# Title

A study protocol to understand urban rewilding behaviour in relation to adaptations to private gardens.

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# Unstructured Abstract

Urbanisation is increasing; an estimated 68% of the world’s population is expected to live in an urban conurbation by 2050. In 2019, London had 9 million inhabitants. Greater London covers an area of 1,569km, 14% of which is vegetated private garden space, a percentage that is declining, negatively impacting biodiversity. Small adaptations to London’s private gardens can turn them into a habitat for wildlife. This study protocol provides detail of research to understand and influence urban rewilding behaviour with a focus on adaptations to private gardens in London. The research follows three phases comprising (1) a scoping review of the existing literature on intent-orientated pro-environmental behaviours with a focus on urban rewilding, coded using the COM-B model of behaviour, (2) sequential mixed methods research including interviews and a quantitative survey to understand the capability, opportunity and motivational factors influencing urban rewilding behaviour, culminating in (3) development of an intervention strategy to promote urban rewilding behaviour using the Behaviour Change Wheel framework. Combining the disciplines of design, environmental and behavioural sciences, this research will provide new insights for influencing the behaviour or urban rewilding.

# Key words

Behaviour Change, Design, Rewilding, Urbanisation

# Funding

This research is funded by London Metropolitan University.

# Disclosure statement

Siân Moxon developed the Rewild My Street website, the basis for intervention development outlined in this study protocol. No other conflicts of interest are reported.

# Biographical note

Justin Webb is a senior lecturer in Public Health and course leader of the MSc Public Health at London Metropolitan University. Justin has been working in the field of public health for over ten years both as a practitioner and as a researcher. Justin's former roles include working as the Director of the Centre for Workplace and Community Health at St Mary's University and as a National Engagement Manager for Macmillan Cancer Support, leading on the charity's healthy lifestyles programme. Justin’s research interest is in understanding and changing behaviour to improve health.

Siân Moxon is a senior lecturer in sustainable design and researcher in urban biodiversity at the School of Art, Architecture and Design at London Metropolitan University. She is an architect, BREEAM accredited professional, author of ‘Sustainability in Interior Design’ and founder of the Rewild My Street urban-rewilding campaign.

# Geographical location

The research outlined in this study protocol is pertinent to Greater London, UK.

# Abbreviations

BCT – Behaviour Change Technique

BCW – Behaviour Change Wheel

COM-B – The COM-B model of Behaviour covering Capability, Opportunity and Motivation

# Word count

The word count for this study protocol, excluding references, is 4,728.

# Introduction

Pro-environmental behaviour is defined as “individual behaviours contributing to environmental sustainability” (Mesmer-Magnus, Viswesvaran, and Wiernik, 2012: p. 160). To date, much of this work has focused on understanding and changing the automatic decisions people make which have an environmental impact, driven by unconscious cognitive processes by targeting contextual factors and *nudging* peoples behaviours in the desired direction (Byerly, et al., 2018). Research has taken place on intent-orientated environmental behaviours, for example, behavioural science has been successfully utilised to improve recycling and reduce household energy consumption (Bamberg and Rees, 2015; Osbaldson and Schott, 2012). Little research has been conducted to understand behaviours which improve and restore biodiversity to urban streetscapes. Research using behavioural science to understand pro-environmental behaviours to improve sustainability and biodiversity is still in its infancy (Byerly, et al., 2018).

### Urbanisation

Fifty-five percent of the world’s population are estimated to live in an urban area with a projected increase to 68% by 2050 (United Nations, 2018). Individuals within cities can adapt, change and transform, their homes and gardens to positively impact on biodiversity. Such behaviours require a conscious effort to reverse the trend seen in many cities of loss of green space.

London is the 4th most populous city in Europe with 9 million inhabitants and the 27th most populous city in the world (World Population Review, 2020). The Greater London area covers a geographical region of 1,569km. In July 2019, the National Park City Foundation declared London as the world’s first National Park city, a movement encouraging Londoners to make London greener, healthier and wilder (Mayor of London, 2019).

The United Nations Sustainable Development Goal number 11 aims to make cities resilient and sustainable (United Nations General Assembly, 2015). Existing policy in England focuses on greening new buildings and public spaces with a biodiversity net gain a condition of planning permission in England (UK Parliament, 2020). The Mayor of London’s Environment Strategy (2018) embodies this approach but also acknowledges the need for guidance for residents on managing gardens for biodiversity. Existing building stock and private gardens are difficult to control and, therefore, are often overlooked, yet could represent a significant improvement to biodiversity thanks to their cumulative land area and potential as habitat corridors linking public greenspaces (Department for Environment, Food and Rural Affairs, 2019).

There are an estimated 3.8 million garden plots (front and back) in Greater London (Wildlife Trust, 2010). Private gardens make up approximately 24% of Greater London, of which 57% is vegetated cover, meaning that approximately 14% of Greater London is made up of private garden green space (Wildlife Trust, 2010). The Wildlife Trust (2010) reported a 12% loss in vegetated garden cover in London between 1999 and 2008 resulting in a loss of wildlife, including birds, mammals, amphibia and invertebrates. Notable species at risk include hedgehogs, the house sparrow, the common frog, and the stag beetle (Wildlife Trust, 2010).

