aim 1. To ascertain the influence of habitat structure, composition and landscape context on biodiversity in urban settings.

Concepts and methodological approaches detailed and justified in chapters 2 and 3 respectively are summarized and adopted as a basis for meeting the objectives of this study:

> Objective 1.1: To select woodlands that differ in urban landscape context and describe their structure and composition;
>
> Objective 1.2 To survey ground beetles in each urban woodland;
>
> Objective 1.3 To relate beetle species richness, community composition, and abundance to the composition and spatial configuration of Swindon's urban woodlands.

Results are examined and discussed in the context of planning for urban growth and development. In doing so, priorities for investment in urban GI from an ecological perspective are proposed.

4.1 Introduction

Landscape ecology approaches aim to address biodiversity decline in fragmented habitats by considering the micro-, meso- and macro- scale characteristics of sites and relationships with surrounding land-uses. Habitats are thereby seen as part of a complex landscape often summarised by the patch-corridor-matrix model (Forman & Godron, 1981) and manifest in policy approaches in the UK calling for 'more-bigger-better managed-connected' habitat patches (section 2.4). The growing body of landscape ecology research seeking to provide evidence to support policy and practice continues to raise more questions, especially in urban settings (Bailey, 2006). Accordingly, a better understanding of the interaction within and between these landscape elements is continually sought.

Small, fragmented woodlands provide refugia for urban wildlife within an intricate network of habitats including hedgerows, grassland, water bodies and the built environment (Croci et al., 2007). Accordingly, research has suggested that urban woodlands, as a principal habitat maintained in European urban landscapes, would be a useful focus for conservation efforts (Croci et al., 2007). Whilst the extent of woodland cover varies considerably across UK towns and cities (Doick et al., 2017), the environmental pressures of urbanisation, isolation and fragmentation of woodland habitats are common to many urban areas. It should also be noted that the growing recognition of the ecosystem service value of trees and woodlands within urban areas has seen recent calls for a large increase in woodland cover in these environments across the UK (UFWAC, 2018).

In common with other towns and cities in the UK, small plantation woodlands are a ubiquitous component of a complex matrix of land cover and land use in urban and suburban Swindon. In comparison with other urban centres in the UK however, the extent of tree canopy cover in the town is low (Doick et al., 2017). In response, policy and practice relating to green infrastructure provision in Swindon aims to increase the extent of urban canopy cover (Swindon Borough Council, 2011). At the same time increasing development pressure in Swindon threatens to further diminish and fragment the town's woodland network. Degradation of habitat networks, consequential to urbanisation and as manifest in the case of woodlands, risks undermining the intent of local planning and other policies to provide for biodiversity gain. A better understanding of the implications for biodiversity relating to potential gains and losses of woodland cover, and where best to direct scarce woodland management resources is therefore needed.

Given practical and resource limitations, assessing biodiversity in any setting is often best achieved using particular species or taxa as surrogates that are indicative of overall biodiversity value. Whilst many urban studies have used birds as surrogates, Gagne and Fahrig (2011) suggest that using a wider range of taxa would be beneficial. Sections 3.2.1 and 3.2.2 detail the roles of surrogates in environmental management and nature conservation together with further discussion on the useful qualities of beetles as surrogate species. Beetles, and in particular ground beetles, are seen as good candidate surrogate species. In brief,

the sensitives of beetles to environmental change has led the taxon to be adopted in many studies related to environmental stress (Cameron, 2012; Do, 2014) and the functional traits of beetles are seen to correlate well with characteristics of 'good indicator species' (Ranio & Neimela, 2003).

By comparing small woodlands across 3 green corridors in Swindon, the study uses abundance and species richness of beetle communities as a surrogate for wider biodiversity and bio-indicator of habitat quality.

4.2 Methods

4.2.1 Site selection and sample areas

Small, broadleaf and mixed plantation woodlands are a common feature associated with post second world war expansion of Swindon from the 1950s to the present day. The various phases of Swindon's urban expansion over that period have been accompanied by the creation of network of establishing woodlands, typically less than 50 years old, sitting within urban landscapes characteristic of prevailing planning and urban design policies of their time. The 3 'woodland corridors' chosen for the study were purposefully selected to represent different periods of urban development from the 1950s to the 1990s as illustrated in figure 4.1. Doing so allowed for consideration of landscape setting alongside the habitat characteristics. Two of the corridors, Richard Jeffries and Shaw Ridge, were also coincidental with routes followed by health walks groups described in chapter 5.

To provide for generally comparable habitat, it was decided to focus solely on broadleaf plantation woodlands, as defined by JNCC, phase 1 habitat survey nomenclature, within each broader woodland corridor and as shown in figure 4.2. Potential survey sites were initially identified from a desk based assessment, using GIS software (Mapinfo Professional 12.0) to interpret aerial photography (supplied by OS get mapping). Initial selection criteria for woodland sites included spatial dimensions of size (>0.1ha) and width (>20m), location and likelihood of being plantation broadleaf woodland. Data available through the UK National Inventory of Woodlands and Forest (DEFRA MAGIC) together with locally available data from the Swindon and Wiltshire Biological Records Centre, were reviewed to

exclude known areas of ancient semi-natural woodland, thus allowing for comparison between broadleaf plantation woodlands.

Preliminary field surveys were carried out to check woodland characteristics of potential sites, including a cursory assessment of the dominant tree species to distinguish between broadleaf, coniferous or mixed plantations. From an initial list of 46 candidate sites 27 woodland sites across the 3 woodland corridors were chosen for survey following the field walkover surveys, shown in figure 4.2a, b & c and summarised in table 4.2.

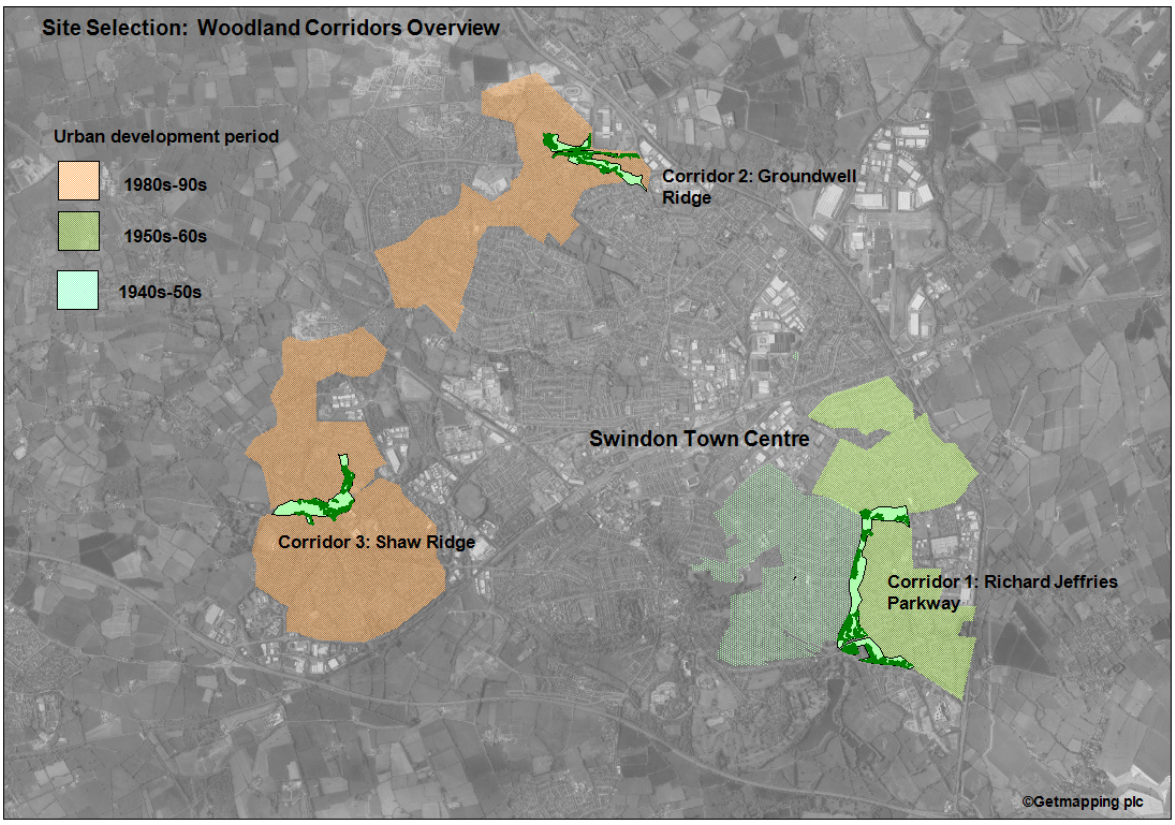
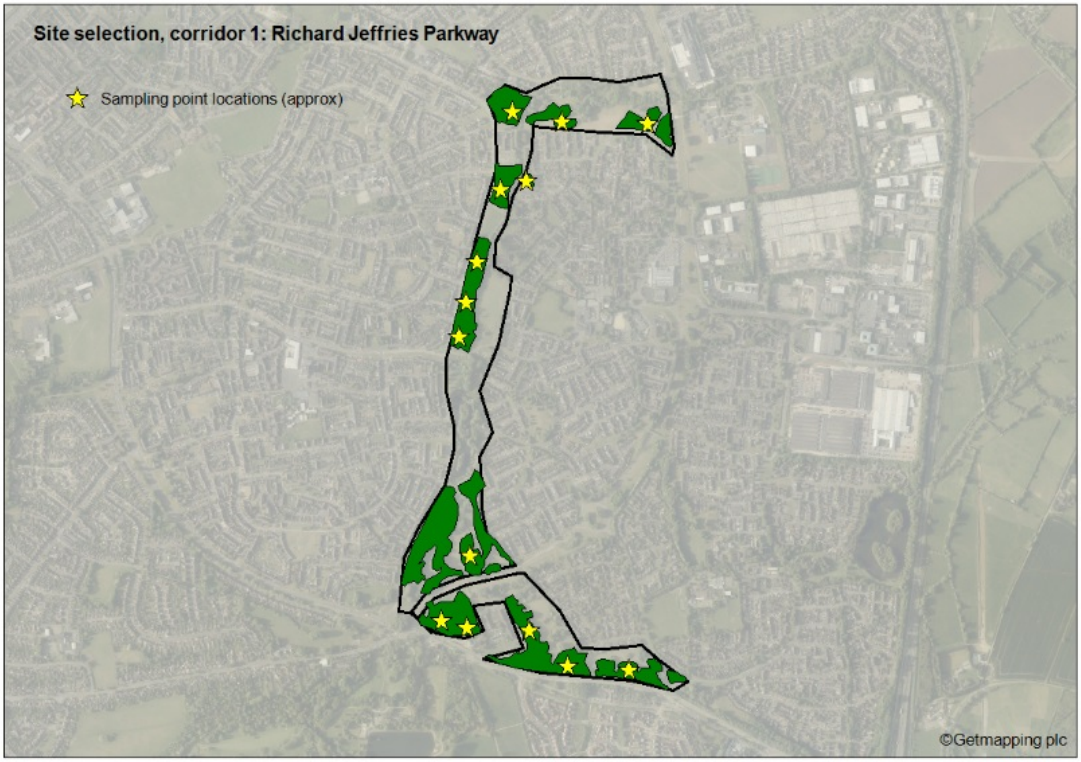
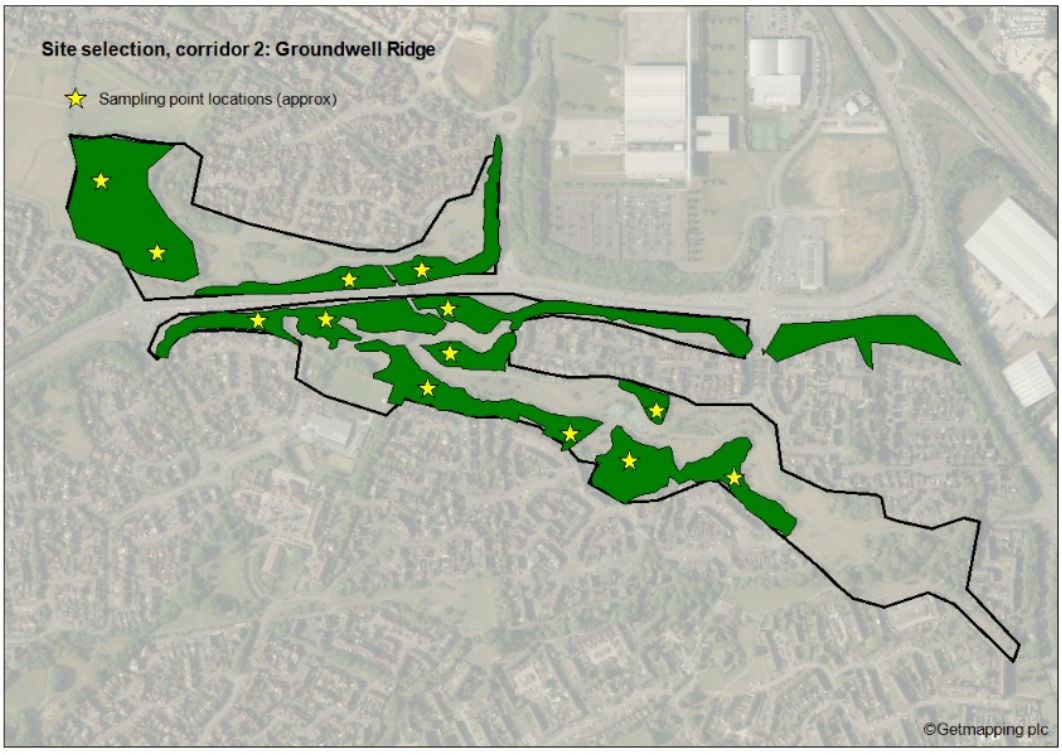


Figure 4.1 The 3 woodland corridors surveyed in relation to Swindon Town Centre and urban character areas. Source data: Swindon Borough Council, Urban Design (2019).

a)


Site selection, corridor 1: Richard Jeffries Parkway
Sampling point locations (approx)
©Getmapping plc

b)


Site selection, corridor 2: Groundwell Ridge
Sampling point locations (approx)
©Getmapping plc

c)

Figure 4.2 woodlands, shown in green, selected for survey within chosen corridors shown in outline. Location of sampling sites are indicated by ∃. a) Corridor 1, Richard Jeffries Parkway, a) Groundwell Ridge c) Shaw Ridge. The underlying aerial photographs indicate the general distribution of open and spaces and built environments.

In addition to the JNCC definition of broadleaf plantation woodland adopted and dimension limits chosen (>0.1 ha area, > 20m width), woodlands selected for the study were defined by their separation from other nearby woodland i.e. where there was a clear intervening land use such as amenity grassland, buildings or roads.

The number of sample plots surveyed was proportionate to the size of the woodland sites within the corridors as detailed in table 4.1. Sample plots within woodland sites were sited to be representative of the overall woodland and ensure that all typical habitats encountered, including open woodland, glades, dense shrub cover, and distinct field layer vegetation were sampled.

Table 4.1. Number of sample plots selected for survey in relation to the size of woodland.

Woodland size (hectares)	Number of sample plots
> 2	3
1-2	2
< 1	1

Table 4.2. Woodland corridors and areas selected for survey together with the number of sample plots within each woodland. Each sample plot = 5 pit-fall traps

Richard Jeffries			**Groundwell Ridge**			**Shaw Ridge**		
Site ref	Area (m2)	No. sample plots	Site ref	Area (m2)	No. sample plots	Site ref	Area (m2)	No. sample plots
RJ2	6190	1	GR1	1710	1	SR6	26310	3
RJ3	7010	1	GR2	10420	2	SR7	1940	1
RJ4	11320	2	GR3	3480	1	SR8	5460	1
RJ5	1310	1	GR4	11270	2	SR9	18020	2
RJ6	8790	1	GR6	5700	1	SR10	2030	1
RJ7	20310	3	GR7	4990	1	SR12	6520	2
RJ10	1330	1	GR8	11710	2	SR13	4740	1
RJ11	18180	2 (1)	GR10	13030	2	SR15	1640	1
RJ13	11770	2	GR11	8850	1			
RJ14	1710	1						
total	**87920**	**14**		**71160**	**13**		**66660**	**12**

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4.2.2 Assessing woodland vegetation characteristics: cover and composition

4.2.2.1 Woodland vegetation criteria of relevance to beetles

The purpose of the study was to consider relationships between habitat qualities of small urban woodlands and abundance, species richness and diversity of carabid beetles. A number of studies report correlations between species richness, abundance and diversity of pit-fall caught beetles and woodland habitat conditions. (Do et al., 2014; Lassau et al., 2005; McElhinney et al., 2005). Vegetation structure and composition alongside other measures of habitat components such as debris, leaf litter, soil conditions have all been shown to influence assemblages of beetles trapped in pit-falls (Lassau et al., 2005).

Four components of woodland habitats have been summarised by (McElhinney, 2002) in terms of meeting the resource needs of invertebrates: over-storey, bark, shrubs and ground vegetation, and litter and woody debris (excluding soils). A suite of biotic and abiotic habitat conditions of woodlands determine beetle populations with no single characteristic being a controlling factor (Do et al., 2014). Whilst general characteristics of woodland structure are important further clarification of causal mechanisms is called for (Lassau et al., 2005).

Use of single measure attributes, such as variation in diameter at breast height, to summarise structural complexity in woodlands has been criticised (McElhinney, 2002) and various studies have combined a suite of measures of habitat characteristics in efforts to provide more robust indices of structural complexity of woodland habitats (McElhinney, 2002). No single index measure of structural complexity has been widely adopted with contextual differences determining methodologies.

In recognition therefore of the multiple habitat attributes likely to influence beetle populations in woodlands a number of structural and compositional measures were adopted for the purposes of this study:

- Extent of vegetation cover within canopy, shrub, field and ground layers;
- Plant species composition disaggregated between woodland structural layers;
- Extent of leaf litter, debris and bare ground; and
- Woodland dimensions: area, perimeter and their ratios.

4.2.2.2 Woodland site selection, timings and methods adopted

Vegetation surveys took place across the 26 woodland sites and associated sample plots set out in table 4.2, giving a total of 39 plots. To best assess vegetation characteristics, the majority of survey work took place during July and August whilst trees were in full leaf and ground and field layers in growth. Further surveys took place in October to assess the extent of leaf litter at a time to coincide with beetle surveys carried out during leaf-fall.

To allow for potential species related effects on beetle assemblages, an initial walkover of all woodland areas was carried out to provide an inventory of dominant and abundant plant species within the upper canopy and shrub layers following DAFOR (Dominant, Abundant, Frequent, Occasional or Rare) criteria based on relative cover. Whilst subjective, DAFOR is a widely used method to make a broad assessment of vegetative characteristics across a site (Kent & Coker, 1992) with the advantages of being quick and simple (Bullock, 2006). The method, as is the case here, is often used prior to more detailed study (Sutherland, 2006). The resulting inventory was subsequently used in further detailed assessments of species composition described in table 4.3.

Structural and compositional characteristics of the woodland survey sites were assessed using 20m x20m quadrats, centred on the pitfall trapping plots used for beetle surveys (see section 4.2.3). Canopy and shrub layer cover, plant species composition and cover of woody debris were visually assessed across the extent of the 20mx20m quadrats. Smaller, 2mx2m quadrats nested within the larger quadrats were used to assess the species composition of field and ground layers. The quadrat dimensions adopted for the purposes of the current research were consistent with published guidelines (Rodwell, 2006; Sutherland, 1992) and other studies relating woodland habitat structure to invertebrate populations (Do, 2014; Spake, 2016).

Assessment of woodland structure looked at the 4 components reported: upper canopy, shrub, field and ground layers. The influence of vertical stratification within canopies on woodland ecosystems and productivity has been widely researched (McElhinney, 2002). Temperate woodlands are often described as comprising four recognisable layers: canopy, shrubs including climbers, field or herb layer, and ground layer (Thomas & Packham, 2007). Whilst precise definitions vary, Thomas and Packham define a canopy layer of over 4.5m, shrub layer 1.5-4.5m, Field layer 2cm-1.5m and the ground layer < 2cm. Distinctions however between such layers can be seen as arbitrary and belie the complexities of woodland structure (Kent & Coker, 1992). A pragmatic approach to distinguish between the woodland layers was therefore taken here based on an assessment of prevailing vegetation characteristics as set out in table 4.3.

The Domin scale was adopted in this research as a measure of the extent of cover of woodland layers and species composition in the case of dominant and abundant canopy and shrub species. Domin criteria as adopted are reproduced here:

Domin score:

1 <4% Cover with few individuals
2 <4% Cover with several individuals
3 <4% Cover with many individuals
4 4%–10% Cover
5 11%–25% Cover
6 26%–33% Cover
7 34%–50% Cover
8 51%–75% Cover
9 76%–90% Cover
10 91%–100% Cover

Cover in this study is defined as the percentage of ground covered by a vertical projection of the vegetation onto that surface (Rodwell, 2006) consistent with other research, as distinct from canopy closure (Goodenough & Goodenough, 2011; Jennings et al., 1999). Visual assessment is a standard means to assess vegetation cover, typically estimated at 5 or 10% intervals, which may include evaluation of multiple layers within a canopy cover (Kent & Coker, 1992). Published scales, including Domin and Braun-Blanquet provide pre-partitioned ordinal scales within which visual estimates of cover can be made (Kent & Coker, 1992). Preliminary woodland assessments carried out as part of this research indicated limited complexity in stand structure and the 10 point Domin scale was therefore used for this study given its greater resolution, in comparison to the 5 point Braun-Blanquet, offering greater potential to identify subtle changes in relatively homogenous stand structure.

Pre-defined and standardised scales for assessing other structural attributes of woodlands such as the extent of organic debris and bare ground are not available. Visual assessments based on arbitrary scales have however been widely used in studies in similar field of research, and adapted to suit the purposes of those individual studies. For example, in their woodland surveys, Bromham (1999) and

Lloyd (2014) visually estimated the percentage cover of bare ground and leaf litter respectively at using 10% intervals. Elsewhere, DAFOR estimates have been extended for use for non-vegetation components (Sutherland, 2006). For this study, visual assessments of leaf litter, coarse woody debris and bare ground were carried out across the extent of the 20mx20m quadrat sample areas. Scores between 1 and 5 were assigned to each attribute, representing their percentage cover at 20% intervals and consistent with DAFOR scales.

The proforma used for woodland vegetation surveys in shown in appendix 2.

Table 4.3 The basis of woodland structural and compositional assessments adopted in this study.

Characteristic	**Measure**	**Method**
% vegetation cover (total for each layer's cover)	Canopy: trees including supple woody vegetation, shrub layer, and field layer and ground layer. (Sutherland, 2006)	Visual assessment within a 20mx20m quadrat: Across extent of quadrat for Canopy and shrub layer. Within 5 No 2mx 2m quadrats for field and ground layer Domin scale used
Plant species composition:% cover for each species	Tree layer, shrub layer Field and ground layer combined	Visual assessment for all across 20mx20m quadrat. All grasses considered as 1. DOMIN scale used
Amount of leaf litter	As % cover	Visual inspection within 2mx2m quadrats. Timing: sites were re-visited to coincide with beetle survey timings post leaf fall. DAFOR scale used.
Bare ground	As % cover	As for leaf litter.
Debris: course wood debris	% cover woody	As for leaf litter.
Woodland dimensions	Area, perimeter, area/perimeter ratio.	Taken from aerial photography using Mapinfo GIS.

4.2.3 Assessing beetle assemblages

4.2.3.1 Pitfall trapping to assess beetle assemblages

As dictated by research objectives, suitable sampling methods need to be adopted (Sutherland, 2006). Techniques widely used for surveying terrestrial beetles include direct observation, sweep netting, vacuum sampling and beating (Sutherland, 2006; Drake et al., 2007). Each method has its advantages and disadvantages and to optimise design of surveys, inherent limitations, biases and practicalities need to be considered and a pragmatic approach adopted (Drake et al., 2007).

Pitfall traps are a widely accepted and extensively used sampling method for epigaeic and other ground dwelling arthropods (Brown & Matthews, 2016; Lange et al., 2011). Pitfall traps are an efficient and inexpensive system allowing for rapid and easy collection of large samples of invertebrates with limited impact of surrounding environment (Kotze et al., 2007). Pitfall traps are easily standardised in relation to trap design, the number of traps used, their spatial configuration within radial plots and sampling duration (Sutherland, 2006).

One of the main disadvantages of pitfall trapping is that catches reflect relative activity rather than relative abundance of species and will vary with prevailing weather conditions (Kotze et al., 2007). Baars (1979) demonstrated however that pitfall trapping provides a reliable relative measure of carabid populations provided trapping is carried out over an extended period. Other disadvantages noted include interference by other animals, effect of surrounding vegetation, biases towards larger species, traps becoming attractive rather than passive for example by pheromone emitting beetles or decaying carcasses (Sutherland, 2006). In comparative studies, as is the case with this research, the impacts of such biases can be minimised by good methodological design (Sutherland, 2006) as reflected in the methods applied for this study.

Pitfall trapping was therefore adopted as the sole technique to sample species richness and abundance of ground dwelling beetles. That the purpose of the study was to compare, rather than provide an inventory of beetle assemblages in

different settings, overcame some of the methodological weaknesses associated with the technique.

In total, 195 pitfall traps were deployed across all survey sites For each sample plot, detailed in table 4.2, pitfall traps were placed within an industry-standard, fixed radius (12.5m) of a central point, with 5 sample points per plot (Kotze et al., 2007). Pitfall traps were placed at the cardinal points: North, South, East and West of a central trap. Each pitfall trap comprised a 77mm diameter to 52 mm, 175 ml plastic cup sunk into the ground, with the excavated soil and vegetation being used to ensure the rim of the cup was flush with the surrounding ground level. A second plastic cup was then inserted to allow for ease of checking and re-setting of traps. Approximately depth of 35mm/75 ml of propylene glycol diluted to 50% with water was placed in each trap to act as killing fluid. Propylene glycol was chosen in preference to ethylene glycol which is commonly used for pitfall trapping but is both attractive and toxic to mammals (Oboyski, 2006). As an effective alternative, propylene glycol is considered non-attractive and non-toxic (Oboyski, 2006) and was therefore used to limit the impact of bi-catch and minimise risk. Given that dried specimens were adequate for the purposes of this study, potential degradation of softer tissues through the hygroscopic nature of propylene glycol (Oboyski, 2006) was not considered to be an issue.

Traps were covered using a piece of wood to protect from rain, falling debris, desiccation, and to limit bi-catch and scavenging (Kotze et al., 2007; Lange et al., 2011). Figure 4.3 shows a pitfall trap in-situ together with the basic kit used to create the traps.

Figure 4.3 Equipment and typical arrangement of pitfall traps.

4.2.3.1 Timing of beetle surveys

The 3 woodland corridors were surveyed over 3 seasons: late summer-autumn (late August-October 2014), spring (April-May 2015) and summer (June-July 2015). These seasons are considered to cover the main period of activity for beetles in the UK (Telfer, 2013) and allow for seasonal variation in species activity and population change to be detected.

Each of the seasonal periods was then divided into 2 back-to-back survey rounds at each site. Each survey round comprised initial setting of traps which were left in situ for a set period prior to emptying, re-setting and reassessing following a further set period. Given practicalities and time constraints, pitfall traps were initially set for a period of 3 weeks before checking and re-setting for a further 3 weeks. Leaving the traps for 3 weeks was considered to be at the upper end of that is considered optimal (Kotze et al., 2007) although other research has used similar or more extended periods (Noreika & Kotze, 2012; Do, 2014). All trap losses, including those where traps were flooded or inundated by debris, were recorded. In response to the large level disturbance of traps during the initial survey rounds, the frequency of trap re-setting was reduced to 2 weeks for subsequent surveys.

