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INVESTIGATING THE
POTENTIAL OF
UTILISING PRIVATE
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WILDLIFE
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ABSTRACT

The rapidly expanding urban environment is a major threat to global biodiversity. Contributing to habitat loss and creating a fragmented ecosystem in which none but the most adaptive generalist species can survive. As urbanisation increases, a growing number of the population find that interaction with nature is removed from their everyday lives, which can lead to a lack of empathy toward nature through an 'extinction of experience'. This research investigates whether utilising private gardens within an integrated wildlife gardening strategy can improve the urban ecosystem by creating sustainable wildlife corridors, simultaneously increasing empathy with nature through increased contact. Using two questionnaires, one to establish public perceptions about wildlife gardening and levels of concern for declines in wildlife populations, and the other surveying teachers to validate the theory of 'nature deficit disorder', a lack of empathy with nature was established among young children, although wildlife concern among adults was fairly high. Many variables affecting wildlife concern and wildlife gardening enthusiasm were analysed, providing useful data for environmental managers to be able to implement the proposed strategy. However, to create a sustainable urban ecological network, and to increase support for wider environmental initiatives, it will be necessary to reconnect the population with nature, through increased environmental education, but also by increasing not just the access to urban green space but the inclination to use it. Increasing the quality, not just the quantity of experience.

CHAPTER 1

1 INTRODUCTION

Of 8,431 UK species assessed in the 2019 state of nature report, 15% are classified as threatened with extinction and 2% are already extinct (Hayhow et al, 2019). The major contributing factor is the intensification of agriculture (Emmerson, et al, 2016; United Nations, 2018), which has not only lead to a dramatic decrease in quality of the most extensive wildlife habitat in the UK but has created a fragmented ecosystem with isolated pockets of habitat unable to sustain viable populations of many species (Haddad et al, 2016). The rapidly expanding urban environment (United Nations, 2018) is another major threat to global biodiversity, but ironically the fate of nature conservation may well rely upon the nature that remains in urban areas. Dunn et al, 2006) coined the phrase 'pigeon paradox' for the dependence of conservation actions on the urban population's direct experiences with nature.

This dissertation will create a plan for a sustainable urban ecological network, investigating the potential of utilising private gardens to create wildlife corridors within the network. Not only exploring the ecological potential but whether, as interaction with nature is removed from the day to day lives of more and more of the population, and

as human beings are “*unlikely to protect what they do not love, and cannot love what they do not know*” (Gould, 1991), the intuitive consequence is a corresponding decrease in support for wildlife conservation.

This chapter will provide an overview of the areas of research that will directly affect the creation of wildlife corridors, then outline the aims and objectives which will frame the research.

1.1 AREAS OF RESEARCH

1.1.1 FRAGMENTATION

Understanding the effects of habitat fragmentation is vital in order to effectively design and manage an urban ecosystem. Fragmentation effects are extremely complex, predominantly because they are dependent upon the habitat composition, landscape configuration, species interactions, external influences and species mobility which will be specific to individual sites (Gippoliti and Corrado, 2017). One way of understanding the dynamics of a fragmented landscape is to view it in terms of meta-populations, a term coined by Richard Levins in 1969 (cited by Hanski & Gilpin, 1991) for a ‘*population of populations*’, distinguishing between the dynamics of a single population and a set of local populations.

1.1.2 URBAN BIODIVERSITY

Meta-population theory becomes more pertinent when assessing urban ecosystems as they are inherently made up of disparate habitats both in size and quality, with urban green spaces often being small and isolated (Lepczyk et al, 2017). However, it is wrong to assume that this universally results in low levels of biodiversity, Aronson et al’s (2014) study on the impacts of urbanisation on bird and plant diversity across 100 global cities, found substantial variations in species density as a result of anthropogenic factors. Biodiversity cannot be analysed in ignorance of species composition, as increased urban species richness generally results from introduced non-natives (even when extinctions of native species are considered) (Winter et al, 2009), often resulting in taxonomic and phylogenetic homogenisation (McKinney, 2005). The latter is rarely considered but the introduction of closely related species is rapidly reversing the regional botanical uniqueness evolved over millennia (Winter et al, 2009; Čeplová, Kalusová and Lososová, 2017). There is also evidence for loss of phylogenetic diversity in urban avian populations (Morelli et al, 2016; Ibanez-Alamo et al, 2017), which could have wider implications for adapting conservation goals to reduce this loss in evolutionary information. Biodiversity needs to be studied at a variety of spatial levels, as high levels of biodiversity at local levels may accompany decreasing biodiversity at the global level (McGill et al, 2015). This research will focus on the garden scale and the urban area as a whole, however strategy must ultimately consider interactions between urban ecosystems at a national scale, ensuring that habitat is sufficiently connected to maintain genetic diversity.

A high proportion of alien species is not universally negative though, the higher floral abundance and diversity often found in urban areas (particularly in private gardens) has been highlighted as an important opportunity for pollinator conservation (Garbuzov and Schurch 2014; Baldock et al 2015; Baldock et al, 2019) as many pollinators seem less particular about the heritage of the flowers they visit. Urban areas can often be richer in native plant species and even harbour self-sustaining populations of rare or endangered species of flora and fauna (Kowarik, 2011; Ives et al, 2016). However, whilst cities could be important in providing refuges which may avoid extinctions in the short term, this does not offset the ecological consequences that their restriction to urban areas has on the natural ecosystem which they vacate (Luna, et al 2018).

Provision of urban biodiversity often masquerades as ‘ecosystem services’ (“the benefits that people gain from ecosystems” (Fisher and Kerry Turner, 2008), the two terms sometimes used synonymously, implying that provision of green space for ecosystem services will automatically benefit biodiversity and that biodiversity itself provides an ecosystem service (Mace, Norris & Fitter, 2011). This is simplistic and potentially problematic, however with well-informed planning, synergising the two can provide conservationists with a useful tool in selling biodiversity measures as socially and economically beneficial (Cimon-Morin, Darveau, Poulin, 2013).

1.1.3 GREEN INFRASTRUCTURE AND ECOSYSTEM SERVICES

The European Commission defines green infrastructure as “*a strategically planned network of high quality natural and semi-natural areas with other environmental features, which is designed and managed to deliver a wide range of ecosystem services and protect biodiversity in both rural and urban settings*” (European Commission, 2013). Green infrastructure is considered by many to be the answer to reconciling ecological conservation with economic development and urbanisation (Thomas and Littlewood, 2010). Providing benefits such as:

- Pollution remediation
- Flood prevention/attenuation
- Recreational benefit
- Human well-being
- Temperature regulation (avoiding urban hot spots)
- Carbon sequestration
- Sewage treatment
- Improving water quality
- Education (city farms, nature reserves)
- Reducing cost (grey infrastructure is expensive)
- Aesthetic appreciation
- Nature conservation

(Wentworth, 2017)

The term green infrastructure is often used as a generic term to refer to any green space, however for this research, green infrastructure will be defined as ‘engineered green space with the primary function of providing anthropogenic benefits’, retaining the key phrase from the European commission definition, ‘strategically planned’.

“Egoism, which is the moving force of the world, and altruism, which is its morality, these two contradictory instincts, of which one is so plain and the other so mysterious, cannot serve us unless in the incomprehensible alliance of their irreconcilable antagonism”.

(Joseph Conrad, 1901, taken from Hannis, 2011)

Urban green infrastructure provides an opportunity to create habitat through anthropocentrically targeted approaches, designing in ecological benefits as a by-product, removing the dependency on altruistic decision making, increasing funding through re-appropriating funds that would usually be spent on grey infrastructure. Simultaneously increasing public perceptions of the benefits of nature.

1.1.4 WILDLIFE GARDENING AND CONSERVATION CORRIDORS

The promotion of gardening for wildlife is a relatively new phenomenon. The Royal horticultural society promote wildlife gardening through schemes such as ‘plants for pollinators’, the ‘plants for bugs’ project and ‘wild about gardens’ (rhs.org.uk, 2020). However until recently their encyclopedia of gardening, which is considered to be the definitive guide to home gardening, devoted only a single page out of 750 to wildlife gardening (Brickell, 2002). There are now numerous schemes promoting wildlife gardening in the UK (appendix, table 6), many run by wildlife organisations promoting the protection of certain species such as the bumblebee conservation trust and hedgehog conservation trust.

Private gardens in the UK cover over 10 million acres (Wildlife Trusts, 2020; Ons.gov.uk. 2020) so their potential as wildlife habitat is significant, however the challenge for this research is coordinating efforts of gardeners. There is little guidance for methods of encouraging wildlife gardening and aligning this with public land management policy (Mumaw and Bekessy, 2017). For private gardens to function effectively within an urban ecological network, habitat will need to be coordinated and aligned with habitat requirements of species in larger nearby habitat patches. Rather than run the risk of the outcomes of many small-scale decisions being detrimental to the overall biodiversity in urban landscapes (Goddard, Dougill and Benton, 2010). This research aims to address the issue that the potential of private gardens is under-utilised, as their management is either non-existent or uncoordinated, and independent of municipal management strategies (Schneider et al, 2019).

An ‘ecological network’ consists of habitat areas of various size, shape, quality and isolation, in order to effectively connect these habitats there needs to be a landscape scale assessment (McHugh and Thompson, 2011), incorporating natural, semi natural

and completely man-made habitat. However in urban areas, gathering data to validate the connectivity of ecological corridors is complex and expensive (Grafius, et al 2017), meaning that there is little specific data to guide planners or to validate the concept. Species data is often only available for single species or taxon, with little data available at a community level, i.e. prey species or species with important co-dependencies (Sabo J, L. 2008; Liu, Newell, White and Bennett, 2018).

1.1.5 PUBLIC PERCEPTION

To maximise the adoption of wildlife gardening it will be crucial to understand general motivations for gardening behaviour, and levels of environmental concern. To influence decision making it is crucial to identify different attitudes, Van der Werff, Steg and Keizer (2013), assert that people with a 'strong environmental self-identity' will engage in environmentally friendly behaviour without any external incentives. However, keen gardeners are often less disposed to participate in wildlife gardening activities because of a desire to adhere to 'perceived norms', which tend to favour conventional gardening design (Nassauer Wang and Dayrell, 2009). Current wildlife gardening initiatives (appendix, table 6) generally only influence keen gardeners who wish to garden for wildlife, with no strategy for 'engaging the unengaged' (Shaw, Miller and Wescott, 2013).

Human-nature interactions in urban areas are important because of the potential negative impacts on wildlife but also because of potential positive impacts on the health and well-being of humans (Soga and Gaston, 2020). The absence of positive interactions can lead to a lack of empathy toward nature (McMahan, 2018) which needs to be addressed for widespread adoption of wildlife gardening practices to become a sustainable reality.

1.1.6 EDUCATION

"If you are thinking a year ahead sow a seed, if you are thinking a decade ahead plant a tree, if you are thinking a century ahead educate people".

(Kuan Chung. d.645bc, taken from Mba D, 2018)

When it comes to ecological knowledge and empathy, children seem to be less connected than ever, Richard Louv (2005) coined the term 'nature deficit disorder', for children who have little contact with nature. Proponents of this theory believe that exposure to nature from a young age will return the population to a general state of 'Biophilia', which is the concept from biologist E O Wilson that humans have an 'innate and genetically determined affinity with the natural world'. *"..to the degree that we come to understand other organisms, we will place greater value on them, and on ourselves"* (Kellert and Wilson 1993). It was summed up by the lepidopterist Robert

Pyle when coining the term 'extinction of experience': "*What is the extinction of a condor to a child who has never known a wren?*" (Shanahan & Fuller, 2016). This research will be carried out in consideration of the following statements:

In urban areas 'nature deficit disorder' is likely to be inherent, particularly in younger people who have had little interaction with nature.

Better environmental education will return the population to a state of biophilia.

1.2 AIMS AND OBJECTIVES

Aim: To investigate whether utilising private gardens within an integrated wildlife gardening strategy in urban areas, can improve the urban ecosystem through establishing corridors between existing habitat, and creating new habitat.

Objectives:

1. To investigate public perceptions of wildlife gardening, and general concern for wildlife.
2. To investigate possible methods for raising levels of concern for wildlife and evaluate whether they could lead to increased participation in wildlife gardening and support for wider conservation goals.
3. To create a strategy for a sustainable urban ecosystem utilising private gardens in consideration of the primary research findings.

1.2.1 RATIONALE

The use of private gardens for conservation is not a new idea, but many of the current strategies are focussed on provisioning for single species or taxa, or encourage wildlife gardening without any strategy for coordinating efforts to create effective wildlife corridors.

This dissertation will attempt to reconcile currently disparate research, evaluating the potential of private gardens as conservation corridors, ecologically, logistically and in consideration of attitudes of garden owners. It will then provide recommendations for improving public perceptions in the long term. It aims to identify an opportunity through unifying scientific research and collaborative use of resources, to create and improve important ecosystems in currently fragmented urban areas, with the potential of creating habitat that is now rare in the wider countryside. Simultaneously increasing environmental connection to urban residents and consequently their empathy to wider conservation issues.

This research is more significant in consideration of the importance of urban areas for many species that are struggling to survive in the wild such as peregrine falcons, who have suffered from persecution from game keepers and pigeon fanciers, and the use

of organochlorine pesticides (RSPB, 2020), but are thriving in many urban areas (Kettel et al, 2018; Allen, 2020), or hedgehogs, whose urban populations are now stronger than those in rural areas (Braaker, Kormann, Bontadina and Obrist, 2017). Whilst they do not replace the need for protecting natural habitat, urban areas can provide significant oases, in a world where there are no habitats unaffected by human interference, as long as there is an '*understanding of ecological and evolutionary responses of organisms to urban environments*' (Eggenberger et al., 2019).

1.3 APPROACH

SECONDARY RESEARCH

Before researching public attitudes toward wildlife conservation and likely participation levels in wildlife gardening, it is first necessary to have an in depth understanding of urban ecosystems. The literature review will investigate current research on the effects of fragmentation of habitat on wildlife populations, the potential of urban ecosystems to be useful habitat, the use of wildlife corridors, the potential of wildlife gardening within urban ecosystems and how public perceptions affect these.

PRIMARY RESEARCH

Chapter 3 will describe the primary research methods chosen for this study, evaluating the reasons for their choice and how they were implemented.

The research will be conducted through the use of two questionnaires.

Survey 1: to determine public perceptions of wildlife gardening.

Survey 2: To investigate the role that exposure to nature at a young age has on the environmental empathy of adults.

SURVEY 1

Initially an online survey will be shared. The sample size will be a minimum of 100 with a necessity for a mix of gender, age and most importantly location. With a mix of urban and rural residents and of urban/rural birthplace.

SURVEY 2

This survey will be aimed at education professionals and will be distributed to schools as an online questionnaire. There is a requirement for a mix of primary/secondary and urban/rural schools.

1.3.1 RESULTS AND ANALYSIS

The research results will be presented and analysed in chapter 4.

1.3.2 CONCLUSIONS AND RECOMMENDATIONS

A strategy will be outlined in chapter 5 for the use of private gardens within urban ecosystems, with the greatest potential in consideration of the research results and literature findings.

Recommendations will be made for future research, outlining possible strategies for improving environmental attitudes and consequently the likelihood of greater participation in wildlife gardening.

CHAPTER 2

2. LITERATURE REVIEW

2.1 HABITAT LOSS AND FRAGMENTATION

Habitat fragmentation is generally considered to be a leading cause of global biodiversity loss (Damschen et al, 2006) and the substantial research on the effects of habitat fragmentation on biodiversity is very diverse (Fahrig, 2003). In her 2013 and 2017 papers, Fahrig claimed that ‘habitat fragmentation per se’ (the term she has used for ‘fragmentation independent of habitat amount’) does not result in significant ecological responses and that many relationships were positive (e.g. abundance and occurrence of species), which she describes as the habitat amount hypothesis, i.e. that the overall habitat area is the most significant factor, regardless of how fragmented it is. There is much debate about the importance of habitat fragmentation ‘per se’, Fletcher et al, (2018) refuted Fahrig’s conclusions, claiming that they derived from reviewing a narrow set of literature, and that there is clear evidence in meta-population data, (a term coined by Richard Levins in 1969 (cited by Hanski & Gilpin, 1991) for a ‘*population of populations*’, distinguishing between the dynamics of a single population and a set of local populations) over decades that habitat fragmentation can increase extinction rates and decrease colonisation rates. Meta-community modelling (a community of meta-populations) conducted by Thompson et al, (2016), concluded that fragmented ecosystems without high connectivity severely restricts the ability of meta-populations to survive. Hadley and Betts (2016) argued that progress in conservation is dependent on viewing habitat loss and fragmentation as completely independent processes. However, this paper was edited by Dr Lenore Fahrig who is spearheading much of the literature carrying these arguments, and it reads more as an endorsement of her opinion rather than offering anything new. Fahrig conceded that the habitat amount hypothesis was a necessary simplification for the advancement of conservation and whilst there is little scientific support for undermining the effects of fragmentation, ensuring the protection of small areas of habitat is important. However, if these habitats remain isolated there will be significant effects on the flora and fauna they support.

The forces acting upon species will often be strongly affected by fragmentation. The Janzen-Connell hypothesis (Janzen, 1970; Connell 1971), states that the density of tree species in tropical forests is maintained by predation of seeds and seedlings near the base of conspecific mature trees, giving a competitive advantage to seeds dispersed the furthest from the parent plant and preventing any one tree species from becoming dominant. This hypothesis has received widespread support, and has been tested in many woodland environments (Comita et al, 2014; Skelsey 2013; Liu, 2015; Nathan, 2004) although the requirement for specialist predators has been called into question (Stump, 2015), and Deniau et al (2017) have claimed that Janzen-Connell effects on oak recruitment in temperate forests are more likely to be due to microclimatic effects. However, testing of the hypothesis mediated by soil biota (Liu,

2015) and fungal pathogens (Bagchi, 2010; Liang, 2015) rather than focusing on herbivorous predators seem to prove that the Janzen-Connell hypothesis is not only a factor in species density and dispersal, but is extremely complex. In a fragmented environment this could result in one tree species becoming dominant or the converse, depending on the species existing within the habitat patch. Further complexity is contributed by Liang et al, (2015), whose study found that the presence of arbuscular mycorrhizal fungi counteracted the effect of soil pathogens and reduced the Janzen-Connell effect.