Data from the Office of National Statistics (2020) suggests that 79% of Londoners have access to a private outdoor space, made up of 98% of those living in a house and 65% of those living in a flat, with on average 4.4 flats sharing a garden. London’s residential gardens offer an opportunity to increase biodiversity by making small adaptions to turn them into a habitat for wildlife. Altering these spaces to accommodate nature could significantly contribute to London fulfilling its aims as a National Park City.

### Rewilding

It is said that the term ‘rewilding’ first appeared in print in 1990 (Johns, 2019), but it was Soule and Noss who refined the term in 1998 to include the conservation of large core reserves, corridors of connectivity for wildlife and the protection of keystone species. For the purposes of this study, rewilding is defined as making places wilder again by bringing back greater diversity of life (Jørgensen, 2015) and interpreted for an urban context as incorporating native plants and animals into urban infrastructure (Mills, et al., 2017). More recently terms such as ‘urban rewilding’ and ‘mini rewilding’ have been used (Stone, 2019); other related terms could include ‘nature friendly’ or ‘wildlife’ gardening. Urban rewilding has been advocated (Prior and Brady, 2017) and is inspired by a wider movement to reinstate self-regulating ecosystems in rural landscapes worldwide, championed by organisations such as Rewilding Earth (2020), Rewilding Europe (2020) and Rewilding Britain (2020), originating from the principle of restoring ‘big wilderness’ (Soule and Noss, 1998).

Greening urban areas enhances biodiversity and benefits humans. Urban environments have potential to support high levels of biodiversity. The latest State of Nature survey by UK conservation organisations found foxes and herring gulls are moving from rural areas, where their conservation status is concerning, to built-up areas (Haydow, et al., 2019). Further, populations of hedgehogs, which are classed as vulnerable to extinction, are showing signs of recovery in urban areas (Haydow, et al., 2019). Species such as peregrine falcons have become city specialists, taking advantage of their tall buildings and feral pigeons (Kettel, et al. 2019), while urban bumblebee colonies are more successful than those in agricultural areas (Samuelson, 2018).

Efforts to improve cities for wildlife are known to be effective, with targeted conservation measures achieving increases in urban populations of certain bat species (Hayhow, et al., 2016). Measures such as creating ponds for amphibians, planting wildflower areas and providing nest boxes and food for songbirds are beneficial to wildlife (Sutherland, 2020). Indeed, urban ponds have been shown to attract similar numbers of invertebrates compared to non-urban ones, while boasting richer species diversity (Hill, et al., 2017).

Vegetation provides ‘ecosystem services’, processes and outputs that are beneficial to humans (Costanza, 1997), with biodiversity having a positive impact on these functions (Harrison, et al., 2014). Cities can particularly benefit, with urban greenery helping to disperse air pollution (Janhall, 2015) and counter problems of urban overheating and surface flooding that will increase with climate change (Gill, et al., 2007). Contact with nature is recommended for its multiple health and wellbeing benefits for people (Maller, et al., 2006). Residents of urban areas with a higher proportion of greenspace feel healthiest (Maas, et al., 2006). Further, the positive impact of urban greenspaces on psychological wellbeing increases with their biodiversity (Fuller, et al., 2007).

### Rewild My Street

Rewild My Street (2019) is the progression of a winning entry for the National Park City Foundation’s June 2017 international design ideas competition *Imagine London as a National Park City*. It explores how a typical London residential street can be adapted to improve biodiversity, supporting the Mayor of London’s vision to make the capital a National Park City; it is this work that inspired this research.

The Rewild My Street website (Moxon, 2019) includes designs based on the Victorian terraced street typology, found in many London boroughs, to represent a typical residential street. Architectural drawings are developed at different scales and projections to show how a notional street adapted for biodiversity could look, providing ideas for how to successfully integrate wildlife measures into existing properties. Rewild My Street offers affordable DIY as well as commercial options to rewild urban private gardens; at January 2021, 770 people had subscribed to the website.

It is acknowledged that not all people in London live in a Victorian terrace street, however, the rewilding options presented on the Rewild My Street website are relevant across London’s residential streets. The Rewild My Street website offers an opportunity to reach people across London to support the rewilding of urban private gardens. The Rewild My Street website provides a basis upon which an intervention strategy could be developed, with changes made to the website itself, coupled with the development of supporting interventions to influence individual behaviour in regard to the rewilding of urban private gardens.

## Rationale for this research

Greening streets for biodiversity provides ecosystem services, such as improved air quality, reduced urban overheating and flood risk associated with climate change, and better health and wellbeing (Harrison et al., 2014). A change in behaviour by Londoners, to transform their gardens, could support these outcomes.

