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Wild ways: a scoping review to understand urban-rewilding behaviour in relation to adaptations to private gardens

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ABSTRACT

Urbanisation is increasing, while global biodiversity is decreasing. Through ‘urban rewilding’ cities could help tackle this biodiversity crisis, while exploiting the benefits of urban nature for residents. Private residential gardens, which have potential to support significant biodiversity, should be a primary focus. Yet their proportion of vegetated space is decreasing through changes made by residents, negatively impacting biodiversity. Small adaptations to private gardens can turn them into wildlife habitat, but understanding residents’ behaviour is critical to developing intervention strategies for this. This paper presents a scoping review of existing literature on understanding intent-orientated, pro-environmental behaviours with a focus on rewilding in urban gardens. The literature is mapped to assess the state of knowledge; it is then coded, using the ‘COM-B’ model of behaviour, to identify the capability, opportunity and motivation factors forming barriers and facilitators to residents engaging in rewilding activity in their gardens. The results show that all COM-B factors need to be considered to understand urban rewilding behaviour, but that opportunity and motivation factors have more influence, particularly reflective motivation. They indicate that facilitators are more significant than barriers and highlight an important body of work that has implications for practice and policy aimed at influencing urban rewilding.

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Behaviour change;
biodiversity; COM-B; urban
rewilding; urbanisation;
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Introduction

Sustainable urbanisation

Urbanisation is increasing, with the 55% of the world’s population estimated to live in urban areas projected to rise to 68% by 2050 (UN 2018). The UN Sustainable Development Goal number 11 aims to make cities resilient and sustainable, including targets to improve access to green spaces, protect natural heritage and reduce the environmental impact of cities by 2030 (UN 2015). To support this transition, cities such as London and Adelaide have committed to the National Park City Charter and becoming greener, healthier environments where people and nature are better connected (National Park City Foundation 2022).





Biodiversity crisis

In parallel, global biodiversity is decreasing: a 20% decline since 1900 in abundance of native species across most major land habitats has put one million plant and animal species at risk of extinction, with the primary cause being changes in land and sea use (Brondizio *et al.* 2019). To halt this unprecedented biodiversity loss, the UN Sustainable Development Goal number 15 aims to restore life on land, by promoting sustainable use of terrestrial ecosystems and

reversing habitat degradation (UN General Assembly 2015). Urban areas are identified as an ecosystem with importance for biodiversity conservation and ecosystem services in the International Union of Conservation Nature’s ‘Global Ecosystem Typology’ (Keith *et al.* 2022). In addition, human interaction with nature is recognised as fundamental to quality of life by the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) through Nature’s Contributions to People, encompassing pollination and seed dispersal; regulation of climate, water and air quality; and cultural benefits from learning and inspiration to physical and psychological experiences (Brondizio *et al.* 2019).

Urban rewilding

‘Urban rewilding’ (Prior and Brady 2017) and ‘mini rewilding’ (Stone 2019) have been advocated as ways for cities to help tackle the biodiversity crisis, while exploiting the many benefits of urban nature for the functioning of cities and wellbeing of their residents (ZSL 2022). ‘Rewilding’, understood as a conservation approach of reinstating natural processes to restore ecosystems (Pettorelli *et al.* 2019), requires rethinking for application to an urban context. For the purposes of this study, rewilding is defined loosely (Jørgensen

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2015), and interpreted for an urban context as incorporating ‘native plants and animals into urban infrastructure’ (Mills *et al.* 2017).

Urban rewilding has tangible benefits for biodiversity conservation. Some animal species, including foxes, herring gulls, hedgehogs (Hayhow *et al.* 2019) and bumblebees (Samuelson *et al.* 2018) are proving more successful in urban areas than rural areas. Further, species such as peregrine falcons are city specialists, benefiting from their concentrations of tall buildings and feral pigeons (Kettel *et al.* 2018). Conservation measures in cities have achieved increases in numbers of certain bat species (Hayhow *et al.* 2016). Small actions, for example providing ponds, nest boxes and bird food, have been shown to be effective in cities (Sutherland *et al.* 2020), with urban ponds attracting greater biodiversity than rural ones (Hill *et al.* 2016).

Rewilding would also benefit city functioning. Increased vegetation and water cover afford ‘ecosystem services’, natural processes that are beneficial to humans (Costanza *et al.* 1997), which are enhanced by biodiversity (Harrison *et al.* 2014). This can counter environmental problems that are prevalent in cities, from air pollution (Redondo-Bermúdez *et al.* 2021) to overheating (Zhang 2020) and surface flooding (Kadaverugu *et al.* 2021), aiding adaptation to climate change (Gill *et al.* 2007).

People living and working in cities would also benefit from urban rewilding, as contact with nature in urban areas offers proven health and wellbeing benefits for residents (Kondo *et al.* 2018), with more biodiverse spaces having the greatest benefit on some health outcomes (Houlden *et al.* 2021). Further social benefits of urban greening include reduction in crime (Kondo *et al.* 2018).

Nevertheless, urban rewilding might also have undesirable impacts on biodiversity, cities and people, which should be confronted. These could affect indigenous wildlife by favouring invasive alien species of plants and animals, and introducing novel diseases (ZSL 2022). People could be affected by established communities being displaced through inflation of property prices caused by ‘green gentrification’, and increasing human-wildlife conflict through increased incidence of road collisions, pet attacks, garden pests and vermin (ZSL 2022).

Research rationale and aim

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 2023). The latest policy in England focuses on greening new buildings and spaces with ‘biodiversity net gain’, meaning an improvement in habitat

value after land is developed, of 10% soon to become a condition of planning permission in England (UK Parliament 2020). The Mayor of London’s Environment Strategy embodies this approach but also acknowledges the need for guidance for residents on managing gardens for biodiversity (Greater London Authority 2018).

Private residential gardens should be a primary focus for urban rewilding, as they constitute a significant cumulative land area – one quarter of major UK cities (Loram *et al.* 2007) – and act as wildlife corridors connecting larger green spaces (Vergnes *et al.* 2013). They therefore have potential to support significant biodiversity (Smith *et al.* 2005), especially when considered at a neighbourhood scale (Goddard *et al.* 2009), yet promoting their conservation is often overlooked in favour of larger, public green spaces (ZSL 2022). Consequentially, the proportion of vegetated space in private gardens, estimated at 62% in the UK (Bonham *et al.* 2019), is decreasing due to changes in how residents manage their gardens, negatively impacting biodiversity (Smith 2011). A recent survey found one tenth of UK householders had replaced their lawn with artificial grass and one quarter had paved over their front garden to create car parking (Aviva 2022).

There are many households with access to a private garden, giving individuals the opportunity to adapt their outdoor spaces to positively impact on biodiversity. Data from the Office for National Statistics (2020) suggests that 88% of residents in Great Britain have access to a private or shared garden averaging 333 m². This comprises 97% of those living in a house and 66% of those living in a flat. Small adaptations to private gardens can turn them into a habitat for wildlife, but understanding residents’ behaviour is critical to developing intervention strategies to enable this (Webb and Moxon 2021).