Studies on the effects of fragmentation on specific species highlight how difficult and complex it can be to predict changes resulting from fragmentation. The Wog Wog habitat fragmentation experiment in New South Wales is one of a few large-scale long-term fragmentation experiments (King et al, 2018) and has been the site of many studies since it was established in 1985. These include findings by Tuff et al (2018), that lizard body sizes were smaller in forest fragments compared to control forests, and a study by Resasco et al (2017), of the same species of lizard, *Lampropholis guichenoti*, found that contrary to their predictions, the lizard changed its ecological niche within the ecosystem, most likely due to changes in distribution of an amphipod prey species. Changes in prey resources and predation are considered to be drivers for evolutionary change. These findings are not surprising when considered in comparison with long held theories of accelerated evolution among island species (Darwin, 1859). Species in isolated mainland habitats are likely to evolve at an accelerated rate as the reduction in species diversity leads to a re-organisation of species interactions, with body size likely to be explained by resource limitations (Millien, 2006; Herrel, 2008; Runemark, 2015). Fragmentation effects on tree growth and survival at Wog Wog found that there was increased growth over the first four years following fragmentation, but both biomass and mortality rates were then equivalent to continuous forest cover areas (King, 2018). However, it was also found that smaller trees were outcompeted in the fragments, driving habitat homogeneity with potential long-term consequences for understorey species. Many researchers consider that island biogeography theory provides a better prediction of species richness in isolated habitats (Lindgren, 2016), highlighting the importance of habitat configuration when assessing plant species richness in fragmented habitats. Island biogeography theory provides an explanation for the dynamics of the observation that larger islands have more species than smaller ones and species levels are higher the closer the mainland is to the island (Jaquet, 2017). Applying island biogeography theory to terrestrial habitat patches is more complicated, as rather than being surrounded by water they can be surrounded by a variety of landscapes which are likely to contain populations of a variety of species, which can often introduce negative effects such as competition or predation (Yu, 2001).

2.2 URBAN BIODIVERSITY

The rapidly expanding urban environment is one of the major threats to global biodiversity, so it is ironic that the fate of nature conservation may well rely upon the

nature that remains in urban areas. Dunn et al (2006) coined the phrase ‘pigeon paradox’ for the dependence of conservation actions on the urban population’s direct experiences with nature.

Much of the research on biodiversity is concentrated at the ecosystem scale with comparatively little research at the species, community or gene level (Botzat, et al, 2016). The majority of the research at the species level is focused on individual species or taxa (Sabo, 2008; Liu, Newell, White and Bennett, 2018), with relatively little focus on species interactions (Dilkina et al. 2016). One reason for this is the umbrella species concept (Seddon, et al, 2008), where a single species is targeted whose range, habitat and resource requirements encompass those of many co-occurring species. This is promoted as a conservation planning concept on the basis that if resources can be targeted on the umbrella species, co-occurring species will naturally benefit without additional attention. However, studies have found that there is a requirement for rigorous assessment of potential umbrella species and of co-occurring species (Seddon and Leech, 2008; Branton and Richardson, 2010; Maslo et al. 2016), so it may not always be the short cut that it seems. A benefit of the umbrella concept is that it is often used to increase financial support and raise awareness by using ‘flagship’ species such as top mammal predators (Sergio, 2006).

This is very relevant to this study as there is a conservation focus on popular species such as bees, butterflies, birds and hedgehogs (appendix, table 6). A focus on fundraising and promotion using these species whilst ignoring less glamorous (or popular) species is a useful conservation strategy as long as it fully considers co-occurring species.

2.3 CONSERVATION CORRIDORS

Possibly the earliest example of an urban ‘green’ corridor is Boston’s ‘emerald necklace’ designed by Fredrick Law Olmsted (the designer of New York’s central park) in the 1870’s (Billis, 2018). This is a seven-mile-long network of parks, meadows and woods, designed to provide sanctuary and tranquillity for Boston’s residents. The idea of ecological corridors to connect isolated areas of habitat didn’t become popular until 1980 in response to the recognition that conservation biology must exceed the boundaries of designated protected areas (lucn.org, 2019)

Corridors can be simply defined as *“a physical or biological strip that allow the movement of species”* (Van Der Windt and Swart, 2007). In urban areas much habitat is more likely to be connected by stepping stones, which are small islands of habitat that are functionally connected, but not continuous (Lynch, 2018). It is also necessary to consider that natural habitat is very rarely continuous landscape, but a sporadic mixture of habitat, which can be vital for the various life cycle stages and for different activities (such as foraging, mating or nesting) (Vimal, Mathevet and Thompson, 2012). However, in an urban area it will be more difficult for many species to travel between these habitat types, potentially limiting the effectiveness of urban habitat to

highly mobile species, to the possible detriment of less mobile co-occurring species, which can adversely affect the target population through the loss of symbiotic species, highlighting the complexities of urban ecosystems and the requirement for ‘context-specific strategies’ (Gippoliti and Corrado, 2017). In their critique of ecological corridors, Boitani et al (2007), pointed out that they oversimplify ‘complex ecological concepts’ and are generally species specific, with information available for only a handful of species, which has been a continuing trend in ecological network research (Sabo, 2008; Liu, Newell, White and Bennett, 2018).

There is a scarcity of scientific knowledge about the specific features that make an ecological corridor effective for conservation (Closset-Kopp, Wasof and Decocq, 2016). The available research is particularly vague concerning requirements of integrating structural and functional connectivity (Nor et al, 2017). In urban areas gathering data to validate the connectivity of ecological corridors is complex and expensive (Grafius, et al 2017), meaning that there is little specific data to guide planners or to validate the concept.

An ‘ecological network’ consists of habitat areas of various size, shape, quality and isolation, in order to effectively connect these habitats there needs to be a landscape scale assessment (McHugh and Thompson, 2011), incorporating natural, semi natural and completely man-made habitat. With a requirement for sufficient habitat patches within the network which are substantial enough to support species populations, which themselves are large enough to ‘export individuals’ (Vimal, Mathevet and Thompson, 2012). There is a particular lack of research in urban areas (Ersoy, Jorgensen and Warren, 2019) and little agreement on the best methods of modelling connectivity (De Montis et al. 2016). There is also debate surrounding the effectiveness of corridors to connect habitat patches, with an alternative view that corridors are more beneficial in creating habitat than linking existing patches (Ignatieva, Stewart and Meurk, 2010; Fahrig, 2013). There is also concern that corridors can have negative consequences, facilitating the movement of disease or non-native invasive species, or creating bottlenecks or ‘ecological traps’ with higher predation rates. (Åström and Pärt, 2013; Haddad et al. 2014). However Hawn, Herrmann, Griffin and Haddad, (2018), found that greater prey movement created trophic subsidies, overriding trophic cascades (*“indirect species interactions that originate with predators and spread downward through food webs”*) (Ripple et al, 2016), created by a lack of prey species in isolated habitats. In his 2019 meta-analysis of corridor efficacy, Resasco found that in spite of negative consequences, ecological corridors are beneficial for conservation.

In a recent literature review, Lynch (2018) found that within the last ten years there have been no studies examining the on the ground results of corridor projects. Most available research either compares the relative potential of corridors and stepping stones, theoretically hypothesises potential negative impacts, or are single species connectivity studies or modelling techniques trying to find ways around the lack of specific data. The consensus is that corridors are beneficial but that negative impacts

must be considered, however, in consideration of the fact that almost all research concludes that there is a lack of data, particularly in urban areas, theoretical research and modelling seems futile. Consequently the final strategy developed in this research will include mechanisms for continuous monitoring through citizen science and regular ecological surveys, facilitating self-improvement and providing data to inform future research.

2.4 MODELLING

Modelling connectivity of urban ecosystems is extremely complex as connectivity is dependent on the landscape and more importantly on the species (Braaker, Kormann, Bontadina and Obrist, 2017). Traditionally the Euclidean distance between two patches is used as a measure of their isolation (Thiele, Buchholz and Schirmel, 2017). However, within an urban ecological network, the intervening habitat is far more variable, and often hostile than natural habitats.

Many modelling tools are used to measure habitat connectivity such as FRAGSTATS, circuit theory and graph theory, however they only measure structural connectivity without being able to incorporate ecological functions or species interactions and synergies (Kupfer, 2012; Li and Wu, 2004). Many studies have used modelling tools to assess landscape connectivity within urban areas without any reference to species (Zhang et al, 2018), and those that do generally only consider a single taxon or species (Grafius, 2017; Nor et al, 2017; Burke et al. 2019; Wan, Cushman and Ganey, 2019). Ersoy, Jorgenson and Warren (2019), modelled a multispecies 'least-cost' corridor in Sheffield, which in the absence of detailed species data used experts to project data for 7 species. This study highlighted many of the same issues that single species modelling encounters, concluding that developing modelling techniques is important to establish landscape scale networks, but without creating a useable model.

For modelling techniques to be valid they must be able to incorporate meta-community data. Miller and Bohannan, (2019), developed a meta-community model, adapted from Shoemaker and Melbourne, (2016), and whilst it is a development of previous ideas it relies on many assumptions. It uses a patch dynamics model which assumes that all habitat patches are identical (Leibold et al., 2004), and all interactions within the matrix (between patches) are simulated randomly without knowledge of conditions.

Generic modelling for connectivity of urban ecosystems is not yet at a stage where it can be particularly useful for planning and managing ecological corridors. Knowledge of structural connectivity and resistance are useful for planning, but a bespoke plan with research on the specific species and environmental/landscape conditions is required. A network with a high dependence on private gardens is more complicated, as this will inevitably create a dynamic ecosystem consisting of a high number of small very varied patches that are liable to change completely at the whim of individual gardeners.

2.5 WILDLIFE GARDENING

'Around a third of urban space in the UK consists of natural land and green space' (Thomas, 2020). In London, private gardens make up almost 24% of the total area of the city, but a report by the London wildlife trust has found that between 1998 and 2006 the area of planted land dropped by 12% as a result of changing gardening habits (Vidal, 2020). Some of the reasons provided by the report were gardens being paved over for parking, reducing upkeep costs for landlords in inner city areas, and suburban residents paving over their gardens in response to changing garden fashions.

The total area taken up by private gardens in the UK is more than 10 million acres which is greater than the combined area of all of the country's nature reserves (Wildlife Trusts, 2020, Ons.gov.uk. 2020). When considered in the context of 15 million small patches of potential habitat (Ryall and Hatherell, 2003) connecting other areas of urban habitat with each other and the wider rural environment, their value cannot be overlooked.

For conservation the major problem is that whilst gardens cover a huge area they are under the control of many individual managers (Belaire, Westphal and Minor, 2015), with conflicting individual habitats potentially creating a negative cumulative effect, what Cooper et al, (2017), described as 'a tyranny of small decisions' (a phrase initially coined by Alfred Kahn in his 1966 essay on market economics (Kahn, 1966)). Each of these individual managers has a different degree of environmental concern and a unique opinion of what constitutes an attractive garden, with a work ethic and level of interest ranging across the entire scale of enthusiasm.

The random structure of private gardens and other urban green space, described by Braem, 1968, (taken from Notteboom, 2018), as a "a patchwork stitched together by a madman" when describing the urban landscape in Belgium, further highlights the difficulty in applying a generic strategy for connecting urban ecosystems. The lack of data for private gardens creates further limitations and obstacles for future planning (Dewaelheyns, Rogge and Gulinck, 2014).

Successful management of urban ecosystems demands that the focus moves past species protection to conservation of the entire ecosystem, with knowledge and consideration of the 'functional integrity of species interactions' (Estes et al, 2011; Ripple et al, 2014). In an urban ecosystem these interactions are often altered from their expected behaviours. Trophic cascades, defined by Ripple et al, (2016), as "*indirect species interactions that originate with predators and spread downward through food webs*", can result from many factors. An early example in garden ecosystems (identified before the term 'trophic cascade' was originally coined by Paine, 1980) was described by Charles Darwin in 'On the origin of species' (1859, p58), describing how the number of cats in an area affect the amount of red clover

(*Trifolium pratense*) that grows. As cats reduce mice populations, mice are the main consumers of bumblebee honey and bumblebees are the sole pollinator of red clover

This is a simple example of a trophic cascade that led to Darwin's observance that bumblebee nests were far more numerous in close proximity to small towns and villages and red clover was consequently more abundant. However, in domestic gardens, the abundance of non-native plant species which are often not predated by native insects, can lead to a reduction of herbivores which in turn will limit top down control by natural predators (Parsons, Kerner and Frank, 2020).

2.6 PUBLIC PERCEPTION

Very little research has been done to assess whether wildlife gardening practices can contribute to the garden's aesthetic quality (Lindemann-Matthies and Marty, 2013), "*what is good may not look good and what looks good may not be good*" (Nassauer, 1995). Adoption of wildlife gardening can be affected by cultural norms (Nassauer, Wang and Dayrell, 2009), 'social norm dynamics' have been found to have a substantial effect on behaviour, with important implications for environmental decision making (Nyborg et al. 2016). The theory of normative expectations, hypothesises that people comply with social norms to avoid feeling resentment from others, i.e. they conform because others conform, regardless of self-interest (Sugden R. 2000). In the context of wildlife gardening, proscriptive injunctive norms (focusing on what others don't do rather than what they do, or more pertinently, what they don't approve of) is likely to be more powerful (Farrow, Grolleau and Ibanez, 2017). However, social norms are affected by pride as much as guilt (Onwezen, Antonides and Bartels, 2013) and so could be harnessed as a useful tool for increasing wildlife gardening practices, if creating wildlife habitat was seen as an achievement rather than a by-product of laziness or neglect.

To influence behaviour, it is necessary to identify different attitudes, Van der Werff, Steg and Keizer, (2013), assert that people with a 'strong environmental self-identity' will engage in environmentally friendly behaviour without any external incentives. However, a study by Shaw, Miller and Wescott, (2013), found that strong connections with nature do not necessarily result in a desire to participate in wildlife gardening. This research also suggested that wildlife gardening initiatives are currently not 'engaging the unengaged'. There are many wildlife gardening initiatives (appendix, table 6) but whilst they are useful in facilitating ecological improvements in gardening habits for participants, those participants are intuitively, keen gardeners, conservationists or both, with no strategy for changing the habits of those who are not already predisposed to do so before they make contact. However, the more keen gardeners that voluntarily participate in these schemes, the more socially acceptable it will become, as wildlife gardening becomes the norm. There is a large gap in the literature regarding public perceptions towards wildlife gardening, with a lot of the focus on community pressure (Williams and Carey 2002; Sirgy and Cornwell 2002; Nassauer et al 2009) with very

little recent research (Campbell-Arvai, 2018). There are however strategies for positively influencing social norms which can be applied to this research. Nyborg et al. (2016) questioned whether there is a tipping point, where damaging behaviour can potentially be turned into positive behaviour and whether policy can push (in this case gardeners) past the tipping point. This strategy requires policy to provide a reason for people to change their habits. One suggestion first posited by Nassauer, (1995), was creating wildlife gardening certification schemes, which should find the tipping point described by Nyborg above, where the normative expectation of traditionally maintained gardens becomes one of gardening for wildlife, which tips into being acceptable through being part of an organised and accredited scheme. This can also remove feelings of cognitive dissonance amongst gardeners who feel that their actions are contradicting their desirable behaviour because of social pressure. This research intends to find out whether being part of a strategic conservation corridor will encourage a change in habits. An understanding of the effects of social norms on behaviour is a vital tool to harness increasing pro-environmental attitudes (Culiberg and Elgaaied-Gambier, 2015), rather than finding ways to override normative behaviour, wildlife gardening needs to become a social norm. Another type of social norm that can be relevant to this research are local norms, i.e. shared norms resulting from shared spatial environment (Fornara, Carrus, Passafaro and Bonnes, 2011). This can be harnessed by designing the strategy for wildlife gardening as part of the ecological network to create a sense of community ownership and collaboration.

2.8 A RETURN TO 'BIOPHILIA'

“Beauty is in the eye of the beholder”.
(Hungerford, 1878)

As urbanisation increases, interaction with nature is removed from the day to day lives of more and more of the population, and as human beings are unlikely to protect what they do not love, and cannot love what they do not know (Gould, 1991), the intuitive consequence is a corresponding decrease in support for wildlife conservation.

Simply providing nature for urban residents is not likely to be sufficient, in a study of urban park users in 2013, Lin et al found that it was ‘orientation rather than opportunity alone’ that motivated residents to spend time in urban green spaces, with 40 % of their sample population saying that they did not use local parks. There is much research that substantiates this need to focus as much effort on encouraging the willingness to use public green space, as is used to provide it (Soga et al. 2015; Soga and Gaston, 2016; Colléony, Prévot, Saint Jalme and Clayton, 2017; Soga and Akasaka, 2019). From a policy perspective this highlights a need to focus on the ‘quality of experience’ as much as the ‘quantity of experience’ when designing green space (Colléony, White and Shwartz, 2019). There is also a growing body of evidence to support theories of nature deficit disorder (Louv, 2005), with growing evidence that frequent exposure to

nature in childhood will result in more positive responses to nature in adulthood (Thompson, Aspinall and Montarzino, 2008; Hinds and Sparks, 2011; Shanahan and Fuller, 2016).

CHAPTER 3

3 .RESEARCH METHODOLOGY

3.1 WHAT TYPE OF INFORMATION DO I REQUIRE?

Before deciding on the most appropriate research methods it is first necessary to establish what type of information is needed to achieve the research objectives.

1. *To investigate public perceptions of wildlife gardening, and general concern for wildlife.*

This can be ascertained with a few simple direct questions, however, in order to gather information that will be useful for the development of a strategic plan for an ecological network, simply knowing the percentage of the sample that are keen gardeners or are concerned about wildlife declines will be of no use.

In order to increase public participation in wildlife gardening it will be necessary to understand whether there is a correlation between gardening enthusiasm and likelihood of participation in wildlife gardening. Public perceptions of different types of gardening activity must be understood to be able to design a strategy with the greatest potential uptake.

Potential reasons for concern/lack of concern for wildlife need to be explored, e.g. whether there is any evidence of nature deficit disorder.

It will be useful to establish whether being part of a strategic conservation corridor is likely to encourage participation, and whether the use of green infrastructure projects would be popular.

2. *To investigate possible methods for raising levels of concern for wildlife and evaluate whether they could lead to increased participation in conservation.*

Short term: What could influence people to change their habits, if not their opinions?

- Social pressure: neighbourhood/community norms could influence habits.
- Overriding altruism: selling the direct benefits of ecosystem services could be an effective option for changing habits (or attitudes towards public green space).
- Cumulative persuasion: the belief that individual actions can make a difference if they are a coordinated component of a larger system.