Byerly et al., (2018) identify the need to build up behavioural insights to achieve sustainability goals. Research has been conducted to understand the personal and social factors that influence pro-environmental behaviour, suggesting that age, gender, religion, social class, knowledge, control, a connection to nature, one’s childhood experiences, political and world view all play a part (Gifford and Nilsson, 2014), however, to influence behaviour, it is important to specify the behaviour in question as closely as possible. The need for such specificity is highlighted by the vast heterogeneity and inconsistency in pro-environmental behaviours, for example, a person can behave environmentally in terms of recycling but can also regularly drive short distances which could otherwise be taken by active travel; the determinants of each of these behaviours are different (Bamberg and Rees, 2015). This research, therefore, aims to understand and influence the conscious intent-orientated rewilding behaviour of making adaptations to one’s own private garden. The Rewild My Street website offers a basis for the development of an intervention strategy to influence urban rewilding behaviour.

## Conceptual framework

Kok (2015) identifies three major challenges in planning effective behaviour change interventions; (1) the correct identification of the change objectives, (2) selection of appropriate behaviour change methods and (3) implementation of the intervention strategy. Peters (2015) highlights the importance of the correct identification of areas for change, suggesting a systematic search and synthesis of the existing literature, a qualitative exploration of the behavioural determinants and a quantitative verification of determinants and beliefs.

Many frameworks exist upon which behaviour change interventions can be based; however, it is not clear which is the most comprehensive and conceptually coherent (Michie, van Stralen, and West, 2011). The Behaviour Change Wheel (BCW) (Michie, et al., 2011), an intervention development framework, aims to overcome this problem by synthesizing 19 behaviour change frameworks with a behavioural model sitting at its centre.

The behavioural model at the centre of the BCW is the COM-B model (Michie, et al., 2011). The COM-B model postulates that behaviour comes about from an interaction between one's *capability* to perform a behaviour, the *opportunity*, and *motivation* to carry out that behaviour (Michie, et al., 2011). The BCW provides an evidence-based stepped approach to changing behaviours encouraging intervention designers to consider a full range of options, choosing only those that are most promising (Michie, Atkins, West, 2014). The COM-B model and the BCW offer a logical approach to overcome the challenges identified by Kok (2015).

The BCW follows three stages towards intervention design (Michie, et al., 2014). Stage one involves understanding the behaviour using the COM-B model. Stage two, involves the identification of intervention options including the selection of relevant *intervention functions* and *policy categories*. *Intervention functions* include education, persuasion, incentivisation, coercion, training, restriction, environmental restructuring, modelling and enablement. Possible *policy categories* to support *intervention function* deliveryinclude use of guidelines, environmental or social planning, communications and marketing, legislation, service provision, regulation and fiscal measures. The *intervention functions* and *policy categories* are considered for their affordability, practicability, potential effectiveness and cost-effectiveness, acceptability, side-effects and safety and equity. Stage three involves identification of intervention content, implementation options and selection of behaviour change techniques (BCTs) (Michie et al., 2013).

## Aim

This research aims to understand and influence the behaviour of rewilding in relation to changes to private gardens within London; this research aims to develop an intervention strategy to influence this behaviour using the Rewild My Street website as a basis for intervention development.

## Objectives

The research aim will be achieved by completion of the following objectives:

1. A scoping review of the existing literature on intent-orientated pro-environmental behaviours, with a focus on urban rewilding, framed using the COM-B model of behaviour and the BCW.
2. Sequential mixed methods research including interviews and a quantitative survey to understand the *capability*, *opportunity* and *motivational* factors influencing urban rewilding behaviour.
3. Co-creation of an intervention strategy with a group of London residents to promote urban rewilding behaviour using the BCW, considering the range of *intervention functions, policy categories,* and *BCTs* with the Rewild My Street website acting as a basis for intervention development.

# Method

The methods to be used are covered in turn by objective.

## A scoping review of the existing literature on intent-orientated pro-environmental behaviours, with a focus on urban rewilding

The scoping review will investigate pro-environmental behaviours in relation to changes to private gardens. A synthesis of the existing literature is an important first step in understanding and influencing behaviour (Peters, 2015). A scoping review approach is selected as this is an emerging research field with heterogeneity in research questions, variables and approaches. This scoping review will map the body of literature in the area of conscious pro-environmental behaviour change, specific to urban rewilding, in a user friendly format.

#### Search terms

A systematic search of the peer reviewed literature will be conducted using the following search string:

(pro-environment\* OR "pro environmental" OR "positive environmental" OR "positive environment" OR proenvironment\* OR eco-conscious OR “eco conscious” OR bio-diversity OR biodiversity OR re-wild\* OR rewild\* OR eco-friendly OR “eco friendly” OR green) AND (cities OR town\* OR city OR urban\* OR suburban OR sub-urban) AND (Behaviour OR Behavior)

As this study specifically aims to understand and influence *gardening for biodiversity* a separate search will be conducted using the following search string, searching for the terms within the title or keyword fields only:

(biodiversity OR bio-diversity OR nature OR wildlife AND garden\*

#### Sources of information

The following databases and search engines will be searched:

* BioOne,
* EBSCO Host,
* Science.gov,
* PubMed,
* Google scholar.