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 while also regularly driving short distances that could otherwise be taken by active travel; the determinants of each of these behaviours are different (Bamberg and Rees 2015).

This review aims to scope the existing literature on urban rewilding with regard to understanding the behaviour of adapting private gardens to support biodiversity. An improved understanding of urban-rewilding behaviour will in turn help to develop intervention strategies to influence behaviour change, specifically in London.

Method

The study protocol for this scoping review and the proposed follow-on research has been published

previously (Webb and Moxon 2021). The methods specific to this scoping review are presented here.

Study design

A scoping review approach was selected as this is an emerging research field with heterogeneity in research questions, variables and approaches.

Search terms

A systematic search of the peer reviewed literature was 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 rewild* 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)

A separate search was conducted for *gardening for biodiversity* 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*[title]

Sources of information

The following databases and search engines were searched:

- BioOne
- EBSCO Host
- Science.gov
- PubMed
- Google scholar.

The authors also reviewed the grey literature, specifically reports from the UK Department for Environment, Food and Rural Affairs (DEFRA), and third sector organisations such as the British Trust for Ornithology, the Centre for Behaviour and the Environment, Conservation Evidence, Earthwatch Europe, the Greater London Authority, 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 were searched using the terms behaviour and rewilding, gardening for nature, gardening for wildlife, and gardening for biodiversity.

Inclusion and exclusion criteria

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

Screening of the literature

Use of a conceptual framework

This scoping review used a conceptual behavioural model to screen the literature, to elucidate the understanding and influencing of intent-orientated pro-environmental behaviour with a focus on urban rewilding. The COM-B model shown in Figure 1 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).

Psychological capability relates to the knowledge or psychological skills, strength or stamina to engage in the necessary mental processes to perform a behaviour; physical capability is the physical skill, strength or stamina. Physical opportunity is opportunity afforded by the environment such as time, resources, locations, cues, or physical affordance to perform a behaviour; social opportunity is the opportunity afforded by interpersonal influences, social cues and cultural norms that influence the way that we think about things. Reflective motivation is the reflective processes involving plans (intentions) and evaluations of a specific behaviour; automatic motivation is the automatic processes involving emotional reactions, desires, impulses, inhibitions, drive states and reflex responses (Michie *et al.* 2023).

The COM-B model was selected as it sits at the centre of a comprehensive intervention development framework, the Behaviour Change Wheel (BCW) (Michie *et al.* 2011) allowing for the findings to support the development of intervention strategies to facilitate behavioural change.

Screening process

The research team first screened the titles, then the abstracts, before a full review, excluding those not relevant to the research aim at each stage. Due to the large amount of identified literature, the papers were divided amongst the research team members. Where a team member was unsure whether to include or exclude a particular paper, a discussion took place and a decision was made with at least one other research team member. A hand search of the included papers was conducted to identify any additional relevant papers. The final papers

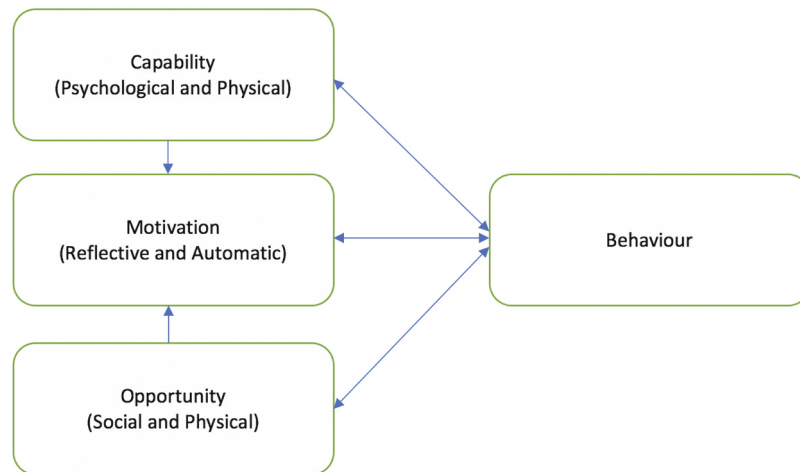


Figure 1. The COM-B model of behaviour.

included within this scoping review were divided between the research team for data extraction using the components of the COM-B model. In addition, the literature was mapped by date of publication, population and study design, to provide an

understanding of the current state of the evidence (James *et al.* 2016). The final coding against the COM-B components was reviewed by the two lead researchers, with differences discussed before the final coding was agreed.