For the first two survey seasons where pitfall traps were in place for 3 weeks, 36.5% of traps were found to be void (n=315). The percentage of void traps dropped to 16.2% (n= 314) during the second survey season, where traps were in place for 2 weeks. Levels of disturbance, however, increased during the final season of surveys again when traps were in place for 2 weeks, with void traps rising to 38% (n=250). Particular impact was felt in woodland corridor 3 along the Shaw Ridge where during round 1 of surveys, 69% of traps were disturbed, and a second round of survey work subsequently abandoned in that area. Details of trap disturbance by survey round and by area are given in in table 4.4.

Table 4.4. Number of traps for each corridor and survey round showing disturbed traps as void

	Rd 1		Rd 2		Rd 3		Rd 4		Rd 5		Rd 6	
	Season 1				Season 2				Season 3			
Area	set	void	set	void	set	void	set	void	Set	void	set	void
1: Richard Jeffries	70	19	65	17	65	11	55	10	60	27	33	13

2: Groundwell Ridge	60	12	60	29	55	10	55	11	55	26	29	4
3: Shaw Ridge	55	38	0	-	40	4	37	6	40	12	33	13
totals	185	69	125	46	160	25	147	27	155	63	95	30
Total % void		37.3		36.8		15.6		18.4		40.7		31.6

Initial efforts to distinguish and count specimens using a hand lens in the field proved impractical given the large number of beetles captured, time constraints and prevailing conditions. Rather, the contents of each pitfall trap were passed through a fine sieve and the sieved contents put into a labelled polythene bag for later lab analysis. Obvious bi-catch e.g. small mammals, slugs and snails were removed in situ and field notes taken accordingly. Each pitfall trap was then re-set for a second round of survey using a clean plastic cup and re-charged with relaxing fluid.

Subsequently the contents of each trap were cleaned to remove debris and non-beetle species. Beetle specimens for each trap were visually differentiated into pseudo-species using a x10- x20 stereomicroscope; as the purpose was to assess overall abundance and species richness rather than provide an inventory, identification to species level was not undertaken. Such an approach proved ineffective for rove beetles (*Staphylinidae* spp.) given difficulties in distinguishing pseudo-species and practicalities of cleaning specimens from trap debris. Staphylinidae species were therefore discounted from subsequent samples. Otherwise, a complete and clean example of each species was kept and carded to act as a reference collection for subsequent samples and for later identification to species level (Luff, 2007) for those species found to be dominant. Figure 4.4 shows the carded specimens.

Only those beetles found to be most abundant were identified to species level. Otherwise, given the stated objectives of the research, beetle species recorded were assigned codes (figure 4.4), against which other samples of the same species could be cross referenced, counted and used in descriptive and

comparative statistical analyses. The codes allocated represented the survey area, site and trap.

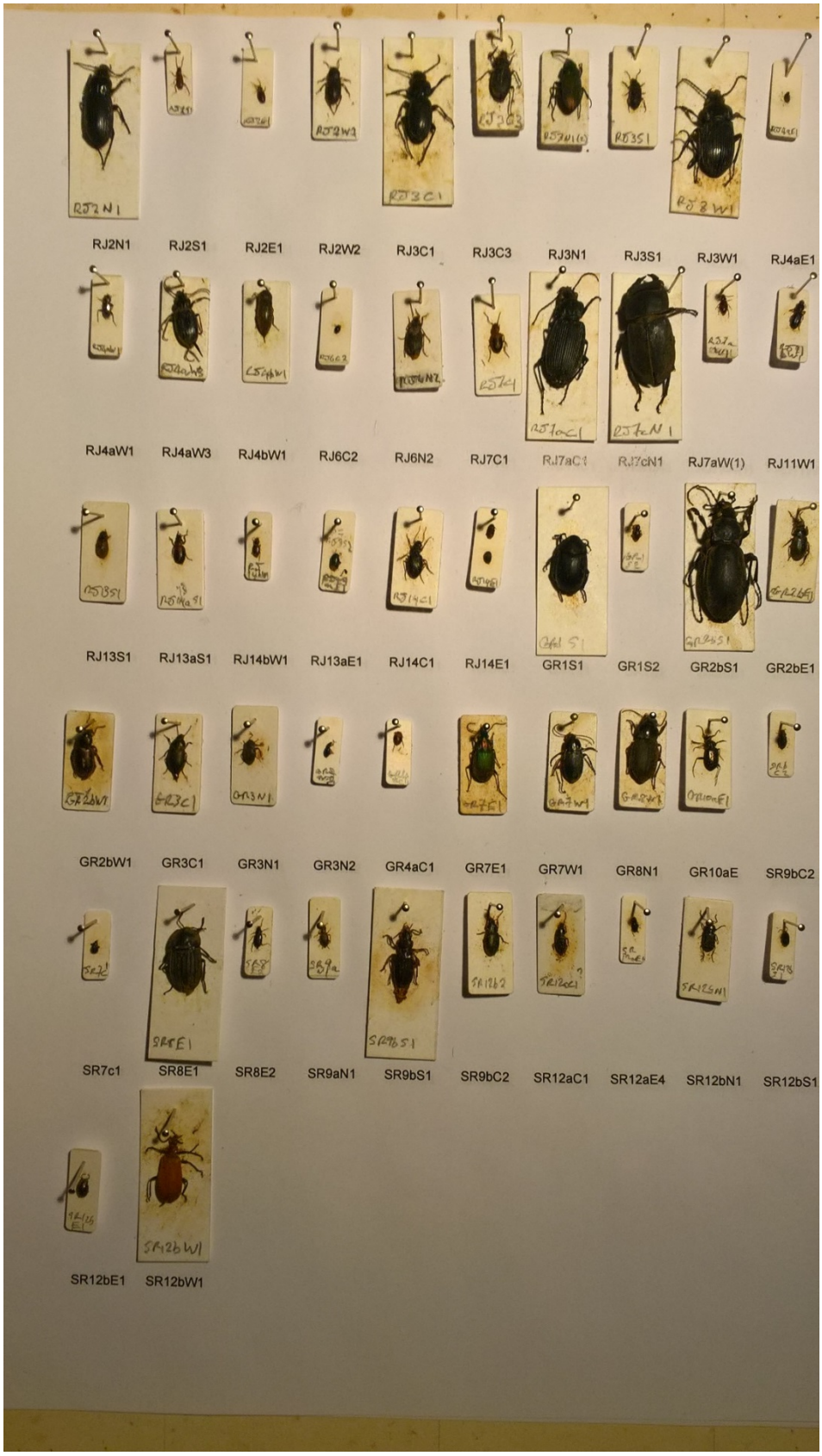


Figure 4.4 Specimen beetles carded for cross-referencing showing allocated alpha-numeric codes.

4.2.4 Data collation and analyses

To enable basic descriptive and subsequent analyses, data recorded on field notes and from lab work for both vegetation and beetle records were cleaned and analysed in Microsoft Excel. Data cleaning within collated data included removal of duplication errors encountered where, for example, specimens of the same species were incorrectly allocated to multiple pseudo-species codes, as well as ensuring zero and void counts were recorded consistently.

Descriptive, exploratory and inferential statistical techniques were calculated in SPSS Version 24 to summarise beetle populations, woodland characteristics and to compare data between sites and corridors.

Both parametric and non-parametric statistical tests were performed depending on whether data fulfilled parametric criteria (based on Shapiro-Wilks tests). Where possible efforts were made to normalise non-parametric data via transformation. Such manipulation of data is a standard, widely adopted statistical approach (Field, 2013). A number of transformations were tested: log10, Ln, square root by which to try and achieve normalisation of data and thereby maximise usefulness of records and allow more powerful parametric analyses to be used where possible. For non-linear data, such as that arising from DOMIN and DAFOR abundance scales, non-parametric approaches were used.

One Way Analyses of Variance were performed to compare structural, and compositional attributes of woodland between the 3 woodland corridors. Where data were non-linear, or could not be normalised, Kruskal Wallis tests were applied. Vegetation structure was compared using DOMIN scores for canopy, shrub, field and ground layers. For non-vegetation components i.e. bare ground, leaf letter and CWD, DAFOR scores were compared. Comparisons of woodland vegetation composition were carried out using species richness data for the 4 component woodland layers.

One Way Analyses of Variance were also used to compare abundance and species richness of beetles between the 3 woodland corridors. Where data could not be normalised, Kruskal Wallis tests were applied. Given extensive and non-uniform disturbance of trap across the corridors, average species abundance per

trap and average species richness per trap avoiding void traps were calculated to allow for meaningful comparisons to be made. Given the relatively low number of replicates, together with emerging results, calculation and comparison of diversity indices, were not carried out. The calculation of daily encounter rates to allow for changes in sampling periods as research progressed, was also not considered necessary. All corridors were surveyed at approximately the same time to give consistency with the main purpose being to compare beetle assemblages between woodland corridors, rather than between survey seasons. Accordingly, to account for potential interaction between seasonal and spatial influences on beetle assemblages Analyses of Covariations (ANCOVA) were performed.

Principal component analysis (PCA) and discriminant function analysis (DFA) were used as exploratory dimension reduction and factor analysis techniques to investigate beetle population characteristics in relation to woodland location, and to identify those species which may act as key variables in relation to woodland structure and composition. PCAs were initially performed using the average abundance of beetles per trap for all species recorded as variables with 2 factors extracted. Subsequent PCAs were carried out to generate more powerful models, for example by excluding those species recorded in very low numbers. Likewise, full model DFAs were carried out, prior to leave- one- out classifications, using average abundance of beetles per trap for all species recorded as independent variables and the 3 woodland corridors as the grouping variable. Subsequent DFAs were performed to strengthen the model and identify key variables (pseudo-species) to use in regression analyses.

Two stepwise multiple linear regressions (MLR, entry criterion alpha=0.05, beta=0.1) were performed to test for relationships between beetle abundance and measures of woodland composition, structure and dimensions. Efforts to normalise species richness data were not successful and therefore not carried forward for MLR analyses. Beetle abundance as the dependent variable within the MLR was represented by Ln transformed data of abundance per trap totalled for all species recorded, excluding void traps. Data were pooled across all survey areas and seasons to provide the maximum number of replicates and thereby strengthen the model. Independent variables used were DOMIN scores as measures of canopy, shrub and field and ground layer cover, species richness for canopy, shrub and

field and ground layers and DAFOR scores for cover of non-vegetative components of the woodland floor.

An initial 'full model' MLR analysis, was carried out to test assumptions: overall multivariate normality (via a q-q or p-p plot), homoscedascity (plot zpred against zresid), and multi co-linearity. A subsequent stepwise regression was performed to identify those woodland characteristics which provided the best predictor of beetle abundance. A second MLR was performed, with the same independent variables, using abundance of a sub-set of beetle species as identified via DFA as key variables.

4.3 Results

4.3.1 Woodland vegetation structure and composition

4.3.1.1 Structure

In order to give an overview across all sites of structural variability within and between woodland layers, DOMIN scores were collated for each of 3 woodland components: canopy, shrub, and field and ground layers combined. To give a better indication of structural heterogeneity within woodland layers Coefficients of Variation (CoV), based on DOMIN scores, were calculated across all sites.

As can be seen from table 4.5 and figure 4.5, the data indicate that across all the woodland sites surveyed, limited variability was encountered within canopy and shrub layers which were shown to be substantially less variable in relative terms to field and ground layers.

Table 4.5 Summary data for woodland structural components recorded in 20mx20m quadrats pooled across all sites (N=33).

Woodland component	DOMIN min	DOMIN max	Median	Interquartile range
Canopy	4	10	9	2
Shrub layer	2	10	7	4
Field+ground layer	3	10	8	4

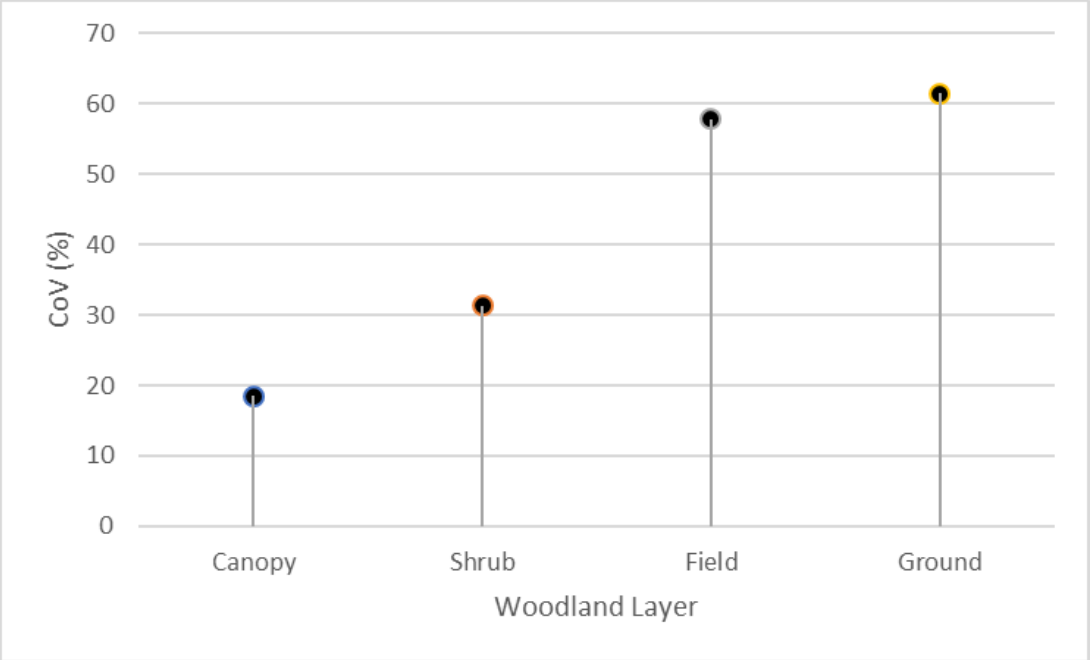


Figure 4.5. Coefficients of Variation (CoV) calculated for woodland structural layers. CoV for canopy and shrub layers and ground layers were calculated using DOMIN scores from the 20mx20m quadrats (N=33). CoVs were calculated for field and ground layers based on Domin scores within the smaller 2x2m quadrats (N=5) nested within the larger quadrat.

Comparison of woodland structure between corridors

To consider potential effects of differences in woodland structure on beetle assemblages, comparisons of woodland structural components were made between the 3 woodland corridors. An initial evaluation was carried out by comparing DOMIN scores for all 3 woodland layers. Woodland canopy cover was seen to differ significantly when compared between the 3 woodland corridors (Kruskal Wallis (K-W) test: X^2=8.03, df=2, p=0.018). Elsewhere, there were no significant differences found in the structural attributes of woodlands, when compared across the 3 woodland corridors using K-W tests: Shrub layer cover (X^2= 2.35, df=2, p=0.31), field and ground layer (combined) cover (X^2=2.69 df=2, p=0.26).

Characteristics of field and ground layers in particular are most likely relevant to ground dwelling beetles and also reflect prevailing light and other environmental conditions consequential to upper canopy and shrub layer cover. As such, heterogeneity within field and ground layers, as determined by calculation of CoV, were compared between the 3 corridors. No significant differences were found

however in CoV when compared across the 3 woodland corridors using K-W tests: Field layer (X^2=4.09, df=2, p=0.13), ground layer (X^2=0.94, df=2, p=0.63).

4.3.1.2 Woodland Composition

Prevalent plant species

To provide an overview of woodland characteristics and to address potential presence/absence effects of host plant species on beetle assemblages an initial inventory of dominant tree and shrub species was collated using the DAFOR scale:

Dominant and abundant woodland canopy species recorded in approximate order of prevalence were: ash (*Fraxinus excelsior*) field maple (*Acer campestre*), Norway maple (*Acer platanoides*), oak (*Quercus robur*) cherry (*Prunus padus / P. avium*), willow (*Salix* spp).

Dominant and abundant woodland shrub layer species recorded, in order of prevalence were: ash, Norway maple, wych elm (*Ulnus glabra*), hazel (*Corylus avellana*), hornbeam (*Carpinus betulus*) and blackthorn (*Prunus spinosa)*.

The results show that tree and shrub species recorded were generally typical of broadleaf plantation woodlands recommended for planting in lowland UK (Rodwell & Patterson, 1994). In addition, dominant and abundant canopy and shrub species (n=11) were present across all 3 woodland corridors, thus making any potential presence/absence effects less likely.

Plant species richness and prevailing ground cover

To provide an overview of vegetation composition and to consider potential effects of plant diversity on beetle assemblages, plant species richness within structural layers of woodlands were calculated and compared between the 3 woodland corridors. Likewise, the extent of ground cover components, bare, leaf litter and coarse woody debris were also assessed and compared. A summary of plant species richness within woodland layers is presented in table 4.6 and the extent of non-plant components of woodland ground layers is given in table 4.7.

Table 4.6 Summary of canopy, shrub field and ground layer species composition pooled for all sites.

Structural component	Species richness				
	Min	Max	Median	N	Interquartile range
Canopy	1	9	4	33	2
Shrub	2	6	*4*	*33*	*2*
Field and ground	4	11	7	33	7

Table 4.7. Summary of DAFOR scores for woodland floor components for all woodland sites. Dominant =5, Abundant =4, Frequent = 3, Occasional=2, Rare =1. Estimated % attributed to DAFOR scores are summarised in appendix 2.

Woodland floor component	Summary of DAFOR scores		
	Max	Min	Median
Bare soil	4	1	2
Leaf Litter	5	1	2
Leaf Litter (October)	5	1	4
Coarse Woody Debris	4	1	3

No significant differences were found in species richness for any of the woodland strata when compared between the 3 woodland corridors, using K-W tests: canopy layer (X^2=4.61, df=2, p=0.10), shrub layer (X^2=5.67, df=2, p=0.06) and field and ground layer combined (X^2=1.25, df=2, p=0.54).

Likewise, no significant differences were found for woodland floor components based on a comparison of DAFOR scores between the 3 corridors and using K-W tests: Bare soil (X^2= 5.54, df=2, p=0.06), leaf litter (X^2=3.76, df= 2, p=0.15), leaf litter (October) (X^2=2.18 , df=2, p=0.38) and coarse woody debris (X^2=4.93, df=2, p= 0.09).

4.3.1.3 Summary of vegetation structure and composition

In summary, 8 out of 9 structural and compositional attributes of woodlands surveyed in this study did not differ significantly when compared across the 3

corridors. Only estimates of canopy layer cover exhibited any statistically significant differences when compared. Canopy cover in itself however showed limited variation, when considered across all sites.

The findings are consistent with the initial premise of the research: to compare beetle assemblages within similar woodlands but across different urban settings. Doing so ensured that potentially large differences in woodland characteristics did not unduly influence beetle assemblages and allowed for more robust pooling of data across woodland areas for subsequent regression analyses (section 4.3.3)

4.3.2 Beetle populations

4.3.2.1 Descriptive overview

To provide an overview of the beetle assemblages recorded in the study, total counts and prevalence for all species were calculated and collated for the 3 woodland corridors and across all sampling periods. Given the dominance of two species, these were identified to species level to consider their traits in relation to habitat suitability.

In total, 13,626 individuals representing 52 beetle species, excluding *Staphylinidae* spp. but including other non-carabids, were counted across all survey areas during the 3 survey seasons. Figure 4.4 shows carded samples of beetles recorded, together with the assigned alpha numeric codes as used in subsequent analyses.

Two dominant species, *Pterostichus madidus* (RJ3C1) and *Nebria brevicollis* (RJ4aW3) accounted for 90% of beetles counted, with 6010 counts and 6235 counts respectively. Both species were also the most prevalent, encountered in 81% and 64% of pitfall traps respectively. As shown in Figure 4.6 prevalence for all other species, determined by the number of traps in which species were recorded, ranged from 0.2 % to 16 %, with total number of beetles recorded for each species ranging from 1 to 200.

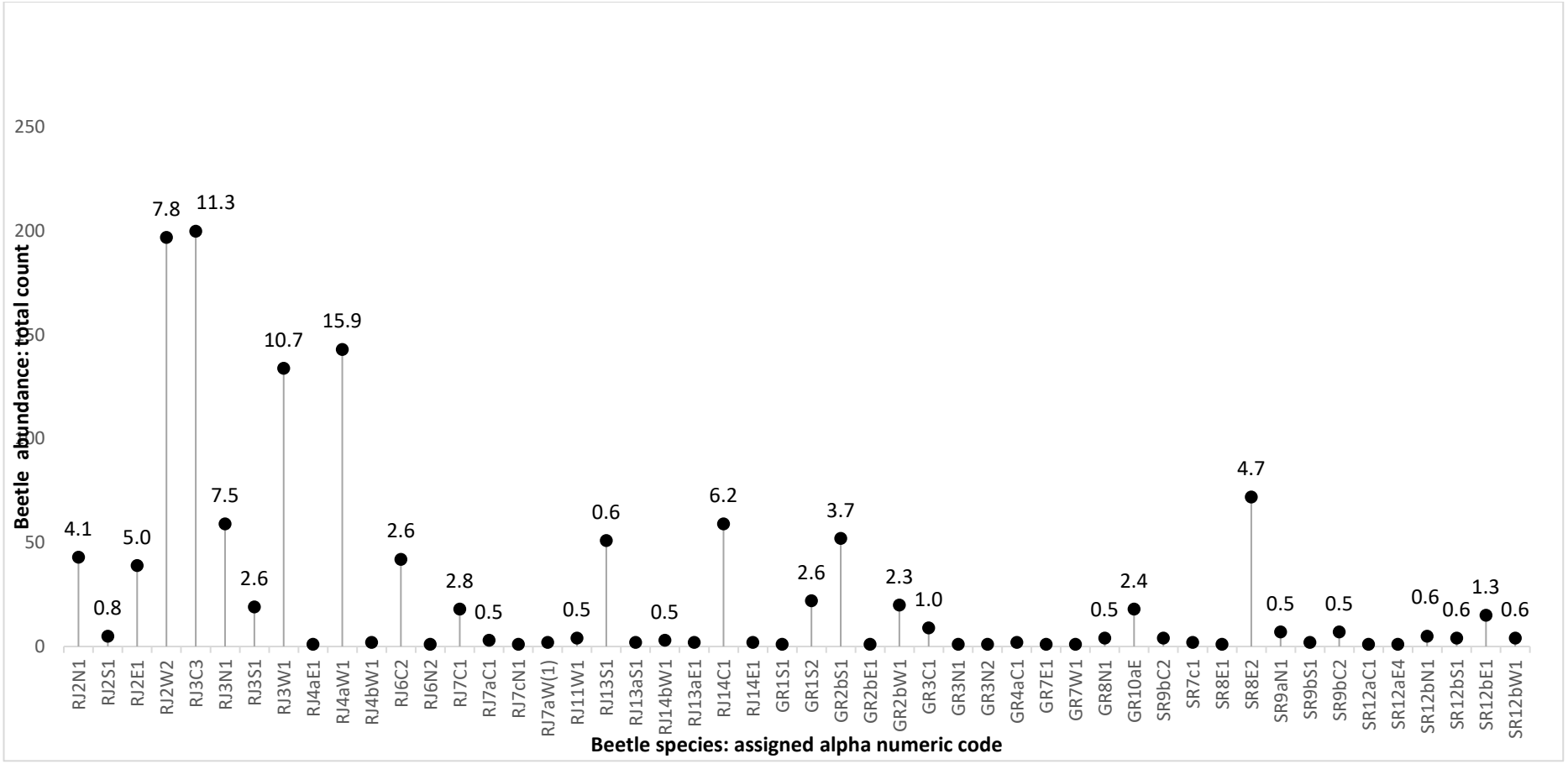


Figure 4.6 Abundance (total count) of species recorded across all sites and survey periods, excluding 2 most prevalent. Numbers above lines indicate % of non-void traps in which species were recorded to give prevalence. If no figure given prevalence<0.5%. Alpha numeric codes assigned to species correspond to those shown in figure 4.4.

To give a practical sense of the numbers and range of beetles encountered during the field work, abundance and species richness of beetles caught per trap and pooled across all sites were calculated. The total count for beetles recorded within individual traps ranged from 0 to 180 with a median count of 12 (N=618, interquartile range 24). The number of species counted in each pitfall trap ranged from 0 to 7 with a median count of 2 (interquartile range=1).

To further illustrate the nature of assemblages compared between the 3 corridors, abundance and prevalence of beetle species recorded per trap, disaggregated between the 3 corridors were calculated as shown in Figures 4.7 and 4.8. For ease of presentation only, the 3 most dominant species recorded are given separately. The data are for illustrative purposes and given the high number of zero counts per trap for individual species, medians and counts per trap only where species were present are used.

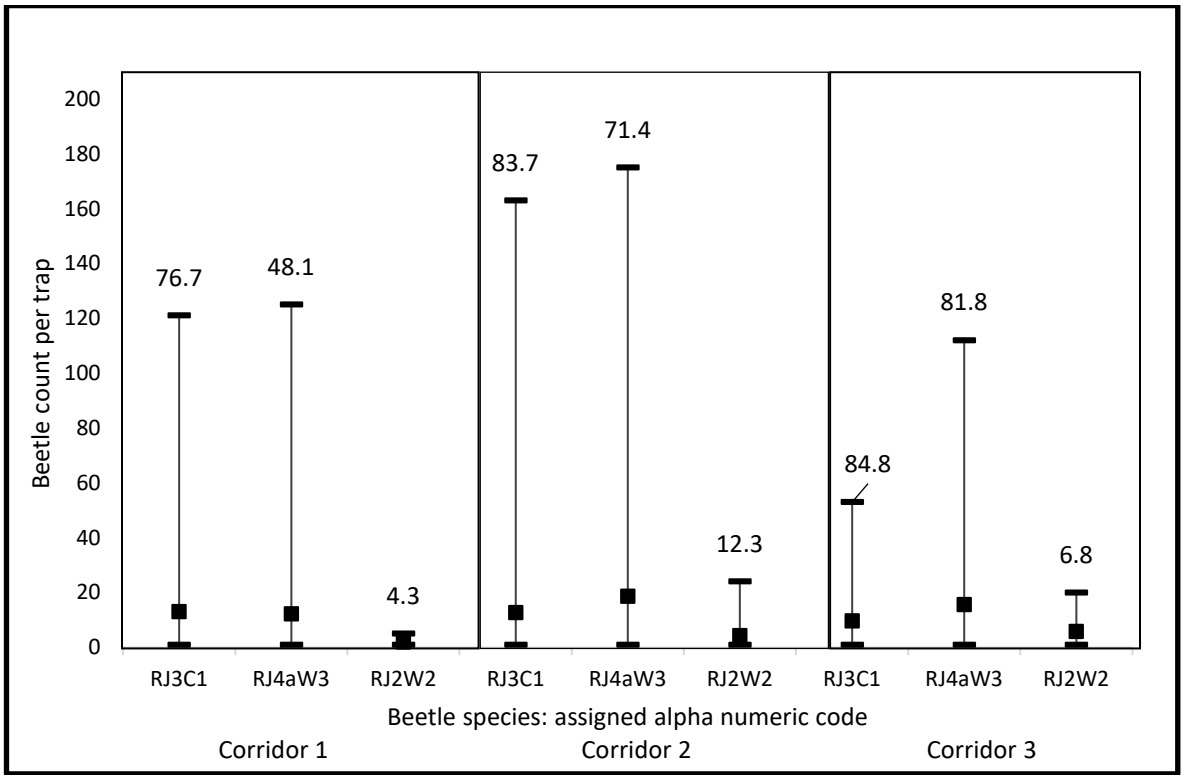


Figure 4.7 Species abundance per trap where present, 3 most abundant species only. Numbers above lines indicate % of non-void traps in which species were recorded to give prevalence. Corridor 1= Richard Jeffries, 2= Groundwell Ridge, 3= Shaw Ridge.

