Title

Wild Ways: A scoping review on influencing urban-rewilding behaviour in relation to adaptations to private gardens.

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Unstructured abstract

Rewilding private residential gardens in cities would make an important contribution to addressing the global biodiversity crisis and citizens' wellbeing. Understanding and influencing urban rewilding behaviour is critical. This paper presents a scoping review of the existing literature on *influencing* intent-orientated, pro-environmental behaviours with a focus on rewilding in urban gardens, building on the authors' preceding paper on *understanding* the behaviour of rewilding in urban gardens. The literature is mapped to assess the state of knowledge and coded using the Behaviour Change Wheel intervention model, to identify the intervention functions (education, training, persuasion, incentivisation, coercion, enablement, modelling, environmental restructuring and restriction) and policy categories (environmental/social planning, communication/marketing, legislation, service provision, regulation, fiscal measures and guidelines) that may influence residents engaging in rewilding activity in their gardens. The results show that although all intervention functions appear, education, training, and enablement are the most cited. Further, while all policy categories are identified as possible strategies to influence urban-rewilding behaviour in

private gardens, environmental and social planning, and communication/marketing are the most cited. This body of work has implications for practice and policy aimed at influencing urban rewilding and suggests a need for action by diverse stakeholders across multiple areas to maximise impact.

Key words

Urban Rewilding, Wildlife Gardening, Behaviour Change, Biodiversity, Sustainable cities and communities.

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Disclosure statement

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Biographical note

Siân Moxon is an Associate Professor of Sustainable Architecture at London Metropolitan University's School of Art, Architecture and Design. Siân's practice-led design research explores urban biodiversity at the Centre for Urban and Built Ecologies (CUBE). Siân leads the 'environment challenge' for London Met Lab and the Art, Architecture and Design Education Declares working group. Siân is an architect, author and founder of the award-winning Rewild My Street urban-rewilding campaign.

Justin Webb is an Associate Professor of Public Health at London Metropolitan University. Justin has been working in the field of public health for over 15 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.

Alexandros Semertzi is an Associate Lecturer in Psychology and Public Health at London Metropolitan University. Alexandros has been working as a Research Assistant since 2021 for three projects related to Public Health at London Metropolitan University. He is currently in his final year completing his PhD in Cognitive Neuroscience. Alexandros's research interest is in attention, memory, and neuroscience of behaviour change for health improvement.

Mina Samangooei is a practicing architect and academic, with research focusing on the role that food production in and on buildings plays for the future of cities. Mina's PhD looked at behaviour theory in relation to people cultivating edible plants on buildings, which has been brought into practice through workshops and other live projects. Mina is a Senior Lecturer in Architecture and Technology at Oxford Brookes University, leading undergraduate and postgraduate modules and conducting research with collaborators.

Geolocation information

This scoping review includes literature from across the world but viewed through a UK lens. This review will support the work of intervention designers and decision makers globally as well as further research by the research team on the development of intervention strategies specifically in London, UK.

Abbreviations

BCW – Behaviour Change Wheel

Word count

The word count for this scoping review, excluding references, is 4,740 words.

Introduction

There are major benefits for people inhabiting or frequenting greener cities, which generally increase proportionately with biodiversity (Harrison, et al., 2014; Houlden, et al., 2021). These comprise better health and wellbeing, reduced criminal activity (Kondo, et al., 2018), cleaner air (Redondo-Bermudez, et al., 2021) and mitigation of the effects of climate change (Gill et al., 2007). The greening of cities is becoming increasingly important with an expected 68% of the global population inhabiting urban areas by 2050 (UN, 2018).

The London Rewilding Task Force defines rewilding as 'an activity that seeks to reinstate natural processes and, where appropriate, missing species allowing nature to shape the landscape to provide wider benefits for wildlife and people' (GLA, 2023). Useful behavioural descriptions in the existing literature include 'sustainable gardening practices' (Coisnon et al., 2019), 'environmentally friendly gardening practices' (Lewis et al., 2018) and 'pro-biodiversity behaviours' (Deguines et al., 2020), with specific behavioural examples including 'selecting plants that benefit birds', 'avoiding non-native plants' and 'leaving space for wild animals' (Coisnon et al., 2019). Further examples include preferring 'a "messier" appearance' and avoiding 'synthetic chemical pesticides and fertilizers' (Lewis et al., 2018), providing 'nectar resources' and 'features benefiting butterflies' (Deguines et al., 2020), and carrying out composting (Nova et al., 2020). Making small changes to private gardens, such as providing food, nesting boxes, and ponds, can turn them into effective wildlife habitats (Sutherland, 2020).