Long term: How can the population return to a state of 'biophilia'?

- "The chicken and the egg": More nature in cities would potentially instil a greater empathy with nature but the best way to increase nature in cities is potentially though increasing empathy with nature in city dwellers. Where

should the focus be? Should environmental education/appreciation goals be incorporated into all green space provision?

- Can improving environmental education in schools and/or increasing the amount of contact that children have with nature increase the potential for urban ecological corridors in the long term as well as support of wider conservation goals?

3.2 RESEARCH METHODS

3.2.1 AVAILABLE RESEARCH METHODS

Qualitative or quantitative

“Not everything that can be counted counts, and not everything that counts can be counted”. (Cameron, W 1963, Taken from Goodreads.com, 2020)

Quantitative data is straightforward to analyse in order to make systematic comparisons, whereas qualitative data will provide more in-depth information but it is likely to be far harder to find any correlation. (Blaxter, Hughes and Tight, 2010). The most appropriate type of data will depend on the research question.

Surveys

Surveys aim to obtain quantitative information by directly questioning a target sample of ‘relevant people from relevant sites’, either by face, phone or online (Denscombe, 2014). ‘One fundamental premise of the survey process is that by describing the sample of people who actually respond, one can describe the target population’ (Fowler, 2009).

Interviews

Interviews are the main method of obtaining qualitative data, and can be in-depth individual or focus group, and are generally looking for ‘meanings’ rather than ‘measuring’ trends in information (Yates, 2004).

Experiments

An ‘*empirical investigation under controlled conditions*’, which is less common in social science research, as when humans realise they are the subject of a research study, they are likely to adapt their behaviour (Denscombe, 2014). Often known as the observer effect, this can also be an issue for interviews. There are also more ethical issues to consider when involving people in experiments (Blaxter, Hughes and Tight, 2010).

3.2.2 CHOSEN METHOD FOR THIS RESEARCH

This research utilised surveys, in the form of online and face to face questionnaires, as the research objectives required an understanding of the opinions of the population as a whole, in order to create a strategy with the greatest potential. Researching

whether apathy towards nature can be addressed within the education system required a more in-depth perspective, consequently there were separate questionnaires to address each issue.

Questionnaire 1, Wildlife Gardening

Questionnaire 2, Education Survey

3.2.3 ADVANTAGES AND DISADVANTAGES OF USING QUESTIONNAIRES

Sending survey requests by e-mail provides an opportunity to reach a wide target audience over a large geographical area (Blaxter, Hughes and Tight, 2010), but can result in variable responses, depending on how regularly the recipient checks their e-mail and whether it comes from a recognised source (Fowler, 2009). (It is very easy to ignore e-mails about surveys).

The replies may not represent the sample population fairly as people with strong views on the subject may be more likely to complete the questionnaire (self-selecting bias) (Kumar, 2014).

Questionnaires (particularly online) save time and cost, and also provide greater anonymity to respondents, increasing the likelihood of honest responses (Kumar, 2014). However, for this research some face to face surveys were conducted which then had to be inputted onto the online questionnaire.

Online questionnaires save time and remove potential user error by automatically uploading the data onto spreadsheets (Jones et al, 2008). The data provided is standardised and can be analysed 'scientifically and objectively' (Learning, 2020), although there is a danger that respondents may 'answer superficially', particularly if the questionnaire is long (Milne, 2020).

3.3 IMPLEMENTING THE RESEARCH METHODS

Both surveys were conducted online using 'Microsoft Forms', to save time in delivering questions, receiving replies, and in processing the data (as it is automatically uploaded onto a spreadsheet). Neither survey needed to be restricted to a particular geographical location, there was a requirement for an even spread of urban and rural responses for both surveys, and an even spread of primary and secondary teachers for survey 2. It is also a more environmentally friendly option, reducing the use of paper and the need to travel.

Surveys were also conducted face to face (for survey 1) as there were not sufficient respondents and a higher percentage of female respondents. This uneven spread was not completely reversed during the face to face interviews as it was much harder to persuade men to participate, however this was not considered a problem as there

were enough men for comparisons between answers of male and female respondents to be compared fairly.

One goal was to have as many questionnaires completed without the researcher present as possible. This was to avoid ‘the interviewer effect’ (Denscombe, 2014), where interviewees may respond differently when being interviewed face to face, and depending upon who is interviewing them. For this survey, people may be more likely to profess more environmentally friendly attitudes assuming that the interviewer will have these opinions. Participants may also be less likely to give honest answers if they think their opinion is likely to be outside the norm, e.g. ‘I don’t care about wildlife’.

SURVEY 1 (APPENDIX, PAGE 85)

Questionnaire design

The sample population needed to be representative of the actual population rather than targeting any specific group. There needed to be a fairly even split between urban and rural respondents in order to distinguish any correlation between gardening practices/wildlife concern and whether the respondents lived/were born in urban or rural areas. The main assumption being that this would correlate to their exposure to wildlife, but there could be many complexities within this reasoning e.g. people who had moved to urban areas may have little concern for wildlife in spite of exposure while young or people brought up in urban areas may move to the country to reconnect with nature. So, the relationships between opinions of urban/rural residents and where they were born needs to be analysed. There needed to be a mix of gender and age to discover whether these factors may affect attitudes. There was no requirement for an even mix of wealth or education status (although the profession of respondents was asked), even though these factors have been used in other studies (Goddard, Dougill and Benton, 2013) and were considered by the researcher to be likely to provide useful information, they widened the scope of the study too far.

The initial survey contained 10 questions about perceptions of green infrastructure, however after a pilot study of ten (using friends and family) the feedback was that the survey was too long. The revised survey contained just three questions about public green space and green infrastructure, rather than evening out the wildlife gardening/green infrastructure mix, so as not to dilute the responses. The mean completion time for the survey was 4 minutes which was considered by the researcher to be short enough to avoid box ticking through respondent fatigue).

Respondents were asked to provide their gender, age, profession and number of children, as these could all be factors influencing attitudes towards wildlife gardening and conservation. The following three questions were very important to the survey

goals, discovering the respondent's location and where they were born. These questions were ambiguous enough not to be too intrusive but established the rural/urban divide, hoping to establish correlations between potential exposure to nature and concern for nature/likelihood to partake in wildlife gardening. The next questions investigated the gardening habits of respondents ranging from 'extremely keen' to 'don't do any gardening' and how worried they are about declines in wildlife. They were then asked more specific questions, finding out what wildlife gardening features they currently have in their garden, what they would be willing to do and what would dissuade them from wildlife gardening. These questions were included to be used to inform the design of the wildlife gardening strategy. The final questions asked whether people would generally be likely to improve their garden for wildlife if they were part of a conservation corridor, whether they would be in favour of green infrastructure being deployed to provide ecosystem services and what they consider the most important reasons for increasing the amount of public green space. This information will be useful to work out the best methods of influencing public opinion in favour of more green space, which will form important links within the ecological corridor.

The survey was carried out in December which wasn't believed to have any relevance to response rates or type. A minimum response rate of 100 was targeted, this was chosen as it was considered that with a reasonably even split of urban/rural respondents it would provide a large enough sample to give a useful cross-section of the population, to fairly analyse each variable.

SURVEY 2 (APPENDIX, PAGE, 90)

Asking teachers closed questions about their opinion as to whether or not they believe that there is a growing disconnect with nature, can indicate whether or not this is a trend. Asking open questions about their opinions on possible reasons and solutions, can be useful for formulating strategies. However, only extensive interviews with children can answer the question as to whether a disconnect with nature truly exists and whether this results from a lack of contact during childhood. Nevertheless, this research can obtain a valuable insight from education professionals which could be useful for strategizing the long-term goals of this research and to frame future research questions.

Questionnaire design

The questionnaire first ascertained whether the respondents taught at primary or secondary level and whether their school was rural or urban. This provided the opportunity to assess any correlation between these factors and the following questions, which asked whether the respondent believed there to be an increasing disconnect with nature among young children, and whether the current curriculum provides enough environmental education.

The following questions examined reasons behind any potential disconnect with nature and wider benefits of environmental education and more hands on (outdoor) lessons in traditional subjects. These questions were either multiple choice with an option to expand their answers, or provided an answer box, encouraging respondents to expand their answers but without specifying it, allowing respondents that didn't want to expand, the opportunity for yes/no answers, limiting the possibility of questions left unanswered by minimising the 'response burden' (Denscombe, 2014). The final question asked for any relevant comments based on knowledge and experience within education.

The design of the survey provided the opportunity to identify whether the belief within the education system was that 'nature deficit disorder' was manifesting itself and whether this was more prevalent in urban areas. It also provides an insight into the opinions of teachers about the reasons behind a potential lack of contact with nature and whether this can be addressed within the education system.

The structure also allowed the opportunity for providing qualitative answers which could be very useful as informed knowledge when developing strategies to overcome obstacles for the implementation of a wildlife gardening strategy.

A minimum response rate of 75 was targeted. This was considered sufficient as the entire sample was known to be within the target population (Teachers), meaning that all responses should be useable, the only requirements being a reasonable split of primary/secondary teachers and urban/rural schools.

To achieve this, the survey was distributed to schools as an online survey, the response rate was mixed and as results came in it was sent out to other schools in response to the primary/secondary and rural/urban mix.

The average time to complete the pilot survey was around 8 minutes, this was considered to be too long but the median time was 4mins 11seconds and the fastest 1minute 14 seconds, so this was considered to be acceptable not to deter respondents who did not wish to elaborate on their answers.

CHAPTER 4

4. RESULTS AND ANALYSIS

Survey 1 (see appendix, page 85)

The focus of this questionnaire was to gain an understanding of the motivations for participation in wildlife gardening activities, primarily seeking to ascertain whether gardening enthusiasm and concern for wildlife would be positive stimuli and to what degree. Then investigating the effect of a series of variables, establishing where and how a strategy for an urban ecological network should be focussed and whether (and if so how) public perceptions need to be changed to facilitate future progress.

Respondents were asked directly about their gardening habits (fig 4.1) and concern about wildlife declines (fig 4.2), which showed that concern for wildlife was very high, with 83% of respondents claiming to be concerned or very concerned, but a far broader spread of gardening enthusiasm with the majority of respondents not doing a lot of gardening, either resulting from apathy or time constraints.

4.1 WILDLIFE CONCERN AND GARDENING ENTHUSIASM

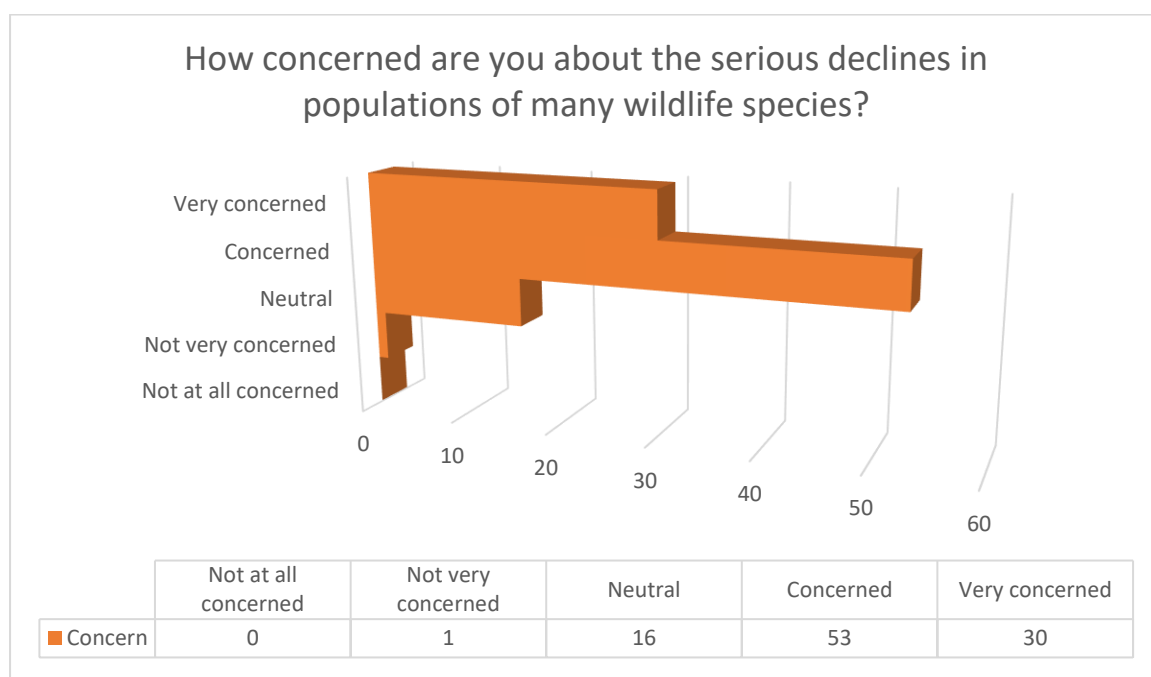


FIGURE 4.1 CONCERN FOR WILDLIFE

These two sets of data were analysed against each other to determine any correlation (Tables 4.1 and 4.2), however, to explore reasons behind any correlation which may be exploited in the formation of the final strategy, they were both then analysed against the other variables collected in the survey.

The data selected for analysis was that which would be of greatest benefit to gain an understanding of public perceptions and motivations, which could be used both for the successful implementation of an urban ecological network, with wildlife gardening performing a key role, and to establish the best way forward to improve public attitudes toward wildlife and general conservation goals for the future.



FIGURE 4.2 GARDENING HABITS

	% of respondents	Very Concerned		Concerned		Neutral		Not very Concerned		Not concerned	
Extremely Keen	10	60%	6	30%	3			10%	1		
Quite Keen	14	29%	4	64%	9	7%	1				
Would like to do more if I had Time	30	33%	10	53%	16	13%	4				
Enjoy the garden but don't do any gardening	18	27%	5	55%	10	16%	3				
Do the bare Minimum	17	12%	2	58%	10	18%	3	11%	2		
Don't Garden	11	9%	1	36%	4	55%	6				

TABLE 4.1 WILDLIFE CONCERN AND GARDENING ENTHUSIASM

	% of respondents	Very Concerned		Concerned	
Extremely Keen	9	3.15	6	5.85	3
Quite Keen	13	4.55	4	8.45	9
Would like to do more if I had Time	26	9.1	10	16.9	16
Enjoy the garden but don't do any gardening	15	5.25	5	9.75	10
Do the bare Minimum	12	4.2	2	7.8	10
Don't Garden	5	1.75	1	3.25	4
	80		28		52

TABLE 4.2 EXPECTED VALUES

H_i = There is no correlation between gardening enthusiasm and wildlife concern

$$\chi^2 = 7.009$$

$$DOF = (2-1) * (6-1) = 5$$

$$P = 0.2$$

$P > 0.05$ so we cannot reject H_i

There was not sufficient data to model the entire dataset, a chi-squared test for respondents who were 'very concerned' or 'concerned' about wildlife declines showed no correlation, (there were still too many cells with expected values < 5 so if the results had been less conclusive they would not have been valid). The researcher expected a stronger relationship between the two variables.

79% of respondents are concerned about declines in wildlife populations, which is extremely positive, there does not appear to be any relationship with general gardening enthusiasm and there is a fairly even mix of gardening habits. This means that a strategy must be developed to target each category of gardener, which will require as much information as possible about the motivations and perceptions of each demographic.

4.2 VARIABLES INFLUENCING GARDENING ENTHUSIASM

Unused Data and Discarded Results

The profession of respondents was the only data that was completely disregarded, even though there could potentially be a correlation between socio-economic status and willingness to participate in wildlife gardening, previous research has found that it has a relatively inconsequential effect (Gaston et al. 2007; Goddard et al, 2013). Studies which have found a positive correlation between affluence and urban

biodiversity (Locke and Grove, 2014; Aronson et al 2017) have generally concluded that this is as a result of a greater amount of public green space such as parks and street trees in more affluent areas. Whilst there is a need for further research into the 'luxury effect' (Grove, Locke and O'Neil-Dunne, 2014), where there is increased spending on gardening as a direct result of higher disposable income (and often larger gardens) it is beyond the parameters of this research.

4.2.1 GENDER

		Extremely Keen		Quite keen		Would like to do more		Enjoy but don't garden		Do the bare minimum		Don't Garden	
Male	45	11%	5	16%	7	24%	11	24%	11	20%	9	4%	2
Female	55	9%	5	13%	7	35%	19	13%	7	15%	8	16%	9

TABLE 4.3 GENDER AND GARDENING ENTHUSIASM

H_0 = Gender will have no effect on gardening enthusiasm.

$$\chi^2 = 6.579$$

$$\text{Degree of freedom} = (6-1) * (2-1) = 5$$

$$P = 0.2$$

$P > 0.05$, H_0 cannot be rejected, there is no correlation.

Gender also had no effect on wildlife concern, although previous research has found that women generally have a greater connectedness and empathy to the natural world (Musitu-Ferrer et al, 2019).