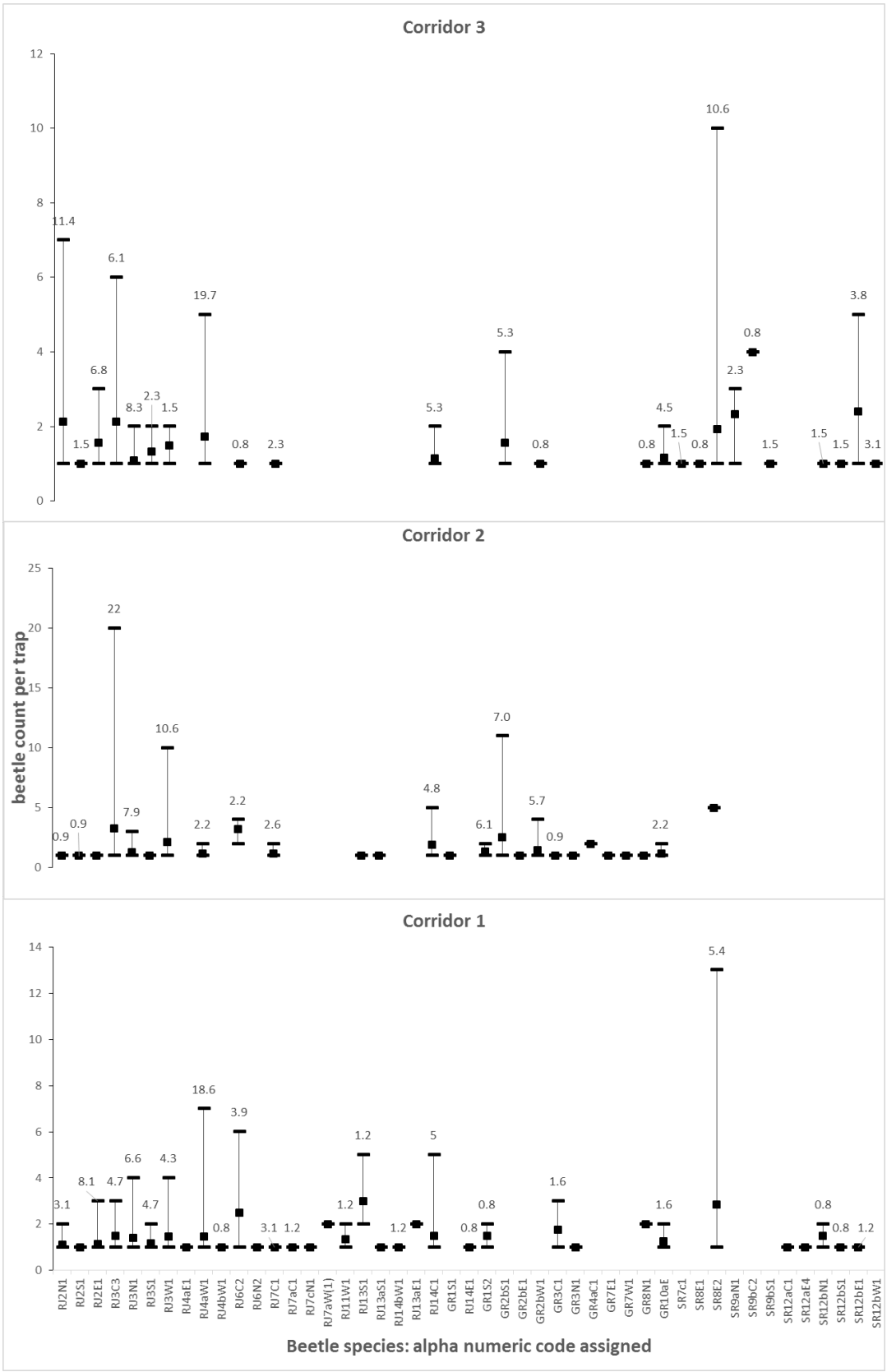


Figure 4.8 Species abundance per trap where present, excluding 3 most abundant species. Numbers above lines indicate % of non-void traps in which species were recorded to give prevalence. Prevalence<0.5% if not shown. Corridor 1= Richard Jeffries, 2= Groundwell Ridge, 3= Shaw Ridge.

4.3.2.2 Comparison of beetle assemblages between woodland corridors

To assess potential differences in beetle assemblages between the 3 woodland corridors, the abundance and species richness of beetles recorded were compared. As tests for normality showed both abundance and species richness data across all three woodland corridors to be positively skewed (Shapiro-Wilk test, $p<0.05$), a number of data transformations were tested. Only natural log transformations of beetle abundance data gave a normal distribution (N=160, Shapiro-Wilk, $p> 0.05$). Transformations for species richness were consistently skewed and therefore non-parametric tests adopted.

Summary statistics for beetle abundance and species richness are shown in table 4.8.

Table 4.8: beetle abundance and species richness calculated per non-void trap for each sampling site (comprising 5 pitfall traps) compared between 3 woodland corridors. N is total number of valid sampling sites for all survey rounds. Corridor 1= Richard Jeffries, 2= Groundwell Ridge, 3= Shaw Ridge.

	Abundance per non-void trap						**Species richness per non-void trap**			
Woodland Corridor	N	Median	Interquartile range	Min.	Max.		Median	Interquartile range	Min.	Max.
1	68	10.57	19.2	0.3	112.0		4.5	3.0	1.0	8.0
2	57	14.0	22.5	2.0	118.4		4.0	1.0	1.0	9.0
3	35	18	25.0	3.5	91.5		5.0	3.0	2.0	8.0

No significant differences were found in beetle species richness between the 3 woodland corridors (Kruskal-Wallis test: $X^2=1.48$, df=2, $p=0.48$).

Using Ln transformed data, there were significant differences in beetle abundance in non-void traps between the 3 woodland corridors (one-way ANOVA: F2, 157=5.008, $p=0.007$). Woodland corridor 1 had significantly fewer beetles than woodland corridor 2 and 3 which did not differ significantly from each other (Tukey multiple comparison test: Corridor 1 versus Corridor 2 and Corridor 1 versus Corridor 2, $p<0.05$, Corridors 2 versus Corridor 3, $p>0.05$).

Given the dominance of 2 species, further comparisons of beetle abundance between woodland corridors were carried out a) excluding the 2 most dominant species and b) with 2 most dominants only. Excluding the most dominant species resulted in no significant difference in Ln abundance per non-void traps between the 3 corridors (Oneway ANOVA: F2, 147=2.85, $p=0.06$). Using the 2 most

dominants in the absence of all other species resulted in a significant difference being observed in Ln abundance between the 3 corridors. Woodland corridor 1 had significantly fewer beetles than woodland corridor 2 and 3 which did not differ significantly from each other (Oneway ANOVA, $F_{2, 155}=4.7$, $p=0.01$. Tukey multiple comparison test: Corridor 1 versus Corridor 2 and Corridor 1 versus Corridor 3, $p<0.05$, Corridors 2 versus Corridor 3 , $p>0.05$).

A one-way ANCOVA conducted to determine the difference between woodland corridors and Ln abundance controlling for timing of survey round (i.e. entering this as a covariate) showed a significant difference in Ln abundance between woodland corridors (ANCOVA, $F_{2,156} = 8.2$, $p< 0.01$) whilst adjusting for survey round.

Comparison of population composition

Principal component analyses

Whilst abundance and species richness showed limited or no differences when compared across the 3 woodland corridors, principal components analyses (PCA) were performed to investigate the species composition of beetle communities encountered across the woodland corridors and to provide data for subsequent inferential analyses.

An initial PCA was carried out using the average abundance of beetles per trap for all species recorded as variables. A scatter plot using the resulting principal components, grouped by woodland corridor is shown in Figure 4.9. For visual comparison 2 outlying data points were removed and the scatter-graph re-plotted using a condensed scale as shown.

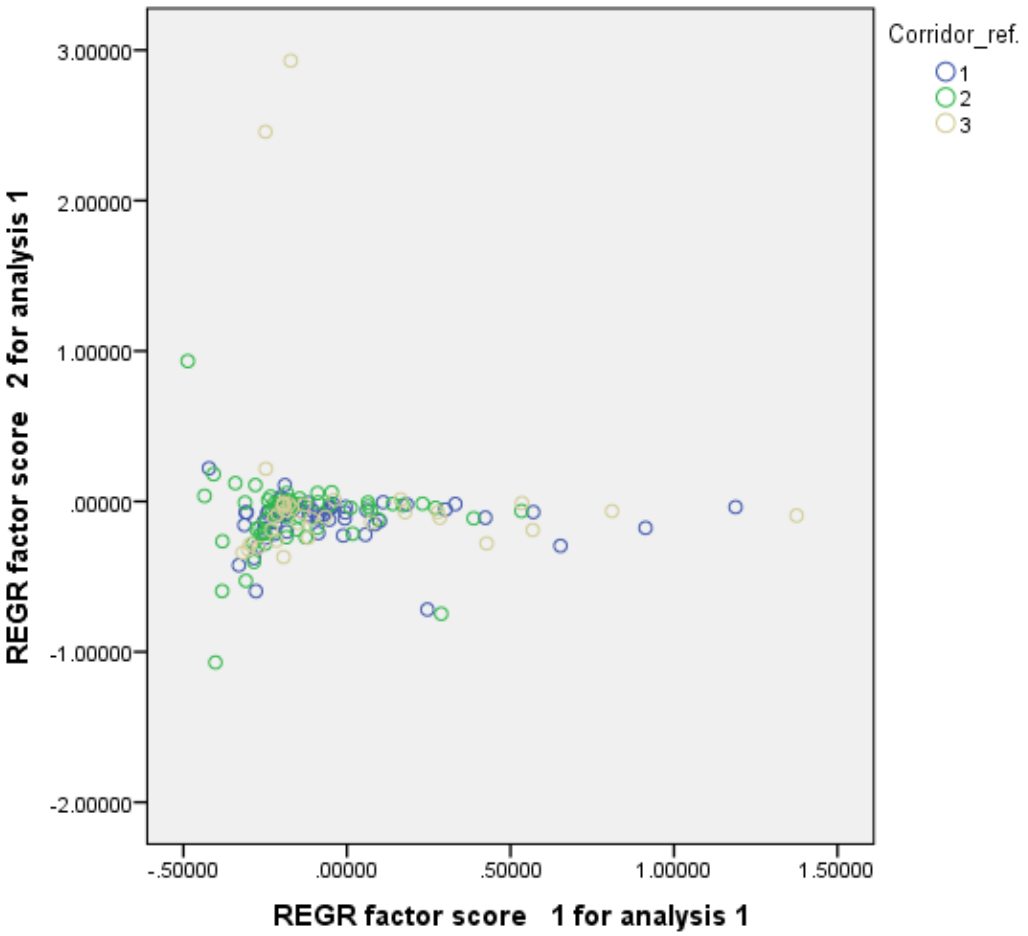


Figure 4.9. Principal components extracted using average abundance of each beetle species per trap, and grouped by woodland corridor. 2 most outlying points removed for presentation purposes.

As can be seen from figure 4.9 beetle communities across all 3 corridors can be interpreted as being reasonably consistent and generally highly clustered. The model using the 2 principal components extracted only accounted for 12.8% of variation observed in beetle communities. Further investigation of the species driving the PCA indicated that the large majority of species had a very low loading on both of the principal components, typically less than 0.1. Only 7 species out of 52 gave component factor loadings of greater than 0.5 and only then on either one (but not both) of the components.

In order to try and generate a more powerful model, a second PCA was undertaken excluding those species recorded where the average abundance of beetles found per trap fell below 1. This approach was felt justified given a) the increased risk of miss-identification of species with a low count and b) that all the species excluded accounted for < +/- 0.05 factor loading for both components of

the initial PCA. Doing so resulted in the total variance explained increasing but remaining low at 17.8%. Similar to the initial PCA, a large number of species were found to have only a weak contribution to the model with a loading on both components of <0.05 on either of the components extracted. The overall PCA result showed no strong patterns in the full beetle communities in relation to corridor. Also, no key species were identified via the PCA through factor loadings for carrying forward to inferential statistical analyses.

Whilst further PCA were conducted, for example excluding the most dominant species, none of the subsequent results however significantly improved the level of variance explained by principal components extracted.

Discriminant function analyses

Discriminant function (DF) analyses were conducted to determine potential differences in beetle communities between the 3 woodland corridors and in an effort to identify key variables for later inferential statistical tests. A discriminant function analysis (DFA) using all species recorded as variables revealed 2 discriminant functions. Overall, using all species recorded, the DF model gave 61.7% of cross-validated groups as correctly classified against a prior probability of 42.6% giving 19.1 percentage points higher relative to random chance. The model performed best for corridor 1 with 84.1% of groups correctly classified, but less so for corridors 2 and 3 (56.1% and 27.8% respectively). A second DFA excluding species where average trap abundance fell below 1 again revealed two significant 2 discriminant functions. This second DFA however only gave a small increase in the % of cross validated groups correctly classified at 62.3% with a weaker result for corridor 3 (19.4%).

Given the relatively weak DFA model with respect to corridor 3, possibly related to the high number of void traps reported for sample sites within this corridor, a DFA was conducted looking at all species variables in corridors 1 and 2 only. A single discriminant function was revealed in this analysis, differentiating beetle communities between the 2 corridors. Overall, using this model 77.0% of cross validated groups were correctly classified compared to a prior probability of 54.8% i.e. 22 percentage points higher relative to random chance (corridor 1=84.1%, corridor 2= 68.4%). To determine key variables within the model, a subsequent

stepwise DFA was carried out. Doing so identified 7 species as significant variables within the model which were subsequently used in inferential statistical analyses (section. 4.3.3): RJ2E1, RJ3C1, RJ3C3, RJ3S1, RJ3W1, RJ4aW3, RJ11W1.

Further DFA were carried out for example excluding the top 2 dominant species. Resultant discriminant functions however did not improve the strength of the models.

4.3.3 Relationship between beetle assemblages and woodland composition.

Multiple linear regression (MLR) analyses were carried out to test for relationships between woodland characteristics and beetle abundance. To maximise the number of replicates, data were pooled across all woodland sampling sites (n= 39) and survey periods (n=6). Beetle abundance was represented by Ln transformed data of abundance per trap totalled for all species recorded, excluding void traps. As indicated in figure 4.10 initial testing carried out to check for overall multivariate normality (via a p-p plot) and homoscedascity (zpred against zresid plot), found assumptions to be correct and allowed for a valid MLR to be carried out.

As detailed in table 4.9 no significant linear relationships were found between overall beetle abundance and measures of woodland structure, composition or spatial configuration. Any potential relationships between subsets of beetle assemblages and woodland composition may be statistically masked within the overall analysis. A further MLR test was therefore performed using (normally distributed) species abundance data for those key species identified in discriminant function analyses in corridors 1 and 2 only as reported in section 4.3.2.2. No significant linear relationships however were found between this subset of beetle abundance and measures of woodland structure and composition, as reported in table 4.9. Given that no predictors of beetle abundance were found to be significant, no stepwise model was generated.

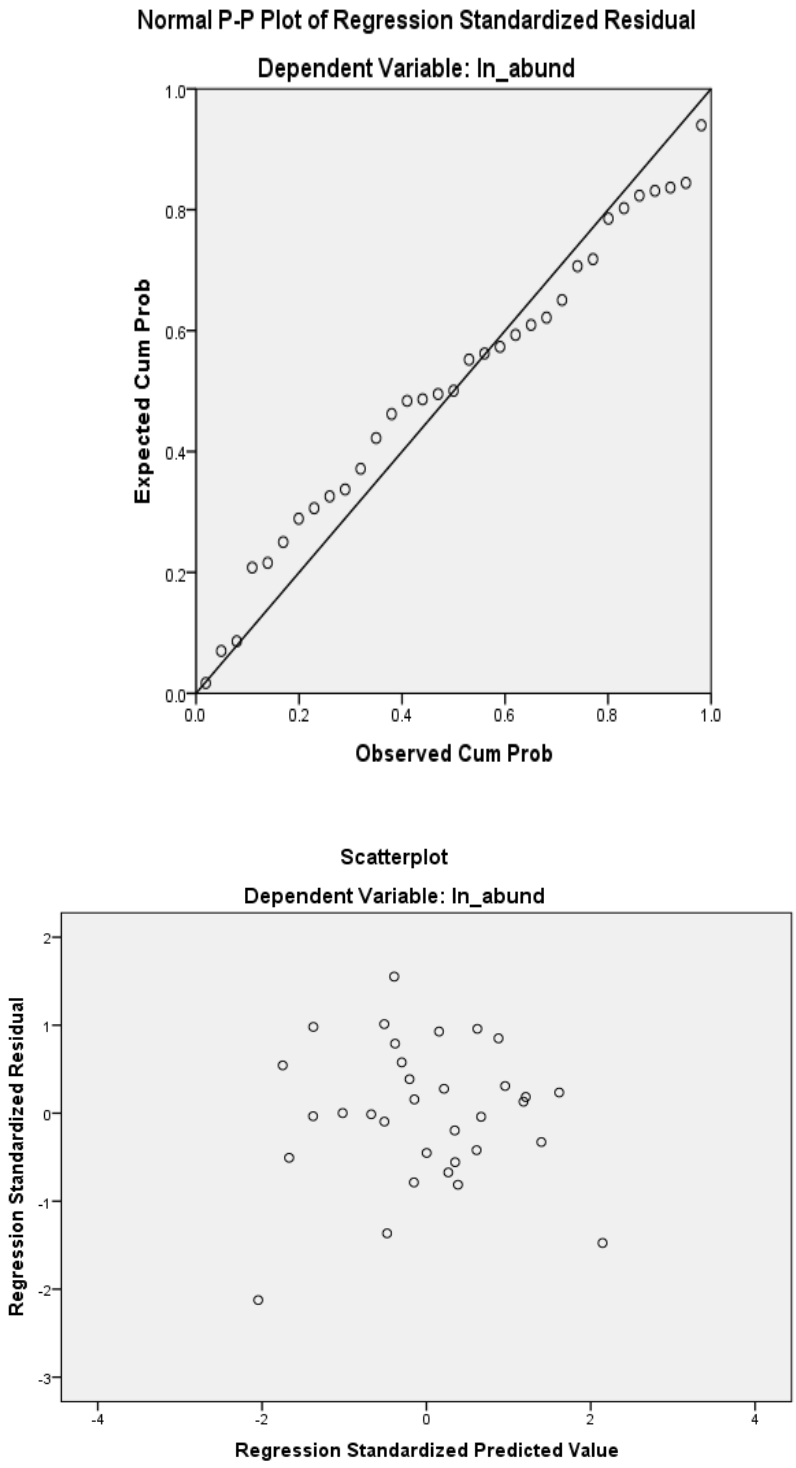


Figure 4.10. Assumptions tests for overall multivariate normality (top) and homoscedascity (bottom), allowing for valid MLR to be performed.

Table 4.9. Linear model predictors of Ln beetle abundance.

Independent variable	Dependent variable= Ln beetle abundance (mean per non void trap) all species included.			Dependent variable = beetle abundance for subset of species identified in DFA analysis		
	B	Std Error	P	B	Std error	P
Constant	2.27	2.21	0.32	-30.37	52.86	0.58
Canopy cover	0.11	0.13	0.37	-0.15	2.43	0.54
Shrub cover	-0.84	0.09	0.37	-4.36	2.01	0.06
Field and ground cover	0.09	0.16	0.59	2.62	3.64	0.49
CoVar ground	0.02	0.01	0.76	0.06	0.13	0.63
CoVar field	0.00	0.01	0.98	0.07	0.12	0.54
Species richness canopy	0.03	0.11	0.78	2.45	2.80	0.40
Species richness shrub	-0.03	0.15	0.86	-0.162	3.32	0.64
Species richness field + ground	-0.01	0.11	0.97	1.82	3.16	0.58
Bare ground	0.06	0.24	0.81	7.59	6.11	0.24
Leaf litter	0.07	0.24	0.73	-2.23	4.46	0.62
Coarse woody debris	0.09	0.18	0.62	3.95	3.62	0.30
Leaf litter (October)	0.21	0.21	0.34	7.73	5.11	0.16
Woodland Area	-.003	0.00	0.54	2.83	1.92	0.37
Woodland perimeter	0.01	0.00	0.21	0.05	0.12	0.19
Perimeter/area ratio	0.01	0.04	0.74	0.06	0.11	0.62

4.4 Discussion

Beetle communities in urban plantation woodlands

The study demonstrated, and is consistent with research elsewhere, that small urban woodlands are capable of supporting a wide range of beetle species and large communities of generalist carabid species. The abundance and number of beetle species encountered during this research is comparable with that of other studies of carabids in urban settings. To give a sense of the similarities, albeit in a different research context, a study by Croci et al. (2008) compared the number of carabid species recorded in urban woodlands (n= 38) to that in peri-urban settings (n=63) in Renne, northern France. Likewise, Fujita et al. (2012) also demonstrated

the importance of small fragments of urban woodlands as reservoirs for beetle species not reliant not continuous forestry. Similarly, Do et al. (2014) report the particular role of urban ‘forest parks’ in providing suitable refuge for ‘different carabid assemblage with high richness and abundance‘ in comparison with other urban land-uses.

The findings in this research are also consistent with investigations demonstrating the dominance of a small number of generalist species in urban woods (Angold, 2006; Gagne & Fahrig, 2011). The dominant 2 species, accounting for 90% of beetles caught in pitfall traps, *Pteroticshchus madidus* (the Black clock beetle, Walters, 2010) and *Nebria brevicollis* (Common Heart-shield beetle, Walters, 2010) are both described as common and widespread across the UK. Both are abundant and typically found in a range of habitats including those in urban settings. *Pteroticshchus madidus* is considered a generalist species found in habitats typical of those in towns and cities: woodlands, open and shaded grassland and gardens and can also be found in houses. *Nebria brevicollos* is reported as one of most common widespread carabid species in the UK found in a variety of habitats including woodlands and gardens (Luff, 2007). The overwhelming dominance of these 2 species in the woodlands surveyed supports the opportunistic species hypothesis: predicting that species that are able to cope with disturbance would increase their dominance (Tothmeresz, 2011, citing Gray).

An increase in species richness of carabids in suburban woodlands has been described as a consequence of an increase in the presence of generalist and open habitat species (Tothmeresz et al., 2011). Given the dominance of two generalist species in this study, it may be expected that other species recorded are likewise generalists, although further identification to species level would be needed to confirm this. Such an observed increase in generalist species, termed the ‘intermediate hypothesis’ (Tothmeresz et al., 2011, citing Gray) contradicts the more usual premise that increasing disturbance typical of urban areas leads to an inexorable decline in species communities. The findings suggest small urban woodlands may be enriched in terms of species richness by being in close proximity to, and in combination with other land uses typical of urban areas. Similar findings relating to urban woodlands have been reported by Croci et al.

(2008), positing that the nature of the urban landscape surrounding woodlands, even at small scales, could be a key factor defining woodland carabid communities in urban settings rather than patch qualities per se.

Likewise, the differences in beetle abundance observed in this study when compared across the corridors may be influenced by landscape rather than patch habitat characteristics: in so far that the study did not reveal any relationships between beetle populations and the structural and compositional measures of their woodland habitats. The results somewhat contradict findings by Angold (2006) who identified habitat quality as being the main factor influencing beetle diversity in urban habitat patches, albeit their research considered a broader range of urban habitats. Angold went on to single out woodland carabid communities, as opposed to those recorded in other urban habitats, were also sensitive to landscape factors. It is difficult however to draw robust conclusions based on the results and further investigations are needed. Measures of abundance are a rather 'blunt tool' and the differences observed were largely driven by the numbers of the 2 dominant species recorded. Moreover, other unrecorded habitat factors could of course be at play and the limited structural variation in the woodland sites selected may be a contributing factor to being unable to uncover such relationships. Similarly, potential differences in beetle communities observed when comparing corridors 1 and 2 as indicated by DFA analyses require further investigation. It was beyond the scope of the study to identify beetles to species level, but doing so would be needed to better understand any such relationships.

Practical difficulties in assessing beetle communities in urban woodlands

The difficulties encountered in pitfall trapping within urban woods, whilst not detracting from trait characteristics of beetles as surrogate species per se does present practical challenges in assessing beetle communities in urban settings.

The large level of disturbance of traps observed included those being dug up, overwhelmed with debris and occupied by large numbers of slugs. Whilst speculative, it is suspected that disturbance may be as a result of inquisitive domestic animals. In this light it was important that non-toxic relaxing fluid was used within pitfall traps. It follows that effort to assess invertebrate communities using pit-fall traps within more open publically accessible open spaces would

present similar if not more challenges. Not only can the number of void traps be seen to undermine confidence in data, but the wasted survey effort detracts from pitfall trapping as an efficient method used in public spaces.

The overgrown and unmanaged nature of the woodlands surveyed also presented further difficulties. Limited access into thicket woodland alongside extensive waste and detritus was not only unpleasant but arguably introduces biases into site selection.

Implications for green infrastructure planning and management

The plantation woodlands surveyed in this study are typical of other woodlands across the urban area of Swindon being largely unmanaged for the purposes of nature conservation. Whilst relatively homogenous in structure and composition, and in the absence of management, the study shows that small urban woods remain as important habitats supporting a wide range of carabid species in large numbers. Increasing urban woodland cover, at the expense of less favourable habitats in urban areas, would support larger populations albeit correspondingly homogenous populations of carabids.

Gross structural changes as the woodlands mature and as a consequence of disturbance events (Kirby et al., 2005) may result in more distinct relationships between habitat characteristics and beetle communities. In the meantime however this study implies that simple interventions to manage structural components of young plantation woodlands may have limited benefit for beetle communities and doing so would result in ‘the usual suspects’ (Bailey, 2006). If however the purpose of woodland management is to develop ‘representative community membership and associated structural diversity’ then more complex and resource intensive interventions would be needed (Bailey, 2006).

Alternatively, research on carabids elsewhere in Europe (Croci et al., 2008; Tothmeresz et al., 2011) proposes that management practices could usefully focus on improving habitats of surrounding land-use around urban woodlands, providing for easier dispersal across green infrastructures. The same could be argued by extension to other fauna with relatively weak dispersal abilities. Such findings support the suggestion that prioritising efforts across the urban matrix may provide better conservation returns than manipulating the size and configuration of

remnant habitat patches (Franklin & Linden-Mayer, 2009) and that the patch-matrix dichotomy (Prugh, 2008) is less pronounced in urban settings. The Landscape Institute (2016) similarly call for a 'softening' of the urban matrix to make it less hostile to movement of fauna. The research here also implies that approaches for off-setting the impact of habitat loss by improved management of remaining habitats, for example in association with urban development, will not necessarily lead to a desired gain in biodiversity.

Beetles as surrogates.

Whilst research using surrogate species in urban areas disproportionally favours birds (Gagne and Fahrig, 2011), the study here illustrates the potential of beetles as a useful taxon to understand the relationships between components of green infrastructure and thereby help guide urban nature conservation practice. The complexity and heterogeneity of urban land uses make it difficult however to draw robust conclusions based on the needs of a particular grouping of fauna (Dallimer, 2012) and contradictory patterns both within and between and within taxa are reported. For example, research has shown carabids respond differently to increasing urbanisation in comparison to birds (Gagne & Fahrig, 2011, and birds differently to butterflies (Dallimer, 2012). Within the Coleoptera family, work carried out by Magura et al. (2013) on another beetle family, the Staphylinidae (rove beetles) presents contradictory evidence to that reported in this study. A better understanding of the habitat needs of particular taxa and clear management objectives are needed before interventionist management of urban woodlands can be confidently said to result in biodiversity gain as sought by UK planning policy. Accordingly, further research across a wider range of taxa and in a wider range of urban settings is called for by this and previous research (Dallimer 2012; Gagne & Fahrig, 2011; Croci et al., 2008). Such a need is further emphasised if considered in light of the limited ability for the public to perceive invertebrate diversity (Hoyle et al., 2018) and as discussed further in section 6.2, limitations of the research.