Many households have access to a private garden, and hence the opportunity to adapt these to positively impact on biodiversity: 88% of residents in Great Britain have access to a private or shared garden averaging 333m^2 (Office for National Statistics, 2020). However, rewilding urban gardens will be a major challenge, when the trend is residents removing vegetation from their gardens, and consequently diminishing their wildlife habitat and environmental benefits (Smith, 2010), replacing it with artificial grass or paving (Aviva, 2022). Despite this cause for concern, there is a lack of policy or guidance targeting conservation in existing private gardens (Pettorelli *et al*., 2022; Mayor of London, 2018), as planning reforms in this

sphere, such as the 'biodiversity net gain' requirement for developments in England to improve a site's habitat value, focus on new buildings (UK Parliament, 2020). Intervention strategies need to be developed to reverse the trend and answer calls for 'urban rewilding' (Prior and Brady, 2017) and 'mini rewilding' (Stone, 2019) in the context of gardens.

A companion paper has scoped the existing literature to *understand* the determinants of the behaviour of urban rewilding (Moxon, Webb, Semertzi and Samangooei, 2023) . This review scopes the existing global literature, viewed through a UK lens, on the intervention functions and policy categories to *influence* urban rewilding in relation to private gardens. This will help to understand the intervention strategies that may influence urban rewilding in private gardens and be helpful to intervention and policy designers in cities across the world. This review and the preceding companion paper on *understanding* urban rewilding will also inform planned additional phases of research culminating in the co-creation of an intervention strategy to bring about change specific to London, UK (Webb & Moxon, 2021).

Method

The study protocol has been published previously (Webb & Moxon, 2021). The methods specific to this scoping review are presented here. We note that the search strategy employed in the companion paper on *understanding* urban rewilding replicates the search strategy presented here. The screening of the identified literature differed across the two review papers: this review identified papers with a focus on the intervention functions and strategies that *influence* urban rewilding; the companion paper identified the literature to support an *understanding* of the determinants of the behaviour of urban rewilding.

Study design

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

Systematic search of the literature

A systematic search of the 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 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)

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 specific to the UK, namely 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 scoping review was inclusive of qualitative and quantitative research methodologies both experimental and observational. Papers not focused on intervention functions and strategies *influencing* 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 an intervention development framework to screen the literature, to elucidate the *influencing* of urban rewilding. The Behaviour Change Wheel (BCW) framework was selected as it is a comprehensive intervention development framework (Michie, et al., 2011). The BCW posits that behaviour can be influenced by nine intervention functions, being (1) education, (2) training, (3) persuasion, (4) incentivisation, (5) coercion, (6) enablement, (7) modelling, (8) environmental restructuring and (9) restriction. It further posits that delivery of these intervention functions can be supported by seven policy categories, being (1) environmental/social planning, (2) communication/marketing, (3) legislation, (4) provision of a service, (5) regulation, (6) fiscal measures and (7) the production of guidelines (Michie et al., 2023). The definitions for the nine intervention functions and the seven intervention strategies are presented in Table 1.

1 Table 1: Intervention functions and policy categories

	Description
Intervention functions	
Education	Imparting knowledge
Training	Using approaches to improve the required skills to perform a behaviour
Persuasion	Inducing positive or negative feelings through communication approaches
Incentivisation	Providing rewards for performing a behaviour
Coercion	Imposing punishments for performing a behaviour
Enablement	Using approaches to enhancing behavioural capabilities and opportunities over and above training and education
Modelling	Imitating or aspiring to the behaviour of others
Environmental restructuring	Changing the setting to increase the chances of behaviour
Restriction	Limiting the opportunities for an unwanted behaviour
Policy categories	
Environmental/social planning	Planning the settings in which people live and work to encourage a wanted behaviour or discourage an unwanted behaviour
Communication/marketing	Publicising and promoting positive messages for a wanted behaviour and negative messages for an unwanted behaviour
Legislation	Introducing laws to control behaviour
Service provision	Providing a service or services to support a wanted or stop an unwanted behaviour
Regulation	Introducing measures to control behaviour
Fiscal measures	Making an unwanted behaviour costly or a wanted behaviour affordable
Guidelines	Providing guiding principles to influence behaviour

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 among 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 included within this scoping review were divided between the research team for data extraction using the intervention functions and policy categories outlined in Table 1. The final coding was reviewed by the two lead researchers, with differences discussed before the final coding was agreed. In addition, the literature was mapped by date of publication, location, and study design, to provide an understanding of the current state of the evidence (James et al., 2016).