The authors will also review the grey literature, specifically reports from the Department for Environment, Food and Rural Affairs, and third sector organisations such as the British Trust for Ornithology, the Centre for Behaviour and the Environment, Conservation Evidence, Earthwatch Europe, The London Mayors Office, Rewilding Britain, Rewilding Earth, Rewilding Europe, the Royal Horticultural Society, the Royal Society for the Protection of Birds, the Wildlife Trusts, the Woodland Trust and the World Wildlife Fund. The websites of these organisations will be searched using the terms behaviour and rewilding, gardening for nature, gardening for wildlife, and gardening for biodiversity.

#### Inclusion and exclusion criteria

This review will be inclusive of qualitative and quantitative research methodologies both experimental and observational. Papers not focused on understanding or influencing intent-orientated pro-environmental behaviour related to urban rewilding will be excluded. Papers not considered research such as commentary articles or opinion pieces will be excluded. No date range will be set.

#### Screening

Papers identified using the search strategy outlined will be screened for inclusion in the scoping review. The papers will be screen in two broad areas, firstly those that aim to explain and understand the determinants of urban rewilding behaviour, and secondly those that aim to influence urban rewilding behaviour. It is acknowledged that some identified papers will fall within both of these categories.

The research team will screen the titles excluding those not relevant to the aim of the scoping review. The abstracts of the remaining papers will be reviewed by the research team excluding those not relevant to the aim of the scoping review. Finally, the remaining papers will be reviewed in full, again with those not relevant excluded. A Kappa analysis of agreement will be performed at each stage to ensure at least a good level of agreement (a Kappa value of 0.7 or above). Differences between the research team’s decisions regarding inclusion and exclusion will be discussed at each stage with a consensus decision made. A hand search of the included papers will be conducted to identify any additional relevant papers.

#### Critical appraisal and synthesis of the existing literature

The research team will read and re-read each of the papers included in the final review. The included papers will be critically appraised for their strengths and weaknesses to inform an assessment on the quality of the paper and thus the weight of the evidence. Aveyard et al. (2015) offer six questions to trigger critical thinking which will be utilised in this review; these six questions are:-

1. Where was the information found?
2. Is it good quality evidence? Consideration will be given to the sample size, type and length of study and the representativeness of those sampled.
3. When was the paper written?
4. What type of paper is it and what are the findings?
5. Who wrote the paper?
6. Why was this paper written?

These six questions will be asked of each of the included papers. All papers included in the final review will be reviewed by the members of the research team with differences discussed. Data extraction tables will summarise each of the included papers in the areas of (1) understanding and (2) influencing urban rewilding behaviour, with additional comments made based on the six questions proposed by Aveyard et al., (2015). Key themes will be identified using the COM-B model and the BCW as a coding framework. In addition, the literature will be mapped by date of publication, the focus area, population, study design, methods, citations with identification of journals, institutions and organisations, to provide an understanding of the current state of the evidence, trends and knowledge gaps (James, Randall and Haddaway, 2016).

## Sequential mixed methods research to understand the capability, opportunity and motivational factors influencing urban rewilding behaviour

A sequential mixed methods approach will investigate the behaviour of the rewilding of urban private gardens. As a new field of study, the qualitative exploration will precede a quantitative investigation. The qualitative investigation will provide a depth of understanding, with the quantitative evaluation providing an understanding of the relative importance of identified behavioural determinants.

### Interviews

The scoping review will identify what is already known about understanding and influencing urban rewilding behaviour. To ensure an accurate understanding of the influences of urban rewilding behaviour, a series of semi-structured phone interviews, selected because of the dispersed nature of the participants across London, will take place. Participants will be recruited, by digital invitation, from a London borough. A snowball sampling and virtual snowball sampling approach will be used with the digital invitation distributed through the networks of London Metropolitan University. This approach is deemed beneficial as participants are likely to know of others who live in the London area. It is acknowledged that this approach is open to community bias, is non-random with a lack of control over the sample generated.

Invited participants who express an interest will be sent, via email, a participant information form outlining the purpose of the study, why they have been invited to take part, what will happen if they choose to take part including risks and benefits, what will happen to the information they provide and who they should contact for further information. Interested participants will be asked to provide informed consent to take part in the study. Consenting participants will be asked to complete a screening questionnaire which will ask about their engagement in urban rewilding behaviour within the last 3 months and their intention to do so in the next 3 months.

Gifford and Nilsson (2014) in a review of personal and social factors that influence pro-environmental behaviour identify the demographic factors of age, gender, social class, education and religion as possible influences of pro-environmental behaviour; therefore, data will be collected on these areas from all consenting participants to support analysis of the qualitative data. Data on house type and size, type and size of garden, house ownership status and London borough will also be collected. Given the large membership, high recognition and influence of nature Non-Governmental Organisations such as the Wildlife trusts and the Royal Horticultural Society, participants will also be asked if they are members or have an affiliation with any such organisation.