4.5 Chapter 4 summary

Woodland plantations were selected across 3 areas of Swindon representing differing urban landscape settings. Structural and compositional attributes of the woodlands pertinent to the study were identified, surveyed, and detailed (objective

1.1). Surveys of ground beetles, a taxon identified as a useful surrogate species for wider biodiversity, took place in each of the woodlands, as a basis for describing their assemblages in terms of composition, species abundance and species richness (objective 1.2). Statistical analyses were subsequently performed to relate characterises of beetle assemblages to woodland attributes (objective 1.3).

Plantation woodlands chosen for the research are a ubiquitous, widespread habitat within the urban matrix of the case study area. The woodlands surveyed were purposefully established in response to prevailing policies and practice at the time in relation to landscape setting for new development and accessibility of local green spaces for access and recreation, including provision of green corridors. The woodlands and other closely associated land-use now provide valuable habitats in close proximity to large populations and thereby opportunity for everyday contact with nature for local communities. The value of such places to local residents in terms of their biodiverse qualities are examined in the following chapter 5.

Chapter 5: The influence of everyday nature on residents' sense of place

This chapter describes the methods used, results and findings to address a stated aim of the research:

Aim 2. To critically examine what determines residents' perceptions of, and values assigned to, nature in urban settings.

Concepts and methodological approaches detailed and justified in chapters 2 and 3 respectively are summarized and adopted as a basis for meeting the objectives of this study:

> Objective 2.1: To identify a social group that engages with urban green space, including urban woodlands in the areas selected for aim 1;
>
> Objective 2.2: To adopt a triangulated approach to elicit residents' perceptions of, and values assigned to, nature within urban green spaces;
>
> Objective 2.3: To utilise a Sense of Place framework to evaluate the contribution of nature encountered within Swindon's urban green space to the value residents assign to these areas.

Results are examined and discussed in the context of planning for urban growth and development. In doing so, priorities for investment in urban GI from a social perspective are proposed.

5.1 Introduction

In the context of increasing urbanisation there are concerns over potential impacts of a disconnection between people and nature on societal, personal and environmental well-being (Soga and Gaston, 2016). Spaces such as gardens, local parks, school grounds, the street-scene and incidental open spaces typical of urban green infrastructure afford opportunity for urban residents to experience everyday contact with nature (Bell et al. 2017; Hoyle et al. 2019). Despite such ready availability of urban open-spaces, the links between the biodiversity qualities

of such spaces and the benefits to be derived from contact with nature has been questioned (Brown and Grant, 2005).

The reasons that contact with nature is of benefit to people remain contested (Dallimer et al., 2012). There have been few studies on the components of, or mechanisms by which, the qualities of naturalised green-spaces impact on quality of life (Bell et al., 2017; Brown and Grant, 2005, Jorgenson and Gobster, 2010). Specifically the role of biodiversity remains unclear (Southon et al., 2019). In addition, research evidence on the effects of people's exposure to green-space is not consistent and causal pathways have not been clearly established: 'what kinds of nature (flowers? trees? animals?) and kinds of contact (viewing? touching? entering?)' (Frumkin, 2003). It has been suggested that better understanding relationships between people and nature could be of profound importance both for biodiversity and public health (Clark, et al., 2014) and therefore how we plan for green infrastructure in the context of increasing urbanisation (Bell et al., 2017; Hoyle et al., 2019).

The limited number of studies examining the link between biodiversity per se and peoples' responses to urban nature have followed a similar methodological path. They are predominantly quantitative, positivist grounded approaches and have yielded somewhat contradictory results (section 3.3). Recent research in the UK, for example by Bell et al. (2017), Hoyle et al. (2019) and Southon et al. (2018) followed both qualitative and quantitative methodologies to better understand the influence of natural qualities of place in urban settings on people-nature interactions. Further research in this area is needed however and this study responds to calls for the adoption of different epistemological positions to be used within the field of urban ecology: to help fill the gaps 'specifically to do with human values and the richness of the everyday lifeworld' (Mugerauer, 2010; Pickett et al., 2008). This study therefore adopted a sense of place framework linking cognitive, affective and conative components of attitude-behaviour theory to principle concepts described within sense of place (SoP) theory, empirically testing the framework offered by Jorgensen and Stedman, (2006). SoP is a term that 'encompasses the meanings and attachments that places hold for people' (Semken and Freeman, 2008), reflecting that SoP is a product of the interactions

involving people, the setting and their social worlds (Kyle and Chick, 2007). Principle components of SoP have been described as place attachment, place identity and place dependency as set out in section 2.3.2.

Swindon's health walk groups, comprising residents who regularly and purposefully use local green infrastructure were chosen as the venue for this research. The objectives of the groups lend themselves well to those of the study: the healthy walking initiative promoting three-fold benefits of group walking, those being improvements to physical and mental health and social well-being (Walking for Health, 2019) with an explicit link to additional benefits of contact with the natural environment (Bird, 2007). In common with other towns and cities in the UK, Swindon continues to undergo rapid extensive regeneration and expansion. The study thereby took place in a town in which the landscape within neighbourhoods, including that in which the health walks operate, is continuing to undergo rapid change, alongside changes in the socio-demographics of local communities.

A 'narrow and deep' ethnographic approach was adopted to reveal residents' attitudes towards local biodiversity developed through their everyday contact with nature.

5.2 Methods

5.2.1 Choice of study area and timing

Swindon's health walk groups were chosen as the venue for the study. Health walks operate across England as part of the Walking for Health Initiative (WHI) coordinated by The Ramblers, a national charity in the UK (WHI, 2019). Health walks are regular group walks typically led by trained volunteers and aimed at improving health and well-being of people described by the WHI (2019) as being less active. Walks are therefore purposefully chosen to be short in distance and over easy terrain as described here for the Swindon health walks. Section 3.3.2 sets out the rationale for choosing walking groups as the research cohort.

In total, 9 walks operate in Swindon. The number of participants in each of the walks ranges from 20-100 dependent on the locality; the walks typically start and finish at a local community centre, last approximately 1 hour and are followed by refreshments and a chance for further socialisation; each walk is coordinated and

led by one or more volunteers; volunteer walks leaders have mapped out a number of suitable routes which vary across the localities from the urban centre to more suburban greener areas.

Two of the nine groups were selected for the purposes of this study: at Lower Shaw Farm in West Swindon, and at Covingham, in East Swindon. Figures 5.1 and 5.2 show the location of the walks and provide a summary description.

The 2 areas were purposefully selected to overlap strongly with those sites studied from an ecological standpoint as detailed in Chapter 4 (and illustrated in figure 5.2). From both social and ecological perspectives, the areas were also chosen provide a contrast in urban landscape character, consequential to the period of development and therefore prevailing urban design and planning policies:

- The Covingham area built in the 1960s and 70s is characterised as residential development along loose street patterns, large blocks and short-straight streets, housing consists predominantly of estates of 1960s-70s terraces, semi-detached, linked-detached and detached housing on loops and cul-de-sacs. Wide grassed verges, long front driveways in open settings. Built form is predominantly linear and horizontal in proportional emphasis. Density range: 19-25 dwelling units (du)/ha Ave: 22 du/ha. (Swindon Urban Planning unit, pers comm.).
- The Lower Shaw area, built in the 1980s-1990s is described as residential development characterised by loose street patterns, short, sinuous streets ending in cul-de-sacs. Housing consists of terraced, semi-detached, linked-detached and detached housing in courtyard-type formations. Front driveways in open setting, medium-sized rear gardens. Heavily landscaped routes throughout. Density range: 28-34 du/ha, Ave: 31 du/ha (Swindon Urban Planning unit, pers. comm.)

To provide a broad comparison of the extent and nature of green infrastructure in the area of the walks, itree canopy software (USFS, 2019) was used to estimate percentage built, green-space and woodland canopy cover within 500m Euclidian distance of the walks' meeting venues. Extent of the built environment was found

to be broadly similar in both areas: at Covingham 54% (+/- 3%) and at Lower Shaw 48% (+/-4%). The main contrast however was seen in the extent of tree canopy cover: at Covingham 13% (+/-2) and at Lower Shaw with a relatively higher cover of 28% (+/-3%).

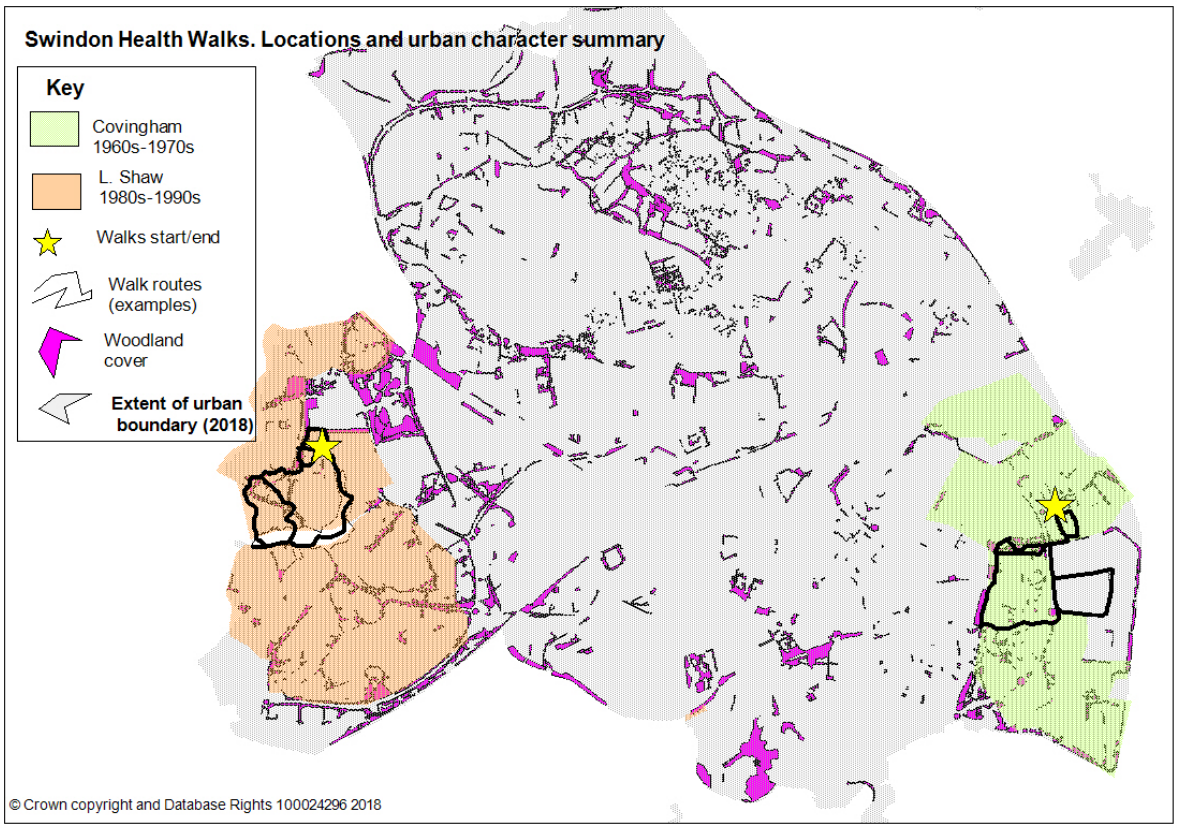


Figure 5.1 Overview of walk locations with respect to urban character. Both walking groups follow similar routes in so far that they weave through a network of urban green infrastructure, keep to surfaced paths, both roadside and off-road, and trace a path through residential areas and local open spaces. Routes at Covingham include retail and light industrial areas in contrast to those at Lower Shaw. Source data for character areas provided by Swindon Borough Council, Urban Design Unit (2018).

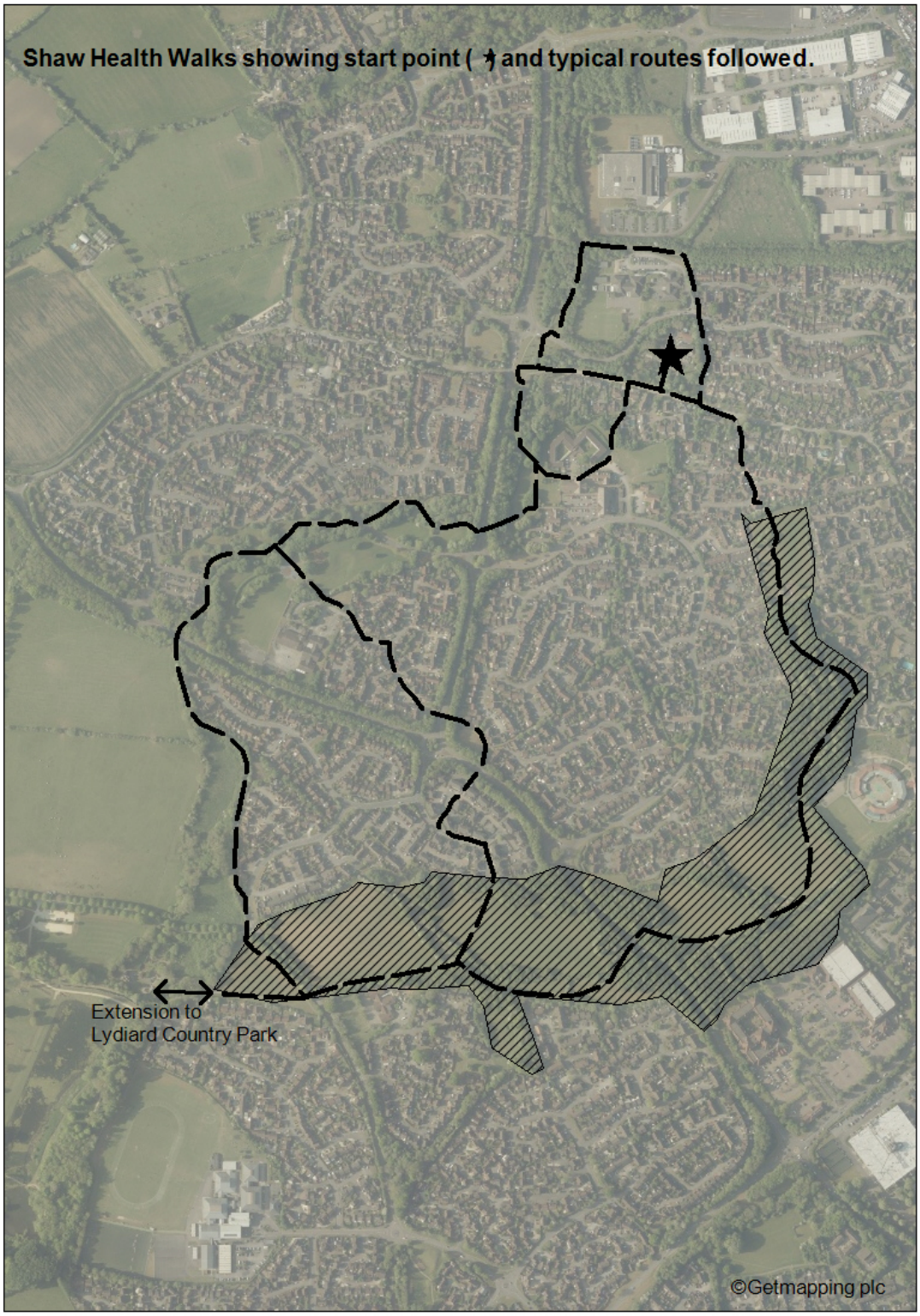


Figure 5.2a The Lower Shaw group meet each Monday 2pm at Lower Shaw Farm, Old Shaw Lane, in West Swindon. The walks run throughout the year. Typical number of attendees is 12-15. Walks are led by a single leader a local resident, often backed up by a second leader if less able attendees opt for a shorter route. Walk duration is approximately 45 minutes, typically ranging from 2 to 6 km in length. Hatched areas indicates the woodland corridor (3) in which ecological surveys took place.

Figure 5.2b. The Covingham walking group meet each Monday at 2pm at St Paul's Church meeting room, St Paul's Drive, Covingham. The walks and run throughout the year. The walk is led and supported by a number of volunteer leaders, coordinated by local members of the UK's Ramblers Association. A nominated walk leader is supported by several assistant leaders. A single walk is offered, i.e. with no differentiation according to attendees abilities. Walk duration is approximately 45 minutes typically ranging from 4km to 6km in length. Hatched areas indicate the woodland corridor (1) in which ecological surveys took place.

In total 30 walks were attended as part of the study: 15 at Lower Shaw and 15 at Covingham. The walks took place over a period of between mid-July, over the winter months and to September of the following year. The study therefore took place across all seasons with an associated range of prevailing weather conditions. There was a gap in attendance of 3 months over the second summer given personal circumstances of the researcher.

5.2.2 Initial contact and introductions

Initial contact was made with the health walks coordinator employed by the local authority. Having set out the broad purpose of the research and discussed the research questions with the walks coordinator, contact was subsequently made with two volunteer walks leaders. That the researcher works in the local authority and had previously been involved in health walks programmes in the area was felt beneficial during the initial introductory period.

At the invitation of the walks leaders, the researcher joined the health walks and introductory discussions took place between the researcher and the walks leaders, seeking their permissions and support for the field work. Having done so, and at subsequent walks the researcher was introduced to other participants in the walking groups and at this stage their consent for taking part in the research was sought and agreed. Consent forms were used, as shown in appendix 3. Throughout this initial period, the purpose of the research work was kept deliberately vague. Doing so was felt necessary to avoid undue bias in subsequent stages of the field work.

In interests of professional integrity and to minimize risk of undermining the research programme, it was considered important that the participants were aware that the researcher was also an employee of the local authority. In establishing such a ‘working identity’ and ‘personal front’ (section 3.3.1) it was made clear that the research was a stand-alone programme and not linked to the researcher’s local authority employment.

5.2.3 Methods of data collection

Allowing for triangulation methods involved:

- The researcher as participant observer (PO).
- Photo-elicitation techniques involving geo-located photographic recording by participants.
- Guided conversations/semi-structured interviewing.

Whilst described here separately, the methods were necessarily mutually dependent and iterative in nature. The justification for adopting these methods is set out in detail in section 3.2.3.

Insights gained, and data collected through PO helped to shape the design and content of subsequent semi- structured interviews, discussions and photo-elicitation stages of the research. Relationships established through PO together with data gathered also helped in more purposive sampling and recruitment of 'key informers' (Brewer, 2005). For example, participants who demonstrated particular interest or good knowledge of biodiversity related concepts in contrast to those indicating little knowledge. Key informers thus provided opportunities for individual case studies and the generation of 'thicker' narrative data.

Participant observer

Following an initial introduction, the researcher joined the health walks groups as a participant on a regular weekly basis where it was feasible to do so over the 18 month period of the field work. The intensity and period of participation helped to facilitate the development of positive relationships between the researcher and participants and gatekeepers. The need for on-going attendance at the health walks by the researcher was dictated by issues of seasonality and consideration of reaching saturation point in data collection.

Observation included that of individual and group behaviour of participants and health walks leaders: through walking, listening, and conversing, together with added dimensions of personal experiences and sharing (Brewer, 2005). The 'nine observational dimensions' proposed by Spradley including space, actors, activity, time sequencing and feeling provided a useful guide (Spradley 1980 cited Reeves et al., 2008 p 512). Given the intent of the research, observations particularly focussed on sensorial interactions between the participants and the landscape

they walked through and the conversations between walkers including the researcher as PO. Such conversations were mostly kept deliberately unguided, particularly in the early stages of field work. Where areas of interest pertinent to the research emerged, effort was made to gently prompt discussions to gain further data.

3 Stages of the walking events are described here, all of which were considered integral to the experience of participation:

The gathering of participants. 15-20 minutes prior to the walks presented an opportunity to better embed within the group, re-engage with previous discussions, ignite new discussions, and target /tee up conversations with particular participants to be followed up during or after the walks.

The walk. (30-45 minutes) During the walks, the researcher would join sub-groups, listen in, target particular overheard conversations, get into the rhythm of the walks, observe, and listen. Swapping between groups took place as felt appropriate and guided by the nature of discussion.

Refreshments (20 minutes) Following the walks, during refreshments, was a time to continue conversations, thinking about the following week's desired topics/ areas.

The taking of notes or recording activities during the walks was deemed too intrusive and would potentially undermine the role of the researcher as participant observer. Rather, field notes were handwritten immediately i.e. within the hour following each walking event.

Photo elicitation

12 health walk attendees, 6 from each group of the 2 groups, were asked to undertake the photo-elicitation work. A balance was sought between male and female as far as proved practically possible.

After initial testing, practicalities dictated that the researcher took the photos rather than health walkers themselves. Rather, participants were asked to indicate anything that took their interest during the walks and photographs taken accordingly. No guidance was given on what was considered 'of interest' and no

limit was set on the number of photographs. Pictures were collated and discussed at subsequent health walks (post-walk) where hand written notes were taken.

Semi-structured interviews.

The semi-structured interviews were the final stage of the study: following participant observation (PO) and photo-elicitation research carried out over the previous 18 months. The purposes of the interviews were to affirm or otherwise patterns emerging from data generated from the PO/photo work and to explore particular areas in more depth.

Health walkers who previously took part in the photo-elicitation work were asked to be interviewed. Where this proved impractical, other walkers were selected, based on previous discussions as part of PO work and personal profiles. 6 walkers, 3 from each of the 2 walking groups took part.

Semi structured interviews were conducted with individuals whilst walking, recorded using a dicta-phone with follow-up discussion immediately post-walk. Carrying out the interviews whilst walking helped in a number of ways: providing visual/other prompts in the landscape, providing more relaxed and less abstract setting than sitting in a room. The approach was not without its difficulties, for example managing the conversation if other walkers joined in and in the case of poor weather.

To stimulate open and relaxed discussions, the interviews took the form of a guided conversation. Interviewees were initially asked general questions relating to their place and time of residence in Swindon, family background and how they felt about their neighbourhood, often following conversations held during previous walks.

Subsequent issues explored were guided by (i) the SoP framework adopted for the research (section 3.3.1) and (ii) an initial analyses of themes apparent from PO and photo-elicitation work. The questions and prompts, as set out in appendix 4, were used as a guide rather than a rigid prescription. As experienced, conversations were found to be generally free flowing, weaving in and out of each topic area and resulting in little need for direct prompting.

5.2.4 Discussing nature and biodiversity

Throughout the research it was considered important to be able to operationalize the ambiguous and contended term of biodiversity. Given the difficulties in defining biodiversity (Haila & Kouki, 1994), there is recognition that the general public may have a low level of awareness and understanding of its meaning (Southon et al, 2018). As reported by Christie et al. (2006) the lack of public understanding of the term can make valuation exercises difficult. They go on however to describe how through use of appropriate language, and through learning via survey work, lay-peoples' attitudes and preferences towards biodiversity can be meaningfully expressed. Similarly, Christmas et al. (2013) report that the term 'biodiversity' is poorly understood and that better framing of the concept is needed for more effective communication with the public. Christmas' work included qualitative research generating four 'everyday stories' as a means to gain insight into how best to engage the public in discussions relating to biodiversity issues.

The term 'biodiversity' was therefore purposefully avoided during field work unless volunteered by research participants. Rather, more general related terms such as nature, wildlife, plants and animals were used as seen to emerge from initial and subsequent discussions.

5.2.5 Data handling and analysis

The primary means of recording data was via hand-written field notes. In doing so it was recognised that the timely recording and organising of field notes is an intensive process, requiring skills and discipline honed throughout the study. Following recommendations from Brewer (2010, p87-88), in addition to recording observational field notes, a journal was kept to record the personal reflections of the researcher as a basis for later reflexivity. Being more obtrusive, the use of both audio and video recording were considered although as research progressed audio was considered the most appropriate medium.

Handwritten field notes and records from photo-elicitation work were initially typed up into electronic form using MS Word prior to collation as source data using

NVIVO software (NVIVO qualitative data analysis software; QSR International Pty Ltd. Version 12, 2018). Audio files from interviews were collated using NVIVO software prior to transcription.

Given the time consuming nature of transcription, estimates of which range from 3 hours to 10 hours of effort per 1 hour of interview (McLellan 2003), a pragmatic approach was taken. First stages involved summarising what were initially considered as key points from each interview with a note of timing for later reference, rather than a verbatim transcription. Recognising that meaning is fundamentally shaped by how things are said (Bailey, 2003) other cues were included in summary notes at this stage such as sighs, laughter, pauses, involuntary vocalisations and tone of voice. Further transcription from audio sources followed: reviewing, focussing and delving deeper into the data as guided by themes emerging through these and other data. The advantage of having a single researcher was apparent in that interpretation and re-interpretation of data was relatively consistent as analyses progressed, and familiarity with data enabled further ideas to emerge. Such an approach is consistent with the constructivist epistemological basis of this research, the transcription process here being considered as a ‘representational and interpretive’ process (Davidson 2009).

The sense of place (SoP) framework adopted for this study utilised data from the 3 stages of the field work. All of these data were interrogated using NVIVO. Coding and analysis of data within NVIVO software broadly followed approaches described by Coffey and Atkinson (1996): coding was used as means to interrogate and interpret data from field and interview notes and transcripts of recorded data. Doing so helped to both reduce data to manageable proportions for subsequent analysis, and ‘opened up’ data to generate new thinking and helped to direct further data gathering efforts. Whilst coding was used as a basis for data interpretation and analysis, the research also needed to be sensitive to the danger of ‘chopping up’ data and losing ‘storied qualities’.

The SoP framework adopted for the research provided the basis for data analyses within NVIVO software. Primary headings of Place Attachment, Place Identity and Place Dependency were established as primary nodes within NVIVO alongside additional nodes to capture potential personal, social and environmental

moderators of SoP. Key themes emerging from the data were positioned as sub-nodes, nested within the theoretical framework established (Figure 5.3 illustrates). Such sub-nodes developed as an iterative process and were allowed to emerge, rather than being pre-determined, as the 3 data sources (from field notes, photo-elicitation and interviews) were interrogated. For example, clear emotional responses expressed or observed were grouped within the Place Attachment node with emerging categories placed as sub-nodes such as setting, communal or individual responses, nature of stimulus and reaction including fear and negative reactions, seasonality, recalled or reactive responses. Case nodes were also used to enable cross referencing of records to individual interviewees.