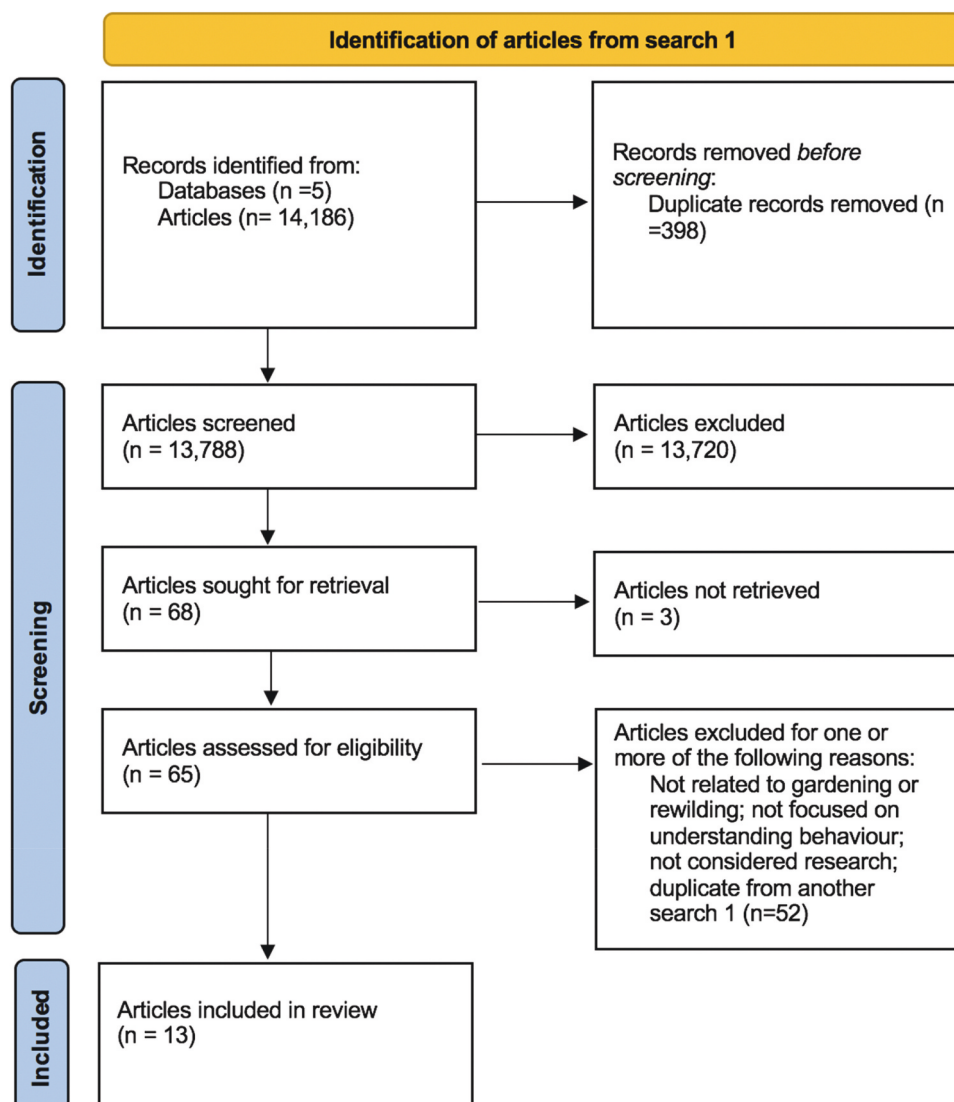


Figure 2. Articles identified in the first search.

Results

Description of the included literature

The retrieval of articles from across the three searches is presented in Figures 2–4. In total across the three searches 34,395 records were identified; after the duplicates were removed 33,647 remained. Following the screening of the identified articles 25 articles were included in this scoping review. Search 1 was completed in July 2021, search 2 was completed in May 2021, and search 3, of the grey literature, took place in June 2021.

Figure 5 presents the frequency of publications in the area of understanding intent orientated rewilding behaviour in relation to urban gardens. The first paper identified in this review was published in 2009. Greater focus has been placed on this area since 2017, with 4 articles identified in this year, 5 in 2018, 4 in 2019, and 2 in 2020. However, this is clearly still an under-researched subject area.

Seven of the included articles were literature reviews. In most cases, these reviews included

literature focused on the psychology of rewilding and conservation behaviours (DEFRA 2008, 2020, Okvat and Zautra 2011, Bauer and von Atzigen 2019, Clayton 2019, Owens and Wolch 2019, Sweeney *et al.* 2019). When coding these articles against the constructs of the COM-B model only factors related to urban rewilding were considered. This, to the knowledge of the authors, is the first scoping review with a specific focus on urban rewilding in relation to private gardens.

The literature review did not reveal any consensus in the field on the definition of urban rewilding in gardens, but the researchers appraised what should be included in, or added to, the study's adopted definition of incorporating 'native plants and animals into urban infrastructure' (Mills *et al.* 2017). The terminology identified as equating to urban rewilding in the literature ranged from the conceptual, such as 'wilderness and rewilding' (Bauer *et al.* 2009), 'nature-based solutions' (van der Jagt *et al.* 2017) and 'human-nature interconnectedness' (Lewis and Townsend 2014), to the more pragmatic, such as 'sustainable gardening

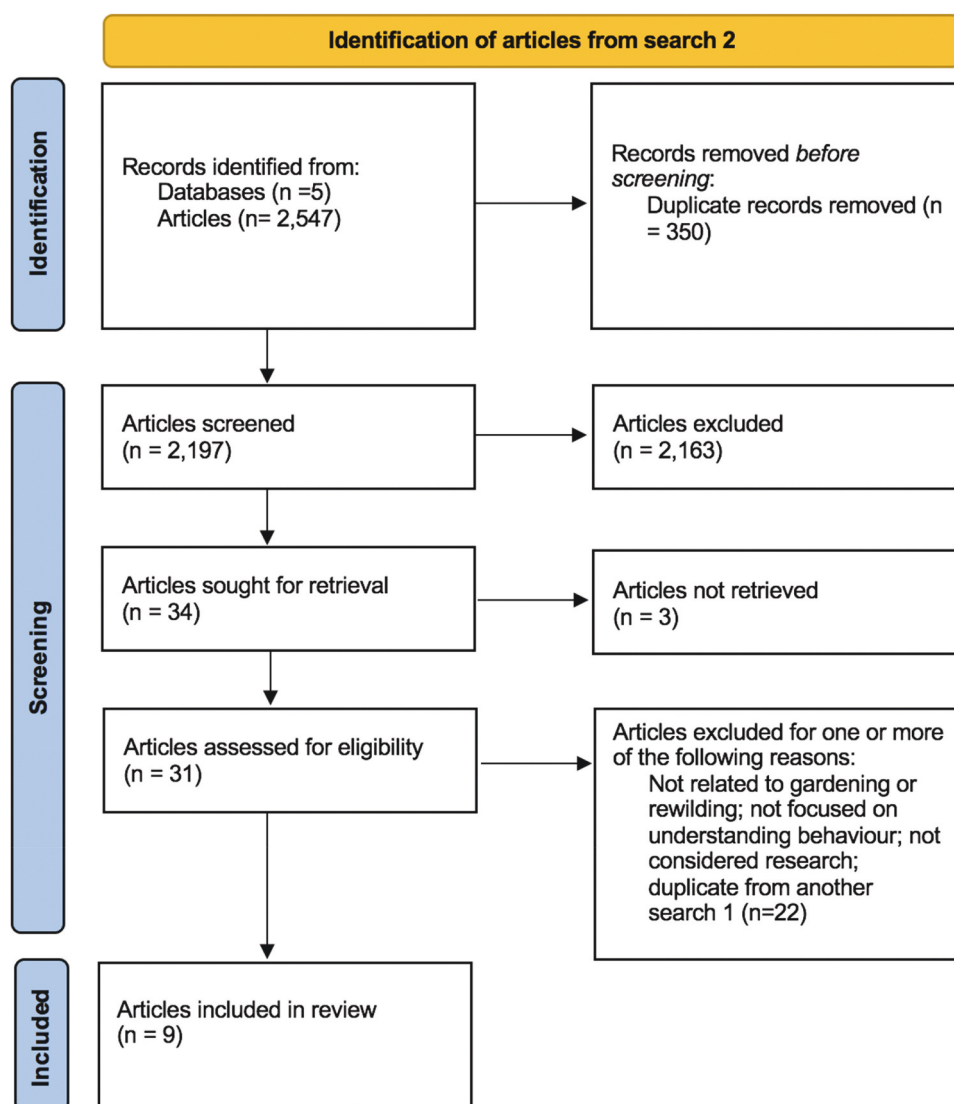


Figure 3. Articles identified in the second search.