Eighteen interviews will be conducted in total; six interviews with those already engaging in rewilding behaviour, six interviews with those that have not engaged but intend to do so, and six interviews with those that have not engaged and do not intend to do so.

Interviews will follow a semi-structured format with the topic guide based on the findings from the scoping review, the COM-B model of behaviour and the BCW. The overarching question in the semi-structured interviews will be “What would it take for you to partake in rewilding behaviour such as making changes to your garden?” The interviews will be recorded and transcribed verbatim and analysed using the COM-B model and the BCW as a coding framework.

### Survey

Assessing the relative importance of the determinants of urban rewilding behaviour is necessary to suggest impactful areas of change. This will be achieved through the use of a quantitative survey. An overarching question will be “For me to partake in rewilding behaviour such as making changes to my garden I would….” with statements organised by *capability, opportunity* and *motivation* created based on the earlier stages of this research*;* agreement to each statement will be measured on a likert scale of 1 (strongly disagree) to 7 (strongly agree). Data will again be collected on the demographic factors of age, gender, social class, education, religion, house type and size, garden type and size, house ownership status, London borough and membership to wildlife and/or gardening organisations, as possible influences of pro-environmental behaviour. Data will also be collected on intention and performance of Rewilding behaviour.

The survey will be pilot tested with a small participant group (n=10) to ensure understanding of the questions. The survey will be distributed through the networks of London Metropolitan University, including staff and students, who live within a London borough. The research team are aiming for completion by as large a sample as possible by again using a snowball sampling approach. Correlation coefficients will calculate the strength of the associations of the determinants to urban rewilding behaviour.

## Development of an intervention to promote urban rewilding behaviour using the Behaviour Change Wheel

Effective behaviour change interventions make use of theory-based approaches. As mentioned earlier in this proposal, the COM-B model and the BCW provide the conceptual framework upon which this research is based.

A collaborative, bottom-up approach, is recommended to the design and development of behaviour change interventions (European Commission, 2012), therefore, an intervention development group will be formed with residents from within London to co-create an intervention strategy. The intervention development group will consider areas for change based on the identified behavioural determinants (*capability, opportunity* and *motivation*), the potential to change a selected determinant and the impact that doing so will have on rewilding behaviour (Michie, et al., 2014). The existing Rewild My Street website will be included within these considerations and will offer a basis around which an intervention strategy can be developed.

A series of workshops, the number, time and duration of which will be defined in collaboration with the intervention development group, will be held to develop an intervention strategy using the staged process outlined by the BCW (Michie, et al., 2014) selecting appropriate *intervention functions, policy categories* and *BCTs* based on the findings from the earlier stages of this research. The affordability, practicability, effectiveness, acceptability, side-effects, safety, and equity for each *intervention function, policy category* and *BCT* (Michie, et al., 2014) will beconsidered before agreeing on an intervention strategy and evaluation plan.

## Data Management

Information gathered will be secured on password-locked computers and the servers at the London Metropolitan University. Hard files will be stored in locked cabinets within the University. Research data will be kept for 10 years (Medical Research Council, 2017). Personal data will be secured and processed in the strictest confidence according to the UK General Data Protection Regulation (UK Parliament, 2018).

Data for analysis and reporting will be anonymised. Identifiable data will be accessible only by members of the research team, authorised personnel from London Metropolitan University and regulatory authorities for monitoring purposes. A secure online survey tool will be used to collect the quantitative data.

## Ethical considerations

The research team will ensure that the presentation of the existing literature in the scoping review is accurate. All of the included papers will be critically appraised by multiple researchers to prevent bias in the reporting.

Participants involved in the mixed methods research will be provided with a participant information sheet and will provide informed consent. Participants involved in the qualitative interviews will not be identifiable in the reporting of the findings. The transcriptions of the interviews will be sent to the interviewed participants to confirm accuracy and allow additional information to be collected after the fact. No additional personal data will be collected from the survey participants other than age, gender, house type and size, house ownership status and London borough. All participants will be able to withdraw from the research and have their data removed at any time without giving any reason and without being disadvantaged in any way.

The members of the intervention development group will develop, agree and sign a terms of reference for the group. Members of the intervention development group will be able to leave the group at any time without giving any reason and without being disadvantaged in any way. All members of the intervention development group will be credited in any publications related to intervention development.

# Results

The research has a proposed end date of 31st August 2023. The expected research outputs are as follows: -

1. A scoping review of the existing literature on urban rewilding behaviour, framed using the COM-B model of behaviour and the BCW. Whilst this is a scoping review and not a systematic review, the results will be reported in line with the PRISMA conventions for systematic reviews (Moher, Liberati, Tetzlaff, and Altman, 2009).
2. Mixed methods research, including interviews and a quantitative survey, to understand the *capability*, *opportunity* and *motivation* of urban rewilding behaviour.
3. An intervention development paper presenting an intervention to positively influence urban rewilding behaviour using the BCW.