4.2.2 NUMBER OF CHILDREN

Children	Extremely keen	Quite keen	Would like to do more	Enjoy but don't garden	Do the bare minimum	Don't do any gardening	
0	0	2	12	6	6	7	33
1	3	5	1	0	3	0	12
2	4	4	13	9	7	3	40
3+	3	2	4	3	0	1	13
	10	13	30	18	16	11	98

TABLE 4.4 NUMBER OF CHILDREN AND GARDENING ENTHUSIASM

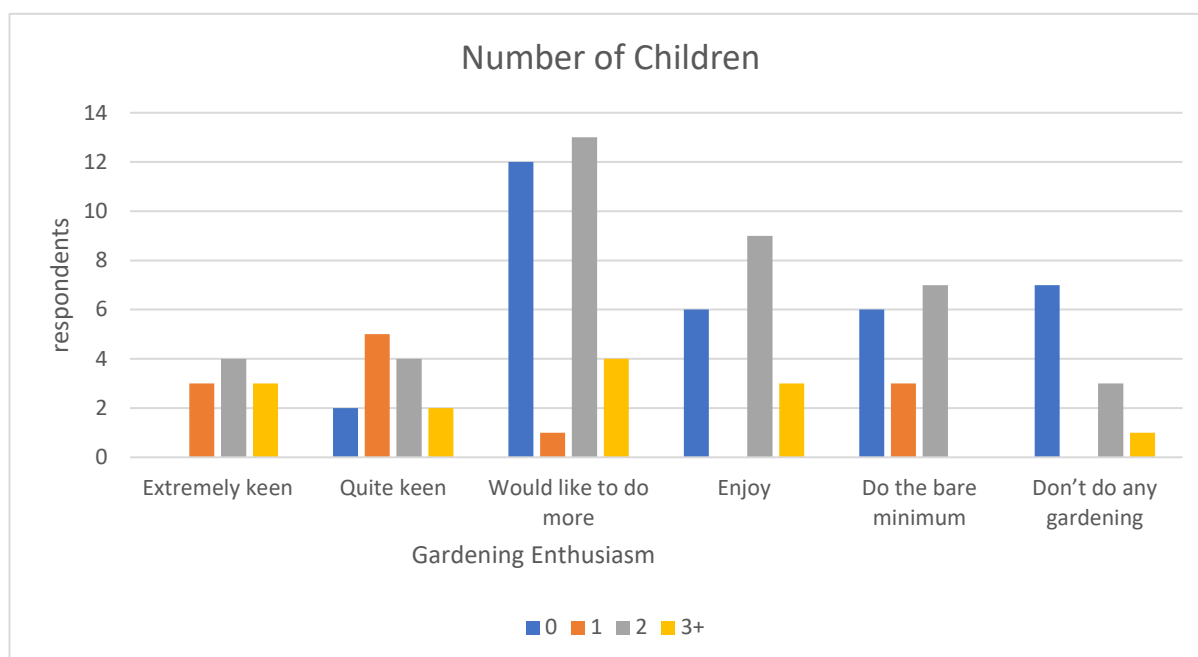


FIGURE 4.3 NUMBER OF CHILDREN AND GARDENING ENTHUSIASM

No meaningful correlations can be deduced from this data, so no link between number of children and gardening enthusiasm can be assumed.

This is quite a complicated variable to assess in isolation as there are many co variables, such as age, 62% of respondents with 3 or more children were over 55 and so are unlikely to have young children living at home, and 65% of respondents with 2 children were over 45. Consequently motivations could be related to age rather than number of children which has a positive correlation with wealth and a bigger house with a larger garden (table 4.5).

		Small		Medium		Large		Very Large	
Under 18	1	1	100%						
18-24	8	8	100%						
25-34	15	10	67%	2	13%	3	20%		
35-44	25	7	28%	11	44%	5	20%	1	4%
45-54	23	4	17%	11	48%	4	17%	4	17%
55-64	18	6	33%	5	28%	5	28%	2	11%
65+	10	1	10%	1	10%	1	10%	7	70%
	100	37		30		18		14	

TABLE 4.5 AGE AND GARDEN SIZE

4.2.2 AGE

Fig 4.4 shows that there is some degree of linear correlation between age and gardening enthusiasm, however this is primarily caused by habits at either extreme. There was only one respondent under 35 in the top two categories and only 4 respondents over 55 in the bottom two. Whilst there is no strong correlation for the data as a whole, the trends that can be seen are fairly intuitive and can be cross

analysed against the other data. Over 65's did not choose 'if I had more time' as they are mostly retired and it can be reasonably assumed that any children have left home. 79% of under 35's have a small garden (all respondents under 25 have a small garden) and 70% of over 64's have a very large garden (table 4.5). The majority of respondents between 35 and 55 enjoy the garden but do little gardening either because of time constraints or disinclination, these figures aren't statistically robust enough to derive meaningful correlations but they are very useful as a guide for targeting wildlife gardening plans.

		Extremely keen		Quite keen		Would like to do more if I had time		Enjoy garden but don't enjoy gardening		Do Bare minimum		Don't do any gardening	
Under 18	1	0	0	0	0	0	0	0	0	0	0	100%	1
18-24	8	0	0	0	0	50%	4	0	0	25%	2	25%	2
25-34	15	0	0	7%	1	40%	6	20%	3	13%	2	20%	3
35-44	25	8%	2	20%	5	24%	6	16%	4	32%	8	0	0
45-54	23	9%	2	9%	2	35%	8	21%	5	13%	3	13%	3
55-64	18	11%	2	11%	2	33%	6	27%	5	11%	2	6%	1
65+	10	40%	4	40%	4	0	0	10%	1	0	0	10%	1
	100		10		14		30		18		17		11

TABLE 4.6 AGE AND GARDENING ENTHUSIASM

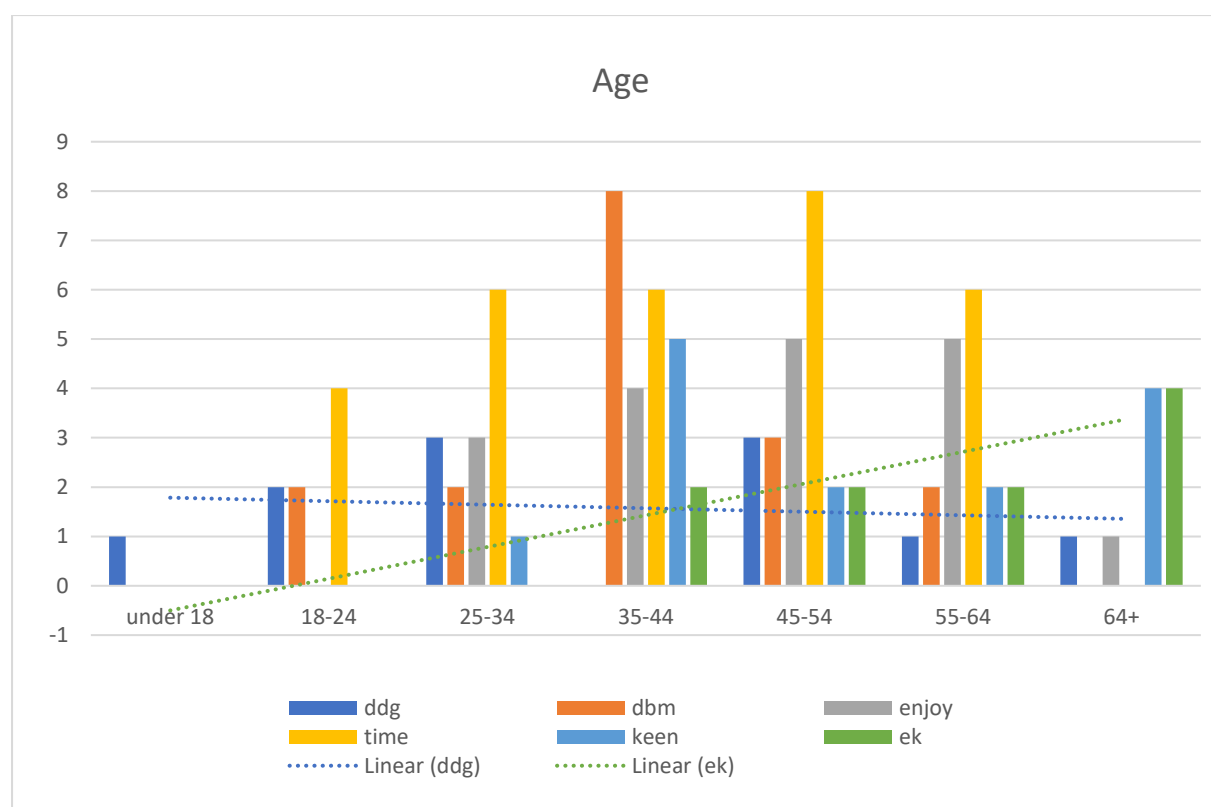


FIGURE 4.3 AGE AND GARDENING ENTHUSIASM

4.2.3 SIZE OF GARDEN

Observed values	Extremely Keen	Quite Keen	Would like to do more	Enjoy	Do bare minimum	Don't garden	
Small/medium	2	4	22	13	16	10	67
Large/very large	8	10	7	5	1	1	32
	10	14	29	18	17	11	99

TABLE 4.7 GARDEN SIZE AND GARDENING ENTHUSIASM

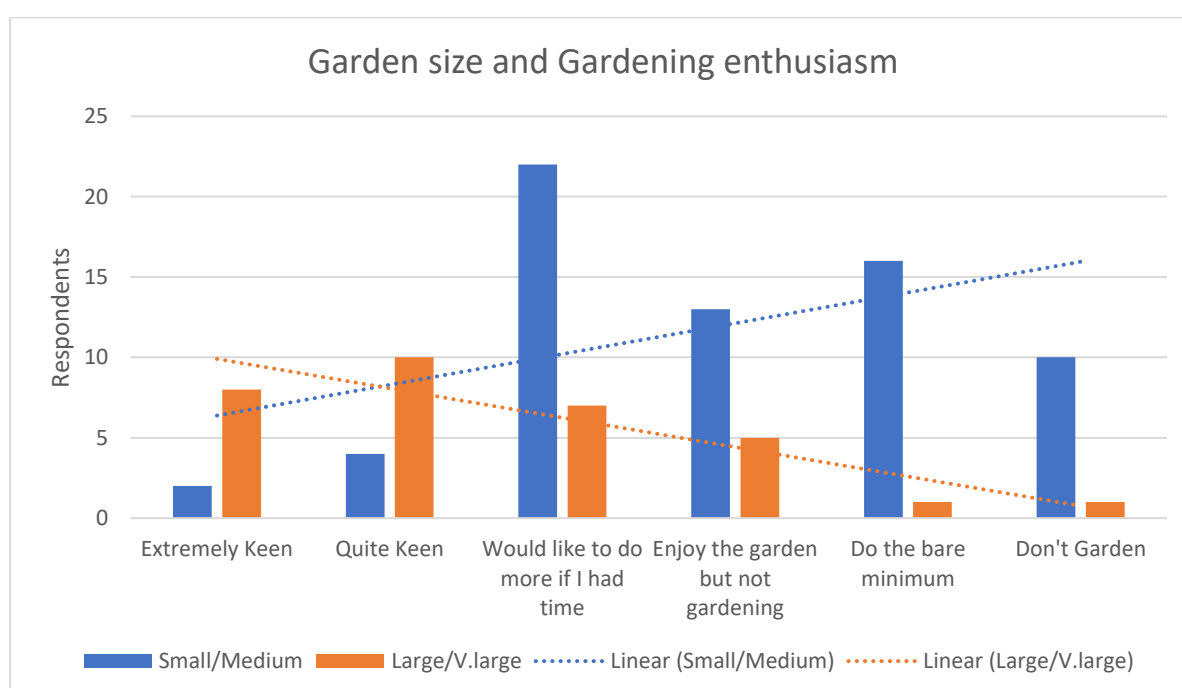


FIGURE 4.4 GARDEN SIZE AND GARDENING ENTHUSIASM

There is a clear correlation between garden size and gardening enthusiasm. Respondents with large/very large gardens are far more likely to be keen gardeners, however, earlier analysis has already established that there is no strong correlation between wildlife concern and gardening enthusiasm, and as discussed in chapter 2, keen gardeners are often less disposed to participate in wildlife gardening activities because of a desire to adhere to 'perceived norms', which tend to favour conventional garden design (Nassauer Wang and Dayrell, 2009). It is therefore necessary to investigate the number of wildlife activities in which respondents would be willing to engage (fig 4.6).

4.3 WILDLIFE GARDENING ACTIVITIES

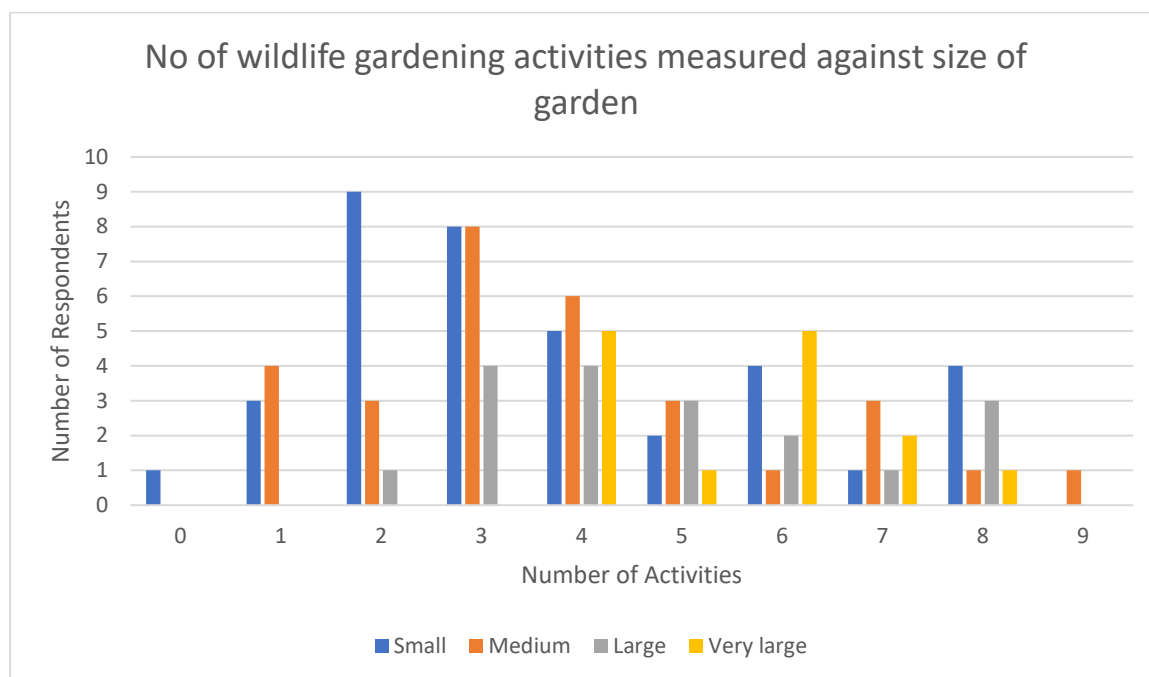


FIGURE 4.5 GARDEN SIZE AND WILDLIFE GARDENING ACTIVITIES

79% of respondents with large/very large gardens chose 4 activities or more, which corresponds with 83% of keen/extremely keen gardeners who also chose 4 activities or more (appendix, table 1). It would be expected for practical reasons that respondents with smaller gardens would choose fewer activities, but this highlights a limitation in this data resulting from the question format. Respondents were asked to choose the wildlife gardening activities in which they would be happy to engage (fig 4.7), however it was not specified whether the choices were functional or hypothetical. I.e. What the respondent would actually be prepared to do in their current garden and situation vs what they would hypothetically be happy to do, so there is no way of knowing whether a respondent selecting 6 activities mean that they would be happy to employ all 6 methods or any one of the selected 6.

Whilst this reduces the integrity of the analysis of the number of gardening activities it does not limit the value of knowing which specific gardening activities are most popular amongst respondents. The three activities that would be perceived as most labour intensive and space consuming are the least popular options (wildflower meadow, wildflower lawn and leave a wild area of garden), although this also may reflect a lack of knowledge (appendix table 7). Counter intuitively, these options (along with 'leaving a wild area') were least popular among respondents with very large gardens, (appendix table 2).

Location has no effect on the number of wildlife gardening activities selected, neither are there trends for specific activities. (Appendix, tables 3 and 4).

Average no of activities selected	
City Centre	3.8
Inner city	4.4
Suburbs	4.3
Village	4.4

TABLE 4.8 LOCATION AND WILDLIFE GARDENING ACTIVITIES

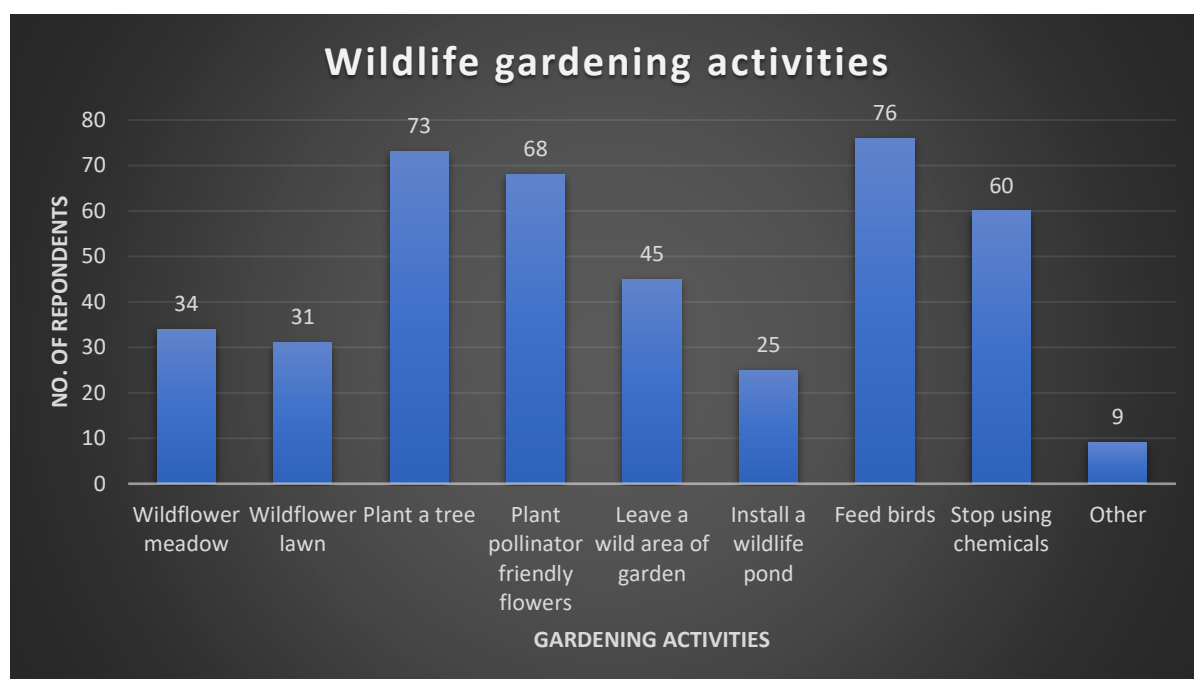


FIGURE 4.6 WILDLIFE GARDENING ACTIVITIES

As discussed in chapter 2, affectation by cultural norms (Nassauer, Wang and Dayrell, 2009), and the theory of normative expectations (Sugden, 2000), would expect keen gardeners to avoid activities that may contradict the social norms of their peers and neighbours. This research has not universally found this to be the case. 80% of keen gardeners said that they would leave a wild area of garden, although this reduced to 50% when combined with quite keen gardeners which was consistent with all other categories, apart from 'don't do any gardening' where only 18% of respondents selected any of the three options that may be perceived as 'untidy' or time consuming.