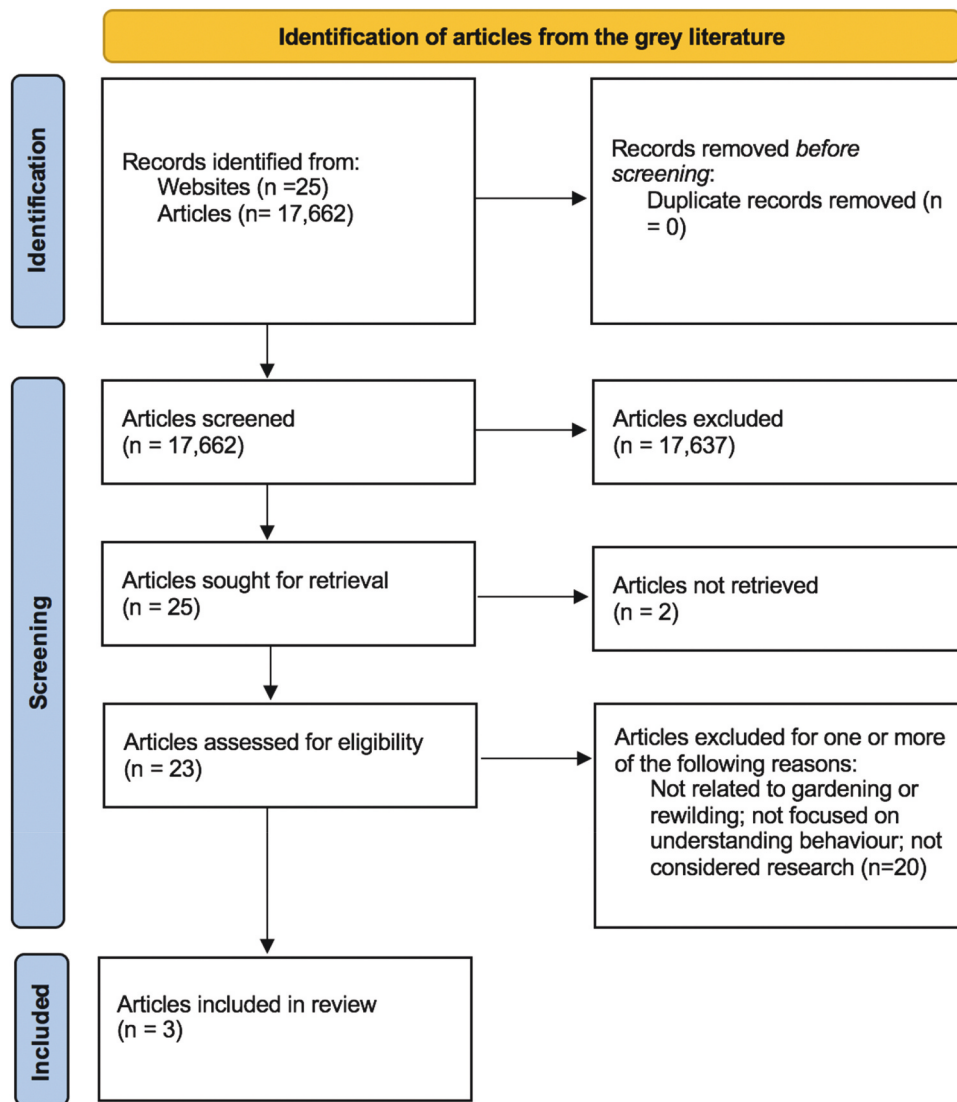


Figure 4. Articles identified in the third search.

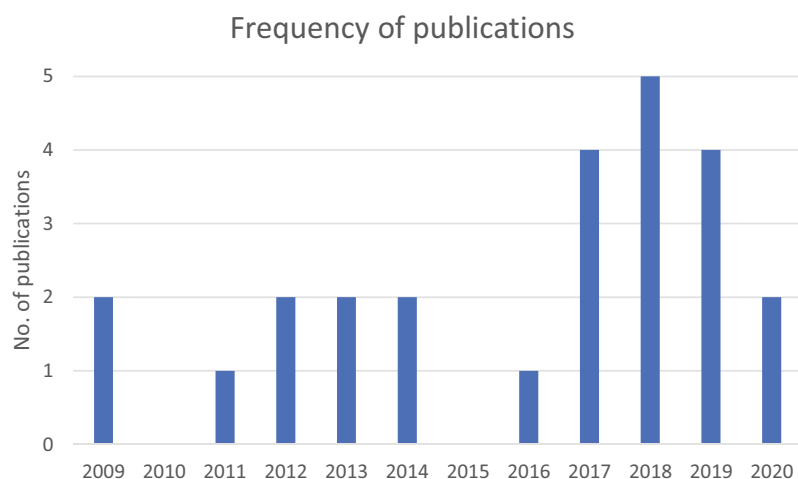


Figure 5. Frequency of publications.

practices' (Coisnon *et al.* 2019), 'environmentally friendly gardening practices' (Lewis *et al.* 2018) and 'pro-biodiversity behaviours' (Deguines *et al.* 2020). Specific examples of activity identified as rewilding behaviour included 'selecting plants that benefit

birds', 'avoiding non-native plants' and 'leaving space for wild animals' (Coisnon *et al.* 2019); preferring 'a "messier" appearance' and shunning 'synthetic chemical pesticides and fertilizers' (Lewis *et al.* 2018); providing 'nectar resources' and 'features benefiting

butterflies' (Deguines *et al.* 2020); and composting (Nova *et al.* 2020). Conversely, behaviour opposed to rewilding included pesticide use (Deguines *et al.* 2020) and 'fencing [being] used to exclude predators such as foxes' (Sweeney *et al.* 2019).

The remaining 18 articles were primary research (Bauer *et al.* 2009, Shwartz *et al.* 2012, van Heezik *et al.* 2012, Goddard *et al.* 2013, van Heezik *et al.* 2013, Canuel *et al.* 2014, Lewis and Townsend 2014, Hobbs and White 2016, Coldwell and Evans 2017, Mumaw and Bekessy 2017, van der Jagt *et al.* 2017, Webster *et al.* 2017, Beumer 2018, Lewis *et al.* 2018, Maller and Farahani 2018 [unpublished], Coisson *et al.* 2019, Deguines *et al.* 2020, Nova *et al.* 2020). Many made use of survey data ($n = 6$). Four articles are considered mixed methods primary research with 8 qualitative studies. The primary research took place in many areas across the world including Australia ($n = 2$), Canada ($n = 2$), France ($n = 2$), the Netherlands ($n = 1$), New Zealand ($n = 1$), Portugal ($n = 1$), Switzerland ($n = 2$), the UK ($n = 4$) and three studies across multiple European countries.

The 18 articles identified in the search of the peer-reviewed literature were published across a wide range of journals (American Journal of Community Psychology, $n = 1$; Australasian Journal of Environmental Management, $n = 1$; Wildlife Research, $n = 1$; Conservation Biology, $n = 1$; Ecological Economics, $n = 1$; Ecology and Society, $n = 1$; Ecosystems, $n = 1$; Environmental Research, $n = 1$; Journal of Environmental Management, $n = 1$; Gaceta Sanitaria, $n = 1$; Science of the Total Environment, $n = 1$; Social Science Research, $n = 1$; PLoS ONE, $n = 3$; Urban Forestry and Urban Greening, $n = 2$; EcoHealth, $n = 1$), with 1 conference paper, and 3 book chapters.