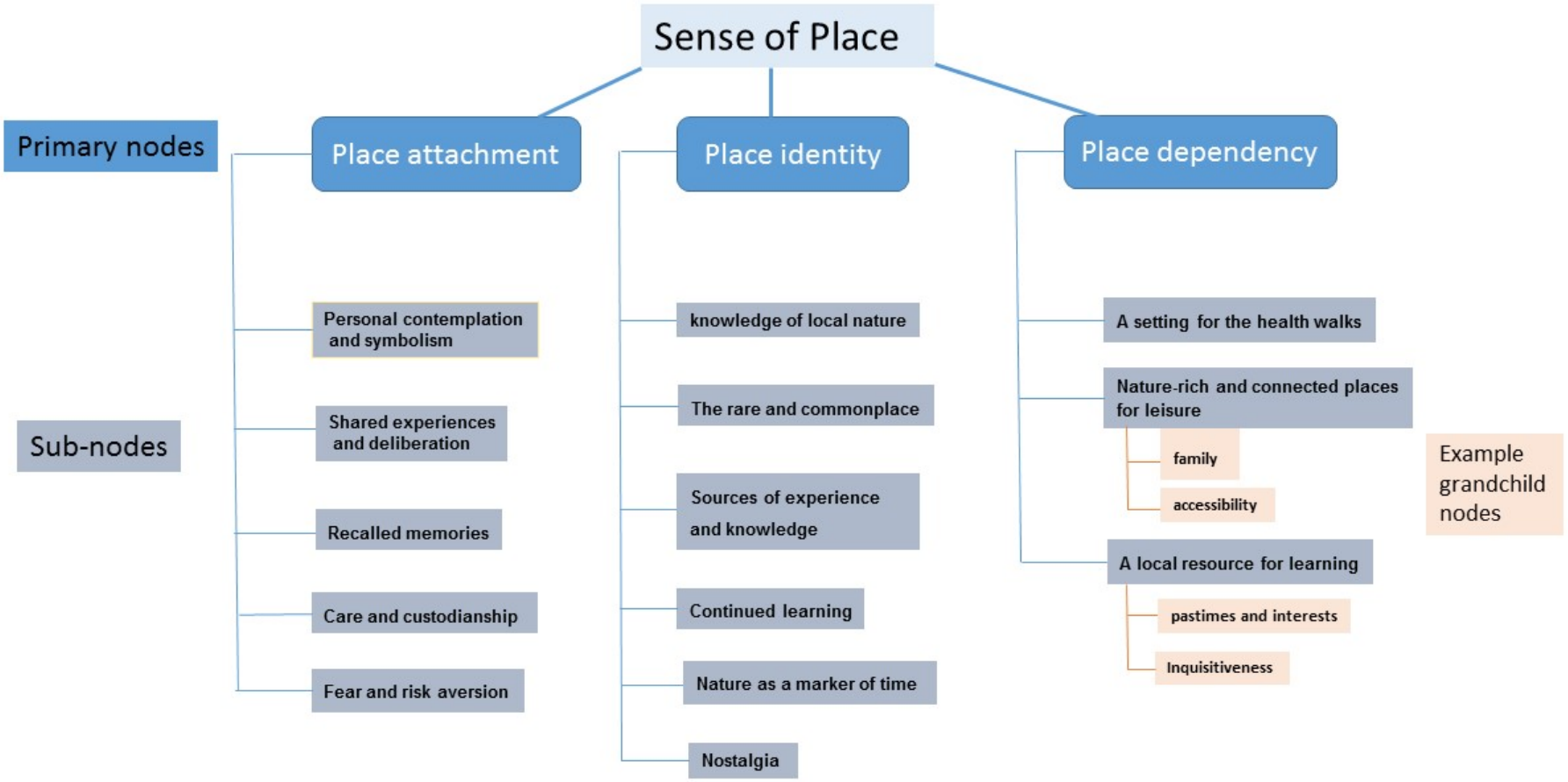


Figure 5.3: Data structure developed with NVIVO. Primary nodes of Place attachment, dependency and identity were determined by the SoP research framework adopted. Sub nodes and lower hierarchies emerged through interrogation and triangulation of field notes, photo-elicitation and interview transcripts.

5.3 Results and Discussion

The results and discussion presented here are founded on the triangulation of methods as described in section 5.2.6. Accordingly, data sources as reported in the results were assigned alpha-numeric codes according to:

- Venue: Covingham (Cv) Lower Shaw (LS);

- Gender: Male (M), Female (F); and

- Data source: Field notes (Fn), photo-elicitation (Pe) and from interview (Iv).

Unless stated otherwise, italicised quotes presented in the results are taken verbatim from audio recorded material or as noted during photo-elicitation work. Non-italicised quotes are as recalled from field notes. Associated supportive and contextual details are shown in brackets [ ].

The first section, 5.3.1, describes and discusses the walkers, walks and nature interactions observed as recorded in field notes and as elicited via photographic and interview stages. Subsequently, section 5.3.2 further evaluates such interactions alongside recollections and discourse within the sense of place framework adopted for the study.

5.3.1 The walkers, walks and nature experienced

5.3.1.1 The walkers

Given the methodology adopted for this research, data regarding age, gender and ethnicity of participants were not methodically sought for the purpose of this study. Rather, the walkers' profiles as set out here are provided to give a general depiction of the study cohort based on observation and notes taken from discussions.

Attendee numbers at Covingham with a range of 6 to 36 participants were consistently higher that those at Lower Shaw, with a range of 8-18 walkers. As recorded in field notes, apparent differences in attendee numbers were attributed by walks leaders to recruitment efforts and capacity of volunteer leaders. [Ls.Cv.Fn.]

Throughout the research period, most walkers were regular attendees. The walk participants at both Lower Shaw and Covingham shared a similar age profile and gender mix. The age range for both groups was estimated as predominantly 55-70 years with individual exceptions, younger and older in both groups: the oldest at 80+ years, the youngest at 25-30 years old. The gender mix for both groups was typically 70-80% female, 20-30% male. The gender balance of the groups somewhat contradicts previous research cited by Clearly et al. (2018) reporting that those who infrequently engage with nature are more likely to be elderly, female and in poor health.

Walkers, both female and male were predominantly medium (nominally considered here as 5-10 years) to longer term residents of Swindon with some 'born and bred' and remaining local to their area particularly at Covingham. Most were married, or previously so, with adult children. A notable number of participants purposefully re-located to the area, post-retirement to live close to their children and grandchildren. For incomers into Swindon, previous residency was widely spread within the UK and in a number of cases internationally, and from both rural and urban upbringings. Although not purposefully assessed as part of the research, in terms of ethnic profile, most if not all could be best described as British, White (ONS, 2015).

In view of the timing of the walks and associated target groups, it is not surprising that most participants were retired. Prior to retirement walkers came from a range of previous employment including professional and manual workers, or not previously in paid work.

5.3.1.2 Demographics of walkers in relation to value, attitude and behaviour concepts

Given the stated approach to the study, that of being 'narrow and deep', the age and associated depth of life experience within the walking groups was considered to provide a valuable and meaningful study cohort albeit within a limited age and ethnicity profile. It is important therefore to consider how the prevailing demographic characteristics of the walkers may have influenced their perceptions of, and attitudes and potential behaviours regarding nature within their locale.

Previous research has reported the influence of age and gender on environmental concern, attitudes and behaviours. Southon et al. (2018) report on the moderating effects of age on nature connectedness, suggesting a relationship with accumulation of knowledge associated with a greater cumulative experience and a greater interest in biodiversity. The same study however did not show age as a moderator of the ability to perceive biodiversity. A review by Capaldi, et al. (2014) report on the positive relationship between nature connectedness and happiness but found that age and gender characteristics did not moderate such a relationship. Similarly, Clearly et al. (2018) stress the importance of adult experience of nature particularly in urban settings, in promoting nature connectedness, irrespective of childhood experiences.

More broadly, demographics, other than age, such as gender, length of residency and familiarity have been identified as important in shaping environmental value orientations with a potentially direct and subsequent relationship to associated behaviours (Vaske and Donnelly, 2001). Value orientations have been defined as patterns of basic belief (Vaske and Donnelly, 1999) or clusters of held values (Seymour et al, 2015 citing Stern) which are postulated to influence attitude and shape evaluation of environmental issues (Kaltenborn and Bjerke, 2002). Whilst not mutually exclusive, environmental value orientations may be seen to lie on a spectrum from eco-centric to anthropocentric (Gagnon-Thompson and Barton, 1994). Anthropocentric, or human centred views, emphasise instrumental values of natural resources). Eco-centric orientations imply nature has inherent or intrinsic worth, independent of human interests (Vaske and Donnelly, 1999).

Value orientations, as described by Raffaelli (2009) in the context of biodiversity conservation, are seen to be founded on fundamental or held values. In the context of value-attitude-behaviour and other cognitive hierarchy theory models, held value typically refers to those fundamental values defined by Rokeach (1973) as ‘enduring belief that a specific mode of conduct is personally or socially preferable to an opposite and converse mode of conduct or end state of existence’. Other terms synonymous with fundamental values have been used elsewhere in research. Held values are ‘ideas or principles that are important to people’ values of people, values as principles’ (Lockwood, 1999). Common

characteristics of these definitions are that values are seen as highly abstract cognitions are generic and non-context specific, few in number, and relatively 'stable and enduring' (Vaske & Donnelly, 1999).

Within a hierarchical typology of values, value orientations are proposed to influence assigned values (van Riper et al, 2012). Whilst much social science research has focussed on the role of held or fundamental values, assigned values are seen as increasingly important in environment related research. Assigned values are described as the values that individuals attach to physical places, goods and services (Seymour et al., 2015 citing Lockwood) and express the importance of an object relative to one or more other objects (Brown, 1984). Assigned values have been claimed to be more useful than held values particularly in the field of natural resource management in understanding peoples' relationships to specific sites and places (Brown and Weber, 2012). Moreover, Seymour et al. (2015) in the context of cognitive hierarchy theory (CHT), hypothesise that assigned values may be better predictors of behaviour than held values. Culturally assigned values attributed to biodiversity have also been proposed as being central a pathway linking nature and human health and well-being (Clark, 2015).

Further details of value-attitude-behaviour concepts and their inter-relationships relating to nature conservation are provided in appendix 1.

It is beyond the scope of the research here to untangle the personal and social factors of walkers at play in relation to their environmental value orientations and attitudes. Caution in this respect is sounded by Gifford and Nilson (2014) stating that 'the answer to "what influences…" is so multi-faceted as to defy reasonable integration and comprehension′. It is reasonable to suggest however that the age and gender profile of walkers as a group, will have influenced their pre-disposition to engage with the health walks (and therein with nature in the urban environment), will have shaped their held and value orientations with respect to the natural environment and hence their perceptions of and attitudes towards the spaces and nature encountered during the walks. In addition, the longer term length of residency of most participants will have influenced their familiarity with local environs.

Understanding the attitudes and behaviours towards nature of such an important demographic, for example in the context of ageing populations and pressures on health care will therefore be critical in urban planning and regeneration: not least the voice and potential influence of such a demographic on prioritising investment in urban green infrastructure which has the potential to provide frequent and direct contact between residents and nature.

The following sections of this chapter therefore go on to detail the experiences of nature encountered by participants during the walks and elucidate the bases for values assigned to urban nature and therein local open spaces.

5.3.1.3 The walks and nature experienced

The walks at Lower Shaw started and finished at Lower Shaw Farm. The great value attributed to the farm, farmyard and farm managers by walk participants was consistently highlighted in all stages of the research: field note observations, photo elicitation and interviews. Attention is therefore paid here to the pertinent characteristics of the farm as a setting.

The farm is a family, cooperatively run enterprise providing a range of training courses related to landscape and land management, health and wellbeing, crafts, cookery, arts, and family orientated activities. The Farm covers approximately 1.25ha of what was once a larger dairy farm. What remains is the farmhouse, a number of agricultural outbuildings, livestock paddocks and an allotment garden. The farm raises a number of livestock including sheep and poultry, the latter having access to the farmyard and often present at the start and end of the health walks.

As recorded in field notes, the farmyard at Lower Shaw (Figure 5.4) felt particularly enriched, with a mix of farm animals, planted areas for amenity and food production, nature encroaching into building and derelict spaces. Whilst birds included typically synurbic species such as blackbird, starlings, sparrows, with some additional species of further note such woodpeckers and thrushes, the level of activity was particularly pronounced at the farm. Bird activity was very noticeable in the woodland and hedges along the farm boundaries, on bird feeders and water baths, roosting in out-buildings. Field notes refer to the extent of

birdsong such as the ‘bubbling’ of starling coming into roost in a boundary hedge and the chatter of Jays, alongside the noise of farmyard animals such as hens, cockerels, geese and sheep.

Figure 5.4 Lower Shaw meeting venue, illustrating the vegetated nature of the farmyard alongside farm animals and general paraphernalia.

In keeping with the ethos of the farm, the buildings both inside and out were decorated with imagery from nature and things taken from nature such as old bird nests and strands of ivy.

The walking groups convened in the farm-yard, seeking shelter if needed under a covered walkway. Small groups of participants would congregate and spread out across the farmyard, seeking shelter as needed whilst waiting for walks to start. On returning to the farm after walking, the groups reconvened in the farmyard before gathering in a meeting room in one of the outbuildings or in the kitchen of the farmhouse. Refreshments, hot drinks and farm-made cakes/biscuits, were provided.

Plants and animals at the farm were observed to stimulate individual responses and group discussions amongst participants. Flora and fauna, and imagery of such (figure 5.5), within the farm setting were repeatedly referenced at all stages of the field study: PO, Pe and Iv and by all participants. Walkers were seen conversing, laughing and joking about farm animals: the ‘comical’ Indian runner ducks

[Ls.M.Fn], *'Cockerel needs a pair of boots. Beautiful cockerel. The boss, must be happy with all his ladies'* [LS.F.Fn].

Fig. 5.5 flora, imagery and disorganisation highlighted and valued by walks participants

Whilst particular plants or animals stimulated such responses, participants also valued a general, prevailing sense of disorganisation and naturalness. Distinctions between natural, semi-natural, agricultural and domestic whilst perceived, were not considered important by the walkers:

'The farmyard is a mish-mash of things but somehow it works.' [LS.M.Pe]

The contrast with the meeting venue at Covingham (figure 5.6) was stark. Walkers met at a community centre integral with St Paul's Church, Covingham. The building is relatively modern, having been built in 1971 and other than a car park has no associated outdoor area. Whilst the community centre was comfortable and welcoming, the external landscape was limited to the car park with surrounding shrub beds, amenity grassland and seating provided in an area of hard standing.

Figure 5.6.Covingham meeting venue, illustrating relatively sparse nature of setting in comparison with that at Lower Shaw (figure 5.4).

As such the grounds of the building were only used as a mustering point at that start of the walks. On returning from the walk, attendees reconvened in the meeting room where refreshments were provided.

A sharp contrast in the natured qualities of the start and finish points for each of the groups was important in setting the scene for the walks. As explored further in section 5.3.2, the farmhouse and its immediate surrounds at Lower Shaw, alongside the ethos of the farm and its owners, were seen to shape the physical and social dynamics of the walks: influencing pace, groupings and the level of discussion and a providing a relaxed informality in contrast to that at Covingham. The importance of setting to create such a 'social atmosphere' has been identified in health related research as being instrumental to physiological and psychological well-being in the context of hospital gardens and other garden settings (Duzenli, 2017). Similarly, in the educational sector a naturalised woodland setting is seen as instrumental in providing a social setting as a foundation of Forest Schools (O'Brien and Murray, 2007).

The walks and nature encountered

The walks at Lower Shaw were usually informally led by a volunteer leader with an additional volunteer in support, often the farm's co-owner. Field notes refer to a

‘laizzez-faire’ approach by the walk leaders in gathering participants at the start of walks and deciding collectively on routes and groupings. Such informality was further enhanced with participants at Shaw often observed at the start of walks, being distracted by farm animals or plants and farmyard paraphernalia:

‘on leaving the farmyard, [walkers] laughing about sheep and watching them strip leaves from vegetation [LS.F.Fn] *‘there’s something natural about it.”* [LS.F.Pe]

In strong contrast, whilst welcoming there was a much more formal feel to start of walks at Cv as participants assembled. Conversations within the meeting venue prior to walking were relatively constrained with extended periods of quiet or ‘awkward silences’. Other than for a brief welcome for new walk member, the group at Covingham formed quickly, setting off on the walks as a single group.

Walkers at Shaw typically divided into two groups with less able participants choosing to follow a shorter route at a slower pace. Example routes are shown in figure 5.2. Depending on the constituent members present and prevailing weather conditions, walk distances typically ranged from 2km to 6km. Walks were centred on either of two areas: Shaw Ridge Linear Park or Peatmoor Lagoons. Surrounded by residential housing and commercial developments, Shaw Ridge Linear Park is a public open space comprising open fields interspersed with woodland copses, extant hedgerows and intersected by several roads. The western end of the linear park is contiguous with the boundary of Lydiard Country Park. The latter is one of four major country parks serving Swindon. Routes to the north of the start point provide a link to Peatmoor Copse and Lagoon. The Copse is classified as a semi-natural ancient woodland (DEFRA, 2019) and designated a Local Wildlife Site primarily for its botanical interest as a wet woodland (Swindon Borough Council, 2013).

At Covingham the whole group walked together, with regular stops to allow for slower walkers to catch up with lead members. On leaving the community centre, walks followed a number of routes (figure 5.2 illustrates), predominantly a combination of residential and industrial estate roadside walking, and off-road pedestrian and cycle paths. Distances covered ranged from 4km to 6km. Some routes crossed primary urban roads, entailing the use of underpasses. All paths followed were hard surfaced. When crossing roads, participants were carefully

marshalled by volunteers, all of whom wore fluorescent tabards. Routes to the west of the start point incorporated the path network along the Richard Jeffries Parkway: a linear public open space following the line of the Dorcan Stream and characterised by mown grassland, woodland copses and water bodies. The Parkway is surrounded by residential development and is connected via a series of road underpasses to Coate Water Country Park to the south. Routes to the east of the meeting point, were dominated by roadside walking and meandered through residential areas, business estates and incidental open spaces.

The walking routes for both Shaw and Covingham groups brought participants into contact with nature across a range of common-place urban settings and across all seasons. Predominantly within residential areas, the urban green infrastructures providing the setting for the walks typically comprised road verges, hedgerows and other boundary vegetation, gardens, incidental and local open spaces including woodland, school grounds, allotments, derelict brownfield sites, public realm landscape planting, ponds and urban water courses. The ready availability, connectedness, landscape and natural qualities of such spaces was clearly valued by participants at both venues:

'*I'm really really impressed, as a newcomer to Swindon, with all the open space and all the footpaths, you can walk with children away from the traffic fumes. Swindon deserves praise. The housing estates are large but they don't look that big cos they're broke up with open areas in between them, and footpaths. I think Swindonians are very lucky*' [Ls.M.Iv]

' [walker] likes the way green routes/off road routes have been protected in Swindon-not like in York. Thinks local (long term residents) of Swindon don't appreciate what they've got. Noted nice green corridor-all the green and blossom starting-like it had been waiting for warm weather and all of sudden bursting out.' [Cv.F.Fn].

In contrast to those at Covingham, the routes at Lower Shaw included other green infrastructure assets of note: the farmyard, a larger lake, and a small area of ancient semi-natural woodland and occasion, when requested a longer route would be followed including the outer fringes of a large country park.

In the context of this research, it is noteworthy that the routes followed did not follow paths directly though the woodlands surveyed for beetles (described in Chapter 4 and illustrated in 4.2 (a) and (c)). Rather, the walking groups skirted

around the woodlands, largely because of issues of accessibility but also given perceived risks (detailed further in section 5.3.2.1).

Described in terms of ecological classifications and following JNCC guidelines (2010), as often employed in development planning, habitat typologies encountered whilst walking are set out in table 5.1 with accompanying narrative. The work here demonstrates how much of the 'urban matrix' falls within the JNCC miscellaneous category with limited definition within sub categories. It is these areas however where much of 'everyday' contact with nature is experienced as evident from this and previously published research (Finlay, 2015).

Although the JNCC classification helps to categorise habitats it does not, by design, give a sense of nature as experienced by walkers. Whilst the purpose of this study was not to provide a systematic survey of species present along the routes, it is useful to provide a sensorial perspective of nature encountered, in contrast to more formal methods of habitat and species classification often employed. The habitats described in table. 5.1 were present to the large extent at both walking venues, but the routes at Shaw were noticeably more vegetated with a much less urban feel. The contrast was recorded as the researcher's own observations in field notes, referring to Shaw routes as at various times '*green and pleasant*', *'a very pleasant work through a richly wooded landscape',' thoughts about LSF [Lower Shaw Farm] being one the nicest green places to be in Swindon'.* In contrast, at Covingham, field notes refer to ." *V[ery]. harsh urban route, not much wildlife noticeable in a very urban setting-bungalows and gardens, , a 'green desert/bleak sort of landscape-all very similar-lollipop trees in mown grass.'*

The photo montages presented in appendix 5 aim to give an overview of the differences and similarities of 'naturalness' between the routes. The montage of photographs, taken during the photo-elicitation stage of the research, alongside field records, walkers comments and interview transcripts are necessarily a pastiche of the researcher's notes as a participant observer and data derived from walk participants.

Table 5.1. Habitat types encountered on health walks as defined by JNCC (2010) habitat nomenclature together with descriptive narrative. Further details in appendix 5.

JNCC habitat classification	**Sub category**	**Habitats encountered via the walks**
A Woodland and scrub	Al Woodland, plantation woodland, semi-natural woodland A3: Parkland and scattered trees	Young (<50 yrs) plantation woodlands alongside scattered trees form a large element within linear open spaces. Peatmoor Copse, noted wildlife site at Lower Shaw.
B: Grassland and Marsh	B4 Improved B6 Poor semi-improved grassland	Small areas of improved/semi-improved grassland may be present along routes at Lower Shaw, associated with urban fringe areas. Otherwise, most grassland appears as amenity.
F Swamp, marginal and inundation	F2 Marginal and Inundation	Potential areas associated with urban drainage features and water-courses.
G Open water	G1 Standing water G2 Running water	Small ponds as urban drainage systems. A large lake at Lower Shaw. Water courses largely profiled drainage channels although exhibiting some semi-natural features and riparian vegetation.
J Miscellaneous	Ephemeral/short perennial (J1.3) Introduced shrub (J1.4) J2 boundaries: -Wall (J2.5) -Hedgerow with trees (J2.3), - Species-rich hedges (J2.4) Built-up areas (J3) Bare ground (J4) Buildings (J3.6)	Associated with unkempt vegetation bordering for example landscape planting and other semi-natural habitats. Shrub planting as part of landscaping within the 'public realm'. Also used as impenetrable edge to woodland plantations in places. Extant hedgerows within urban developments, some potentially species rich. Derelict sites, gardens allotments and school grounds.

The contrast in the degree of naturalness evident between the walking venues, does not mean that the forms of nature in terms of habitats, species, and phenomena experienced were different per se. Rather the gross structural composition and heterogeneity of the landscape at Shaw gave the impression of a much more naturalised scenery. The latter was further enhanced at Shaw with the local topography at Shaw Ridge gave extensive views over surrounding areas and a lake, often visited during the walks and providing the additional interest of a large water body.

It is important to note that considered across 30 hours of observing participants during walks, throughout the period as participant observer social interactions between walkers were largely predominant in comparison with walkers' interactions with the environment through which they walked: covering autumn, winter, spring and summer seasons, and for both health walks groups irrespective of the walk route, area or prevailing weather conditions.

Walkers typically formed quickly from the start of the walks into small groups, in twos or threes with largely continual discourse throughout the period of each walk. Whilst small groups interchanged members, this pattern was consistent at all walks attended. Despite seemingly strong visual, auditory, somatosensory and olfactory stimuli presented by the walk environment, on most occasions participants appeared largely oblivious to their surroundings. For longer term residents and regular participants of the walks, familiarity with the routes taken could be a moderating factor. As recorded in field notes however, and for both venues, seemingly evident and multi-faceted stimuli failed to rouse any observable response amongst most walkers: heavily laden white cherry blossom in bright spring sunlight, hedgerows laden with fruits, autumnal colours in trees alongside paths, murmerations of starlings, squabbling magpie and jays, strong smells of urban foxes, senescent leaves on the ground, rotting fruit on pavements, a red kite (*Milvus milvus*) circling over school playing fields [Ls.Cv.Fn]. Where however interactions with surroundings were observed, often in response to small and mundane stimuli, such responses were both pronounced in strength and varied in means of expression as discussed in detail section 5.3.2.

Floral and faunal species encountered during the walks were similar for both groups. The typical vegetation composition associated with the habitats set out in table 1 were broadly similar. Plant species recorded in field notes, represented in photographs taken by participants and discussed during interviews were similar for both walks and singled out on the basis of sight, smell, touch, seasonal associations. Flora (and fungi) species noted included: the ‘first’ snowdrops and hazel catkins as signs of spring, small patches of wood anemones, tree and hedgerow blossom particularly hawthorn, blackthorn and cherry, autumnal leaf colours of maple spp., fruiting species such as blackberries, blackthorn, hawthorn and apple, fungi on trees and within grassland areas.

Faunal species noted were dominated by birds with some exceptions for insect species (butterflies, bees and wasps), domestic pets and, at Lower Shaw, the farmyard animals. Bird species recorded and discussed during the walks were similar for both venues and seen as typically urban species for example, blackbirds, sparrows, starlings, robins, and corvid spp.. Unidentified birds were recorded based on their bird-song. Species were not solely noted based on their presence per se but more so their activities witnessed for example, squabbling, singing, feeding, bathing, coming in to roost.

The research findings here support previous research stressing the importance of urban landscapes in providing experiences of nature for urban residents. Clearly et al. (2018), defining urban nature as ‘all the plants and wildlife that live in the city’ go as far as to say that peoples’ very connection with nature is dependent on their ability to experience nature in urban settings. Such experiences were seen in this study to be both personal and social, manifest across all sensorial experiences, and operating in response to nature at scales from individual plants and animals to broad landscape vistas. The characteristics of such experiences, the way they were interpreted by walk participants alongside personal and social recollection is now evaluated in greater depth within the Sense of Place framework established for this research.

5.3.2 Sense of place (SoP) analysis

The analysis of SoP presented here is founded on the conceptual framework adopted for the study (section 3.3.1): relating affective, cognitive and conative

components of attitude to attachment, identify and dependency attributes of SoP respectively.

The sub-headings used, defined as sub-nodes within NVIVO, represent the main themes that emerged from data gathered across all 3 stages of the field work: field notes, photo-elicitation and interviews.

5.3.2.1 Place Attachment

Place attachment can be described as a person to place bond that evolves through emotional connection (Wolf et al., 2014). Attachment may be seen from biological (for example to attractive, calming features), individualistic (first-hand experience of locations), and socio-cultural perspectives (shared ideologies of groups and shared interactions) as described by Farnum et al. (2015).

Accordingly, place attachment discussed here is founded on the emotions as expressed by health walk participants, both as individuals and as groups in response to natural qualities of green infrastructure encountered: through speech and involuntary verbal cues, as observed in non-verbal communication, and in some cases in written form provided directly by participants.

Personal contemplation and symbolism.

Throughout the walks at each venue and across all seasons, both small mundane stimuli, and larger scale*,* gross structural components of landscape, were seen to elicit deep personal responses both positive and negative. Seemingly benign observations of plants and animals often led to long discourse with the researcher often tinged with the bitter-sweet of nostalgic recall (as further detailed in section 5.3.2.2). Examples at Cv (figure 5.7) include those of wild barley growing in a roadside gutter and a patch of daises on a roadside verge. At a larger scale*,* such as silhouetted tree lines, colours of trees and their '*ageless'* [Cv.F.Pe] qualities, the sound and movement of water and cloud forms elicited a similar strength of emotional response:

[Overlooking stream, leaning on the rail, listening to] '*the sound of the water, like the wind, like fire'* [Cv.M.Pe].

The latter were more aligned to a general sense of ‘immersion’ in nature: ‘*breathing in*’ [Ls.F.Pe] the beauty of nature, quiet contemplation and of symbolism (Fig 5.8). The findings support research by Bell at al., (2017) who reported opportunities to connect with wildlife in local green spaces were a common component of ‘immersive place narratives’.

Fig 5.7*:* mundane natural stimuli, eliciting strong responses from walk participants: wild barley in roadside gutter, patch of daisies in verge [Cv.F.Pe].

Fig 5.8. Beauty and symbolism observed by walkers in gross structural landscape elements, pathway as symbolic of life journeys [Ls.F.Pe]. Quiet contemplation of movement and reflections in water [Ls.MF.Fn].

Participants at Lower Shaw consistently referred to natural qualities of the farm, closely intertwined with the meaning they attributed to the farm itself, in strong and positive emotional terms. Walkers’ fondness for the farm could be observed from their behaviour as individuals and as a group, from their evident focus during photo-elicitation work, as well as explicit statements during informal discussions and semi-structured interviews. A deep personal affection was widely expressed

and often founded on a general feeling of disorganisation and naturalness within the farmyard:

'I love this place, I love walking around it, I love looking at it…cos it is more natural, [they] leave stuff growing even if it's a weed' [LS.F.Iv]. *'I love the jumble [of the farmyard]'* [LS.M.Iv]

Responses (in the farmyard setting) were sometimes spontaneous and emotionally charged, with walkers excited to share their joy in nature observation with the researcher, in one case to the point of reciting poetry:

'Little Ladies white and green, with your spears about you, won't you tell us where you've been, since we've been without you.' [LS.F.Iv.]