# Discussion

A change in behaviour from Londoners, to make over their gardens to attract more wildlife, could increase the capital’s biodiversity and resilience to climate change, while also improving health and wellbeing. This research aims to understand the behaviour of rewilding urban gardens with a focus on London. The findings of this research may be transferable to other cities. This research follows a phased approach, starting with a review of the existing evidence pertinent to urban rewilding behaviour. This in turn will influence primary research to further understand this behaviour within the context of London, follow by development of an intervention strategy to improve this behaviour supported by the existing Rewild My Street website. This phased approach is a strength of this research.

Theory based behaviour change interventions have been shown to be more impactful than those without a theoretical grounding. Behavioural science has been applied to pro-environmental behaviours (Bamberg and Rees, 2015; Byerly, et al., 2018; Osbaldson and Schott, 2012), however, in most cases the application of theory has not been linked specifically to an intervention development framework, the use of the COM-B model and the BCW overcomes this. The evidence-based approaches to be used in this research have been successfully applied in other areas such as public health (Webb, Foster, and Poulter, 2016; Webb, Hall, Hall, and Fabunmi-Alade, 2016; Webb, Stockwell, and Chavez-Ulgade, 2017) and are transferable to future studies to understand and influence rewilding behaviour.

Whilst this study protocol does not include the impact testing of the resulting intervention strategy, this will be developed once the detail of the intervention strategy is known, allowing for the selection of the most appropriate research methods. This research focuses on London and this could be seen as a limitation, however, as mentioned earlier in this paper, context and specificity are important in understanding and changing behaviour. It could be argued that even focusing on London as a whole is not specific enough, considering the differences in streetscapes across the city; the influence of such differences should be identified in the qualitative element of this research.

This research is significant and timely in addressing arguably the biggest challenge of our times, the environmental crisis. Combining the disciplines of design, environmental science and behavioural science will provide new insights for tackling this challenge, directly in the case of the ecological decline and indirectly in the case of climate change. Research into urban rewilding, in regards to changes to city gardens, is in its infancy. With urbanisation increasing coupled with a worrying trend in the reduction of vegetated green spaces in London, facilitating behaviour change in the rewilding of London’s private gardens is important to support biodiversity; this cross-disciplinary research will contribute to this important topic.

# References

Aveyard, H. (2010) *Doing a literature review in health and social care: A practical guide.* Berkshire: Open University Press. ISBN: 9780335238859

Bamberg, S. and Rees, J. (2015) ‘Environmental attitudes and behavior: Measurement’, in Wright, J, D. (ed), *International Encyclopaedia of the Social &*

*Behavioral Sciences*, *2nd edition, Vol 7*. Oxford: Elsevier. pp. 699–705. ISBN: 9780080970868

Byerly, H., Balmford, A., Ferraro, P.J., Wagner, C.H., Palchak, E., Polasky, S., Ricketts, T.H., Schwartz, A,J. and Fisher, B. (2018) ‘Nudging pro-environmental behavior: evidence and opportunities’, *Frontiers in ecology and the environment*, 16 (3), 159-168. <https://doi.org/10.1002/fee.1777>

Costanza, R., d'Arge, R., de Groot, R., Farber, S., Grasso, M., Hannon, B., Limburg, K., Naeem, S., O'Neill, R.V., Paruelo, J., Raskin, R.G., Sutton, P. and van den Belt, V*.* (1997) ‘The value of the world’s ecosystem services and natural capital’, *Nature*, 387(6630), pp. 253–260. https://doi.org/10.1038/387253a0

Department for Environment, Food and Rural Affairs. (2019) *Biodiversity net gain and local nature recovery strategies: impact assessment.* London: Crown copyright.

European Commission. (2012) *Future brief: Green behaviour – issue 4.* Bristol: Science Communication Unit, the University of the West of England.

Fuller, R.A., Irvine, K.N., Devine-Wright, P., Warren, P.H. and Gaston, K.J. ‘Psychological benefits of greenspace increase with biodiversity’, *Biology Letters*, 3(4), pp. 390–394. https://doi.org/10.1098/rsbl.2007.0149

Gill, S. E., Handley, J.F., Ennos, R. and Pauleit, S. (2007) ‘Adapting Cities for Climate Change: The Role of the Green Infrastructure’, *Built Environment*, 33(1), pp. 115–133. https://doi.org/10.2148/benv.33.1.115

Harrison, P.A., Berry, P.M., Simpson, G., Haslett, J.R., Blicharska, M., Bucur, M., Dunford, R., Egoh, B., Garcia-Llorentea, M., Geamănă, W., Geertsema, W., Lommelen, E., Meiresonne, L. and Turkelboom, F. (2014) ‘Linkages between biodiversity attributes and ecosystem services: a systematic review’, *Ecosystem services*, 9, 191–203. <https://doi.org/10.1016/j.ecoser.2014.05.006>