Understanding urban rewilding in relation to urban private gardens

Analysis of the literature against the COM-B components of psychological capability, physical capability, physical opportunity, social opportunity, reflective motivation and automatic motivation, and the demographic factors related to the behaviour of urban rewilding in private gardens are presented in Table 1.

All COM-B categories were found in the literature with multiple factors that potentially influence behaviour identified. Opportunity and motivation components accounted for more factors than capability components. Reflective motivation generated the most factors, while physical capability generated the least. Encouragingly, more facilitators than barriers to urban rewilding were found, across all categories except physical capability.

Capability

Psychological capability is more widely cited than physical capability in facilitating urban-rewilding behaviour. A lack of knowledge was identified as a barrier and facilitator to behaviour (DEFRA 2008, van Heezik *et al.* 2012, 2013, Hobbs and White 2016, Coldwell and Evans 2017, Clayton 2019, Deguines *et al.* 2020). Specifically, ecological awareness (Webster *et al.* 2017, Lewis *et al.* 2018, Bauer and von Atzigen 2019) and biodiversity knowledge (DEFRA 2008, Coldwell and Evans 2017), particularly about common species and their needs (van Heezik *et al.* 2012, Deguines *et al.* 2020), including that gained from participation in wildlife gardening schemes (Mumaw and Bekessy 2017, Deguines *et al.* 2020) or visiting the countryside (Coldwell and Evans 2017) were facilitators of behaviour. In contrast, low awareness of gardens' biodiversity value (Beumer 2018), poor knowledge of opportunities for gardening for wildlife (Hobbs and White 2016) and of species' native status (van Heezik *et al.* 2012) were barriers. Psychological capabilities, whether barriers or facilitators, were linked to early-life determinants of attitudes to nature (Bauer *et al.* 2009).

Barriers were observed in terms of physical capability, with lack of physical capacity to garden preventing urban rewilding activities being carried out (Lewis *et al.* 2018) and age-related decline sometimes slowing the pace of such activities (Mumaw and Bekessy 2017). Developing skills, particularly in relation to the use of tools to monitor and track garden wildlife, were facilitators in the physical capability domain (Hobbs and White 2016).

Opportunity

Physical and social opportunity are cited comparably widely as determinants of urban-rewilding behaviour. Physical barriers to urban rewilding included lack of space (Lewis *et al.* 2018, Deguines *et al.* 2020), lack of time (Mumaw and Bekessy 2017, Lewis *et al.* 2018), money (Hobbs and White 2016, Lewis *et al.* 2018, Bauer and von Atzigen 2019) and lack of plant availability (Lewis *et al.* 2018). The physical cue of living in an urbanised environment was also an apparent deterrent to rewilding behaviour (Deguines *et al.* 2020), maybe due to a lack of interaction with the natural world (Clayton 2019). The physical environment might impact in the moment behavioural decisions, for example, a period of drought might hinder gardening for biodiversity (Canuel *et al.* 2014).

Physical facilitators comprised access to funding (van der Jagt *et al.* 2017), or a disposable income to spend on supporting resources (van Heezik *et al.* 2013, Canuel *et al.* 2014, Hobbs and White 2016, Bauer and von Atzigen 2019), access to equipment (Hobbs and White 2016) and reliable information and expertise (van der Jagt *et al.* 2017, Coisson *et al.* 2019). Access to

Table 1. The barriers and facilitators for urban rewilding in private gardens.

COM-B Component	Barriers	Facilitators
Capability – Psychological	Lack of awareness of gardens' biodiversity value. [1] Lack of knowledge of opportunities for 'gardening for wildlife'. [18] Lack of knowledge of species' native/exotic status. [16] [24]	Awareness of the opportunities for 'gardening for wildlife' and associated community projects. [18] Biodiversity knowledge. [7] [8] [16] [21] Ecological awareness [5] [6] [23] Knowledge of common species and their needs. [9] [16] [21] Learning about wildlife. [18] Sources of ideas (other gardens, media, friends, family, neighbours). [5] Sustained citizen-science/wildlife-gardening participation. [9] [10]
Capability – Physical	Age-related decline. [10] Lack of physical capacity. [5]	Skill development (particularly use of tools to monitor and track species within the garden). [18]
Opportunity – Physical	Climate i.e. heat wave, drought. [20] Cost. [5] [18] High urbanization. [9] Lack of disposable income. [20] [23] Lack of interaction with the natural world. [24] Lack of plant availability. [5] Lack of time. [5] [10] [19] Space constraints. [5] [9]	Access to expertise. [11] Access to funding. [11] Access to monitoring equipment to track wildlife. [18] Access to land. [11] Access to local community projects and events. [18] [19] Access to reliable biodiversity information. [4] [11] Access to resources to help wildlife i.e nesting boxes. [18] Disposable income to invest in resources. [20] [21] [23] Garden ownership. [4] Large garden. [9] Living in a rural context. [4] Location suited to rewilding. [13] Opportunity to interact with nature. [18] [19] [22] [25] Time spent gardening. [12] [4]
Opportunity – Social	Display of personal values - neatness. [5] Duty to maintain neighbourhood standards of tidiness (esp. front gardens). [14] Family garden rules. [5] Sensitivity to neighbours' concerns. [10] Societal values for gardens. [13][23]	Back gardens – less social pressure to maintain standards. [14] Belonging to community of wildlife observers. [9] Co-creation. [11][13] Display of personal values - messiness. [5] Encouragement of wildlife-friendly gardening. [9] Example of neighbours. [5] [14] Family garden rules. [5] Green-minded persuading others. [8] Observation of other gardens [5], social group influences. [23] Social aspects of a community project. [18] Visiting countryside. [7]
Motivation – Reflective	A focus on global impact inhibits local action. [8] Controlling unwanted vegetation in large gardens. [9] Feeling a need to control nature to meet aesthetic standards. [2] [23] and aesthetic preferences. [5] [23] Having an 'individualist', 'hierarchist' or 'fatalist' 'cultural theory' perspective. [1] [23] Human-wildlife conflict. [15] Intentions might not result in action. [19] Other priorities – garden's practical functionality, a low-maintenance approach, or tidiness. [1] Perceived lack of space for coexistence with predators. [13] Preference for ornamental gardens prompting chemical use. [4] Safety and wellbeing concerns. [15] Strong attachment to established garden's style/form. [10]	Ability to choose pace and extent of wildlife-gardening activity. [10] Community projects seen as interesting, socially beneficial [18] and an opportunity for skill development. [9] [18] Compatibility with aesthetic preferences [5] [10] - for greenery/wildflowers. [1] Compatibility with functional preferences - ornamental gardens [4] – shade/screening/drought resistance/survivability/low maintenance. [10] Having an 'autonomous', 'dynamic' or 'egalitarian' 'cultural theory' perspective. [1] [23] [24] Interest in gardening and desire to advance gardening [10] biodiversity, [5] [10] [14] wildlife knowledge [18] and to try something new. [10] Interest in planting native or favoured species. [10] [15] Positive attitude civic environmentalism and environmental stewardship. [1] [3] [5] [6] [10] [12] [21] [22] Perceived local/national impact. [8] Perceived educational value for children. [4] Positive interactions with local wildlife [10] (or not affected by wildlife). [24] Positive relationship with nature. [13] [17] [23] [24] Preference over managed landscapes. [24] Valuing gardens for relaxation and being outdoors. [1] [15] [17] [24]
Motivation – Automatic	Disliked species. [15]; Fencing to exclude predators. [13] Early life determinants of attitudes to nature. [2] Feeling threatened by nature. [2] [23] [24]	Already doing some (environmental) activity. [8] Childhood connection with nature. [3] Connection to nature [24] Early life determinants of attitudes to nature. [2] [23] Environmental identity. [4] [24] Feeling concerns about rewilding are addressed appropriately. [2] National identity – native species. [16] [21] Past experiences. [5] Positive emotions towards wildlife. [18] Satisfaction from attracting wildlife. [14] Specific attitudes to rewilding over more general attitudes [23] Trust of environmental associations. [4]