This could be a result of the high degree of environmental concern among respondents, corresponding with Van der Werff, Steg and Keizer's (2013) assertion, that people with a 'strong environmental self-identity' will engage in environmentally friendly behaviour without any external incentives. Although figures for suburban residents found that only 45% would leave a wild area of garden, 40% would have a

wildflower meadow and only 30% a wildflower lawn (appendix, table 4), in spite of the fact that 90% of suburban respondents are concerned or very concerned about wildlife (table 4.12). This indicates the potential influence that location can have on behaviour, and highlights that a strategy to increase environmental awareness and wildlife gardening participation is unlikely to be successful if it does not consider the power of social norms in the decision making process.

Chapter 2 evaluated current methods of overriding social norms, one solution is the creation of wildlife gardening certification schemes, which validate behaviour that may otherwise be perceived as negative by neighbours. When asked whether they would change their behaviour if they were part of a strategic conservation corridor, only 10% of respondents said no (fig 4.8). Among these 10 respondents there was no correlation when analysed against any other variables.

4.4 STRATEGIC WILDLIFE CORRIDOR

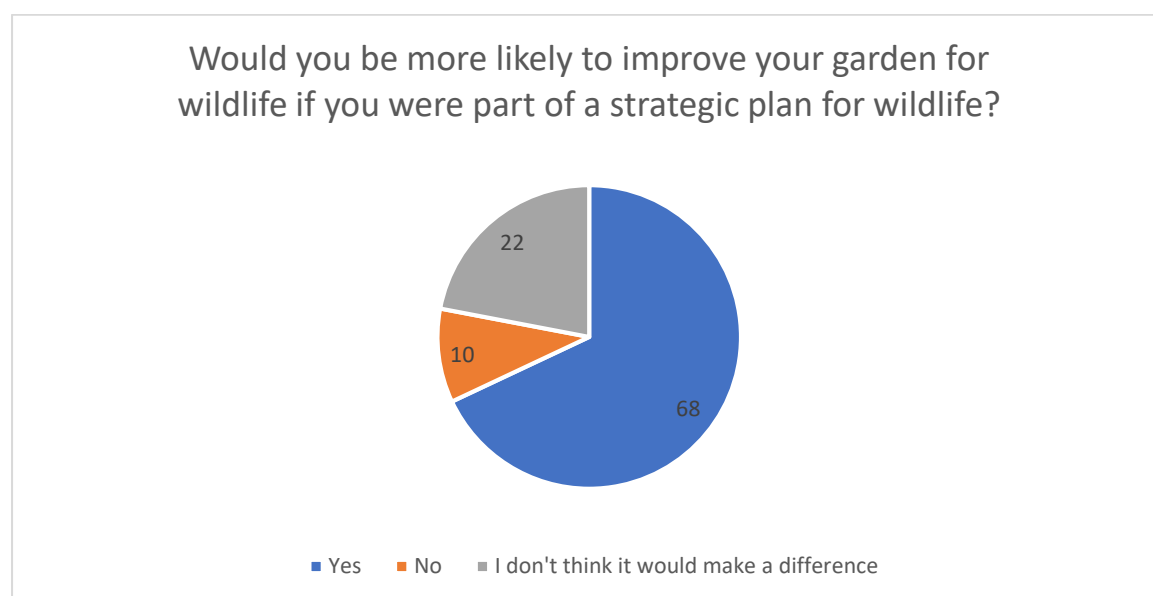


FIGURE 4.7 STRATEGIC WILDLIFE PLAN

This is a promising statistic when considered as a potential to change behaviour and override social norms, and could lead to wildlife gardening methods spreading by 'social diffusion' (Nassauer, 1995), creating a sense of community ownership and collaboration by enhancing 'local norms', i.e. shared norms resulting from shared spatial environment (Fornara, Carrus, Passafaro and Bonnes, 2011).

4.5 URBAN/RURAL GRADIENT

Determining concern for wildlife declines and wildlife gardening enthusiasm along a rural/urban gradient is key to this research for two reasons. To inform the final strategy, which will need to be adapted for different urban delimitations, but may also be affected by differences in attitude in urban/rural locations. Establishing whether there will be

less environmental empathy among respondents who have had little exposure to nature, supporting Richard Louv's (2005) hypothesis of 'nature deficit disorder' which will create a central goal for the long term strategy.

of Place birth	Number of respondents	Very Concerned		Concerned		Neutral		Not very Concerned		Not Concerned
City	29	34%	10	31%	9	31%	9	3%	1	0
Town	41	21%	9	63%	26	12%	5	2%	1	0
Village	21	14%	3	66%	14	14%	3	5%	1	0
Isolated Rural	9	66%	6	33%	3		0		0	0
Total	100		28		52		17		3	0

TABLE 4.9 PLACE OF BIRTH AND WILDLIFE CONCERN

Chi-Squared Test

The table has been collapsed into urban and rural in order to perform a chi-squared test, however there are still cells with expected values of 0 and more than 20% with an expected value less than 5. The similarities between the observed and expected data clearly show that there is no correlation which validates the P value of 0.684, meaning that being born in a rural or urban area has had no effect on the concern for wildlife of the sample population.

Observed	Very Concerned	Concerned	Neutral	Not very concerned	Not Concerned	
Urban	19	35	14	2	0	70
Rural	9	17	3	1	0	30
	28	52	17	3	0	100

TABLE 4.10 URBAN/RURAL OBSERVED VALUES

Expected	Very Concerned	Concerned	Neutral	Not very concerned	Not Concerned	
Urban	19.6	36.4	11.9	2.1	0	70
Rural	8.4	15.6	5.1	0.9	0	30
	28	52	17	3	0	100

TABLE 4.11 URBAN/RURAL EXPECTED VALUES

86% of rural respondents were concerned or very concerned about wildlife declines compared with 77% of urban. All respondents born in an isolated rural location were concerned about wildlife declines (table 4.9), unfortunately the sample size of 9 undermines the significance of this statistic. Table 4.12 Shows that 45% of the sample currently live in a rural area, meaning that there has been a 15% urban to rural migration. Further research into the validity of the 'nature deficit disorder' concept, would benefit from surveying a larger sample of rural born respondents and questioning them further about the amount of contact with nature they had as children.

Unfortunately the sample size and broader objectives of this research made this unfeasible.

Location	% of respondents	Very Concerned		Concerned		Neutral		Not very Concerned		Not Concerned
City Centre	12	41%	5	25%	3	25%	3	8%	1	0
Inner City	21	24%	5	66%	14	10%	2	0		0
Suburbs	21	29%	6	61%	13	10%	2	0		0
Village	45	26%	12	46%	21	22%	10	4%	2	0
Total	99		28		51		17		3	0

TABLE 4.12 LOCATION AND WILDLIFE CONCERN

There is no correlation between current location and wildlife concern. Analysing current location against other variables will be important for identifying where wildlife gardening plans need to be adapted depending on location.

Observed		Small		Medium		Large		Very Large	
City Centre	12	8	67%	2	17%	2	17%	0	
Inner City	18	14	78%	2	11%	2	11%	0	
Suburbs	22	5	23%	11	50%	5	23%	1	5%
Village	46	9	20%	15	33%	9	20%	13	28%
Expected		Small		Medium		Large		V. Large	
City Centre	12	4.408		3.673		2.204		1.714	
Inner city	18	6.612		5.510		3.306		2.571	
Suburbs	22	8.081		6.734		4.040		3.142	
Village	46	16.897		14.081		8.448		6.571	
	98	36		30		18		14	

TABLE 4.13 OBSERVED AND EXPECTED VALUES FOR GARDEN SIZE AND LOCATION

H_i = Location has no effect of garden size

$\chi^2 = 22.155$, DOF = $(4-1) * (4-1) = 9$

$P = 0.01$, < 0.05 therefore H_i can be rejected

As expected the majority of city centre and inner-city residents have small gardens. Suburbs and village are more evenly split, knowledge of garden sizes in different areas will be important when creating the final strategy, including prioritising areas that would benefit the most from more public green space.

4.6 WHAT WOULD DISSUADE YOU FROM WILDLIFE GARDENING?

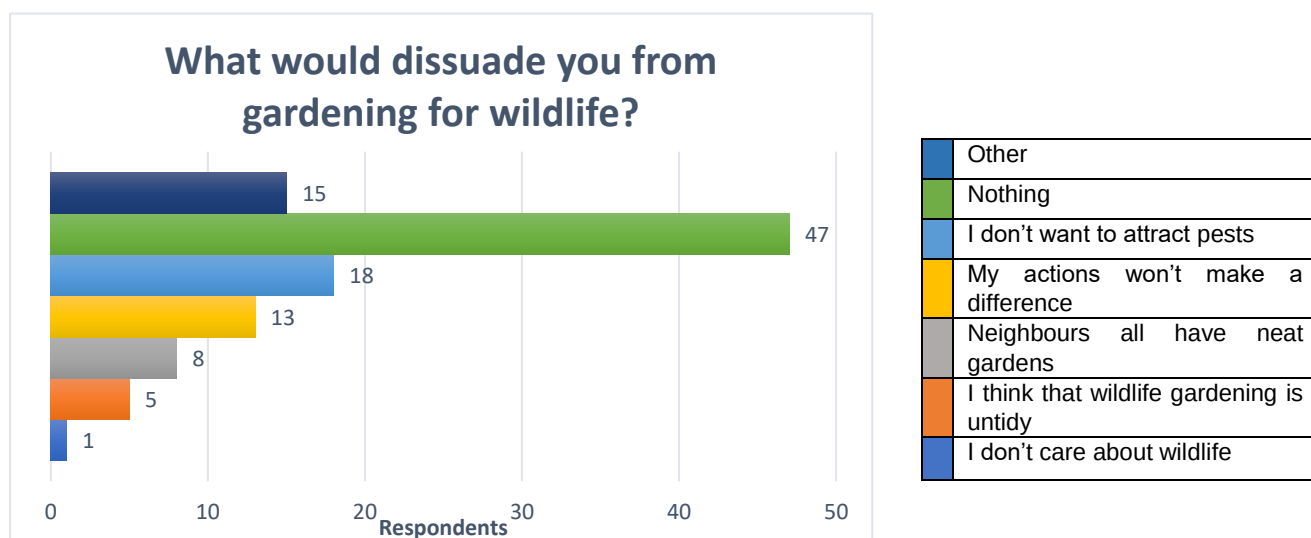


FIGURE 4.8 WHAT WOULD DISSUADE YOU FROM WILDLIFE GARDENING?

The 'other' category was made up of 'spiders', 'lack of time', three said that their garden is too small, two said that it was not practical because their children play in the garden, one said that it was too difficult and another that they 'didn't know anything about it'. These comments flag up the necessity for education, not necessarily about environmental concern as only one respondent said that they didn't care about wildlife, but methods of wildlife gardening. Similarly the 5 people who said that wildlife gardening was untidy and the 8 that were worried about their neighbours, may change their opinion if the general perception of wildlife gardening changed. Gardens can be a useful contributor to a wildlife corridor simply by planting a tree, feeding birds or planting pollinator friendly flowers in place of double bloomed Mediterranean bedding plants every summer, none of which are untidy or likely to offend the neighbours. If these gardens were all part of a strategic wildlife corridor within the wider urban ecosystem, the results from question 16 (fig 4.8) indicate that the opinion of 13 respondents that their actions won't make a difference will change. Understanding of the distribution of these opinions across a rural/urban gradient is useful to inform the final strategy. The only statistic that is notable is that 13 of the 14 respondents that chose 'pests' live in urban areas (table 16).

		Nothing	Pests	Won't make a difference	Neighbours	untidy	Don't Care
City Centre	9	33% 3	44% 4	0	11% 1	11% 1	0
Inner City	19	53% 10	26% 5	5% 1	16% 3	0	0
Suburbs	19	36% 7	21% 4	21% 4	16% 3	5% 1	0
Village	41	65% 27	2% 1	12% 5	10% 4	7% 3	2% 1
		47	14	10	11	5	1

TABLE 4.14 LOCATION AND DISSUASIONS FOR WILDLIFE GARDENING

	Nothing	Pests	Won't make a difference	Neighbours	Untidy	Don't Care	
Urban	20	13	5	7	2		47
Rural	27	1	5	4	3	1	41
	47	14	10	11	5	1	88

TABLE 4.15 LOCATION AND DISSUASIONS FOR WILDLIFE GARDENING

4.7 UNWELCOME GARDEN WILDLIFE

Changing attitudes about unwelcome garden wildlife is more difficult to overcome, as perceptions of wildlife vary greatly as can be seen in fig 4.10.

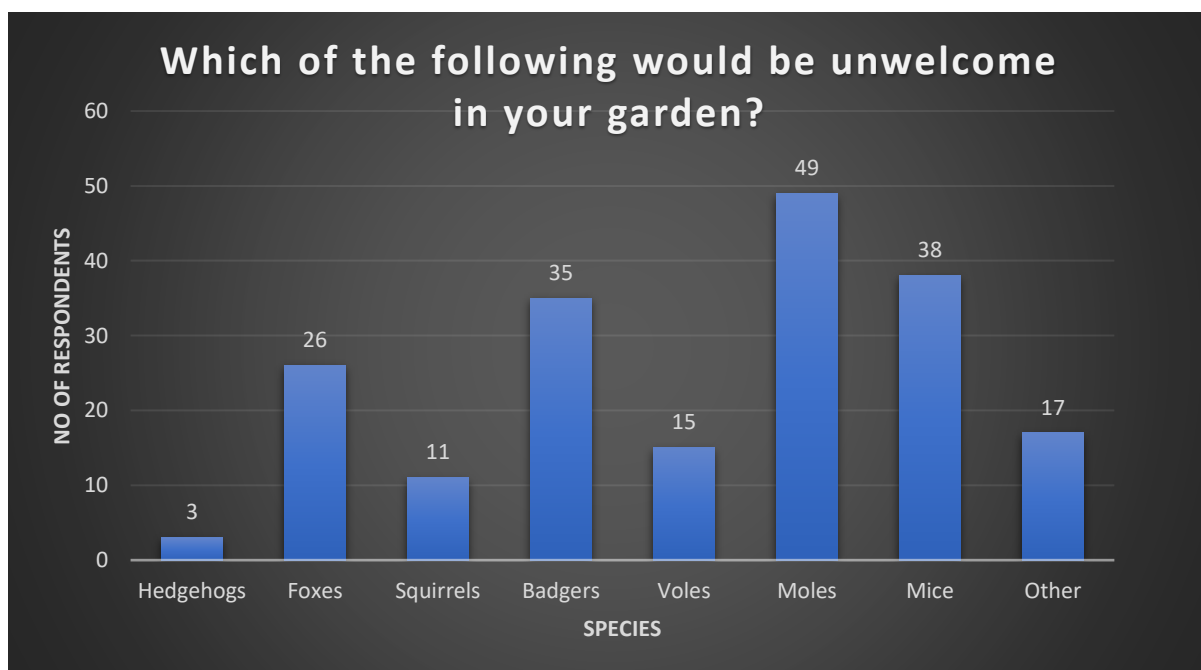


FIGURE 4.9 UNWELCOME WILDLIFE

Respondents could choose as many options as they wished, the 'other' option consisted mostly of 'rats' or none'. Rats were not included as it was assumed that they would be fairly universally unwelcome, perhaps a 'none' column could have been included but the intent was to discover which species were most widely considered as

pests rather than the percentage of the sample who would be worried about attracting pests as this had already been established (fig 4.9).

Analysing this data is complicated, as interactions between species must be considered. 26 respondents said that no species would be unwelcome in their garden (see appendix, table 5). However if the 26 respondents who wouldn't want foxes in their garden put up solid fences to keep them out, they are likely to create barriers within the corridor limiting the hedgehog's potential range. Similarly whilst only 3 respondents wouldn't welcome hedgehogs into their garden, if some gardeners were using slug pellets in their gardens this could undo any work in other gardens to provide for them, by both removing prey and introducing poisoned prey into the food-chain. Moles were the least popular, this is not surprising but needs addressing as a conservation objective. The mole is a universally unwelcome visitor, in gardens, fields or sports grounds, consequently it is vital that in wild land where they cause no problems that they are not persecuted. This has relevance for this research for the planning of larger patches of habitat within the ecosystem, moles would not be targeted for conservation except indirectly through the improvement of soil ecosystems, but must be tolerated wherever possible. Mice are the least popular visitor after moles which is very likely because people generally assume that all mice are house-mice, changing people's opinion will be difficult and many people may not want to feed birds in their gardens because it is likely to attract vermin. Table 4.15 Shows that only 1 rural respondent out of 41 would be concerned about attracting pests into their garden, further research would be beneficial to explore the reasons behind different perceptions of 'pests' in urban and rural areas.

Hedgehogs should be a primary conservation goal for three reasons, firstly they are 'almost' universally popular, and as discussed in chapter 2, they can be treated as an umbrella species as their range and requirements are complimentary to many co-occurring species. Finally, they are an endangered species being championed as a flagship species by many environmental organisations who could be useful partners to promote this urban wildlife gardening strategy.

4.8 GREEN INFRASTRUCTURE

The final three questions in the survey investigated the public perceptions of green infrastructure to assess its potential for contributing to an urban ecological network. The researcher decided that it was not feasible for this research to investigate this topic in any more depth. However the following data is useful for managing the design of the network, and for identifying useful future research.

Fig 11 shows that there is overwhelming support for the use of Green infrastructure for providing ecosystem services.