Hayhow, D.B., Burns, F., Eaton, M.A, Al Fulaij, N., August, T.A., Babey, L., Bacon, L., Bingham, C., Boswell, J., Boughey, K.L., Brereton, T., Brookman, E., Brooks, D.R., Bullock, D.J., Burke, O., Collis, M., Corbet, L., Cornish, N., De Massimi, S., Densham, J., Dunn, E., Elliott, S., Gent, T., Godber, J., Hamilton, S., Havery, S., Hawkins, S., Henney, J., Holmes, K., Hutchinson, N., Isaac, N.J.B., Johns, D., Macadam, C.R., Mathews, F., Nicolet, P., Noble, D.G., Outhwaite, C.L., Powney, G.D., Richardson, P., Roy, D.B,, Sims, D., Smart, S., Stevenson, K., Stroud, R.A., Walker, K.J., Webb, J.R., Webb, T.J., Wynde, R. and Gregory, R.D. (2016) *State of nature 2016*. The State of Nature Partnership. Available at: https://www.rspb.org.uk/globalassets/downloads/documents/conservation-projects/state-of-nature/state-of-nature-uk-report-2016.pdf (Accessed 15 January 2021).

Hill, M.J., Biggs, J., Thornhill, I., Briers, R.A., Gledhill, D.G., White, J.C., Wood, P.J. and Hassall, C*.* (2017) ‘Urban ponds as an aquatic biodiversity resource in modified landscapes’, *Global Change Biology*, 23(3), pp. 986–999. <https://doi.org/10.1111/gcb.13401>

James, K.L., Randall, N.P. and Haddaway, N.R. (2016) ‘A methodology for systematic mapping in environmental sciences’, *Environ Evid,* 5 (7). <https://doi.org/10.1186/s13750-016-0059-6>

Janhäll, S. (2015) ‘Review on urban vegetation and particle air pollution – Deposition and dispersion’, *Atmospheric Environment*, 105, pp. 130–137. https://doi.org/ 10.1016/j.atmosenv.2015.01.052

Jørgensen, D. (2015) ‘Rethinking rewilding’, *Geoforum*, 65, pp. 482–488. https://doi.org/ 10.1016/j.geoforum.2014.11.016

Johns, D. (2019) ‘History of rewilding: ideas and practice’, in du Toit, J. T., Pettorelli, N., and Durant, S. M. (eds) *Rewilding*. Cambridge: Cambridge University Press (Ecological Reviews), pp. 12–33. doi: [10.1017/9781108560962.002](https://doi.org/10.1017/9781108560962.002).

Kettel, E.F., Gentle, L.K., Yarnell, R.W. and Quinn, J.L. (2019) ‘Breeding performance of an apex predator, the peregrine falcon, across urban and rural landscapes’, *Urban Ecosystems*, 22(1), pp. 117–125. https://doi.org/10.1007/s11252-018-0799-x

Kok, G. (2018) ‘A practical guide to effective behavior change’, *The European Health Psychologist, 16*(5), 156-170. <https://doi.org/10.31234/osf.io/r78wh>

Maas, J. Verheij, R.A., Groenewegen, P.P., de Vries, S. and Spreeuwenberg, P.(2006) ‘Green space, urbanity, and health: how strong is the relation?’, *Journal of Epidemiology & Community Health*, 60(7), pp. 587–592. https://doi.org/10.1136/jech.2005.043125

Maller, C., Townsend, M., Pryor, A., Brown, P. and St Legeer, L*.* (2006) ‘Healthy nature healthy people: ‘contact with nature’ as an upstream health promotion intervention for populations’, *Health Promotion International*, 21(1), pp. 45–54. https://doi.org/10.1093/heapro/dai032

Mayor of London. (2019). *London National Park City*. Available at: <https://www.london.gov.uk/what-we-do/environment/parks-green-spaces-and-biodiversity/london-national-park-city> (Accessed 5 March 2020)

Medical Research Council. (2017) *MRC regulatory support centre: Retention framework for research data and records.* London: MRC

Mesmer-Magnus, J., Viswesvaran, C. and Wiernik, B. M. (2012). ‘The role of commitment in bridging the gap between organizational sustainability and environmental sustainability’, in Jackson, S.E., Ones, D.S. and Dilchert, S (Eds.), *Managing HR for environmental sustainability* (pp. 155–186). San Francisco: Jossey-Bass/Wiley. ISBN: 9780470887202

Michie, S., Atkins, L. and West, R. (2014). *The behaviour change wheel. A guide to designing interventions.* London: Silverback Publishing. ISBN: 9781291846058

Michie, S., Richardson, M., Johnston, M., Abraham, C., Francis, J., Hardeman, W., Eccles, M.P., Cane, J. and Wood, C.E. (2013) ‘The behavior change technique taxonomy (v1) of 93 hierarchically clustered techniques: Building an international consensus for the reporting of behavior change interventions’, *Annals of Behavioral Medicine*, 46(1), 81–95. <http://doi.org/10.1007/s12160-013-9486-6>

Michie, S., van Stralen, M. M. and West, R. (2011) ‘The behaviour change wheel: A new method for characterising and designing behaviour change interventions’, *Implementation Science*, 6(1), 42. <http://doi.org/10.1186/1748-5908-6-42>