(Continued)

Table 1. (Continued).

COM-B Component	Barriers	Facilitators
Demographic factors	Cultural differences may exist and should be considered. [23] High ethnicity-deprivation index. [7]	Age –no consensus – younger [23], middle [8] to older aged. [4] [8] [21] Country of residence with high GDP. [4] Country of residence with high Environmental Cultural differences may exist and should be considered. [23] Gender – female. [4] High socio-economic status. [7] Higher/lower household income. [8] Home ownership. [4] [8] Household size – larger, with children. [4]; smaller, older people [21] People from rural areas look more favourably on rewilding [23] Performance index. [4] Left-wing political sensibility. [4] More educated. [4] [8] [21] [23] National characteristics. [4] Owning a cat/dog. [1] Time at property – longer more positive [23] Those already engaged with wildlife/nature organisations. [18] Unmanaged nature more accepted in Western societies [23]

Notes: [1] Beumer (2018); [2] Bauer *et al.* (2009); [3] Lewis and Townsend (2014); [4] Coisnon *et al.* (2019); [5] Lewis *et al.* (2018); [6] Webster *et al.* (2017); [7] Coldwell and Evans (2017); [8] DEFRA (2008); [9] Deguines *et al.* (2020); [10] Mumaw and Bekessy (2017); [11] van der Jagt *et al.* (2017); [12] Nova *et al.* (2020); [13] Sweeney *et al.* (2019); [14] Goddard *et al.* (2013); [15] Maller and Farahani (2018); [16] van Heezik *et al.* (2012); [17] Okvat and Zautra (2011); [18] Hobbs and White (2016); [19] Shwartz *et al.* (2012); [20] Canuel *et al.* (2014); [21] van Heezik *et al.* (2013); [22] Owens and Wolch (2019); [23] Bauer and von Atzigen (2019); [24] Clayton (2019); [25] DEFRA (2020).

land (van der Jagt *et al.* 2017), resources (Hobbs and White 2016), and owning a garden, particularly a large one (Coisnon *et al.* 2019), encouraged rewilding behaviour. Physical cues of living in a more rural context (Coisnon *et al.* 2019) in a suitable location for rewilding (Sweeney *et al.* 2019) were conducive to rewilding behaviour, as was having time to spend gardening (Nova *et al.* 2020), access to local community projects (Shwartz *et al.* 2012, Hobbs and White 2016), and an opportunity to interact with nature (Shwartz *et al.* 2012, Hobbs and White 2016, Coldwell and Evans 2017, Bauer and von Atzigen 2019, Owens and Wolch 2019, DEFRA 2020).

Social barriers to rewilding behaviour included cultural norms concerning societal values for gardens (Sweeney *et al.* 2019); interpersonal influences such as family garden rules (Lewis *et al.* 2018); and sensitivity to neighbours' concerns or a desire to display one's personal values about neatness, especially in front gardens (Goddard *et al.* 2013, Mumaw and Bekessy 2017, Lewis *et al.* 2018). Nevertheless, displaying personal values about wildness can be a facilitator (Lewis *et al.* 2018), as can social influences (Bauer and von Atzigen 2019), observing other gardens, including those of neighbours (Goddard *et al.* 2013, Lewis *et al.* 2018); there is less pressure to conform to neighbourhood standards of tidiness in back gardens (Goddard *et al.* 2013). Positive interpersonal influences on urban rewilding included green-minded people persuading others (DEFRA 2008), co-creation (van der Jagt *et al.* 2017, Sweeney *et al.* 2019), wildlife-friendly family garden rules (Lewis *et al.* 2018), encouragement of wildlife-friendly gardening (Deguines *et al.* 2020) and belonging to a community of wildlife observers (Hobbs and White 2016, Deguines *et al.* 2020).

Motivation

Reflective motivation is more widely cited than automatic motivation in understanding urban-rewilding behaviour. Barriers and facilitators in the reflective motivation domain are the most widely cited of the COM-B components.

It is suggested that people approach specific conservation practices based on values that are relevant to them (Clayton 2019). Reflective motivation forming facilitators involved holding an environmentally focused world view or 'cultural theory' perspective (Beumer 2018, Bauer and von Atzigen 2019), resulting in ecological awareness (Webster *et al.* 2017, Lewis *et al.* 2018) or seeing oneself as part of nature (Bauer *et al.* 2009, Lewis and Townsend 2014, Sweeney *et al.* 2019); and having a positive attitude to civic environmentalism and environmental stewardship (van Heezik *et al.* 2013, Lewis and Townsend 2014, Mumaw and Bekessy 2017, Webster *et al.* 2017, Lewis *et al.* 2018, Owens and Wolch 2019, Nova *et al.* 2020). Conversely, having a cultural theory perspective that is not conducive to environmental awareness was identified as a barrier, as was prioritising other factors, such as the garden's functionality, tidiness or low maintenance requirements (Beumer 2018, Lewis *et al.* 2018, Bauer and von Atzigen 2019). However, some have a preference for more natural landscapes (Clayton 2019).

Valuing gardens for relaxation outdoors (Okvat and Zautra 2011, Beumer 2018), and being able to choose the pace and extent of rewilding activities (Mumaw and Bekessy 2017) were identified as facilitators. Other reflective motivations facilitating urban-rewilding behaviour included helping biodiversity (Goddard *et al.* 2013, Mumaw and Bekessy 2017, Lewis *et al.*

2018), native species (Mumaw and Bekessy 2017, Maller and Farahani 2018) or the environment generally (Mumaw and Bekessy 2017, Beumer 2018, Lewis *et al.* 2018, Nova *et al.* 2020); creating a retreat (Okvat and Zautra 2011) or local green space (Maller and Farahani 2018) to enhance one's connection to nature in the city (Okvat and Zautra 2011, Goddard *et al.* 2013, Sweeney *et al.* 2019); and the perception of having local or national environmental impact (Coldwell and Evans 2017). Conversely, focusing on having a global impact on environmental issues could be a barrier by deterring local action in one's own garden (Coldwell and Evans 2017). Wanting to practice gardening (Mumaw and Bekessy 2017, Coisnon *et al.* 2019), either to increase existing knowledge or try something new (Mumaw and Bekessy 2017), and capitalise on its educational value for children (Coisnon *et al.* 2019) were important motivators for rewilding behaviour.