Shared experiences and deliberation.

Whilst walking, flora, fauna and natural phenomena observed at both venues provided the stimulus for enthusiastic discussion amongst participants. Seemingly benign observations of plants and animals often led to long discourse and emotionally charged sharing of experiences. These were more often emotionally positive but sometimes negative, and often leading to collective recollections. Similar findings have been reported by Bell et al, (2017) who highlight the opportunities offered by public spaces and 'threshold spaces' for valued impromptu social interactions.

Reactions were manifest in observable physical responses within groups of walkers, e.g. recoiling, deep breathing and quiet observation, smiling, physical contact with others in the group: a grabbing of arms, arms around shoulders, hands held. Such responses often acted as a spring board to wider discourse and sharing of experience as evident through animated discussions, laughter and personal stories being recounted whilst walking:

'walkers were observed stopping and hugging and followed by laughter in response to noticing a brimstone butterfly fluttering along a woodland edge. When asked one of the walkers was referred to as 'the yellow butterfly lady.'' [Ls.Fn].

As the researcher was being drawn into the conversations, the 'energising' effects of these emotional experiences, including in combination with the act of walking, was clearly felt. Whilst similar observations and reactions were experienced at

both walking groups they appeared to be generally more pronounced at LS and influenced by more naturalised settings.

Over and above individual responses, participants at LS exhibited clear, strong and positive emotional connections to the farm and its immediate surrounds as a group. The farm provided a relaxed setting to be together, a conducive place to share memories and experiences, and resulting in a spontaneity of conversation and emotions expressed not observed at Cv. A collective sense of well-being pervaded and could be attributed in large part to the semi-natural qualities of the setting. Such positive feelings not only contributed to a more open, discursive start to the walks at LS but also influenced the subsequent dynamics of the walks and shaping of conversations.

Recalled memories

Observations of nature whilst walking and talking provided direct connections for some participants to previous life events including eliciting fond, long term memories.

Insects swarming over a garden shrub stimulated recollection of *'bees and bugs and all sorts*' [Cv.F.Pe] when bringing up her children. Likewise, participants were observed laughing about childhood memories of spiders and snails and recalling the popular verse 'incy wincy spider'. One walker had fond memories of their pet 'house spider, Horace' which they [as a family] used to talk to and would inevitably be replaced by the 'son of Horace.' [Ls.F.Fn]

Such observations were particularly pronounced at LS, within the farm buildings and farmyard at LS. In some cases the perceived rural setting of the farm, albeit surrounded by housing, led to recall of long term childhood memories of a bucolic rural upbringing:

'what more could you want, the farm is absolutely wonderful, I never thought I'd find anywhere like this brings me back to my [rural] childhood, oh 60 years, a wonderful atmosphere.' [Ls.F.Iv]

The farm buildings themselves were described as being 'dressed with nature' and 'farm paraphernalia' [Ls.MF.Fn], with natural imagery lending a countryside feel to the venue. Happy memories were recalled of '*visiting aunt with a market garden*

and driving a tractor with cousin' and '*Loves the farmhouse, memories of childhood with Uncle and Aunt'.* [Ls.F.Iv]

Such positive nostalgic expressions were, in several cases, mixed with some sense of sadness, melancholy and recollection of very personal and sensitive memories. Whilst recalled memories were clearly expressed in emotional terms, section 5.3.2.2 considers nostalgia in more depth as a component of place identity.

Care and custodianship

Walkers also expressed empathy, care and concern for nature related to observations during walking and particularly at the LS farmyard: 'reminded of breaking ice in garden bird bath, topping up of bird-feeders and turning around of a mirror so an inquisitive blackbird didn't get worn out.' [LS.M.Pe] In some ways, such care was being reciprocated in terms of the walkers' health and well-being, several of whom expressed a sense of gratitude for the farm itself and the walks leaders as managers of the farm [Ls.F,M.Fn,Iv,Pe]. Cues from nature such as the '*beautiful snowdrops*' [LS.F.Iv] and the '*lovely wild berries and things that crept up*.' [LS.F.Pe] evoked feelings of gratitude that the farm is cared for and at the same time walkers well-being is cared for including a feeling of being *'safe'* [LS.F.Iv].

Such positive sentiments of gratitude were also expressed at Covingham: towards both the walks leaders in response to their knowledge of place and nature, and towards the local authorities (undefined) as managers and custodians of the open spaces and nature therein. '[walk leader] *is brilliant, he knows all these areas and he stops and tells us about stuff like these flowers* [wood anemones in patch at base of tree].' [Cv.M.Pe]. *'We're lucky in Covingham cos the council look after all these plants and bushes. People moan a lot but they don't realise what they* [the council] *have to do*.' [Cv.F.Pe].

Fear and risk aversion

Conversely negative emotions expressed relating to concerns over lack of maintenance and care, feelings of personal risk, and anxieties over pressures from new developments tempered, and were often juxtaposed alongside, more positive

emotions expressed. Whilst common to both groups such negative responses were felt more apparent at Cv. Woodland areas at Cv in particular were described as ‘no go’ areas. Concerns expressed were founded on what could be hidden within, not only from a social nuisance perspective but also a fear of plants and animals: ‘*bugs and creepy crawlies*’ [Cv.F.Fn], ‘*horrible snakes* [walker seen to shiver]’ [Cv.M.Fn], irritant and (perceived to be) poisonous vegetation [Cv.Ls.M.F.Fn]. Field work described in Chapter 4, lends some support to these concerns. Woodlands surveyed in both the Cv and LS areas were found to be impenetrable in large parts with woodland edges being encircled by dense shrubbery. Within the woodlands were dense and thorny shrub layers, field layers dominated in places by nettle and bramble, and extensive detritus some of which was a health risk. Woodland survey field work was abandoned in some areas given the extent and nature of waste tipping. Moreover a sense of being seen to be ‘lurking’ or being isolated in the woods was often felt during the field work, much heightened by being proximity to urban areas [Cv.Ls.Fn].

Place attachment summary

Walkers consistently expressed or were observed to exhibit, strong and positive emotional responses to nature observed during the walks. Walkers demonstrated emotional attachment to individual plants and animals, to wider attributes of landscape, and associated phenomena such as animal behaviour. Responses were evident across all health walks and in both naturalised areas and highly urbanised settings to the extent that even small patches of vegetation elicited positive emotional reactions. Feelings were however particularly intensely observed at Lower Shaw where naturalised attributes of the farmyard sat alongside the ethos of the farm managers, to elicit an individual and collective sense, and expression of well-being.

The research findings support the assertion by Lumbar et al. (2017), who also looked at walking interventions, that emotion and compassion are important pathways between people’s experiences in nature and their health and wellbeing. More generally and across all walks, whilst reactions were manifest within individual walkers, emotions were often heightened through the sharing of experience and contextualised and enhanced though narratives of recalled

memories. Again, these findings are consistent with the research by Lumbar et al. (2017) indicating the added value of walking in groups in nature rather than alone.

5.3.2.2 Place identity

As adopted within the theoretical framework of this research (Chapter 3, section), place identity is defined as the extent to which a place becomes a part of personal identity (Proshansky, 1978). As place identity has been directly related to the cognitive component of attitude theory, participants' cognition of nature encountered and their level of knowledge and understanding is more broadly considered here. It is recognised however that such knowledge and understanding is processed alongside other mediating and moderating factors to shape place identity.

Nostalgia straddles both place attachment and place identity realms, in so far that nostalgia can be described as a blend of cognition and emotion (Sedikedes et al., 2011). Given the role ascribed to nostalgia in relation to self- identity and self-continuity (Wildchut et al., 2010) and consideration in this research of the role of nature experienced in the locale, it is considered here as primarily a component of place identity although substantial overlap with emotion and therefore place attachment is evident.

Participants' knowledge of local nature.

Walkers generally did not demonstrate or explicitly state that they had expert knowledge in terms of species identification for any wildlife. Many walkers, when questioned would generally respond that they had little knowledge of their local wildlife. When pursued further however, it was apparent that plants and animals common-place in urban settings were well known widely across the groups and constituted a familiar part of their immediate and local areas. Moreover such familiarity was often accompanied by expressions of ownership particularly of birds but also small mammals:

*'We have a family of sparrows in the garden, don't think my wife likes it [a sparrowhawk] , taking our sparrow.' [*Ls.M.Iv]

*'We put bread and stuff out for our squirrel, know we're not supposed to but he's funny and our cat sits and watch him.' [*Cv.F.I*]*

The research cohort also demonstrated a broad knowledge of where to experience 'enriched nature' in the major open spaces in Swindon. Of the parks named by walkers, all are recorded as Local Wildlife Sites (WSBRC, 2018): Mouldon Hill, Coate Water, Sevenfields, Lydiard Park, Stanton Park. With only a few exceptions, data suggest that walkers were generally unfamiliar with formal wildlife designations per se and wholly unaware of habitat classifications underpinning the designations of these sites. Longer term residents expressed a familiarity and sense of ownership, referring to these areas as 'their' sites. Responses were often accompanied by expressions of concern for the future of such sites in the face of development pressure and local authority funding pressures:

'Coate Water Park, Mouldon Hill is really lovely and Woodland Trust new woodland planting, we've done a lot of walking around there. Around the lakes there we've got the swans, ducks herons, and coots, and unfortunately the geese as a well. But it's still good and like Coate Water, the birds on the lake you've got the grebes, if you're lucky to be there in spring when they're doing their mating, and the heronry. And Lydiard, lovely to walk around, you've got the lake which encourages all the birds. So there are lots of things, I find that really sad cos the council are up against it trying to look after all of these places, expensive to keep going, trying to bring some kind of partnership in.' [Cv.M.Iv]

In summary, participants generally demonstrated extensive, rather than expertise understanding of both very localised nature and where to seek out other nature in the wider locale. Such knowledge and the sense of ownership expressed suggests both 'everyday' and 'special' nature form an integral part of residents' understanding of their localities. The extent to which such knowledge becomes embedded as part of personal identity however is unclear from the data and further investigation would be required to better understand how such knowledge acts as a moderator or mediator of place identity.

The rare and commonplace

The cognitive (and affective and conative) ties to nature revealed through the study were not dependent on flora and fauna being considered rare or unusual. During questioning, interviewees would often try to recall their knowledge of the unusual such as those they consider rarer species, solely related to fauna and

almost exclusively birds. Examples included at LS where a husband and wife recalled watching a large bird standing in a ditch near their garden (later confirmed as a sighting of a crane). Other references to the 'unusual' include sightings of kingfishers, egrets, herons and red kites:

'He talked a lot about what they see locally in a small brook near their garden: kingfisher, heron, egret and a crane. He knew they had been re-introduced in Somerset. He also talked about red kites, buzzards, field-fares and foxes-seen when with children from Australia and how unusual it was for them to see foxes.' [Ls.M.Fn]

Whilst the unusual was seen in some cases to infer a 'novelty value' it was common place, familiar nature to which participants repeatedly showed a deeper connection. There was no evidence that such familiarity generated unfavourable attachments such as satiation or boredom discussed in research elsewhere (Sluckin et al.,1983).

Sources of experience and knowledge

Familiarity with local wildlife stemmed from knowledge acquired from childhood to present day learning and experiences, and from formal and informal, often family based education. Interviewees also discussed their enjoyment and the role of wildlife television documentaries in raising their interest in wildlife conservation in a wider global and national context.

Experience of nature at school, particularly in younger years, was formative for several participants who recalled childhood memories of particular teachers and group leaders in settings such as school grounds, urban open spaces and wider landscape:

'I remember a competition at school, I would only be about 5, a prize for the first person to take a cowslip into school, planted not cut and I found one and planted it in a jam jar and took it to school and won prize. Ye I remember that. That's good cos then you associate with them don't you.' [Cv.F.Iv]

'There was a teacher, I think he was something to do with science. Anyway I always remembered him showing us [nature related] stuff outside at school. He had big hands and a beard and he always laughed when he showed us things like leaves and plants, [that experience] always stayed with me.' [Ls.M.Iv]

Likewise, immediate and extended family were also often referred to as a source of experience and knowledge drawn from childhood experiences:

'Dad was always in to nature and things and I used to go along with him, I suppose I learned listening to him.' [Cv.F.Iv]

'I remember saying to my Mum, she was always out in her garden and she's say you know why don't you do this or that, she said you wait one day you'll appreciate it and I do now, I'm always in my garden. So I got it from her, years ago I couldn't be bothered with all that but that's how you change.' [Ls.M.Iv]

What can be seen is the role of influential people kindling a long remembered interest and establishing a deep cognitive and emotional connection to nature. Importantly in the context of this research, such connections were seen to be formed from experiences within immediate environs including gardens, school grounds, and local open spaces. Similarly, participants were also keen to pass on their knowledge and enthusiasm for the natural world to the next generation within their families and using local spaces as valuable local resources for learning (detailed further in section 5.3.2.3). The data did not allow for a detailed investigation of the relative roles of schools and family based experiences but doing so would have been useful given the emphasis placed on childhood experiences as being formative in establishing nature connectedness (section 2.2).

Participants were consistently seen to attach strong cognitive connections to nature observed and recalled in their locale, from looking through the kitchen window, walking in the immediate neighbourhood and visiting larger local open spaces. Such connections were seen to be deep-rooted in a lifetime of experiences from early childhood to present day. In the case of childhood experiences, the recollections of walk participants appears consistent with childhood development research, (detailed in section 2.2) emphasising the importance of nature experiences in 'middle childhood' defined as 6-12 years, describing this as a critical period of cognitive and emotional development during a time when children start to explore *'explore their environments to make memories and develop cognitive capacities'* (Kellert, 2005, Pretty et al. 2009). The research findings here imply that the 'profound and positive' health and wellbeing benefits ascribed to children's' contact with nature and the flow of such benefits through to

adulthood may be realised from day to day experiences in urban settings. This is a position supported by previous research the walk participants' seemingly intuitive and widely expressed opinions that local open spaces, including gardens and school grounds provide a critical resource for children to learn and develop an understanding and connection with nature. Moreover, research participants saw themselves as having some responsibility to address potential disconnections between current and future generations of children and nature and considered local open spaces as an important venue to do so.

Continued learning

An interest in learning about local nature continued for most participants and was seen as an important aspect to the walks. Some purposefully sought out more formal learning using local open spaces:

' [referring to expert], *I've done several courses with him, first one was a foraging for food course, don't recall too much of what I can eat there's a few things that stuck, within a few yards of walking from here he'd probably named about 20 different species you could eat. His knowledge is so vast. What he did do was open my eyes to what I was seeing, up until then I would walk around and see trees and shrubs and birds, but not really appreciate the difference between a blackthorn or an erm. So now, just sparked/got a little more interest in enjoying the different species and learning a bit more.'* [Ls.M.lv].

For most however, shared learning about nature whilst walking was extensively reported by participants as an integral part of the walks, described further as a component of place dependency in section 5.3.2.3.

Whilst considered interesting in its own right, identification and knowledge of particular species and assemblages was not considered by participants to be critical to their immediate enjoyment and valuing of nature:

'I love trees, haven't a clue what it is and doesn't bother me that I don't. It's the different colours and different shapes. I can look at those flowers and think they're really pretty, the shape of the leaves underneath, haven't a clue what they are.' [Cv.F.lv]

What could be seen was that the process of knowledge sharing, rather than the knowledge itself was paramount for walkers, to such an extent that learning about nature was seen to become part of group identity. At both venues, the familiar

common-place nature experienced on the walks provided opportunities for such shared learning, albeit more clearly observed and strongly expressed during the Lower Shaw walks.

Nature as a marker of time

Nature and natural phenomena observed appeared to mark change and the passing of time for participants on a range of temporal scales. Annual seasonal changes were often noted such as early spring flowers (snowdrops and hazel catkins), autumnal leaf colours, the form of leafless trees in winter, the gathering of birds, acted like a '*ticking clock'* [LS.F.Pe].

For longer term residents of Swindon, extant habitats and landscape features absorbed into subsequent urban development acted as a reminder of how Swindon has changed over their lifetimes. Walkers not born and bred in Swindon would refer back to the natural landscape of previous areas where they lived, often drawing parallels and comparisons with their current neighbourhoods:

'I was raised in Parks South, so Shaftesbury Lakes was the edge of Swindon, what is now Eldene and Liden was farmland. I was less than 10, our idea of going out to play was to go 'over the lakes', so we would disappear over the lakes in to the farmland, we would be gone all day, no way parents could contact us, never an issue. Endless fun just exploring getting told off by the farmer, in forests, building dams across rivers.' [Cv.M.Pe]

Nature encountered and discussed would remind participants of life events such as the growing up of children and grandchildren, marriages, and deaths, marking periods over their lifetimes from childhood to later in life:

'[discussing photograph of elder in blossom] *I always remember my daughter's wedding. They had a horse and carriage and by time they got to the reception, there was loads of blossom, I think it was cherry, blowing around [*it was*] beautiful.'* [Cv.F.Pe]

On longer timescales still, discussions about the age of trees and a small remnant ancient woodland evoked responses harking back to an unknown and ill-defined past alongside concerns about the future of the natural environment, uncertainties of climate change impacts and the importance of the role for future generations.

'important that they know [about nature] and understand and pass on to their own families, if you break that thread then it's not carried on, grandchildren used to go out and get tadpoles and watch them change.' [Cv.M.Iv]

Nature as experienced, and changes in nature reflected on, were therefore seen to provide temporal reference points for walkers in some ways integral to personal identity and thereby place identity. Given the age profile of most walkers, it is perhaps not surprising that such self-identity was often expressed in nostalgic terms.

Nostalgia

Health walk participants consistently and extensively recalled contact with nature from past experiences, particularly from childhood but also other important life events. Many such recollections are easily categorised as being nostalgic, that is 'fond and personally meaning narratives and often rosy memories of childhood and other close relationships' (Sedeikedes, 2015).

Nostalgic recollections of health walk participants' experiences of nature fell on a spectrum from positive to negative or from sweet to bitter. Recall of such experiences were in response to nature encountered during walks, promoted by questioning, via photo-elicitation or often emerging through conversation between the researcher and participant and between participants. Recollections were skewed towards the positive with many walkers exhibiting emotional responses through smiling, laughter, physical gestures. Positive nostalgic expressions were, in several cases, mixed with some sense of melancholy: a brimstone butterfly seen flying in the farmyard was seen as a symbolic representation of a recent loss of loved one. In two cases, memories of nature were closely related to almost solely negative experiences in childhood or bereavement and resulted in a deeper sense of melancholy.

Nature based nostalgic responses were found consistently across both of the health walk groups irrespective of the walk's setting although feeling more pronounced at Lower Shaw, possibly related to a more conducive natural and relaxed setting described in section 5.3.2.1. Commonplace nature encountered during the health walks often in very urban environments triggered strong nostalgic

responses for individuals. Two examples for the Covingham (and thereby more urban) walking group are given here:

- wild barley growing in a roadside gutter (Figure 5.3) sparked a prolonged discussion with the researcher and fellow walkers spanning childhood recollections of rural upbringings, fond memories of playing outdoors in fields now built on, extended families and lost loved ones. [F.Cv.Pe.Fn]

- a small roadside planter of flowers overgrowing with dandelions reminding a widow of her husband's work as a nurseryman in Swindon, how she always had a 'lovely' garden, how that area of the town had changed beyond recognition and there seemed to be a growing lack of care and concern in comparison to 'days gone by.' [Cv.F.Pe.Fn]

Health walkers' nostalgic recollections, prompted by nature encountered and emerging through deliberation, fell on a spectrum from positive to negative or from sweet to bitter. Prior to the latter part of the 20th century nostalgia was predominantly seen as a maladaptation or psychological illness limited to a small number of people (Abeyta, 2016). Whilst research remains limited more recent psychological studies have reframed the concept of nostalgia in a more positive light with potential benefits for human health and well-being (Wildshut et al., 2010). As was found in this study, nostalgic narratives are reported as being expressions tending towards the positive rather than the negative (Wildshut et al., 2010) and whilst 'bittersweet', more 'sweet' than 'bitter' (Sedikides et al. 2015). Ramifications of nostalgia for health and wellbeing are increasingly seen as far reaching: *'*nostalgia is not just an old sepia-toned photo, locked in a box. Its power is far reaching and can light the way ahead*'* (Cheung, 2013). A number of psychological studies have set out both the social benefits and benefits to the self, deriving from nostalgic reverie. Sedikides et al (2015) summarise such benefits: drawing strength and motivation from memories of close others, promoting perceptions of friendship, social support, nurturing sentiments of protection and love, lowering attachment avoidance and attachment anxiety, engendering a sense of interpersonal competence, promoting pro-social behaviour, strengthening desire for intergroup contact, countering self-discontinuity and fosters self-continuity. Later in life, nostalgia has also been shown to make people feel more youthful, in

turn predicting the extent to which people are healthy and confident (Abeyta and Clay, 2016) and such that nostalgia confers a sense of optimism (Cheung et al., 2013,).

The findings of this study were consistent with such reported nostalgia derived benefits. The research cohort was, by design, of limited age-range and highly skewed towards the more elderly. Whilst nostalgia has been shown to be experienced by everybody regardless of age, it may play a more prominent role later in life (Wildshut et al. 2010). In short, as people get older they become increasing aware of time and the fragility and meaning of human life and subsequently attach greater importance to relationships (English and Cartensen, 2016). Moreover, it is the commonplace and familiar rather than the scarce that provide 'familiar sensory cues' described as typical component parts of nostalgia narratives (Sedikides et al., 2015). Correspondingly it was common place and familiar nature encountered by walkers that triggered strong nostalgic recall.

Place Identity Summary

Walkers at both venues demonstrated an extensive, rather than specialist knowledge of wildlife typically encountered in their local areas. Their understanding of local nature was often expressed in intimate and familiar terms suggesting a personally important component of place. Close familiarity and a sense of ownership was also expressed for nature-rich green spaces, considered special, beyond their immediate areas but within the urban setting. Whilst rare or unusual wildlife sightings in local areas inferred novelty value, a deeper cognitive attachment to the commonplace was evident.

Participants emphasised the importance of local open spaces, including gardens and school grounds, as venues to develop a lifelong (and continuing) interest in, and familiarity with nature. Whilst not dependent on formal education, the role of influential people be they teachers or family members and friends was considered as part of a shared responsibility for intergenerational learning about, and developing a connection with nature. It was the familiar and common-place nature as experienced on the walks that participants saw as providing opportunities for

such shared learning and to the extent that the process of knowledge sharing between walkers helped to define group identity.

Nature observed and discussed during the study provided temporal reference points for walkers in some ways integral to their personal identity and often expressed in nostalgic terms. Importantly, it was the commonplace and familiar nature encountered that provided 'familiar sensory cues' (Sedikides et al., 2015) that triggered strong nostalgic recall.

5.3.2.3 Place Dependency

Place dependency as discussed in this section is the 'potential of a place to satisfy an individual's needs by providing settings for his/her preferred activities' (Jorgensen and Stedman, 2001). Allied to the concept of place satisfaction it is the component of Sense of Place relating to the conative dimension of attitude theory and thereby is so far that it 'shapes not just meeting needs but also tendencies and actions' (Jorgensen and Stedman, 2001).

A setting for the health walks

Local and urban green infrastructure provided the settings for meeting the needs of the health walks groups per se. Where consistent with the requirement for ease of access along surfaced paths, the walks' leaders purposefully identify routes to maximise use of local naturalised open spaces and connecting, vegetated, off-road pathways.

As evident from participant observer, photo elicitation and interview stages of the research the natural qualities of the walking routes played a central role in the walk experience, albeit nature appeared to provide a seemingly sub-conscious background, secondary to social discourse as set out in section 5.3.2.1. Throughout the walks, whilst people were in conversation, nature encountered provided a prompt for, and a 'common language' interwoven in social discourse and a catalyst for sharing memories during and after the walks. Natural landscape elements were frequently identified during photo elicitation work, albeit more frequently at Lower Shaw. Stimuli included scenic qualities such as views, vistas and movement of water alongside plants (and fungi), animals and their activities observed.

The quote below, taken from interview transcript, provides a useful illustration of how nature becomes interwoven within conversation and highlights a number of themes discussed further in this and other sections: sharing experiences, learning, childhood experience, nostalgia, accessibility, impact on health and well-being. As presented here verbatim, the quote encapsulates well the extent to which a conversation about nature became an integral part of, and represented the experience of the walk participant. Within the narrative, the interviewee who was a devotee to the walks, enthusiastically described how personal, social and physical dimensions of place interact resulting in an evident impact on self-reported sense of health and well-being:

'*I'm a pensioner and you're never too old to learn, it's amazing what you can find out talking to new people but even teaching youngsters and smiling at things like telling my grandson different things to make him interested in and teach him to grow up looking and not just walking and not seeing, and I'd say this is a blackbird and that's a sparrow and this's a magpie and just teaching him in our garden and watching them feed off the fence and I often make people smile cos we took him a walk one day and I was so pleased cos he was only 4 and he says 'oh there's a magpie, and I was so thrilled that he didn't just say there's a bird, but I nearly cried laughing and I tell this story to people to make them laugh cos it flew off and he said 'oh look it's gone to grandad's for dinner' [both laughing] and in the walking group that makes people happy cos it's better than taking a pill to share a joke isn't it ? for people who've been sat on their own in the house all day to talk and have a laugh is as I say better than taking a pill., but that made me so smile, he was only 4 and he'd remembered that and he'd realised he'd got to feed as well didn't he, you know ? [yes,ye]. he saw it fly away and he was sharing something with me instead of just walking along and some children think isn't it boring just walking with elderly people but we weren't we were sharing an experience like we do on the walk as well. So it's not just about talking to people about have you washed the pots today or just done something boring at home,[so something more interesting and stimulating] and that's another thing people have left any jobs they've got to do at home like the grass might need cutting and the ironing needs doing, you put that to one side, forget about it and share a happy time doing something that's good for your health, it's good for your well being it's good for your physical health, you get some physical exercise , it's part of these health walks do a good healthy speed to get your heart beating so its good for your physical health and emotional health as well.' [LS.F.Iv]*

A local resource for learning

The same interviewee went on to further express her thoughts on how nature provided an important means for shared learning during the walk. Other data from field notes, interviews, and photo-elicitation likewise emphasised the value of learning from each other in relation to nature observed. Discussions during the walks and at interview stage also centred around learning experiences on guided walks and bespoke training courses elsewhere and at other times in local semi-natural spaces in Swindon

"I admired [walk leader] knowing the mushrooms and then she brought them back and made some fantastic soup and the people who stayed here told us how delicious it was and again on these walks different people can look in the gardens and the trees and the bushes and they can tell you things again things that you wouldn't be aware of. I can look and see things but they can tell me about them and we all learn from each other on the walks and show each other different things so we get a sense of well being from the beautiful things we see and it makes us talk to people we don't know and we make friends with them." [LS.F.Iv]

Local open spaces, including gardens and school grounds were extensively discussed as providing a critical resource to support children's' understanding of nature in both informal and formal educational settings. Concern was repeatedly expressed over the potential loss of open space (seen as an educational resource), as a result of development pressure. Childhood learning and exploration of nature were repeatedly referred to, to the extent of representing held beliefs, as reason to conserve nature both in urban spaces and beyond. Participants drew on their own long held memories of nature experiences in childhood, how they encouraged their own children and grandchildren to observe and enjoy wildlife:

'If they build all these houses, be nothing for the kids to see, they'll have to go to the zoo or something.If we just keep on, it's like to global warming issue, if we just carry on willy nilly you'll end up destroying home environment and planet itself." [Ls.F.Iv]

'So living in Swindon I still treasure going around and seeing greenery every day and how wonderful and how lucky we are and I was grateful and I remember it was a man teacher and I've never forgotten that, and I showed my grandchildren and I made them aware of birds wherever we went out I used to say there's a bird and I've give them the name, not

to boss them about to make them aware that were different ones and of different sizes.' [Ls.F.Iv]

Beyond their own families, participants emphasised the importance of childhood for learning about and understanding nature more generally. When asked why such learning was considered a priority, the reasons cited were that nature:

- is a fundamental part of life;
- should be there for children to enjoy;
- a legacy to pass through generations; and
- that learning about nature in childhood helps to foster concern and custodianship and prevent future harm to the natural world.