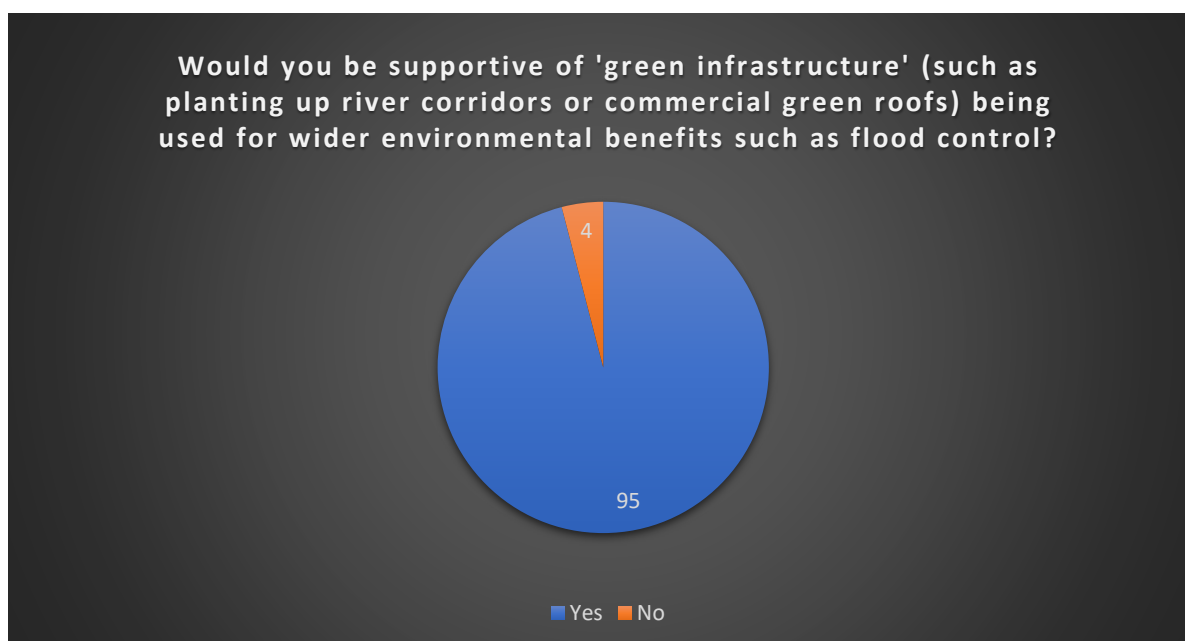


FIGURE 4.10 SUPPORT FOR GREEN INFRASTRUCTURE

	Aesthetics		Well-being		Recreational Benefits		Pollution remediation		Wildlife Habitat		Carbon Sequestration		Flood Control		Somewhere For children To play	
City Centre	3	30%	7	70%	3	30%	4	40%	7	70%	1	10%	1	10%	4	40%
Inner City	2	10%	14	70%	8	40%	12	60%	13	65%	5	25%	1	5%	5	25%
Suburbs	2	14%	6	43%	10	71%	4	29%	10	71%	4	29%	1	7%	4	29%
Village	2	6%	23	68%	13	38%	10	29%	29	85%	8	23%	3	9%	9	26%

TABLE 4.16 LOCATION AND BENEFITS OF PUBLIC GREEN SPACE

Respondents were asked to choose what they believed were the three most important reasons for increasing the amount of public green space, 21 Respondents chose more than three options, many choosing all of them, these results were discarded for the analysis.

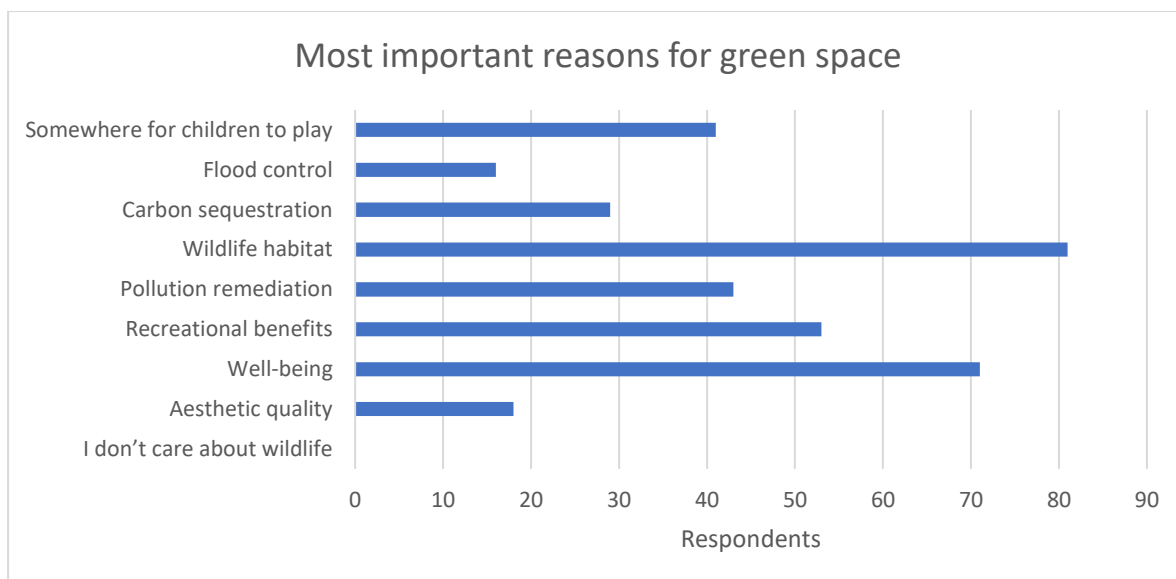


FIGURE 4.11 *BENEFITS OF GREEN SPACE*

Wildlife habitat was the most popular option in each demographic, this may be influenced by the topic of the questionnaire and be slightly higher than expected.

Pollution remediation is higher in urban areas which would be expected.

4.9 WHERE WOULD YOU GARDEN FOR WILDLIFE?

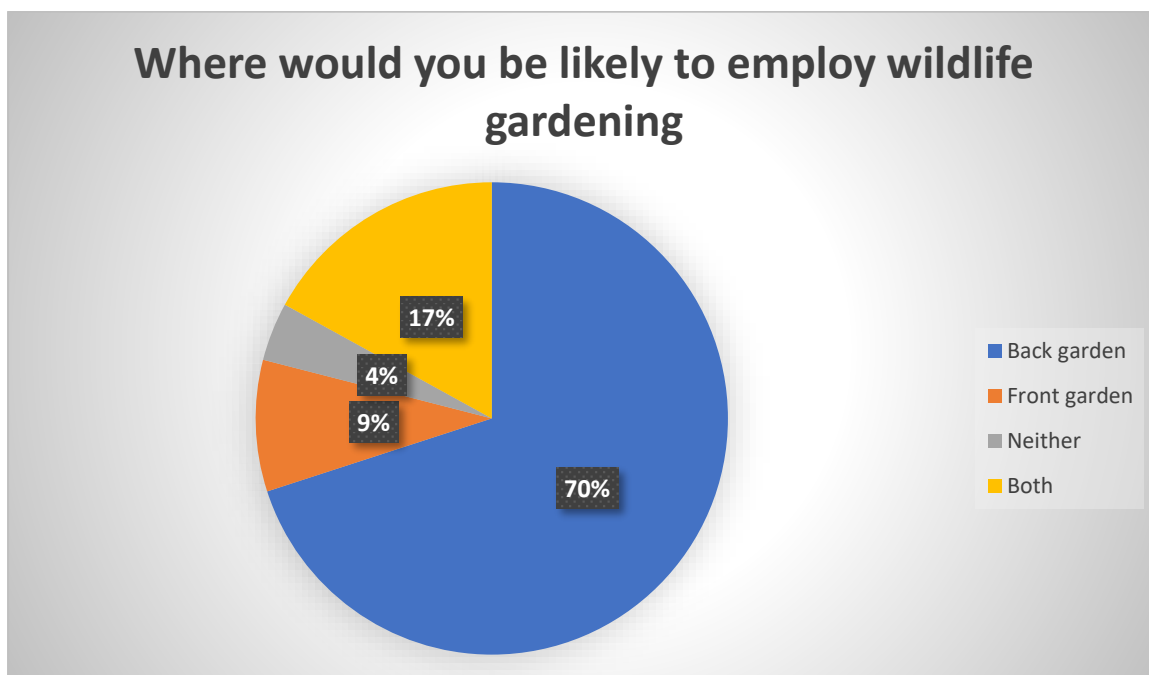


FIGURE 4.12 *FRONT GARDEN VS BACK GARDEN*

Only 26% of respondents would use their front garden. Possible reasons could be

- Front gardens are often used for parking
- Conforming to 'norms of neatness' is more likely to be an influencing factor, people will be less concerned in back gardens which are usually fairly private.
- Front gardens are 'too small'

As discussed in chapter 2, the increasing trend to pave front gardens for parking is creating problems with increased run-off. Although flood control was not a popular benefit of Green infrastructure (fig 4.12), in inner city areas there is the potential to combine green infrastructure such as bio-swales (a vegetated trench or low lying area to absorb storm-water runoff, see appendix, fig 1), street trees and pollinator pathways with front garden improvement schemes, selling flood control as an additional ecosystem service.

Survey 2 (appendix, page 90)

The aim of this survey was to investigate the role that exposure to nature at a young age has on the environmental empathy of adults in consideration of the following statements.

In urban areas 'nature deficit disorder' is likely to be inherent, particularly in younger people who have had little interaction with nature.

Better environmental education will return the population to a state of biophilia

4.10 DISCONNECT WITH NATURE

Survey 1 has found a far higher degree of concern for wildlife than the researcher expected, although this does not widely manifest itself in the environmental behaviour of the general public. There was also no evidence of less empathy with nature in urban areas. However, the results of survey 2 overwhelmingly validated the assertion that there is an increasing disconnect with nature among young children (fig 4.14), with 96% of teachers believing this to be the case.

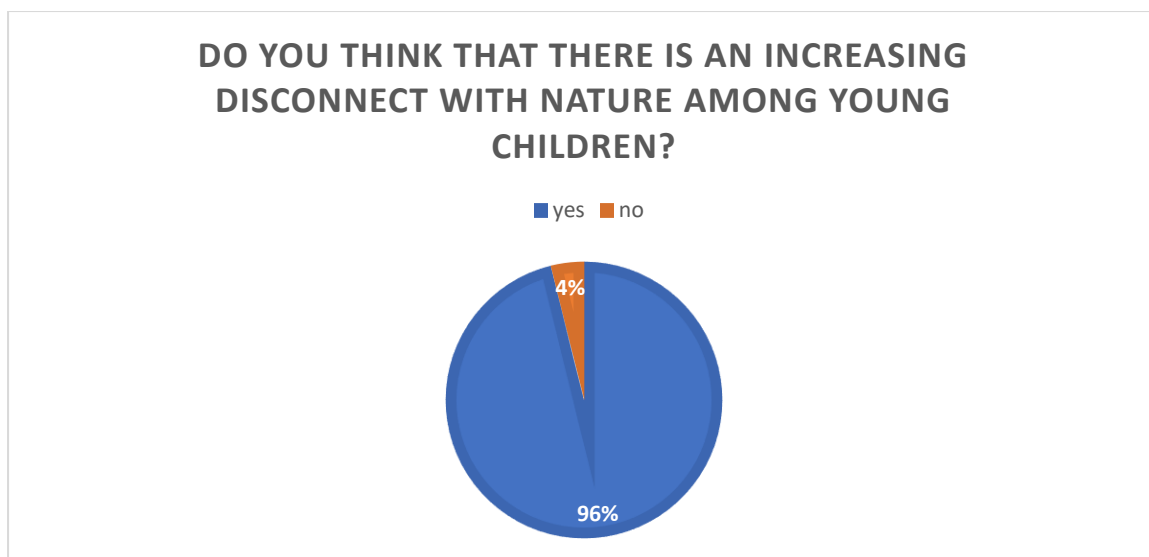


FIGURE 4.13 *DISCONNECT WITH NATURE*

Fig 4.15 shows that only seven respondents thought that a lack of green space could be a contributing factor, with 80% believing that children are disinclined to leave their computer games to go outside. 69% believed that parents didn't feel safe letting their children out alone and 35% that parents have little interest in nature. These results are consistent with findings in chapter 2 that it is 'orientation rather than opportunity alone' that motivated residents to spend time in urban green spaces, with 40 % of the sample population in a study by Lin et al, (2013) saying that they did not use local parks. Fig 4.12 shows that only 41% of respondents considered 'somewhere for children to play' to be an important reason for the provision of public green space. These answers indicate that providing green space is not sufficient, encouraging children and their parents to use this green space is the challenge if returning the population to state of biophilia is to be achieved.

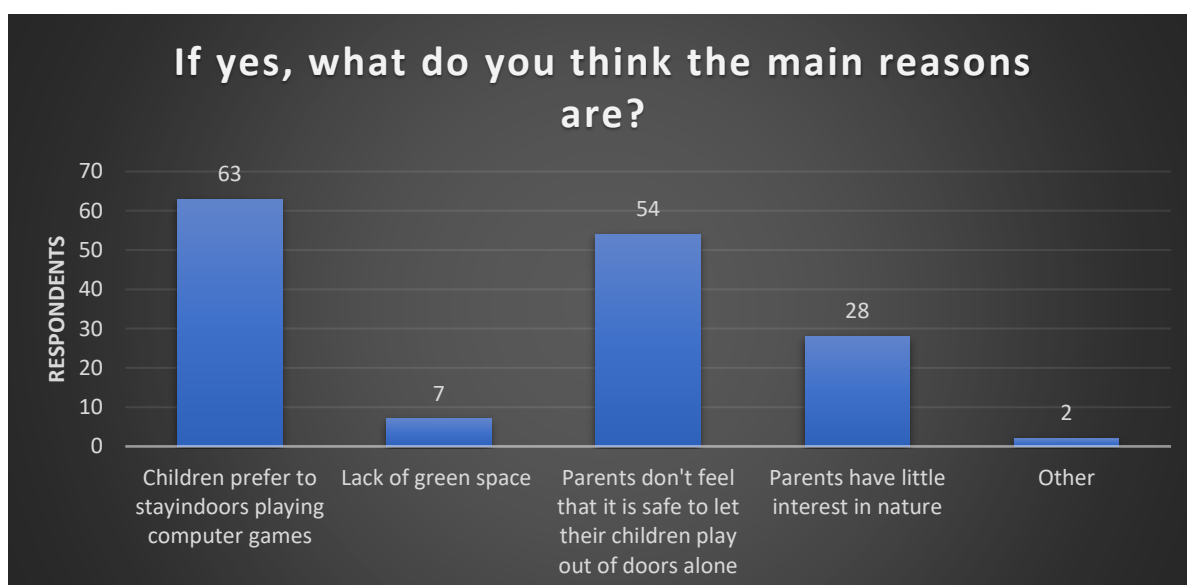


FIGURE 4.14 *REASONS THAT CHILDREN ARE DISCONNECTED WITH NATURE*

4.11 ENVIRONMENTAL EDUCATION?

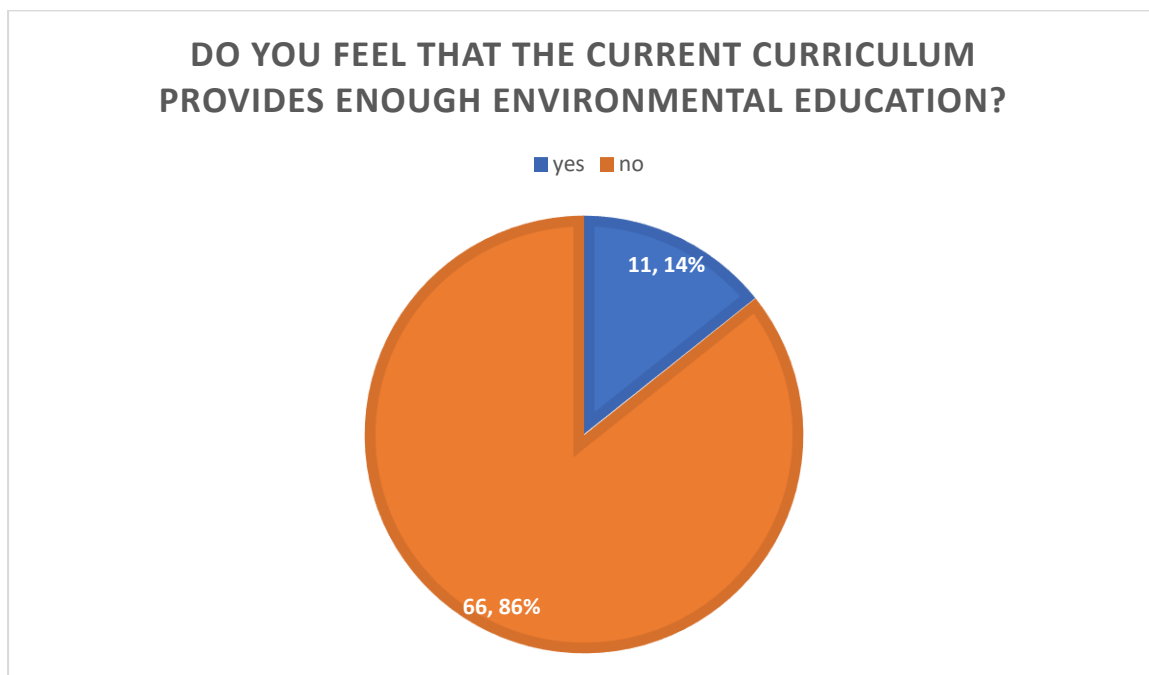


FIGURE 4.15 ENVIRONMENTAL EDUCATION

Figures 4.16 and 4.17 show that the vast majority of teachers that took part in the survey feel that there is not enough environmental education, and that regular exposure to nature provides benefits to children with behavioural or attention problems.

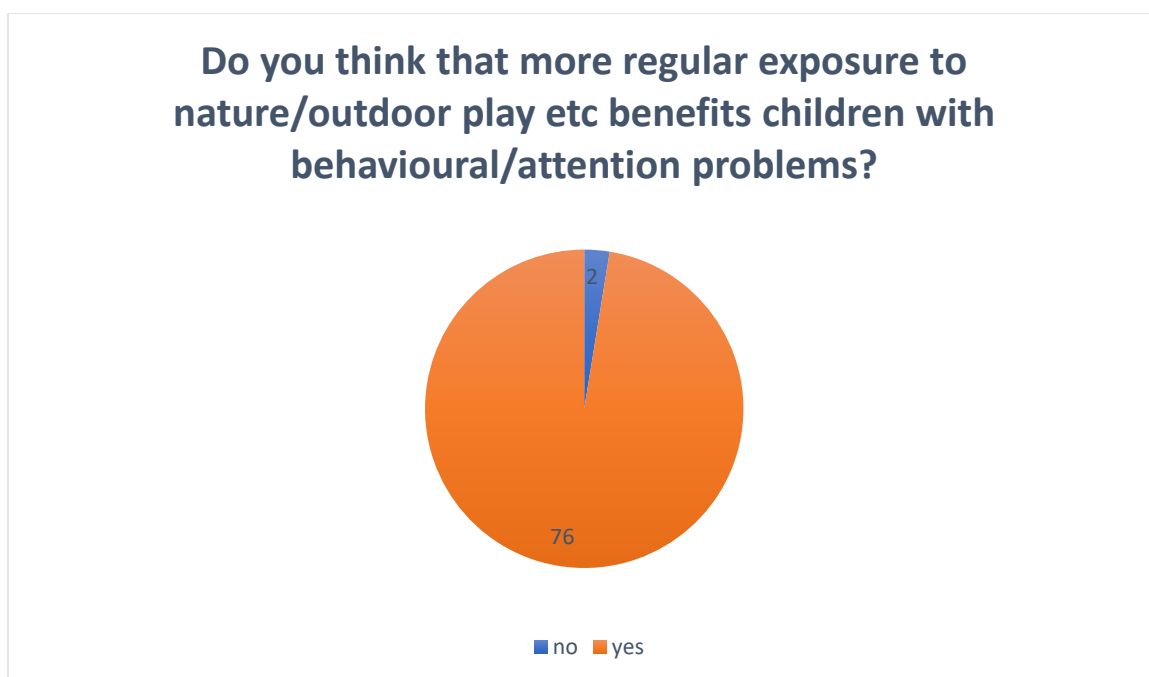


FIGURE 4.16 BENEFITS OF NATURE

4.12 QUALITATIVE DATA

The final 5 questions are tabulated below with an overview of the responses.