Mill, J.G., Weinstein, P., Gellie, N.J.C., Weyrich, L.S., Lowe, A.J., Breed, M.F*.* (2017) ‘Urban habitat restoration provides a human health benefit through microbiome rewilding: the Microbiome Rewilding Hypothesis’, *Restoration Ecology*, 25(6), pp. 866–872. https://doi.org/10.1111/rec.12610

Moher, D., Liberati, A., Tetzlaff, J. and Altman, D.G. (2009) ‘Preferred reporting items for systematic reviews and meta-analyses: The PRISMA statement’, *PLoS Medicine* 6(7), e1000097. <https://doi.org/10.1371/journal.pmed.1000097>

Moxon, S. (2019) ‘Drawing on nature: a vision of an urban residential street adapted for biodiversity in architectural drawings’, *City Territ Archit* 6 (6), 1 – 13. <https://doi.org/10.1186/s40410-019-0105-0>

Office of National Statistics. (2020). *Data set: Access to gardens and public green space in Great Britain*. Available at: https://www.ons.gov.uk/economy/environmentalaccounts/datasets/accesstogardensandpublicgreenspaceingreatbritain (Assessed 21 January 2021).

Osbaldson, R. and Schott, JP. (2012) ‘Environmental sustainability and behavioural science: meta-analysis of pro environmental behaviour experiments’, *Environ Behav* 44, 257-99. <https://doi.org/10.1177/0013916511402673>

Peters, G. Y. (2018) ‘A practical guide to effective behavior change: how to identify what to change in the first place’, *The European Health Psychologist, 16*(5), 156-170. <https://doi.org/10.31234/osf.io/hy7mj>

Rewind My Street. (2019) *Transforming London's streets for wildlife*. Available at: <https://www.rewildmystreet.org/> (Assessed 5 March 2020).

Rewilding Britain. (no date) *Rewilding Britain*. Available at: https://rewildingbritain.org.uk/ (Accessed 19 November 2020).

Rewilding Earth. (no date) *Rewilding*. Available at: https://rewilding.org/ (Accessed 19 November 2020).

Rewilding Europe (no date). *Making Europe a wilder place.* Available at: https://rewildingeurope.com/ (Accessed 19 November 2020).

Samuelson, A.E., Gill, R.J., Brown, M.J.F. and Leadbeater, E. (2018) ‘Lower bumblebee colony reproductive success in agricultural compared with urban environments’, *Proceedings of the Royal Society B: Biological Sciences*, 285. https://doi.org/10.1098/rspb.2018.0807

Soulé, M. and Noss, R. (1998) ‘Rewilding and biodiversity: complementary goals for continental conservation’, *Wild Earth*, pp. 19–28.

Stone, H. (2019) ‘What is Rewilding? (extended version)’, *Rewilding News*, 24 January. Available at: <https://rewildingnews.com/2019/01/24/what-is-rewilding-extended-version/> (Accessed: 14 February 2021).

Sutherland, W.J., Dicks, L.V. and Smith, R.K. (2020). *What Works in Conservation 2020*. Cambridge, UK: Open Book Publishers. <https://doi.org/10.11647/OBP.0191>

UK Parliament. (2018). *Data protection act 2018.* London: Crown copyright.

UK Parliament. (2020). *Environment bill 2019-21 (Bill 220).* London: Crown copyright.

United Nations. (2018). *68% of the world population projected to live in urban areas by 2050, says UN* Available at: <https://www.un.org/development/desa/en/news/population/2018-revision-of-world-urbanization-prospects.html> (Assessed 5 March 2020).

United Nations General Assembly. (2015). *Resolution adopted by the general assembly on 25 September 2015 (A/RES/70/1).* New York, NY: United Nations. Available at http://www.un.org/ga/search/view\_doc.asp?symbol=A/RES/70/1&Lang=E

Webb, J., Foster, J. and Poulter, E. (2016) ‘Increasing the frequency of physical activity very

brief advice for cancer patients. Development of an intervention using the behaviour

change wheel’, *Public Health*, 133, 45-56. http://doi.org/10.1016/j.puhe.2015.12.009

Webb, J., Hall, J., Hall, H. and Fabunmi-Alade, R. (2016) ‘Increasing the frequency of

physical activity very brief advice by nurses to cancer patients. A mixed methods

feasibility study of a training intervention’, *Public Health*, 139, 121–131. http://doi:

10.1016/j.puhe.2016.05.015

Webb, J., Stockwell, J. and Chavez-Ulgade, Y. (2017) ‘The reach, adoption, and effectiveness of online training for healthcare professionals’, *Public Health*, 53, 107–110.

<https://doi.org/10.1016/j.puhe.2017.08.016>

Wildlife Trust. (2010) *London: Garden City?* London: Wildlife Trust

World Population Review. (2020) *London Population 2020.* Available at: <http://worldpopulationreview.com/world-cities/london-population/> (Assessed 5 March 2020).