'It's important for your children as well to learn about nature and animals and different things [q: why] to show them how it all works, to appreciate it. For them it's a learning thing, for us as adults we just like seeing these nice things, but kids are actually learning [q:why ?] cos it's nice to know about nature and the ecosystems and how things develop, maybe know how to look after plants and trees and things like that, so they don't maybe vandalise them, so they're interested in them and help look after them really. I think they're lucky they live in a place where they have got the opportunity to do that, some kids are brought up and they never see trees and they never walk through woods cos of the area they live in, important to learn at young age.' [Cv.M.Iv]

At the same time there were evident concerns that children, as witnessed from participants' own experiences, were too distracted by other activities to be interested in nature or that a prevailing aversion to risk was undermining opportunities for children to explore in natural settings.

'*[her children are] busy doing other things but hopefully the interest for nature I've tried to kindle in them has stayed, usual for kids to go through disinterested stage but maybe comes back especially if they have their own children but grandchildren have too many gadgets and screens to look at.'* [Cv.F.Iv]

'It's not surprising is it,[parents] don't let their children out any more,too scared something might happen.' [Ls.M.Iv]

Nature-rich and connected places for leisure

The availability of naturalised spaces was seen as important for providing a setting and materials for leisure activity: for informal recreation and relaxation, games and

sports, participating in the arts, food and drink, volunteering, spending time with family and friends and celebrating life events. The importance of the local environs was also emphasised by the walkers as affording readily accessible opportunities for regular, 'spontaneous and unplanned contact with nature' (Kelly, 2006). Proximity and connectivity of spaces were consistently seen as important in making nature immediately accessible to research participants. Beyond their own residential areas, walkers were well aware of, and valued, the availability and accessibility of Swindon's local and major open spaces as places to enjoy nature:

'*I'm really really impressed, as a newcomer to Swindon, with all the open space and all the footpaths, you can walk with children away from the traffic fumes. Swindon deserves praise. The housing estates are large but they don't look that big cos they're broke up with open areas in between them, and footpaths. I think Swindonians are very lucky*.' [Ls.M.Iv]

'[participant] regularly walks grandchildren to school at Seven Fields across Penhill. Often sees squirrels, foxes, birds. Thinks it is important that children see wildlife" [Cv.F.Fn]

Health walkers repeatedly described their contact with local nature in terms of a common resource supporting informal and formal leisure activities, hobbies and past-times, traditional practices and providing materials for learning. Such use values extended critically to local naturalised spaces providing the setting and resources for social interaction and discourse. Familiar, common-place nature was seen to offer a shared heritage, providing a common language and basis for sharing experiences. Whilst individual, contemplative moments in nature were observed and discussed on the walks, the over-riding sense was of sharing and deliberation. Local nature was therefore seen to promote social connectivity and cohesion, the health and well-being benefits of which are extensively described in both academic research and practice.

To a more limited extent participants discussed how they use local open spaces to forage for food and other materials. Discussions around traditional practices such as making preserves and drinks from hedgerow fruits and flowers, use of berries to flavour alcoholic drinks such as sloe gin, were often framed within a deep sense of nostalgia and often with reference to health benefits:

'[she] used to make rosehip syrup for her kids, good for vitamin C. If you make elderflower cordial it helps to condition against hay-fever from the flowers. Rosehips, not seen locally

were there any around Shaw? Saw some later in the walks overhanging the path '*there are my rosehips."* [Ls.F.Fn]

Several walkers discussed how they used local open spaces for their nature based past-times including photography, drawing and painting and for fishing. With a few exceptions, other than in the context of gardens, only a small number talked about using their local spaces for purposefully observing nature e.g. for bird-watching:

'walker photographer looking over a bridge for a 'shot', visited Barbury Castle and trying to take picture of orchids-suffered a heart attack when walking up the embankment-but got good photo of orchids![laughing].' [Cv.M.Fn]

'When asked where he goes locally to see birds he said he would like to find a local patch to record. He talked about walking from here (Covingham). Trying to get licence and key to access the bird hide at Coate Water SSSI (his words).' [Cv.M.Fn]

Gardens were singled out by participants as places where people enjoy observing and caring for nature. Responders would often refer to wildlife visiting their gardens as familiar friends. Moreover, gardens were reported as spaces where people share experiences of nature with family and friends. Such activities extended to incidental open spaces in the immediate vicinity of participants' homes.

'*we haven't got grandchildren but my daughter-in-law occasionally fetches nieces and nephews to our house and we have squirrels which are a bit of a nuisance but kids are so excited when they see them and it's just nice to point out things to them. Cos we get a robin and point a robin out to them.'* [Cv.F.Iv.]

Place dependency summary

In summary, local open spaces and nature therein were shown to provide a valuable local resource to meet the needs of residents and therefore perform an important role in shaping place dependency. General recreational and past-time uses founded on the natural qualities of local spaces were seen to be interwoven with a desire to share and learn about nature with family, friends and other walkers. Nature encountered within local green spaces provided a resource for shared and deliberative experiences to the extent of nature providing a common source of knowledge and language. Particular value was placed on local spaces, including gardens, as a resource for childhood learning and developing a lifelong

connection with nature. Gardens specifically were singled out, consistent with research by Brindley et al. (2018) stressing the importance of gardens, as a widespread component of urban green infrastructure, to provide both hedonic and eudaemonic wellbeing benefits with regard to nature connectedness. It can be argued that more elderly residents sometimes with limited opportunity to travel further afield, as was seen for the health walk participants, are more critically dependent on gardens and locally available green spaces for the range of experiences described.

The research here supports previous findings stressing the importance of everyday urban landscapes: that whilst memorable individual experiences or ‘occasional immersions in nature’ (Kelly, 2006) and as reported by the health walkers, can be valuable, more time spent in nature can be associated with a closer connection to nature (Richardson, 2015, Strife and Downey, 2009). Clearly et al. (2018) stress the importance of everyday urban nature, going so far as to say there is a critical dependency between availability of nature within urban green infrastructure and human connectedness to nature. Whilst nature connectedness may be forged in childhood, this study, consistent with that of Bell et al. (2017), has shown a continued desire for ‘re-forging’ of such connections into later life. Conversely, a lack of regular positive experiences in nature has been shown to foster what might be considered as negative emotions of fear, discomfort and dislike of the natural environment (Strife and Downey, 2009 citing Bixler).

5.4 Chapter 5 Summary

Two of Swindon’s health walks groups were identified and selected as a useful cohort of local residents for a ‘narrow and deep’ quantitative study. The groups were purposefully chosen as they walk in the same areas as those selected for woodland surveys set out in Chapter 4 (Objective 2.1). Extended participation by the researcher over a period of 14 months allowed for a triangulated, ethnographic based approach to elicit perceptions of and values assigned to nature encountered within urban green spaces (Objective 2.2). A sense of place framework established by previous research in this field was adopted as a means to evaluate values assigned by the walkers to nature encountered in their local green spaces (Objective 2.3).

The research revealed the extent to which everyday nature experienced in immediate vicinities of where people live is part of an interwoven, complex human-nature relationship contributing to residents' SOP. Both walks venues revealed similar findings although seemingly more pronounced at Lower Shaw. It was at the latter where responses to evident diversity of flora and fauna, native or otherwise, and manifest in gross landscape structure, was most keenly observed.

In summary, common place nature encountered in local spaces and often in seemingly mundane contexts was seen to play an integral role in shaping resident's SOP, with crucial implications for health and well-being. The study uncovered the deep, nostalgic and diverse emotional, cognitive and practical ways by which participants attached values to everyday nature in urban settings. Such values appeared to be largely socio-culturally derived, through personal life-long experiences, through a process of continued sharing of knowledge and experiences, and through a commonly shared interest in nature.

The extent to which the values expressed by the walkers were shaped by deeper 'held' values or moderated by other personal and social factors however remain unclear and further study would be needed to investigate such relationships. Caution is sounded however by Gifford and Nilson (2014) who stress the arguably unfathomable complexity of the personal and socio-cultural that shape environmental value orientations and attitudes.

The findings from the study demonstrated the critical personal and social roles that the urban matrix (section 2.1.2) plays in relation to nature conservation in towns and cities. The conclusions are concordant with those from an ecological perspective as detailed in Chapter 4 and therefore suggest that modest improvements in terms of increasing naturalisation of local open spaces will bring about both ecological and social gains.

The research made evident the socio-cultural significance of smaller areas of greenery including gardens and incidental patches of vegetation alongside larger open spaces and semi-natural habitats. As urbanisation increases, so do the pressures on such components of the urban matrix. Planning for future growth and regeneration of towns and cities therefore needs to recognise the combination of ecological and social worth of these characteristically urban spaces. Principles and

approaches embedded within green infrastructure planning including multi-functionality (and consequentially multi-benefits), offer an opportunity to better recognise the combined values of urban matrix habitats. The following Chapter 6 therefore investigates the potential of green infrastructure planning as a means to establish mutually supportive ecological and social priorities for place making in urban settings.

Chapter 6: Conclusions

This chapter pulls together the research findings, in the form of a synthesis to address the stated aims of the study. Aims 1 and 2 and associated objectives of the research have been addressed in previous chapters and are summarised here:

- Aim 1. To ascertain the influence of habitat structure, composition and landscape context on biodiversity in urban settings.

  As detailed in Chapter 4, this study demonstrated the importance of plantation woodlands, as a ubiquitous component of an urban matrix, in providing valuable urban wildlife habitats. Results indicated that manipulation of matrix habitats surrounding woodlands may bring greater nature conservation benefits than efforts to alter woodland structure and composition per se.

- Aim 2. To critically examine what determines residents' perceptions of, and values assigned to, nature in urban settings.

  As detailed in Chapter 5, this study demonstrated the importance of urban matrix habitats in providing for residents' everyday contact with nature. The study revealed the emotional, cognitive and conative dimensions by which values are assigned by residents to seemingly mundane nature encountered in the immediate vicinities of where they live. The findings indicated that investment in the natural attributes of local and incidental open spaces could result in substantial benefits for residents' health and well-being.

Concepts embedded within, and the practice of, green infrastructure planning offer a means to integrate potentially disparate environmental and social facets of urban place making. Accordingly, the final part of this chapter addresses the third aim of the study:

Aim 3. To establish the potential of green infrastructure planning to provide a nexus between ecological and social priorities for urban biodiversity conservation.

Within this chapter, green infrastructure planning is discussed as a means to inter-relate ecological and social dimensions of urban biodiversity conservation in the case study area and thereby address the associated objectives of the research:

Objective 3.1: To synthesise the potential role of green infrastructure planning as a basis to integrate ecological and social perspectives in urban settings; and

Objective 3.2: To provide a mechanism through which both ecological and social benefit can be delivered in urban settings and provide recommendations for policy and practice.

Research limitations and recommendations for further studies are discussed prior to drawing conclusions and making recommendations based on the research findings for consideration in green infrastructure planning policy and practice.

6.1 Synthesis

Nature residing in and as experienced in urban green infrastructure has both ecological and socio-cultural importance. Prioritising and disaggregating policy and practice, for example into the ecological or recreational, when we plan, create and maintain urban spaces risks undermining the additionality central to concepts of multi-functionality and connectivity in green infrastructure. Rather, as shown in this study, nature conservation and socio-cultural interests of our urban spaces are complexly intertwined, and can be usefully addressed through the theory and practice of green infrastructure planning. This is a view supported by the Landscape Institute (2016) which calls for the use of ‘network science’ as a means to unify biophysical, social and economic systems in relation urban landscapes. Doing so would help to better recognise the value of the small, interconnecting and incidental green spaces often dismissed when considered from solely eco-centric perspectives.

Habitats in urban settings, as usefully represented by plantation woodlands, host a pool of nature accessible on a day-to-day basis for urban residents. Woodland plantations in Swindon provide extensive habitats for ‘unseen’ nature hosting a range of species in high numbers as exemplified by beetles, albeit that associated assemblages are somewhat homogenous across the urban landscape. That the size and configuration of the woodlands surveyed in this study showed no discernible impact on the species richness and abundance of beetles suggests that small, incidental fragments of woodland can continue to support a range of

fauna typical of larger areas. The findings here are not consistent with research elsewhere citing ‘apparent robust generalisations’ that area and spatial dimensions per se of urban green spaces are found to influence species richness (Norton et al., 2016). This research does however support the case as reported for other landscapes (Prugh, 2008, Franklyn and Lindenmayer et al, 2008), that the patch-matrix dichotomy often employed in the field of landscape ecology is perhaps less robust in urban settings where:

- the matrix and patch characteristics are less differentiated and
- the matrix itself is less hostile to faunal assemblages dominated by generalist, opportunistic and synurbic species able to withstand pressures and thrive in man-made and novel habitats e.g. gardens, allotments.

Whilst inconclusive the study suggested there may be some influence of surrounding land-use on species assemblages inhabiting woodland plantations. Further extensive research is needed however across a range of taxa and employing techniques of landscape ecology to better determine potential ‘within-city’ (Norton,2016) or ‘embedded city’ (Werner, 2011) effects.

For young woodland plantations, ubiquitous in urban settings, woodland structure and diversity of vegetation as assessed in this study also showed no discernible impact on beetle species assemblages (section 4.3.3). Manipulation of vegetation structure may therefore have limited impact on the abundance and richness for this taxa: for this habitat type at this scale and at this stage in its lifecycle. For these immature woodlands, in the absence of more complex and resource demanding interventions, it may just be a matter of time for larger scale changes over extended periods of time are needed before increases in diversity can be observed, associated for example with the ageing of trees and a build-up of dead and decaying matter. Conversely the environmental and disturbance pressures associated with these habitats at typical urban scales, may dictate that biodiversity in these woodlands remains relatively homogenous even given the passage of time. Given the lengthy timescales involved in woodland maturation, comparative rather than longitudinal studies of woodland are needed to better understand if simply leaving young urban woodland plantations to mature without interventionist

management is a valid conservation approach. Likewise, whilst beetles may be considered as useful surrogates for wider biodiversity, further studies across a wider range of taxa, such as those by Croci et al., (2008) are needed to better understand the influences of quality and spatial configuration of habitats on species encountered within urban green infrastructures. Moreover, better alignment of surrogates of biodiversity from an ecological perspective with those from a social perspective is needed as discussed further in section 6.2.

The commonplace nature encountered in urban landscapes, such as that associated with urban woodlands described in this research, provides a critical resource underpinning residents' sense of place. Whilst at times and in particular contexts, the study showed that the unusual or rare may infer additional value enhanced through deliberation, it is the experience of the everyday nature typical in urban settings that is of over-riding significance. Everyday urban nature was seen to influence emotional, cognitive and conative realms of residents' SoP, thereby shaping attitudes towards, and their apportioning of value to nature in their locale. Such influences were apparent for most research participants who were best summarised as passively interested, enthusiastic consumers of nature rather than activists. None were shown to be completely disinterested or apathetic and the health walkers represent an important, though not comprehensive, cross-section of society. Given the temporal aspects of SoP reported in this study, from childhood to nostalgic reflection, further research through extended, longitudinal studies would be beneficial to see how pathways of such 'nature connectedness' develop through life. Similarly, whilst the values attached to nature by research participants were best described as 'culturally assigned' (section 5.3.2) the extent to which these values were shaped by held values or value orientations as described within cognitive hierarchy theory, or those value typologies expressed through innate hereditary pathways proposed by the biophilia hypothesis (2.3, appendix 1), requires further investigation.

Beyond the immediate 'human perceptible realm' (Gobster et.al, 2007), the majority of diversity in nature remains hidden and unknown to urban residents, as exemplified by the richness and abundance of beetles reported in this study (section 4.3.2). Residents' perceptions of diversity in nature, both spatial and

temporal, were however apparent: shaped by visual interpretations of gross structural heterogeneity of landscape elements in combination with other sensorial experiences of nature and natural phenomena encountered, and through social deliberation including shared assumptions that urban is different, less nature-rich than the non-urban. In this way residents may be considered as being immersed in a 'pool of nature', much of which is sensed but undifferentiated, and benefit from such, without the need to understand and disaggregate nature into its component parts: as one of the health walkers summarised, '*It's like having a nice meal, you don't need to know what all the ingredients are.'* Previous research by Clark et al., (2014) has posited that the greater the diversity of such a pool of nature available then the greater the opportunity to derive culturally determined benefits critical to human well-being (Russel et al., 2013). The findings here however stress that such benefits can be derived from the widespread, seemingly mundane nature, as available and experienced across urban settings. In this case common-place plants, animals and natural phenomena provide a readily accessible resource on which to build individual, shared and common experiences.

For the individual, a lifelong, deep and culturally embedded connection with nature when encountered in urban landscapes was revealed amongst the research cohort: spanning childhood experiences to nostalgic reflections later in life. The connections with nature as expressed by individuals appeared to be shaped to a large degree by shared experiences of nature both past and current, enhanced through deliberation and learning, and providing a common language for social discourse. As discussed in section 5.3.2, participants attached clear emotional value to, and increased cognition of, nature encountered through their shared experiences whilst walking, including those of the researcher as participant observer. In this way, nature as experienced by residents and site users in urban settings may be usefully considered as a largely social phenomenon through which affective, cognitive and conative realms of sense of place may be enhanced. Again, the emphasis here is on the importance of common experiences of commonplace nature in commonplace settings, shared through a common language.

Planning for a loss of existing green-space within Swindon through urban densification, and development expansion into surrounding farmland is a challenge shared across other towns and cities in the UK. As for other areas across the UK, the pressures of urbanisation on the town's 'resident nature' are recognised within local planning policies (Swindon Borough Council, 2013) which seek biodiversity gain from new developments consistent with national planning policy (Ministry of Housing, Communities and Local Government, 2019). In parallel, green-infrastructure and related policies within the Swindon's local development plan (Swindon Borough Council, 2013) aim to achieve other environmental and social gains consistent with national guidance. As discussed in Chapter 2, section 2.5, at times such policies may appear ineffective and in some cases to be in conflict, both within the local plans and other planning and policy work being carried out by local authorities. Anecdotal evidence in Swindon (pers. comm. Smith, Colbran planning policy unit, Swindon Borough Council) together with research elsewhere (Calvert et al., 2018) suggests Swindon is similar to other UK towns wrestling with policy challenges as they seek to operationalise concepts such as multi-functionality and connectivity embedded in green infrastructure planning.

The implications of the research findings as set out in section 6.3, are therefore framed within the context of how expanding towns like Swindon develop coherent, consistent and effective green infrastructure policies and practice which meet both ecological and socio-cultural needs. Prior to doing so, the limitations of the research are considered.

6.2 Limitations and recommendations for further research

Swindon Town provided a useful and relevant setting to the research. Whilst sharing characteristics of other small towns in England, the landscape, setting and demography of Swindon, pertinent to the study will differ from other settlements, in for example coastal towns or large cities. The nature and availability therefore of the 'everyday landscapes' seen as critical in this study are likely to differ across other such urban settings. That urban biodiversity is particularly complex and dependent on a broad range of bio-physical, socio-economic, and cultural factors

makes comparison across town and cities problematic (Werner, 2011). It is felt however, that the bases for residents' affiliations and valuing of nature in their locale revealed in this research, such as shared experiences and childhood learning is likely to be consistent across communities elsewhere. It would be useful however for similar research to take place in ostensibly different urban settings such as inner cities or towns with a greater degree of retained landscapes' such as ancient woodlands or heathlands, to test this position. Likewise, focussing research on other such retained habitats if and where they form a widespread ubiquitous component of the urban landscape may identify different priorities for investment in urban green infrastructures.

The use of a single taxa, i.e. beetles, as a surrogate for wider biodiversity, whilst a pragmatic and justified approach clearly has limitations. Although the functional traits of beetles correspond well to idealised surrogate species (Chapter 3, section 3.2.2) further research is needed to test for potential correlations between beetle assemblages and other insect and wider taxa. Doing so is arguably more relevant in urban settings where a deeper understanding of finer grained habitat preferences of generalist and opportunistic species could provide greater insight. More specifically, given that public perception of biodiversity is likely to be taxon-dependent as described by Hoyle et al. (2018), a better understanding is needed of correlations between urban assemblages of less superficially distinctive (and visible) taxa such as ground beetles and those more in the 'perceptible realm' (Gobster et al., 2007) such as plants, butterflies and birds.

From a social perspective, this study purposefully sought to follow a narrow and deep ethnographic approach and the choice of research cohort was therefore necessarily constrained. The limited age profile of research participants, whilst valid for the study, is a particular consideration when trying to apply research findings more widely. For example, the emphases placed by participants on recalled childhood memories and their interrelations with children and grandchildren will not be as relevant, or at all relevant, to younger age groups. It has also been suggested that older peoples' perceptions of biodiversity may differ from younger age groups given their accumulated knowledge and experience, and arguably more interest in nature (Southon et al., 2018). Given sufficient time and

resources a larger stratified study may help uncover how perception and valuing of urban nature varies across different age groups. In the absence of longitudinal studies, doing so would also help to understand how such relationships may evolve over different life stages.

The locations for study within Swindon were chosen to align ecological survey work (beetles in woodlands) with that of the health walks study (walking through or in close proximity the same wooded areas). In practice however, the nature of the terrain and poor accessibility of the woodlands precluded to a large extent walking through the woodland sites per se. Rather, the woodlands with a few exceptions, provided a backdrop, albeit an important one, to the walks. Future research work involving a closer spatial alignment of ecological and social facets of research, such as that carried out by Chang et al. (2016), Hoyle et al. (2018, 2019), and Southon et al. (2018) and employing both quantitative and qualitative approaches would be of benefit.

6.3 Research implications and recommendations for policy and practice

6.3.1 The urban matrix as a priority for investment

The research findings underline the importance of the urban matrix that is the extensive network of green-spaces forming much of the green infrastructure within towns such as seen in Swindon and described in section 2.1. The significance of matrix habitats is apparent from both ecological and social perspectives, and within urban areas the ecological and social become intimately intertwined. As reported in non-urban landscapes (Franklin and Lindenmayer, 2009) the extent of the matrix is likely to far outweigh remnant priority patch habitats often the focus for conservation policy and efforts. Moreover, in urban settings as this study has shown, it is these areas that urban residents have meaningful contact with nature on a daily basis. Increasing urbanisation however risks a net loss of small urban green spaces as a consequence of urban compaction. In addition, budget pressures experienced by local authorities in the UK and a consequential under-investment in open spaces also threatens to undermine the quality of what spaces remain. This research has shown that such losses in both the extent and quality of

the urban matrix is likely to detract substantially from nature conservation and associated socio-cultural gains sought through national and local planning policies and associated strategies in the UK.

6.3.2 Priorities for urban nature conservation

Nature conservation priorities in urban settings may therefore be better served by greater protection of, and investment in habitat improvements within, the smaller, nature impoverished incidental areas forming much of the fabric of urban green infrastructure. Woodland plantations, as investigated in this study provide a useful example: indicating that investment in management of larger patches may not bring about the nature conservation gains often sought without resort to complex and resource intensive management interventions. Rather, local, modest and scalable changes to evidently nature-poor areas could provide a greater cumulative impact across an urban landscape. Doing so would result in an overall 'softening' of the matrix as called for by the Landscape Institute (2016). Example interventions could include relaxed mowing regimes to create more extensive ecotones between woodland and amenity grassland, the creation of small scale 'novel' habitats such as planting of wildflower and nectar rich areas for pollinators including non-native species as suggested by Hoyle et al., (2018), and the establishment of trees in otherwise open areas.

It may be argued that such a focus would provide 'more of the same', homogenous habitat typically experienced in urban settings. Such an argument however appears to:

i) under-value the capacity of such habitats to support a range of species in high numbers, as is the case reported here for beetles;

ii) risks undermining a precautionary approach to urban nature conservation. In the absence of robust, generalised evidence on the relative roles of urban landscape elements within a patch-matrix model, or where such a model breaks down, extensive rather than intensive interventions are justified and consistent with 'more, bigger, better, more joined' nature conservation principles as adopted in the UK Government's 25 year environment plan (HM Government, 2018); and

iii) grossly under-estimates the socio-cultural value placed on common-place nature by urban residents.

6.3.3 Investing in the socio-cultural value of urban GI

With increasing understanding of the health and well-being benefits to be derived from human contact with nature, recent research suggests that cultural values assigned to nature play an important role (section 2.2). Residents have been shown through this study to attach such cultural values, across affective, cognitive and conative realms, to nature experienced in seemingly ecologically impoverished localised spaces. Such values were seen to be tempered by frustrations and perceived risks associated with poorly managed spaces. Planned loss, or neglect of small open spaces, within urban green infrastructure risks undermining opportunities for residents' day-to-day contact with nature and associated health and well-being benefits to be gained. Moreover, urban densification also risks the reduction in number and extent of gardens within new housing developments. This is a particular concern at a time when research, including within this study, suggests that gardens may be least if not more important in promoting nature connectedness and mitigating poor health as other urban greenspaces (Brindley et al., 2018). The negative effect of green infrastructure degradation may be intensified if such localised spaces, as a venue to meet and share experiences in nature, are not provided or of such poor quality as to potentially reverse any positive impacts. Greater priority should therefore be given to retention and management of local and incidental open spaces, not only as destinations for recreation but more generally as providing a 'back-drop' of nature attendant to everyday life. Given a planned decrease in the extent of gardens, the importance of providing such communal open spaces is amplified.

This research indicates that relatively modest management interventions to improve the qualities of retained open spaces could bring substantial social benefits. Consistent to those proposed in the previous section 6.3.2, examples include, creating and maintaining paths in otherwise inaccessible urban woods, tree planting in open grassy areas, a managed shift away from 'the usual' intensive amenity mowing regimes, providing an increase in flowering species within amenity areas. Where resources are particularly limited, as currently

experienced in UK local authorities who remain as the main protagonists regarding ownership and management of public open spaces, prioritising of effort would be required: to identified areas of need in relation to social demographics including indicators of health and well-being.

More generally, whilst the nature-human dose-response relationship remains poorly qualified and largely unquantified, a precautionary approach analogous to that proposed for spatial ecological networks seems justified. Likewise, nature conservation principles of ‘more, bigger, better and joined’ appear to apply equally to, and are strongly inter-related with the socio-cultural particularly if biodiversity conservation in urban setting is considered a largely socio-cultural phenomenon, proposed as a consequence of this study. There is concern therefore that planning polices, as guided by the national policy planning framework in England, largely dismiss the importance of the small ubiquitous open spaces in both social and nature conservation terms. The concern is amplified when these two perspectives can be seen to be inextricably connected in urban settings as shown in this research. Moreover, new approaches being developed in the UK for biodiversity off-setting in relation to new development risk leading to increased loss of, and diverting investment away from urban green spaces in favour of ‘nature somewhere else’.

This study indicates that policies and practices seeking biodiversity gain in urban settings should better integrate the dual ecological and socio-cultural dimensions of place. Prioritisation of, and investment in, people-nature connectedness should be considered as much an attribute of biodiversity gain as investment in bio-physical elements of open spaces. Concepts embedded within, and the practices of, green infrastructure planning provide the opportunities to do so as addressed in the final section of this thesis.