Question	Overview
Do you believe that it is likely that knowledge and understanding of nature at an early age will instil a greater environmental awareness/appreciation in later life?	Only one respondent answered no, with the view (which was a caveat of some other replies) that it must be continued throughout education and reinforced at home.
Do you believe that it would be beneficial to include more hands on (outdoor) lessons in geography and the sciences and alternative P.E. options?	Every respondent said yes, but with many pointing out that it was not practically possible within the current curriculum.
Do you think that it would be more beneficial to concentrate efforts on education 'in' the environment for primary age children?	15 out of 76 responses said no, as the message gets lost as they leave primary school.
Do you believe that a farm/nature reserve/woodland with classroom facilities available to all local schools be a useful facility, for use in a formal qualification as mentioned in 7, for use in traditional lessons such as geography or biology and for teaching early years pupils about the natural world/where their food comes from etc.?	Every respondent answered yes, but many mentioned issues of cost and logistical issues of taking children out of school.
Do you have any comments based upon your knowledge and experience within education that you feel may be useful?	All respondents were in favour of more outdoor education, the common theme was that within the constraints of an exam focused system it is difficult. At primary level there are a lot of initiatives, particularly in schools that have high numbers of pupils with 'emotional problems'.

All qualitative answers were divided into themes, the most commonly mentioned pros and cons for increasing the amount of environmental education, and using the outdoors more frequently for traditional subjects have been collated in table 18 (Benefits shaded green and constraints red).

Issue	Number of mentions
Cost	6
Logistics	6
Time constraints	19
Beneficial for children who struggle academically	29
Health and well-being	6
New curriculum may address issues	9
Eco-clubs and forest schools are useful	8
Doesn't continue after primary school	5
Message isn't reinforced by parents	4

TABLE 4.17 PROS AND CONS OF INCREASED OUTDOOR LEARNING

The strong message from these results is that spending time in nature is hugely beneficial for children, providing practical learning tools and being particularly advantageous for children with learning or behavioural difficulties. Lessons do not need to be focused on nature or environmental issues, as they will be a by-product of practical outdoor lessons such as biology or geography. Many primary schools have eco-clubs and there is increasing use of forest schools, but these are not currently creating a connection with nature that carries on into later life. The clear message is that this kind of change cannot happen within the current education system, with no space in the teaching week and all of the focus on exam results.

CHAPTER 5

5 CONCLUSIONS AND RECOMMENDATIONS

This chapter will briefly review this dissertation, then present an outline of a strategy for an urban ecological network in consideration of its findings. Finally providing recommendations for future research.

Urbanisation is a major cause of habitat loss, and the fragmentation of much of the remaining habitat, but urban areas are ironically key for the future of many wildlife species. Primarily because of the amount of land they cover and the potential to create habitat which now rarely exists in the wider rural environment. Support of conservation goals is also widely believed to be dependent upon the direct experiences with nature of the growing urban population. This dissertation reviewed the current research on ecological corridors, habitat fragmentation and wildlife gardening, creating a foundation of ecological knowledge to inform the planning of an urban ecological network. The relationship between ecological theory, public perception and social norm dynamics was then assessed to frame the primary research, with a principal goal of obtaining the information necessary to effectively incorporate private gardens as wildlife corridors, designed and managed in consideration of public perceptions and motivations and therefore more likely to succeed. Potential methods of raising levels of environmental concern were investigated to highlight future research possibilities and to create a strategy that can strengthen over time.

This research has achieved its aims and objectives, although many of the findings contradicted the researcher's expectations, and limitations in the research methods produced some data that was not useful to the research. Even the disappointments have identified new avenues of research in an area with a scarcity of scientific data and a need for applied practical research.

5.2 RESULTS

Chapter 2 established that viewing urban ecosystems in terms of meta-populations or meta-communities is especially pertinent, as they are inherently composed of disparate habitats both in size and quality. This research has expectedly found that the human urban population is equally varied in their habits and opinions, making managing wildlife corridors of private gardens especially difficult. Goddard et al's (2009) observation of the outcome of many small scale decisions potentially being detrimental to overall biodiversity in urban landscapes, is one driver for creating a coordinated wildlife corridor, the other is to create a feeling of community ownership and override negative social norms, pushing wildlife gardening over the tipping point (Nyborg et al, 2016) into becoming a socially acceptable norm. The assumption that people will be more willing to change their habits if they are considered social or community norms is validated by this research, with only 10% of respondents being unwilling to change their behaviour if they were part of a strategic plan for a wildlife

conservation corridor. Harnessing the power of local shared norms can make wildlife gardening not only acceptable, but the prevalent behaviour.

The concept of trophic cascades is useful when viewing the urban ecosystem with humans at the top of the food chain. The success of the ecological network as a whole is dependent on the human meta-population. A complication of managing human meta-populations is the potential variance in attitude and behaviour created by location, economic status, education and formative experiences. This research has assessed many of these issues, however there are many areas for future research that are currently lacking in knowledge. For example if it was found that less affluent areas participated far less in wildlife gardening (validating the 'luxury effect', Grove, Locke and O'Neil-Dunne, 2014), then this population of humans would not be contributing to the cumulative actions of the meta-population and potentially create a gap in the connectivity of the system. Urban delimitations were not found to have a meaningful effect on attitude, but the limited garden size correlating with increasing density of urban areas will require more reliance on public green space and imaginative use of green infrastructure.

To create effective corridors there need to be as many gardeners participating as possible, across the breadth of the network. The number of respondents who were concerned about declines in wildlife populations was far higher than expected, and whilst levels of gardening enthusiasm varied, the number of respondents who would be willing to participate in wildlife gardening within a wildlife corridor was positive. However, the plan must find ways to 'engage the unengaged' (Shaw, Miller and Wescott, 2013).

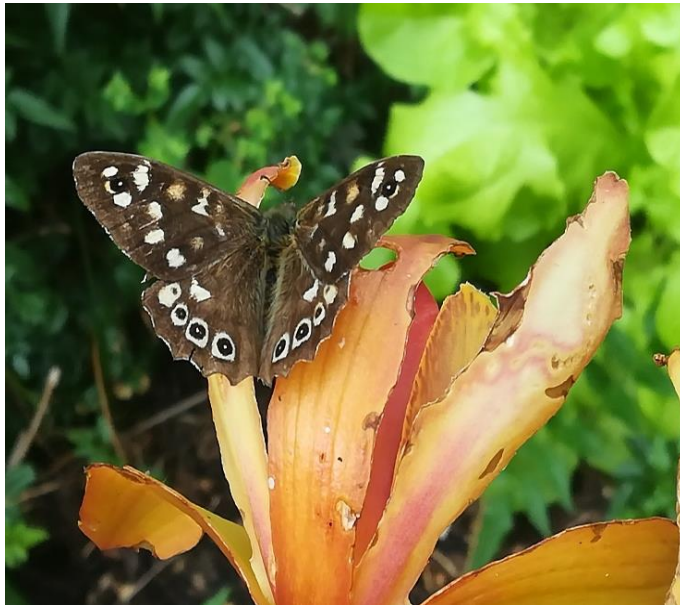
Increasing examples of the 'extinction of experience' are intuitively intertwined with increasing urbanisation. As the urban population's direct experiences with nature diminish, so does their affinity with nature and consequently their support of conservation actions. However this research does not unequivocally support this widely believed and instinctive theory, wildlife concern was higher among rural born residents but not conclusively enough to validate a theory of nature deficit disorder (although it was identified that surveying a larger sample of rural-born residents would be necessary to test this result). Perhaps looking at the quality of experience would be more useful. The majority of respondents in survey 2 believed that children are less connected with nature, not because they do not have access to green space, but because they do not use it, either because they prefer to stay indoors playing computer games or because their parents felt unsafe to let them play out of doors alone. This statistic didn't vary between urban and rural areas, indicating that the problem is cultural rather than solely due to location. This validates the theory that it is 'orientation rather than opportunity alone' that motivates people to spend time in nature.

This clearly indicates that for wildlife gardening to be a sustainable and functional part of urban ecosystems, more needs to be done than creation of a strategy for residents

already likely to be predisposed to help wildlife. Provision of more public green space will not be sufficient to increase connection with nature.

The final plan is designed to be utilitarian but without ignoring species interactions, to avoid the potential of inadvertent ecological problems, such as trophic cascades, bottlenecks or ecological sinks/traps. Boitani et al's (2007) critique of ecological corridors, asserted that they oversimplify 'complex ecological concepts and that there is only information available for a handful of species', however there is not a great deal of evidence supporting criticisms of ecological corridors, and the studies that have been carried out do not focus on urban ecosystems, which highlights an opportunity for further research.

The lack of data, suitable modelling techniques and scientific knowledge of urban ecological corridors, present an opportunity to create a strategy designed to grow and improve over time. Utilising the best knowledge available and supplementing it through constant monitoring, combining citizen science with regular ecological surveys.



URBAN ECOLOGICAL CORRIDOR

BRIEF OUTLINE FOR
AN URBAN
ECOLOGICAL
NETWORK
INCORPORATING
PRIVATE GARDENS AS
WILDLIFE CORRIDORS.

SURVEYS

Before any strategy can be devised it will be necessary to have a geographical and ecological knowledge of the urban ecosystem, so there will be a requirement for:

- **Landscape scale ecological surveys** of all significant green space within the urban area, identifying species populations and habitat type, size and quality. Identified in chapter 2 as an essential starting point (McHugh and Thompson, 2011), and providing the necessary knowledge to create a context specific strategy (Gippoliti and Corrado, 2017).
- **Survey of surrounding rural area**, identifying habitat type and quality, existing species and size of populations. To create sustainable, genetically diverse meta-communities, it will be necessary to export/import individuals between rural and urban populations as well as between populations within the urban ecosystem (Vimal, Mathevet and Thompson, 2012).
- **GIS mapping, identifying potential corridors**, opportunities for increasing the amount of public green space, potential barriers and opportunities for engineered green Infrastructure solutions.

This will not only identify potential corridors but also their quality. Prospective corridors consisting mainly of small gardens will have limited habitat potential in individual gardens, and this research has established that there is less gardening enthusiasm among residents with small gardens. This arms planners with the knowledge needed to target residents with appropriate strategies, e.g. a small garden owner who dislikes gardening may be happy to leave a wild area of garden.

DYNAMIC MAP

Using the information from the surveys, a dynamic map of the entire ecosystem will be created. This will be available on a website with a downloadable app, allowing a large amount of information to be provided to gardeners, but also facilitating the citizen science aspect of the project. It will:

- Allow residents to be able to view their own contribution, and the neighbourhood/community level contribution. 26% of respondents in survey 1 said that they would be discouraged from wildlife gardening because they think it is untidy and neighbours will disapprove, or because they do not think that it will make a difference. Being able to see the actions of neighbours and the wider community can develop local norms, i.e. shared norms resulting from shared spatial environment, and create a sense of community ownership and collaboration. This is corroborated by the high number of respondents who said that they would positively change their behaviour if part of a strategic wildlife corridor.
- Have a greater effect than wildlife certification schemes, overriding negative proscriptive injunctive norms. Social norms were found to be affected by pride as much as guilt, if a sense of individual and cumulative achievement can be

garnered then pride in being part of the wildlife corridor and guilt of not participating can push wildlife gardening over the tipping point into being the 'normal' behaviour.

MONITORING

In a recent literature review, Lynch 2018 found that within the last ten years there have been no studies examining the on the ground results of corridor projects. Chapter 2 identified both a lack of species data and a scarcity of research into the functionality of urban wildlife corridors. Chapter 4 then highlighted the many variables that need to be considered. There was no strong correlation between gardening enthusiasm and wildlife concern, and the type and number of wildlife gardening activities in which respondents were prepared to engage varied.

Steg and Keizer's (2013) assertion, that people with a 'strong environmental self-identity, will engage in environmentally friendly behaviour without any external incentives', was not consistent with the results of this research. Although 90% of suburban respondents professed concern for wildlife, this did not translate into a willingness to participate in wildlife gardening activities that are perceived to be labour intensive or untidy, such as creating a wildflower meadow. Whether this is a result of normative behaviour, gardening enthusiasm or a lack of knowledge is difficult to establish.

Urban wildlife corridors that are well planned and self-reporting will provide continuous data about the level of participation and the types of gardening activities employed by residents, which can be analysed to discover differences in behaviour across urban delimitations and measured against the variables used in this research. As well as building up ecological knowledge of the functionality of wildlife corridors.

Grafius et al, (2017), highlighted a major limitation being that the process of gathering data to validate the connectivity of ecological corridors is complex and expensive, meaning that there is little specific data to guide planners or to validate the concept. Creating a system that facilitates the use of citizen science, combined with regular ecological surveys can overcome these issues (for urban networks).

The enthusiasm of the public to participate in citizen science projects is well proven, in 2018, 482,915 recordings of bees were submitted to the 'great British bee count', 73% of these sightings were made in gardens (Wignall, Alton and Ratnieks, 2019). In January 2020, nearly half a million people participated in the RSPB's annual bird count (The RSPB. 2020, (2)). These initiatives and many others are facilitated through the use of smart apps, which will also be adopted for this project.

APP

User input

- Provide info of wildlife gardening activities and biodiversity features, which can be updated at any time
- Provide species observations
- Community/neighbourhood groups can be established

App output

- Uploads individual garden information to dynamic map
- Provides ecologists and environmental planners with up to date information about the entire network
- Provides gardeners with information, e.g. increases in species populations,

Benefits

- Gardeners should feel a sense of community ownership, they can see that the network is successful and by extension their actions are worthwhile
- Environmental planners receive real time developments, allowing the system to evolve efficiently and providing 'a wealth of scientific data over time.

Ecological surveys will be conducted annually if possible to monitor changes in the overall network.

This app is developed from the 'Gartenapp' (Schneider, Strohbach, App, M. and Schröder, B. 2019), and will suffer from the same deficiencies. Primarily that use of the app is reliant upon voluntary participation of residents, and will be ineffective if the number of users is low. However, within the strategy, the app can be an important motivational tool as well as an invaluable guide for environmental planners.

INDIVIDUAL WILDLIFE GARDEN PLANS

For the strategy to be sustainable it must be designed within parameters of convenience to the garden owners. A range of garden plans will be available on the website providing options for gardeners at every scale of enthusiasm and for all garden sizes. Including minimal options such as 'plant a tree' or feed the birds.

Encouraging participation at any level of input will be important. The number of wildlife gardening activities that respondents were happy to engage in varied greatly, and it is as important to encourage an unconvinced resident to plant one tree as it is to encourage a complete wildlife garden at the opposite end of the scale. At the landscape level each small action is important, both as an immediate habitat improvement and as a means to increasing the connection with nature for the gardener.

The three most labour intensive wildlife gardening activities were also the least popular choices, this could be addressed by providing plans, as many of these respondents would be unaware of the practicalities.

Different levels of enthusiasm must be targeted with appropriate plans. A resident who has no interest in gardening and is not concerned about having a tidy garden (but has high environmental concern) may be happy to leave a wild area of garden, and might be glad of the excuse of it being a strategically planned wildlife garden.

Rather than attempt to coordinate habitat types provided within corridors, it could be more effective to maximise the overall area of habitat by tailoring plans to gardeners as long as connectivity is maximised, then monitoring the effectiveness. Ersoy, Jorgenson and Warren, (2019) concluded that a mix of land cover provides the greatest benefit for multi-species, mimicking the variety of natural habitats.

EXAMPLE: FRONT GARDEN

In areas where parking is a problem and most front gardens have been paved over, one option would be to:

- Replace walls/fences with Hedges: Creating habitat, food-source, cover for small burrowing mammals etc.
- A green driveway (McAllister, 2020; Drivewayexpert.co.uk. 2020) will reduce runoff, and allow the exchange of gas, water and nutrients between the soil and the atmosphere, (Li et al, 2017). Increasing Co2 absorption and cooling, and allowing the soil ecosystems to survive, consequently providing food for birds etc.

The results of questions 19 and 16 would indicate that there is a good chance of such proposals being supported not just by individual gardeners but by the wider community/neighbourhood.

- 95% of respondents said that they would be supportive of GI to provide ecosystem services such as flood control.
- Only 10% of respondents said that they would be unlikely to improve their garden for wildlife if they were part of a strategic plan for a wildlife corridor.

This would suggest that if a strategic plan was proposed combining wildlife gardening and ecosystem service provision it would be widely accepted. This plan could also incorporate public green infrastructure initiatives where appropriate, such as bio-swales (a vegetated trench or low lying area to absorb storm-water runoff, see appendix, fig 1), street trees or pollinator corridors. On streets where parking is a big problem there may be no space for this type of green infrastructure, making the use of gardens more important.

Flood prevention was the least popular choice for the importance of public green space in question 18, however with flooding in the UK becoming a more regular problem it shouldn't be difficult to persuade residents of the benefits.

Pollution remediation was chosen by 60% of inner city residents so this could be harnessed to improve public perception of the benefits of increasing vegetation.

An important consideration is the choice of plant cover for engineered green infrastructure, as due to the specific requirements of plants, (e.g. in bio-swales to be able to tolerate waterlogging but also dry conditions, similarly for green roofs, and also the ability to tolerate pollution), non-native species are often chosen, which will provide ecosystem services such as carbon sequestration and temperature regulation but are likely to be less useful for wildlife.