Reflective motivations forming barriers to urban rewilding included wanting to discourage certain species (Maller and Farahani 2018), particularly predators (Sweeney *et al.* 2019); and being concerned about human-wildlife conflict or safety and wellbeing (Maller and Farahani 2018). Other reasons for not rewilding were aesthetic preferences (Lewis *et al.* 2018), such as a strong attachment to an established garden's form or style (Mumaw and Bekessy 2017), controlling unwanted vegetation (Deguines *et al.* 2020) and preference for ornamental gardens prompting chemical use (Coisnon *et al.* 2019).

Rewilding was more likely to be undertaken if it was compatible with the gardener's aesthetic (Mumaw and Bekessy 2017, Beumer 2018, Lewis *et al.* 2018) and functional preferences (Mumaw and Bekessy 2017, Coisnon *et al.* 2019). Observing positive results of citizen science initiatives (Deguines *et al.* 2020) also facilitated rewilding. Positive interactions with local wildlife (Mumaw and Bekessy 2017) and having sources of ideas (Lewis *et al.* 2018) were shown to motivate people to carry out rewilding activities.

Automatic motivations involving negative emotional responses to nature, such as feeling threatened by it or compelled to control its appearance, were seen as barriers to urban-rewilding behaviour. However, feeling these concerns were addressed appropriately by a trustworthy source was found to be a facilitator (Bauer *et al.* 2009). Other facilitators were automatic behaviour prompted by positive past experiences (Lewis *et al.* 2018), including a connection to nature in childhood (Lewis and Townsend 2014), which can determine attitudes to nature in later life (Bauer *et al.* 2009, Bauer and von Atzigen 2019). The anticipation of satisfaction from attracting wildlife (Goddard *et al.* 2013) is a facilitator of behaviour. Simply carrying on with environmental activities one is already doing (DEFRA 2008) is also categorised under automatic motivation. Beliefs, such as having trust in

environmental associations (Coisnon *et al.* 2019), having an environmental identity (Clayton 2019), a national identity in regard to native species (van Heezik *et al.* 2012, 2013) and an innate connection to nature (Clayton 2019) were also facilitators of behaviour.

Demographic factors

A high ethnicity-deprivation index (Coldwell and Evans 2017) was identified as a barrier to urban rewilding. The potential for cultural differences was highlighted in the literature and should be investigated in future research (Bauer and von Atzigen 2019). Ethnic minority groups in both the USA and European countries seem to prefer more managed and less natural landscapes compared to the white majority in those regions (Clayton 2019). The fact that indigenous or immigrant perspectives might differ from those of the dominant culture is a reminder that not everyone values unmanaged nature to the same extent. People from rural areas look more favourably on rewilding (Bauer and von Atzigen 2019).

National characteristics, namely living in a country with high GDP or Environmental Performance index (Coisnon *et al.* 2019) were reliable indicators of rewilding behaviour, suggesting government influence. Demographic facilitators were high socio-economic status (Coldwell and Evans 2017), home ownership (DEFRA 2008, 2020, Coisnon *et al.* 2019) and education level (DEFRA 2008, Coisnon *et al.* 2019). Having a left-wing political outlook, being female (Coisnon *et al.* 2019), having a larger household size (with children) (Coisnon *et al.* 2019) and time at the property (Bauer and von Atzigen 2019) were also facilitators. Age is a facilitator. However, this seems to be context specific, as younger (Bauer and von Atzigen 2019) middle- (DEFRA 2008) and older-aged people (van Heezik *et al.* 2013) were all identified as looking more favourably on urban rewilding. Interestingly, having either a high or low household income could be a facilitator (DEFRA 2008). National characteristics (Coisnon *et al.* 2019), such as having a strong national identity associated with native species (van Heezik *et al.* 2012) can be a facilitator, as can owning a pet cat or dog (Beumer 2018), arguably an indicator of being an animal lover generally. Those already engaged with wildlife or nature organisations are more likely to engage in urban rewilding (Bauer and von Atzigen 2019).

Discussion

The aim of this scoping review was to understand the literature on intent-orientated pro-environmental behaviours, with a focus on urban rewilding, framed using the COM-B model of behaviour. The focus of this paper is on understanding urban-rewilding

behaviour in private gardens, in relation to capability, opportunity and motivation factors.

The results show that all COM-B categories are important in understanding urban-rewilding behaviour in private gardens, although the number of factors related to having the opportunity and feeling motivated to carry out rewilding activities appear to be greater than those related to being capable of doing rewilding activity. Reflective motivation is the determinant with the greatest number of factors that could influence rewilding behaviour. Facilitators seem to be more numerous than barriers, although this might perhaps be explained by the reviewed papers generally being framed in a positive manner to promote conservation action.

The state of the literature

The literature on urban rewilding in relation to gardens is in its infancy with the first journal publication coming in 2009; only 18 papers have been published in peer-reviewed journals since (up to June 2021). No one journal is dedicated to the topic of urban rewilding with the 18 publications spread across 15 titles. Moreover, the literature does not show a consensus on how urban rewilding should be defined or what it should include and exclude in the context of gardens. Behaviour is context specific and therefore more research is needed to better understand how to encourage residents to make adaptations, or refrain from detrimental practices for wildlife and biodiversity. The aim of this scoping review is to support such work in London, the world's first National Park City; no published research literature was found specific to this context. Therefore, the next stage of this body of work is to collect primary data from Londoners on urban-rewilding behaviour in relation to adaptations to private gardens, using the findings of this scoping review to feed into the study design. Understanding current rewilding behaviour in private gardens is an important first step before trying to positively influence this behaviour through practice and policy.

Implications for practice and policy

Successful practice interventions will need to impart the psychological skills needed for residents to be capable of participating in rewilding, such as an awareness of the biodiversity value of urban gardens, ideally instilling these skills from an early age. In practice it is often assumed that increasing knowledge will lead to behaviour change. While knowledge is a necessary condition underlying behaviour change, it is rarely enough to change behaviour on its own (Geiger *et al.* 2019). Projects should also tackle any physical barriers to rewilding by allowing residents to participate at their own pace.