6.4 A strengthened role for green infrastructure planning

Green infrastructure planning (GIP), as it sits at the ‘nexus between disciplines’ (Norton et al, 2019), offers potential solutions to better prioritise potentially competing demands on urban spaces. As pressures from urban compaction and urban expansion grow, urban GI strategies seek to compensate quantitative loss of green space with qualitative gain in what remains (Hansen 2019). With

embedded concepts of multi-functionality and connectivity providing guiding principles, GIP seeks to better integrate natural and socio-cultural dimensions of place and the processes by which priorities are identified (section 2.5). At the same time, there is a risk of nature conservation being lost in a plethora of demands, broadly termed environmental services, on urban green infrastructure (UGI). There is however, as shown in this study, a convergence of benefits in relation to provision of green spaces close to where people live and potential to increase the natural qualities of urban landscapes at a very local scale.

Policy and guidance for GIP exists in the UK at national, regional and local levels (Jerome et al., 2019). The UK Government's National Planning Policy Framework (2019), sets out planning goals in relation to GI, including those related conserving and enhancing the natural environment and specifically seeking net biodiversity gain. More broadly the 25 Year Environment Plan (HM Government, 2018) describes aspirations for increasing and improving GI in relation to urban planning, urban tree planting, landscape scale 'nature recovery networks, health and wellbeing, and aims to develop 'stronger new standards'. In the case study area, Swindon's GI Strategy is directly linked to the Local Plan via several inter-dependent policies including those for green infrastructure, biodiversity and community forest (Swindon Borough Council, 2015). An abundance of associated guidance and case studies supporting such policies are available. The TCPA (2019) in the UK host a resource library contain over 1300 such documents.

Despite the availability of extensive guidance, gaps between policy, planning and practice remain (Pauliet, 2019; Jerome et al. 2019). The nature of the gaps is related to both a lack of conceptual clarity regarding core principle of GI such as multi-functionality (Hansen, 2019) and uncertainty and lack of confidence amongst practitioners (Jerome et al., 2019). Gaps are exacerbated by resource pressures on local authorities in the UK as primary protagonists in GIP and GI provision. These challenges are reflected in the case study area where, anecdotally and as experienced by the researcher, levels of awareness and understanding in relation to GI and GIP appear evidentially low. Examples can be seen in recently published neighbourhood plans within the study area which largely describe GI in terms of assets with a primary use e.g. for play or general recreation with only superficial, if

any, reference to other functions and benefits let alone wider GI networks and strategic thinking. In these cases, there has been little or no consideration of GI as a network of place and functions, and process in the form of GIP.

Work is therefore needed to strengthen the theoretical foundation of GIP principles and their translation into effective policy and practice. A more robust understanding of the principles of GI and GIP is needed to shift away from GI being a ‘broad and elusive’ term (Hansen and Pauleit, 2014) to one that embodies clear guidance. Calls for, and first steps in developing benchmarks for GI standards (Calvert et al., 2018, Hansen et al. 2019, Sinnett et al., 2018) including those related to nature conservation are therefore welcome and require further elucidation to aid translation into policy and practice. Accordingly, recent work in this field by Jerome et al. (2019) proposes a set of 23 principles to guide GIP including those related to health and well-being and nature conservation alongside core principles such as multi-functionality.

Incumbent in new approaches to GIP is an increased understanding of the multiple scales within which other GI concepts such a multi-functionality and connectivity operate, not least for nature conservation and accessibility: street, neighbourhood, within town and as urban networks embedded in the wider landscape. Taking a more collaborative, inclusive methodology, engaged with local communities, would help to provide a ‘bottom up’ local-scale view of GI priorities. A consequential role of GIP would be to align the local-scale view with a more typical, strategic, asset based ‘top down’ approach (Jerome, 2017) to achieve harmony between neighbourhood, within-city and embedded city networks (Calvert et al., 2018, Norton et al. 2016, Werner, 2011).

More broadly, GIP should embody principles of collaboration and inclusiveness (Sinnett et al., 2018, Kambites and Owen, 2006; Mell, 2008) beyond professional protagonists and to a much greater extent as is currently practiced. Embedded in the principles of GIP is the need for strengthened cross-disciplinary working (Sinnett et al., 2018, Mell, 2008, Kambites and Owen, 2006). The Landscape Institute (2018) highlight some of the challenges in language and perception when working across disciplinary boundaries in the context of creation ecological networks: illustrating a mismatch between ecological and landscape planning

approaches goal and priority setting, and definitions of ecological units and networks. As found in the research reported here, difficulties in language and perception in relation to GIP, for example when discussing biodiversity (section 5.2.4) are further amplified in discussions between professional and no-professional audiences.

In the context of these challenges, citizen involvement together with a better understanding of human-nature relationships have been described by Pauliet (2019) as areas needing the greatest improvement in relation to urban GIP. Correspondingly, the mutual roles of urban biodiversity per se and biodiversity as a service providing culturally assigned value, as shown in this study, need to play a more defined role in GIP. Otherwise, biodiversity risks being neglected as a broader sweep of ecosystems services are prioritised in future urban planning, on the assumption that biodiversity gain will necessarily follow. Better definitions of goals for urban biodiversity enhancement acting a different spatial scales are therefore required. The research here recommends that such goals should place much greater value on the local, common-place nature able to thrive in the intricate network of green spaces within urban settings. An emphasis on the local would also necessarily require the closer engagement with communities called for by other research (Pauliet, 2019).

Complimentary to a more locally inclusive approach to GIP would be to develop an extended definition of urban biodiversity, recognised in policy, which encompasses people-nature interactions. Doing so would allow for public values derived from peoples' relationships with nature to be integrated into targets for biodiversity gain and thereby help to prioritise conservation efforts in favour of those that provide social investment for example through information and education provision, and engagement activities. To support such a broader social characterisation of urban biodiversity, and subsequent goal setting, a greater understanding of the oft termed 'intangible cultural benefits' attributed to biodiversity is needed. This study has shown that the foundations for these benefits come into focus in urban settings and that intangible does not necessarily mean unfathomable. Better characterisation of such intangible benefits will help prioritise decision making and allocation of often scant resources in the planning and management of urban

green infrastructure. Doing so would likely place a much more equitable emphasis on investment in people and promotion of nature connectedness, than in the biophysical elements of place when striving for environmental gain.

6.5 Concluding remarks

This thesis has explored the roles of local open spaces, integral to urban landscapes, in delivering ecological, personal and social benefits. Adopting quantitative and qualitative based methodologies it drew on findings from two field studies within spatially overlapping locations of the case study area.

The research demonstrated the importance of a network of interlacing green spaces, typical of urban GI, in supporting wildlife across urban landscapes. The investigation did not reveal relationships between the habitat structure, composition or spatial dimensions of urban broadleaf plantation woodlands and assemblages of ground dwelling beetles, which were chosen as a useful surrogate of wider biodiversity. Rather, the study suggested that it is the close proximity of different types of green space constituting a fine grained urban matrix that allow nature typically encountered in urban areas to thrive.

The research also demonstrated the extent to which the same urban green spaces including small, seemingly nature-poor spaces can elicit a connectedness to nature within local residents. Deeply embedded cultural values assigned by research participants to commonplace plants and animals encountered whilst walking through urban areas were made evident: expressed in the emotions and actions of individuals and as shared with others. The ready availability and natured qualities of such spaces clearly provided meaningful everyday opportunities for people-nature interactions, the health and wellbeing benefits of which are widely accepted.

Losses in both the quantity and quality of local green spaces as a consequence urban densification and potential lack of investment are therefore of concern. At the same time, policies and practices related to biodiversity conservation which undervalue the everyday and commonplace nature close to where people live risk further undermining efforts to realise ecological and social gains associated with urban green spaces.

Green infrastructure planning (GIP) as widely applied in policy and practice in urban settings offers a means to address such concerns: seeking to realise the potential of urban green spaces to deliver multiple, often mutual functions and associated benefits in relation to nature and people. This thesis proposes that local and incidental urban green spaces and attendant commonplace nature should feature to a greater extent and be more visible in GIP than is currently practiced. Doing so would require strengthening of GIP frameworks to include embodying a broader social characterisation of urban biodiversity. The latter would help ensure that values assigned by local residents to nature in their immediate locale are better represented alongside strategic scale approaches to GIP across towns and cities.

Appendix 1. Reference Chapter 2, section 2.3.1 and Chapter 5, section 5.3.1.2

Value-attitude-behaviour concepts and their inter-relationships as represented in research and grey literature relating to nature conservation and natural resource management.

Held and assigned values

Raffaelli et al. (2009) set out a typology of values in the context of biodiversity conservation illustrating the multi-dimensional and contested concept of value. Included in the typology are *held values*, within which sit *non-use values* such as those attributed to aesthetics. In the context of value-attitude-behaviour and other cognitive hierarchy theory models, held value typically refers to those fundamental values defined by Rokeach (1973) as 'enduring belief that a specific mode of conduct is personally or socially preferable to an opposite and converse mode of conduct or end state of existence'. Other terms synonymous with fundamental values have been used elsewhere in research. Held values are 'ideas or principles that are important to people' values of people, values as principles (Lockwood, 1999). Common characteristics of these definitions are that values are seen as highly abstract cognitions are generic and on- context specific, few in number, and relatively 'stable and enduring (Vaske & Donnelly, 1999).

Whilst much social science research has focussed on the role of held or fundamental values, assigned values are seen as increasingly important in environment related research. Assigned values are described as the values that individuals attach to physical places, goods and services (Seymour et al., 2015 citing Lockwood) and express the importance of an object relative to one or more other objects (Brown, 1984). Assigned values have been claimed to be more useful than held values particularly in the field of natural resource management in understanding peoples' relationships to specific sites and places (Brown and Weber, 2012). Moreover, Seymour et al. (2015) in the context of cognitive hierarchy theory (CHT), hypothesise that assigned values may be better predictors of behaviour than held values. Culturally assigned values attributed to biodiversity have also been proposed as being central a pathway linking nature and human health and well-being (Clark, 2015).

Value orientations

Value orientations have been defined as patterns of basic belief (Vaske and Donnelly, 1999) or clusters of held values (Seymour et al, 2015 citing Stern) which are postulated to influence attitude and shape evaluation of environmental issues (Kaltenborn and Bjerke, 2002). Accordingly, value orientations are proposed to influence assigned values (van Riper et al, 2012). Whilst not mutually exclusive, environmental value orientations may be seen to lie on a spectrum from eco-centric to anthropocentric (Gagnon-Thompson and Barton, 1994). Anthropocentric, or human centred views, emphasise instrumental values of natural resources (Vaske and Donnelly, 1999). Eco-centric orientations imply nature has inherent or intrinsic worth, independent of human interests.

Biophilia Value typologies.

The biophilia hypothesis suggests that a human dependence on nature is innate within the humans and has a hereditary basis (Kellert and Wilson,1993). A weakening of such a human-nature dependency is described as leading to a 'deprived and diminished existence' (Kellert, 2005). Underpinning the biophilia hypothesis, Kellert and Wilson (1993) set out 9 value typologies describing the ways in which people fundamentally 'value and affiliate with the natural environment.' The 9 value typologies are set out in table A1.1.

Table A1.1. Value typologies described in support of the Biophilia Hypothesis (from Kellert and Wilson, 1993).

Value typology	**Summary Description**
Utilitarian	Material exploitation of nature
Naturalistic	Satisfaction derived from direct contact with nature
Ecologistic	Scientific study of nature
Aesthetic	Physical appeal and beauty of nature
Symbolic	Use of nature for metaphorical expression and language
Humanistic	Emotional, 'love of nature'

Moralistic	Spiritual reverence and ethical concern
Dominionistic	Control and dominance of nature
Negatavistic	Fear, aversion alienation from nature

Elsewhere in research literature, landscape values typologies have been used to characterise human perceptions of the natural environment (van Riper, 2012) and described as relationship values 'bridging the gap between held values and assigned values' (Brown & Weber,2012).

Value-attitude-behaviour (VAB) model.

In social psychology studies, the VAB model has been widely used to understand behaviour. According to Homer and Kahle's (1988) cognitive hierarchy model, values influence behaviour indirectly through attitudes. The value-attitude-behaviour model therefore implies a hierarchy of cognitions in which the influence theoretically flows from more abstract cognitions (i.e. values) to mid-range cognitions (i.e. attitudes) to specific behaviours. The main feature of this model is its emphasis on the mediating role of attitudes on the values and behaviours relationship.

Vaske and colleagues (2001) expanded the hierarchical model by exploring the mediating role of value orientations, on the relationship between normative beliefs and demographic variables (length of residency, gender, education, and income), that is, demographic variables → value orientations → normative beliefs → behaviour). Other work has suggested that behaviour is not fully mediated via attitude but that there may be direct relationships between value orientations and behaviour (Vaske and Donnelly, 1999).

Thompson and Barton, 1994 (cited Kaltenborn and Bjerke, 2002 p.2) summarise anthropocentric or eco-centric motivations for people's concerns for the environment. Such concerns can be attributed to a person's value orientations be they egoistic, social-altruistic or bio-centric (Stern and Dietz, cited Kaltenborn and Bjerke, 2002). Studies also suggest that variables such as experience, knowledge,

attitudes, and beliefs mediate socio-demographic variation in public support for the environment, (Cottrell, 2003 cited Davies 2011 p 27). The UK NEA (2013) has recently recognised the need for a better understanding of such non-use, shared cultural and plural values ascribed to nature.

Attitude-behaviour theory provides a framework within which to consider the complexities and multi-dimensionality of attitudes towards the environment and how they manifest in peoples' responses to their local environment (Davies, 2011). Attitudes have been summarised as 'a person's general feeling of favourableness or unfavourableness towards some stimulus object*'* (Fishbein and Ajzen, 1975). A multi-component view of attitudes appears generally accepted according to which attitudes are seen as comprising a person's beliefs (cognitive), feelings (affective) and action (conative) tendencies. A number of theoretical models have been used to describe a link between values, attitudes and behaviour toward the environment. For example, the "ABC" and "Value Belief Norm" theories described by Stern (2000), and the Theory of Planned Behaviour (Ajzen, 1991).

Appendix 2. Reference Chapter 4, Section 4.2.2.

Form used for woodland structural and compositional assessments

Site **Date**

Vegetation Cover Domin Scores

Layer	Canopy	Shrub	Field/ ground	Quadrat					
					1	2	3	4	5
Total layer cover				Field					
				Ground					
By species									
Ash									
Field Maple									
Norway maple									
Oak									
Wych Elm									
Bird cherry									
Hazel									
Poplar balsam x									
Willow (crack/white)									
alder									
hawthorn									
hornbeam									
Pop. tremula									
dogwood									
blackthorn									
Sp1									
Sp2									
Sp3									
Sp4									
Sp5									
Sp6									
Sp7									
Sp8									
Sp9									
Sp10									

Other cover DAFOR rating, 20mx 20m quadrat (guide: D= 81-100%, A=61-80%, F= 41-60% O= 21-40%, R= 0-20%)

Bare ground	
Leaf litter	
Coarse woody debris	

Appendix 3. Written consent form. Reference section 5.2.5

Participation Consent Form: Study being carried out by Jonathan Wilshaw, Research Student.

I understand that my participation in the research study will involve discussions and responding to questions during the health walks and in semi-structured interviews/ group or individual meetings, that may be voice recorded. These questions and discussions will involve issues regarding attitudes towards my local environment.

I understand that my participation in this study is entirely voluntary. I understand that I am free to ask questions at any time or to discuss any concerns with Jonathan Wilshaw or with the research supervisors, Chris Short , Senior Research Fellow, Countryside and Community Research Institute, or Anne Goodenough, Course Leader for Biosciences, at the University of Gloucestershire (Contact details below), or the University's Helpzone service.

I understand that the information provided by me will be held confidentially, such that only the project team (Jonathan Wilshaw, Chris Short and Anne Goodenough) will see any transcriptions or hear any original recordings before these are anonymised. I understand that no other staff involved in marking the research work will see any transcriptions or hear any original recordings prior to them being anonymised. My comments will be held in confidence and will be anonymised prior to any electronic or paper-based publication. I understand that in accordance with the Data Protection Act this information may be held indefinitely.

I understand that I can withdraw from the study at any time and for any reason during the data collection period (August 2014- September 2015). Withdrawal after the study has been written up and published will not be possible. Finally, I understand that at the end of the study a summary of the research will be provided if I request it.

I, (please print name).....

consent to participate in the above outlined study.

Signed: ……..

Date: ……..

Appendix 4. Framework for semi-structured interviews. Reference section 5.2.6

Issue/topic area	**What does it cover**	**Areas explored in discussion**	**Prompts from PO /photo work ****
Opening question	Opening up discussion, making relevant to setting, start discussion at a point prompted by the interviewee.	What aspects of enjoyment of walks. Motivations for walking in group and perceived benefits.	
Held values	Values of people, underlying values, value orientations.	Values regarding nature in its own right or benefits/dis-benefits for people. biocentric/anthropocentric leanings Global vs local: just as important locally, here in Swindon ?	nature in its own right, people as part of nature. symbolism
Caring and change.	Perceived change over time, risks, threats.	Are things getting better or worse for nature/wildlife? Look for global to local. Implications for next generation will live in a nature rich area (here)? Feeling expressed. Perceived threats to nature and wildlife in the area	care to apathy expressed. Concern over other peoples' apathy. Poor management, protection of open spaces against development, climate change
Assigned values	Valued held by people: aka value perspective, use/non-use values, instrumental values. Make locally specific.	Why help/ conserve nature here, close to home? Any things you would like to see more of/less of you / nature you could happily do without?	Utility values eg fruit/firewood, education, family cohesion, recreation, health, aesthetic Contemplation, spirituality, tradition Attraction to aversion

Knowledge of biodiversity encountered: general and local	Awareness/Perception of biodiversity. General level of knowledge Understanding of space/neighbourhood w.r.t. biodiversity, where/what? What role biodiversity in experience: visual, sound, smell, feel.	Comparison of local, Swindon and other places. What sorts of animals or plants encountered? Commonplace vs are/unusual. Native, natural vs introduced and managed Tidiness vs 'wild'	extent of greenspace in Swindon Include novelty, awe to indifference.
Shared experience and learning.	Where, when, how is knowledge gained? Formal/informal education. How important and why Enhanced experience if shared?	Shared vs solitary experiences of nature. Who, where, when. Sources of own knowledge Does it matter to you if you know/don't know ?	Consistent reference to shared experiences
Recollection, childhood experience	particular childhood memories, recollections.	Childhood and memorable moments.	Small/minor to significant life experiences
Action/activity	How involved/what actions are taken, negative and positive, local, wider/global.	Potential range of activities, e.g. feeding birds in garden, member of local organisation, national organisation to wider environmentalism Level of active engagement in watching nature, locally or more widely Engagement in activities/practices that might harm nature.	One-off, ongoing. Not knowing what to do/how to do, where opportunities lie. Potential conflicts between what's said and what's done
Things not covered	Other (relevant) areas of participant's interests.	Issues not covered or opportunity for participants to re-emphasise. Opportunity to 'open-up' at end of interview	

Appendix 5. Reference Chapter 5, section 5.3.1.

A participant's perspective of habitats and nature experienced whilst walking compared between the two venues. The montage of photographs, taken during the photo-elicitation stage of the research, alongside field records, walkers comments and interview transcripts are necessarily a pastiche of the researcher's notes as a participant observer and data derived from walk participants.

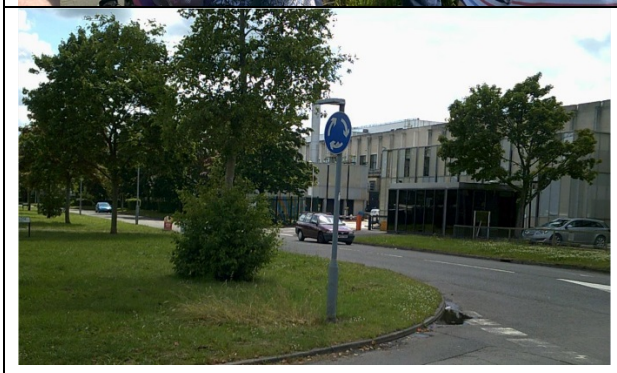
Lower Shaw

	Narrative from Photo-elicitation (Pe) and from field notes (Fn) as participant observer
	<u>The farmyard</u> Farmyard very busy with animals, lots of birdsong from the trees/hedgerows around the farm, groups of magpies very active in a tree near the lake. Other walkers commenting/taking pictures of Indian runner ducks (people laughing, comical) (Fn) '*Beautiful cockerel: 'the boss', gorgeous colours* '(Pe) '*Birdsong. Lots and lots of different sorts*'. Part of his job is to top up bird feeders, recognises blue tits, great tits, blackbird, starlings, magpies, crows, pigeons, seagulls (Fn). 1st snowdrops seen this year. Other walker noted catkins out on hazel, which we talked about later around the table(Fn)
	<u>Boundary features, hedgerows</u>. Loves autumn colours, seeing seasons change. Berries in hedgerow, food for wildlife (Pe) '*shady, soft mix of environments, 2 in harmony' (Pe).* *Amazing fungus*. Remembers a bright yellow fungus on a tree near the bus stop. Fungus all the way up the tree. (Pe).

	Birds. Has seen red kites and remembers seeing a kestrel. Starlings bubbling in hedgerow. (Fn) He asked about fruit/food in the hedgerows (Fn) Brambles: not dying back because too warm.
	<u>Plantation woods and amenity grass</u>. At one point along the walk the path narrowed with lots of bird activity in the shrubs and trees along the path. Happened during a lull in the conversation- a 'tame' blackbird in the tree watching the walkers watching him (Fn) 2 jays un-noticed by walkers (Fn)] Log pile: should wood be left to form habitat or taken away to burn? what's most sustainable? (Pe) Loves the brown of the trees against the blue skies of a winter's day. Once tried to buy a set of curtains to match. (Pe) Bird life very active including thrushes and woodpeckers. Lots of bird song/calling in hedgerow, easier to see when no leaves on trees. (Fn) Not much wildlife (fauna) noticeable but good autumn colours. Tree line of beautiful autumn colours, people don't see these things. (Fn)
	<u>Open standing water, ancient woodland remnant</u>. Wildlife: birds, water birds-swans ducks and Canada geese, butterflies, terrapins in water. Likes taking grandchildren going to weir to see the terrapin. Fascinated by ducks/geese. (Pe) Knows Peatmoor Copse as a bit of ancient woodland. '*Sounds romantic, a time before deforestation. Difficult feeling to describe being in the woods, something more than just a group of trees together' (Pe)*

	<u>Small Watercourses</u> Reminded of ditch near home, watching an egret. (Pe) Overlooking stream, leaning on the rail, listening to the sound of the water,' *like the wind, like fire'*.Other member of the group wanted to tell people about the first kingfisher she had seen on the local stream. (Fn)
	<u>Scattered trees, formal planting, amenity grass</u> Shape of trees against sky. '*Don't need to know what sort of tree it is*.' (Pe) Nice tree, likes the shape and play of shade and sun. '*Trees are stoic, toughing it out over winter' (Iv)*
	<u>Residential areas, gardens,incidental spaces:</u> Apples not being used. Reminded him of story of elks/horse in Scandanavia trying to get in to trees to eat fermenting fruit and becoming addicted: the 'crazed elk'. (Fn) Ivy on tree raising issues of lack of tree/forestry management. (Fn) Dandelions continuing to grow when they shouldn't, aware because his wife picks dandelions for their guinea pigs. (Pe) Also sees lots of squirrels and 'that sort of thing' very common in the parks. (Fn)

Covingham

	<u>Formal landscape around centre.</u> Unkempt, formal planting within hard landscape. Grass worn. (Fn)
	<u>Urban trees, road verges, formal planting</u>. Talked about blossom from poplar trees Thought they were problematic plants and garden centres won't sell them. (Fn) Having notice dandelions in verge talked about her mother making dandelion drink. (Fn). Conversations about 'pollen' falling off trees, seeds coming off willow, flying into people's faces. (Fn) Wild poppies [cultivated in garden], lovely, pretty colours and natural. (Pe) Blossom on floor, '*nice and soft. springy, spongy'* to walk on. (Pe) Wild barley [in verge], not many people would notice but remembered growing on the farm. (Pe) Jackdaws flying over with seagulls, how seagulls are becoming a real nuisance. Thought about wasps in her garden. (Fn)
	<u>Urban hedgerow</u> Lots of spring-like activity,loud and varied birdsong. Blossom spectacular in sunlight and despite walking underneath the bows of a tree in full blossom I didn't notice any reaction from walkers. First flush of green. Also picking up some scent from the hedgerows. (Fn)

	Other walker called this a May tree, thinks it is hawthorn. Elder flowers, good for cordial and wine making. (Fn) Rosehips, didn't think there were many around her area but had seen lots out at Lydiard. Useful for Rosehip syrup. (Fn)
	<u>Connecting greenway</u>: Trees, shrubs heavy with fruit, haws, rosehips, blackberries, autumn colours just starting. (Fn) Some kicking of conkers fallen on the path. (Fn) Noted nice green corridor-all the green and blossom starting-like it had been waiting for warm weather. (Pe) .
	<u>Residential, gardens and incidental greenspace</u> Ducks out of place, funny, *out for walk and got lost*. Nice to see unexpected wildlife. (Pe) Ivy running up side of house a problem, vegetation overhanging path needed cutting back as it was a nuisance brushing against leg when wet (Fn) Seagull, how it was now like being at the seaside. She noted a jackdaw flying over. (Fn) Thought they had wasps nesting in the house so took advice but found to be bees. (Fn) Rosehips, not seen locally: saw some later in the walks overhanging the path 'there are my rosehips'. (Fn)

	Also noted roses coming into full bloom. Her husband used to work 'parks and gardens' (Fn) lady cutting back plants around car park. Where will the insects go? joked about forming a protest group. (Fn) Wisteria climbing over fence, nice to see things cared for. Nice rambling rose coming into flower. (Pe)
	<u>Expansive amenity grass</u> Magpies squabbling, lots of berries nuts on pavement, leaf strewn, bird song from isolated tree in a 'green desert/bleak sort of landscape-all very similar-lollipop trees in mown grass. (Fn) Only response observed during the walk was the '*smell of freshly mown grass'* (Fn) Walk stopped in couple of locations, despite sun on back, blossom in trees and plenty of bird activity v. little noticeable response to the environment we were in. More interest shown in dogs walking past. (Fn) Cherries starting to ripen on trees. (Fn) Pet dogs, they are dog lovers, good for social exercise. (Fn)
	<u>RJ corridor Plantation woodland, small water body, beetle survey area</u> when stopped on bridge over brook, [walker], looking for a photo. Hawthorn heavy with berries. Some of group stopped along the way to pick blackberries. Lady walked through leaf litter on path-'the sound of the autumn'(her words.) He noted the 'ducks' [moorhens] on the lake (Fn) Ground anemones, seen lots on other walk and recognises what they are. Would recognise lots of trees and birds, spring flowers such as bluebell, primrose, cowslip celandine etc. (Fn)

	Talked about some of the small woodlands we walked passed: unwelcoming place, would be concerned about safety, but also prompted him to ask if there would be any snakes there. (Fn) Other walkers mentioned how nice the '*May Flowers'* were. Overhead the same lady talking about the smell of foxes we had just past. No-one else appeared to notice when walked past the lake .Spring in full flow, blossom, bird and butterflies including brimstones and tortoise shells. Chiff chaff calling. (Fn) Walked past several woodlands where I have been beetle surveying. Noted how green things were looking, heavy with spring growth. (Fn) Went 'off piste' alongside the RJ woodlands. Talk about brambles (in flower) and how they will be good for blackberries later in the year, also blackthorn and jokes about gin. (Fn)

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