PROMOTION

To increase awareness and maximise participation levels, there will be collaboration with.

- Community groups
- Local wildlife groups
- Wildlife charities (hopefully gaining support from wildlife charities that currently promote wildlife gardening such as the bumblebee conservation trust and RSPB).
- Schools
- City farms
- Community allotments/Gardens

EXAMPLE: UTILISING FLAGSHIP SPECIES

Chapter 2 highlighted the benefits of utilising flagship species to promote conservation goals. Hedgehogs were identified, as populations are now stronger in urban areas, possible reasons are less predation by badgers, more food and shelter, and milder climate, (Braaker, Kormann, Bontadina and Obrist, 2017) but they frequently travel up to 1500km a night so need good connectivity. Urban habitat could be a refuge, and this research has shown that hedgehogs are a popular species. They are also an umbrella species, as their requirements overlap with those of many other species.

Peregrine Falcons are another species whose success in urban areas is a contrast to their struggles in their natural environment (Allen, 2020). Whilst they are not an umbrella species, they can be useful as a flagship species, highlighting success stories and engendering a sense of pride in the urban communities where they are thriving.

EXAMPLE: SCHOOLS

The number of children in a household was not found to have any consequential effect on the likelihood of respondents to engage in wildlife gardening activities. However, involving schools within the catchment of the network should mean that households with young children would increase their positive activity and also be keen to monitor, report and receive updates.

This will also develop a knowledge and understanding of nature in children, and could address the effects of a lack of interest in nature among parent's, which was considered by most respondents in survey 2 to be a contributing factor for a growing disconnect with nature among children.

Local schools could help by:

- Doing school projects about wildlife gardening/local wildlife
- Learning about the wildlife within the town/city
- Creating a school wildlife garden or nature reserve
- Using the dynamic map to monitor the school, their area and the entire urban area's progress

QUALITY OF EXPERIENCE

Survey 2 concluded that lack of green space isn't a strong factor influencing the lack of interaction with nature. This was corroborated by survey 1, where only 41% of respondents considered 'somewhere for children to play' to be an important reason for the provision of public green space. This reinforces the study by Lin et al, 2013, which concluded that it was 'orientation rather than opportunity alone' which influences urban resident's use of public green space.

'Human beings are unlikely to protect what they do not love, and cannot love what they do not know' (Gould, 1991), therefore stimulating a love of nature through creating opportunities to use and understand nature will be necessary.

Incorporating mindfulness and well-being, (Nhsforest, 2020; Coedlleol, 2020). Fitness groups or woodland crafts are all current examples of increasing the quality of experience with nature that can be developed.

5.3 NATURE DEFICIT DISORDER

The results of survey 2 overwhelmingly validated the assertion that there is an increasing disconnect with nature among young children, with 96% of teachers believing this to be the case. 98% believed that spending time in nature is hugely beneficial for children, providing practical learning tools and being particularly advantageous for children with learning or behavioural difficulties, and 86% believe that there is a need for more environmental education.

Within the constraints of this dissertation, this was valuable information, validating theories of nature deficit disorder, the importance of the message being reinforced by parents and the need for quality of experience as well as quantity, with only 9% of respondents believing that a lack of green space is a factor for children spending less time in nature.

The conclusion of this research is that there is a need to refocus the education system but with the clear message that this kind of change cannot happen within the current structure, with no space in the teaching week and all of the focus on exam results. A greater environmental connection can be a by-product of a more enlightened approach to teaching traditional subjects, which would be a particular benefit to pupils with attention disorders and behavioural problems, who struggle to learn in a traditional classroom setting.

A starting point for research would be a more extensive and focused survey, which would inform interviews with teachers, pupils and management, to establish where change is needed, and identify areas where this change can be practically (and financially) implemented).

5.4 FOCUS FOR FUTURE RESEARCH

This dissertation has identified other areas that would benefit from research. A larger, more focused study into environmental concern along a rural-urban gradient, concentrating on the effects of formative exposure levels to nature would provide scientific backing to what are currently unproved theories of nature deficit disorder and extinction of experience, and be useful to the research opportunity into benefits of environmental education identified above. Effects of wealth on behaviour and the specific underlying reasons would also benefit urban environmental planners, providing more information to explain differences in wildlife gardening enthusiasm and concern for wildlife.

5.5 FUTURE DEVELOPMENT

The potential of large green infrastructure projects fell outside of the parameters of this research but will be a key aspect of successful urban ecosystems.

e.g. Commercial/Industrial Buildings

Legislation for including green roofs on new commercial buildings such as the New York tax abatement scheme (Urbanstrong, 2020).

Utilising commercial buildings for urban agriculture will not only have benefits to biodiversity and the environment, but will provide jobs which will connect local people to the food that they eat and reduce the burden on land needed for traditional agriculture (Brooklyn Grange, 2020; appendix, fig 2)

5.6 LIMITATIONS OF THIS RESEARCH

As a result of the broad scope of the primary research, for some variables (e.g. number of respondents born in rural areas) the numbers of respondents were a little low to give meaningful results, creating the opportunities for future research mentioned above. For the same reason it was difficult to use non-parametric statistical tests for a lot of the data. Some of the questionnaires were carried out face to face which may have influenced respondents. As pointed out in chapter 4, some question wording was slightly ambiguous and could be misinterpreted (the wildlife gardening activities in which respondents would engage should have been less vague). An urban ecological network will also encompass fresh water (marine if coastal) habitats, but this research had to limit itself, this will need to be considered for future research, as will the surrounding countryside, as this is key to maintaining genetically successful populations. Rivers and lakes/ponds/canals etc. are also important for flood water management and as particularly attractive areas of nature to the public.

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APPENDIX

		0		1		2		3		4		5		6		7		8		9	
A	10			1	10 %					3	30 %	1	10 %	3	30 %	1	10 %	1	10 %		
B	14							3	21 %	5	4 %	1	7 %	2	14 %			2	14 %	1	7 %
C	30	1	3 %	2	7 %	1	3 %	7	23 %	8	26 %	2	7 %	5	16 %	1	3 %	3	10 %		
D	18					3	16 %	4	22 %	2	11 %	3	16 %	1	5 %	5	27 %				
E	17			3	18 %	6	4 %	4	2 %	1	6 %	1	6 %					2	12 %		
F	10			1	10 %	3	30 %	3	30 %	1	10 %	1	10 %	1	10 %						
		1		7		13		21		20		9		12		7		7		1	

TABLE 1, NUMBER OF WILDLIFE GARDENING ACTIVITIES AND GARDENING ENTHUSIASM

A	Extremely keen
B	Quite keen
C	Would like to do more
D	Enjoy the garden but don't do any gardening
E	Do the bare minimum
F	Don't do any gardening

	Activity	Small garden	% of respondents	% of category	Large garden	% of respondents	% of category
1	Feed birds	27	36%	73%	15	20%	83%
2	Plant a tree	26	36%	70%	18	25%	100%
3	Plant pollinator friendly flowers	25	37%		13	19%	72%
4	Stop using chemicals	20	33%	68%	12	20%	67%
5	Leave a wild area of garden	17	37%	46%	7	15%	39%
6	Wildflower meadow	10	32%	27%	8	23%	44%
7	Wildflower lawn	13	42%	35%	7	22%	39%
8	Install a wildlife pond	10	40%	27%	6	24%	33%
	Activity	Medium garden	% of respondents	% of category	Very Large	% of respondents	% of category
1	Feed birds	19	25%	63%	12	16%	86%
2	Plant a tree	18	25%	60%	9	12%	64%
3	Plant pollinator friendly flowers	17	25%	25%	11	16%	79%
4	Stop using chemicals	16	26%	53%	10	17%	71%
5	Leave a wild area of garden	13	29%	43%	5	11%	36%
6	Wildflower meadow	12	35%	40%	3	9%	21%
7	Wildflower lawn	11	35%	37%	3	10%	21%
8	Install a wildlife pond	6	24%	20%	3	12%	21%

TABLE2, GARDEN SIZE AND WILDLIFE GARDENING ACTIVITIES

		Wildflower Meadow	Wildflower Lawn	Plant a tree	Wildflowers	Wild area	Wildlife pond	Feed birds	Stop using chemicals
City Centre	11	4	4	7	6	4	4	8	5
Inner City	21	6	8	18	12	8	5	16	20
Suburbs	20	8	6	15	18	9	5	13	12
Village	45	17	19	33	33	24	10	39	24
		35	37	73	69	45	24	76	61

TABLE 3, LOCATION AND WILDLIFE GARDENING ACTIVITIES

	Wildflower Meadow	Wildflower Lawn	Plant a tree	Wildflowers	Wild area	Wildlife pond	Feed birds	Stop using chemicals
City Centre	36%	36%	64%	55%	36%	36%	73%	45%
Inner City	29%	38%	86%	57%	38%	24%	76%	95%
Suburbs	40%	30%	75%	90%	45%	25%	65%	60%
Village	38%	42%	73%	73%	53%	22%	87%	53%

TABLE 4, LOCATION AND WILDLIFE GARDENING ACTIVITIES

		0		1		2		3		4		5		6		7	
City Centre	11	3	27%	2	18%	2	18%			1	9%	2	18%	1	9%		
Inner City	20	7	35%	2	10%	5	25%	4	20%	1	5%	1	5%				
Suburbs	21	5	24%	5	24%	6	29%	1	5%	3	14%	1	5%				
Village	45	11	24%	13	29%	5	11%	5	11%	6	13%	3	7%	1	2%	1	2%
		26		22		18		10		11		7		2		1	

TABLE 5. NUMBER OF UNWELCOME SPECIES CHOSEN BY RESPONDENT AND LOCATION

British beekeepers association	https://www.bbka.org.uk/gardening-for-bees
Friends of the earth	https://friendsoftheearth.uk/bees/beefriendly-plants-every-season
Bumblebee conservation trust	https://beekind.bumblebeeconservation.org/home/1
Butterfly conservation	https://butterfly-conservation.org/how-you-can-help/get-involved/gardening/gardening-for-butterflies https://butterfly-conservation.org/sites/default/files/1.bc_gardening_leaflet_v3.pdf
RHS	https://www.rhs.org.uk/advice/profile?PID=648
St Davids Pollinator trail	https://www.thebugfarm.co.uk/pollinator-trail/
National Pollinator strategy: England	https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/794706/national-pollinator-strategy.pdf
Wildlife Trusts	https://www.wildlifetrusts.org/sites/default/files/2017-12/ecxt.pdf

TABLE 6: WILDLIFE SCHEMES

Activity	Description
Feed birds	Low maintenance, must be planned so as not to create a dinner table for local cats. Expense of buying seed will be a deterrent to some.
Plant a tree	All but the smallest garden can accommodate a tree (e.g. a fruit tree on a non-vigorous rootstock). It is low maintenance, won't upset neighbours and if replicated on a community scale can make a huge difference to the overall habitat.
Plant pollinator friendly flowers	If every garden grows some pollinator friendly flowers (preferably native), it will have a huge cumulative effect. Either changing habits from non-native bedding, or just a window box.
Stop using chemicals	Most chemical uses have an effective equivalent, encouraging native predators such as ladybirds, toads and hedgehogs. It may be more difficult to change the habits of the keenest gardeners, who may not be prepared for rust and blackspot to blight their rose for example.
Leave a wild area of garden	Even a small area in the back corner, or behind the shed is invaluable, a patch of long grass or a pile of logs can provide shelter for many species.
Wildflower meadow	Spectacular on a large scale but in urban gardens would perhaps be more feasible to advocate a wildflower patch, can be a beautiful border to a traditional lawn and far less time consuming than a traditional border.
Wildflower lawn	If planned correctly is less work than a traditional lawn, although it may take some effort to initially reduce the dominance of stronger grasses. Planting a mix of low growing wildflowers in the lawn, including hemi parasitic plants such as yellow hay rattle. Depending on the species chosen will be cut every three to six weeks.
Install a wildlife pond	Work to install and needs a small amount of annual maintenance, but even a small well designed pond will be a haven, not just for pond-life but for birds and mammals.

TABLE 7 GARDEN ACTIVITIES INFORMATION



FIG 1. A BIO-SWALE AT 4TH AVENUE AND DEAN STREET IN BROOKLYN. (PHOTO: NYC WATER/Flickr) TAKEN FROM (DWYER, L. 2014).



FIG2. ROOFTOP FARM IN BROOKLYN, NEW YORK, (TAKEN FROM BOYER, 2013)

SURVEY 1

WILDLIFE GARDENING

This survey is part of a study for my MSc dissertation to investigate the feasibility of establishing ecological corridors incorporating wildlife gardening to create sustainable urban ecosystems. Please leave blank any questions that you feel uncomfortable answering.

1. Gender

- ☐ Male
- ☐ Female
- ☐ Prefer not to say
- ☐

2. Age

- ☐ Under 18
- ☐ 18-24
- ☐ 25-34
- ☐ 35-44
- ☐ 45-54
- ☐ 55-64
- ☐ Age 65 and older

3. Profession?

4. How many children do you have?

- ☐ 0
- ☐ 1
- ☐ 2
- ☐ 3 or more

☐ Prefer not to answer

5. Nearest town/city

6. Location

☐ City centre

☐ Inner city

☐ Suburbs

☐ Village

☐

7. Where were you born

☐ City

☐ Town

☐ Village

☐ Isolated rural

8. How worried are you about the serious declines in population of many wildlife species?

☐ Not at all concerned

☐ Not very concerned

☐ Neutral

☐ Concerned

☐ Very concerned

9. What size garden do you have

- ☐ Small: less than 10m x 10m (half a tennis court or smaller)
- ☐ Medium: up to 10m x 20m (1 tennis court)
- ☐ Large: (Between 1 and 2 tennis courts)
- ☐ Very large: (More than 2 tennis courts)
- ☐ I don't have a garden

10. Which of the following describes your gardening activities best?

- ☐ Extremely keen
- ☐ Quite keen
- ☐ Would like to do more if I had more time
- ☐ Enjoy the garden but don't enjoy gardening
- ☐ Do the bare minimum
- ☐ Don't do any gardening

11. Which of the following do you have in your garden?

- ☐ Bird Feeder
- ☐ Flowering plants
- ☐ Pond
- ☐ Compost heap
- ☐ Wild area (e.g. nettles or long grass)
- ☐ Trees
- ☐ Vegetable patch
- ☐

12. Which of the following would be unwelcome in your garden?

- ☐ Hedgehogs
- ☐ Foxes

- ☐ Squirrels
- ☐ Badgers
- ☐ Voles
- ☐ Moles
- ☐ Mice
- ☐

13. In which of the following wildlife gardening activities would you be happy to engage?

- ☐ Wildflower meadow
- ☐ Wildflower lawn (mowing every three weeks)
- ☐ Plant a tree
- ☐ Plant pollinator friendly flowers
- ☐ Leave a wild area of garden
- ☐ Install a wildlife pond
- ☐ Feed birds
- ☐ Stop using chemicals
- ☐

14. Where would you be most likely to employ wildlife friendly gardening?

- ☐ Back garden
- ☐ Front garden
- ☐ Neither
- ☐ Both

15. What would dissuade you from wildlife gardening?

- ☐ I don't care about wildlife
- ☐ I think that wildlife gardening is untidy
- ☐ Neighbours all have neat gardens and they will complain
- ☐ I don't believe my actions will make a difference
- ☐ I don't want to attract pests
- ☐ Nothing
- ☐

16. Would you be more likely to improve your garden for wildlife if you were part of a strategic plan for a wildlife conservation corridor?

- ☐ Yes
- ☐ No
- ☐ I don't think it would make a difference

17. Which of the following are present in your neighbourhood?

- ☐ Parks
- ☐ Street trees
- ☐ Public amenity planting (bedding or wildflowers)
- ☐ Urban farm
- ☐ Woodland
- ☐ Nature reserve
- ☐

18. Please select what you believe are the three most important reasons for increasing the amount of public green space

- ☐ I don't care about green space
- ☐ Aesthetic quality
- ☐ Well-being
- ☐ Recreational benefits
- ☐ Pollution remediation
- ☐ Wildlife habitat
- ☐ Carbon sequestration
- ☐ Flood control
- ☐ Somewhere for children to play

19. Would you be supportive of 'green infrastructure' (such as planting up river corridors or commercial green roofs) being used for wider environmental benefits such as flood control?

- ☐ Yes
- ☐ No
- ☐

SURVEY 2

EDUCATION

This survey is part of a wider study for my MSc dissertation to investigate the feasibility of establishing ecological corridors incorporating wildlife gardening to create sustainable urban ecosystems.

It is intended to address the hypothesis that children have less empathy and connection with the natural world (particularly in urban areas) and whether this can be addressed by changes within the education system.

Please leave blank any questions that you feel uncomfortable answering. Many thanks!

1. Profession

2. Teachers

☒

Primary

☐

Secondary

3. School location

☐

Urban

☐

Rural

4. What key stage level do you teach?

5. Do you think that there is an increasing disconnect with nature among young children?

☐

Yes

☐

No

☐

Other

6. If yes, what do you think the main reasons are?

- ☐ Children prefer to stay indoors playing computer games
- ☐ There is a lack of accessible green space
- ☐ Parents do not feel that it is safe to let their children play out of doors alone
- ☐ Parents have little interest in Nature
- ☐

7. Do you feel that the current curriculum provides enough environmental education?

- ☐ Yes
- ☐ No

8. Do you think that more regular exposure to nature/outdoor play etc benefits children with behavioural/attention problems?

- ☐ Yes
- ☐ No
- ☐

9. Do you believe that it is likely that knowledge and understanding of nature at an early age will instil a greater environmental awareness/appreciation in later life?

10. Do you believe that a formal qualification incorporating agriculture/horticulture/botany/ecology for example would?

- ☐ Benefit children that struggle with traditional subjects
- ☐ Create a greater sense of environmental awareness/appreciation
- ☐ Have a positive effect on pupils' general attitude/attention
- ☐ Is unnecessary
- ☐

11. Do you believe that it would be beneficial to include more hands on (outdoor) lessons in geography and the sciences and alternative P.E. options?

12. Do you think that it would be more beneficial to concentrate efforts on education 'in' the environment for primary age children?

13. Do you believe that a farm/nature reserve/woodland with classroom facilities available to all local schools be a useful facility, for use in a formal qualification as mentioned in 7, for use in traditional lessons such as geography or biology and for teaching early years pupils about the natural world/ where their food comes from etc?

14. Do you have any comments based upon your knowledge and experience within education that you feel may be useful?