Projects that address concerns about insufficient time, space, funding and plant availability limiting residents' opportunity to take part in rewilding are likely to be effective, as are those that encourage buy-in at community level across a neighbourhood. Projects could benefit from highlighting the many motivations for rewilding, such as connecting with nature, educational value, creating a green retreat and helping the environment locally; in parallel, they would be advised to either mitigate or encourage greater tolerance of demotivators, such as disliked species, health and safety fears and undesirable aesthetics. Moreover, intervention projects should show how rewilding can be compatible with residents' functional and aesthetic preferences in respect to their gardens, and offer a trustworthy source to allay fears about nature. Projects should be inclusive of residents with pets, and those of both high and low incomes, but advocate different approaches to rewilding to suit different budgets and aim to minimise pets' impact on wildlife (Moxon 2021).

Policy interventions might need to focus on creating a greener public environment around residential areas to show the potential opportunities for local greening and rewilding; and modelling maintenance practices in public spaces that shift local or regional perceptions around the aesthetics of rewilding. At national level, a clear message from the government about the value of rewilding private gardens could well be influential. Policy that increases interaction with local wildlife may be beneficial in motivating residents to conduct urban rewilding in their own gardens. This is timely, as UK conservation policy is currently under scrutiny. Conservation charities the Wildlife Trusts, the Royal Society for the Protection of Birds (RSPB) and the National Trust branded new government proposals for removing EU protections for nature, relaxing planning laws in 'investment zones' and reviewing nature-friendly farming schemes an 'attack on nature' (RSPB 2023). Such changes could undermine the UK Government's pledge to restore 30% of land and sea for nature by 2030 through the goals in its Environmental Improvement Plan (2023) (UK Gov). Meanwhile it raises concerns around existing policy, such as Biodiversity Net Gain, which allows for the gains to be made on a different site to the development (UK Parliament 2020).

Policy and practice interventions should be mindful of the demographic factors involved in urban rewilding of private gardens and the prevalence of these characteristics in the intervention location, in particular the ethnicity-deprivation index. It will perhaps be most productive to prioritise changing the behaviour of those more likely to be receptive to urban rewilding, before targeting harder to reach groups.

This scoping review focuses on understanding behaviour. It is acknowledged that understanding behaviour is the first step in bringing about change

and that a further review of the mechanisms to influence change at a practice and policy level is required. The BCW lends itself to identifying and categorising such mechanisms, as it includes nine possible intervention functions (education, training, persuasion, incentivisation, coercion, enablement, modelling, environmental restructuring and restriction) and seven policy categories (environmental/social planning, communications/marketing, legislation, service provision, regulation, fiscal measures and guidelines) that have been shown to influence behaviour (Michie *et al.* 2023).

The evidence included within this review indicates that all intervention functions except coercion, and all policy categories could have a bearing on influencing urban rewilding behaviour in private gardens. These findings suggest a need for action across multiple areas to maximise impact. This might include raising awareness of urban rewilding benefits among the public and schools (van Heezik *et al.* 2012, Goddard *et al.* 2013); engaging more urban residents in citizen-science, community gardening and council-run wildlife gardening programmes (Mumaw and Bekessy 2017, Deguines *et al.* 2020); reviewing the target audience and framing of messaging from urban-rewilding campaigns (van Heezik *et al.* 2012, Coisnon *et al.* 2019); prohibiting chemical use in gardens (Canuel *et al.* 2014); and offering grants, tax incentives or product giveaways to support rewilding (DEFRA 2008, van der Jagt *et al.* 2017, Beumer 2018).

Implications for research

This paper has focused on the scoping review's findings on understanding urban-rewilding behaviour in city gardens in relation to capability, opportunity and motivation factors. Given that research into urban rewilding in city gardens is in its infancy, the findings make an important contribution to an emerging field by offering a comprehensive review of existing literature from a cross-disciplinary perspective. This will form a basis for the work of other researchers investigating urban rewilding, across disciplines and internationally, advancing an important and timely topic.

The findings will also inform planned follow up research from the authors, detailed below, focused on urban rewilding in the gardens of London (London Metropolitan University 2022):

- Phase 2: Mixed-methods research, including interviews and a quantitative survey, to understand the capability, opportunity and motivational factors influencing urban-rewilding behaviour in London.
- Phase 3: Development of an intervention strategy to promote urban-rewilding behaviour, using the Behaviour Change Wheel framework.

- Phase 4: Testing of the intervention strategy with before and after impact assessment.

It will be important to assess whether the scoping review's findings are reflected by these more practical stages of the study, and indeed the London context. With London experiencing increasing development pressure coupled with decreasing vegetation in its residential gardens, facilitating behaviour change in the rewilding of private gardens is critical to tackling nationally declining biodiversity levels. Further, London's status as a globally influential capital and pioneering commitments as a National Park City (Mayor of London 2023) will ensure the study has relevance to other cities worldwide.

These stages will also offer an opportunity to further explore the definition of urban rewilding and what related behaviour constitutes in the context of private gardens. This will be considered in Phase 2 by exploring the interview and survey participants' definitions of urban rewilding, and any correlation to demographic factors, and with focus groups in Phase 3. In addition, further cross-disciplinary research to investigate and refine the definition of urban rewilding will be needed outside of this study.

Strengths and limitations of this paper

A core strength of the review is the use of multiple systematic searches to ensure specific and comprehensive scoping of the topic. Another strength is the use of the COM-B model to categorise the barriers and facilitators to urban-rewilding behaviour enabling future progression to intervention development using the BCW (Michie *et al.* 2014).

A limitation of the review is that only literature available in English was included, therefore unique insights from papers in other languages could have been missed. While this is not expected to significantly affect later phases of this study, which is focussed on a UK context, it is a gap that could be addressed by other researchers. In addition, while the screening stage was verified by two researchers, for feasibility the coding stage was divided among individual researchers. It is acknowledged that this could have resulted in bias and error at this stage. However, this was mitigated against by all researchers following the COM-B framework and the two lead researchers discussing any points of contention. A deliberate limitation of the paper is that it covers only understanding urban-rewilding behaviour, as this aspect enables substantial debate in isolation. However, a companion paper following the same format will address influencing urban-rewilding behaviour and the two papers can be read either separately or together, depending on the reader's area(s) of interest.

Conclusion

The scoping review has revealed an important body of work in the nascent field of understanding urban-rewilding behaviour in private gardens. Applying the COM-B model of behaviour has enabled urban-rewilding behaviour to be understood in relation to capability, opportunity and motivation factors, with respect to both barriers and facilitators. This will have ongoing value in providing a foundation for further research in the field. Moreover, it will allow intervention designers to propose practice and policy for rewilding private gardens in cities that is based on an understanding of current behaviour.

Author contributions

SM and JW were co-investigators and wrote the final manuscript, with SM as lead author. JW designed the study. JW and AS conducted the searches. SM, JW and AS conducted the screening. SM, AS, JW and MS conducted the coding. SM and JW conducted the analysis. All authors read and approved the final manuscript.

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This scoping review includes literature from across the world but aims to support the development of intervention strategies specifically in London, UK.

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