Results

Description of the included literature

The retrieval of articles from across the three searches is presented in Figures 1 to 3. 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, 26 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.

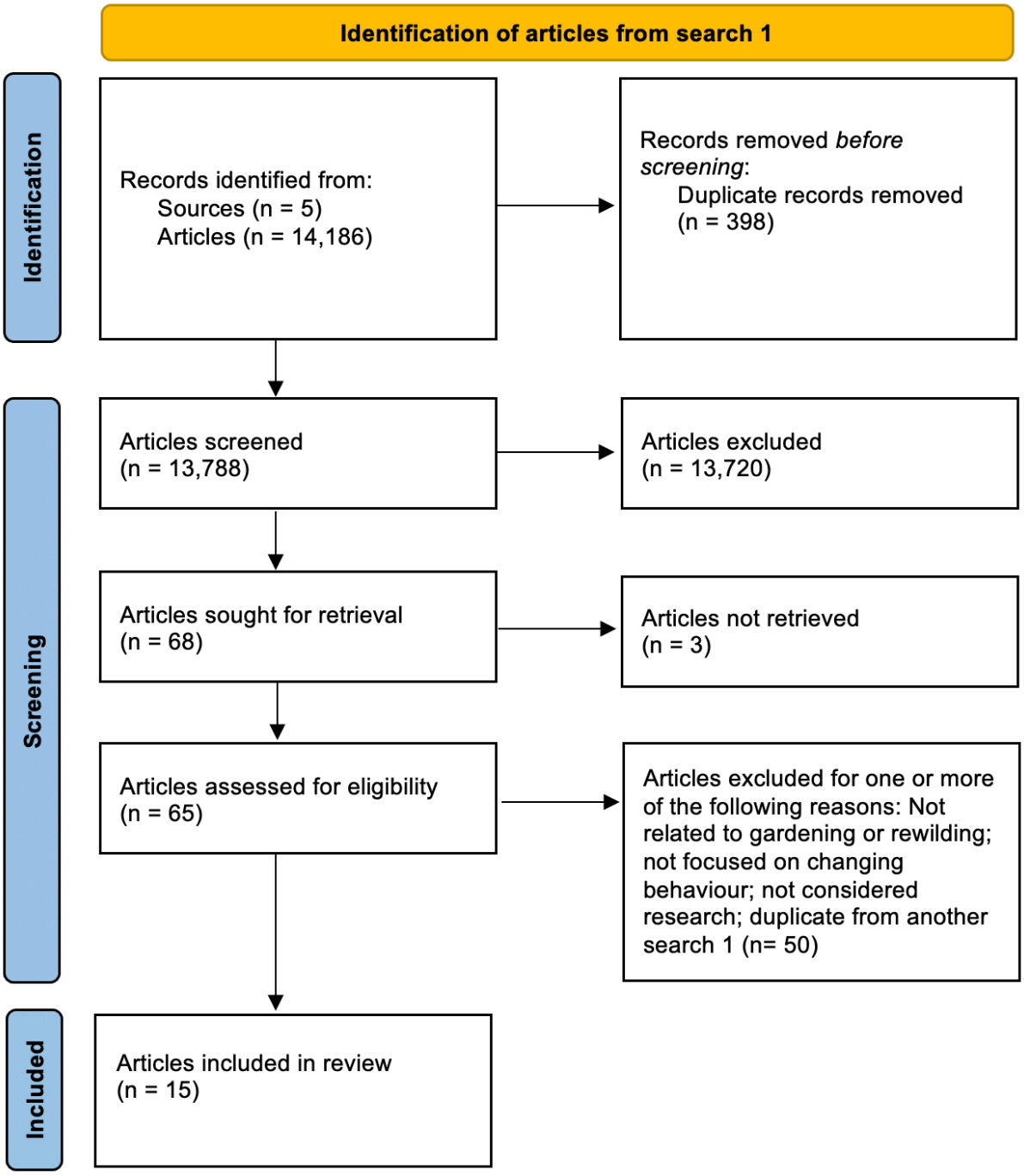

Figure 1: Articles identified in Search 1

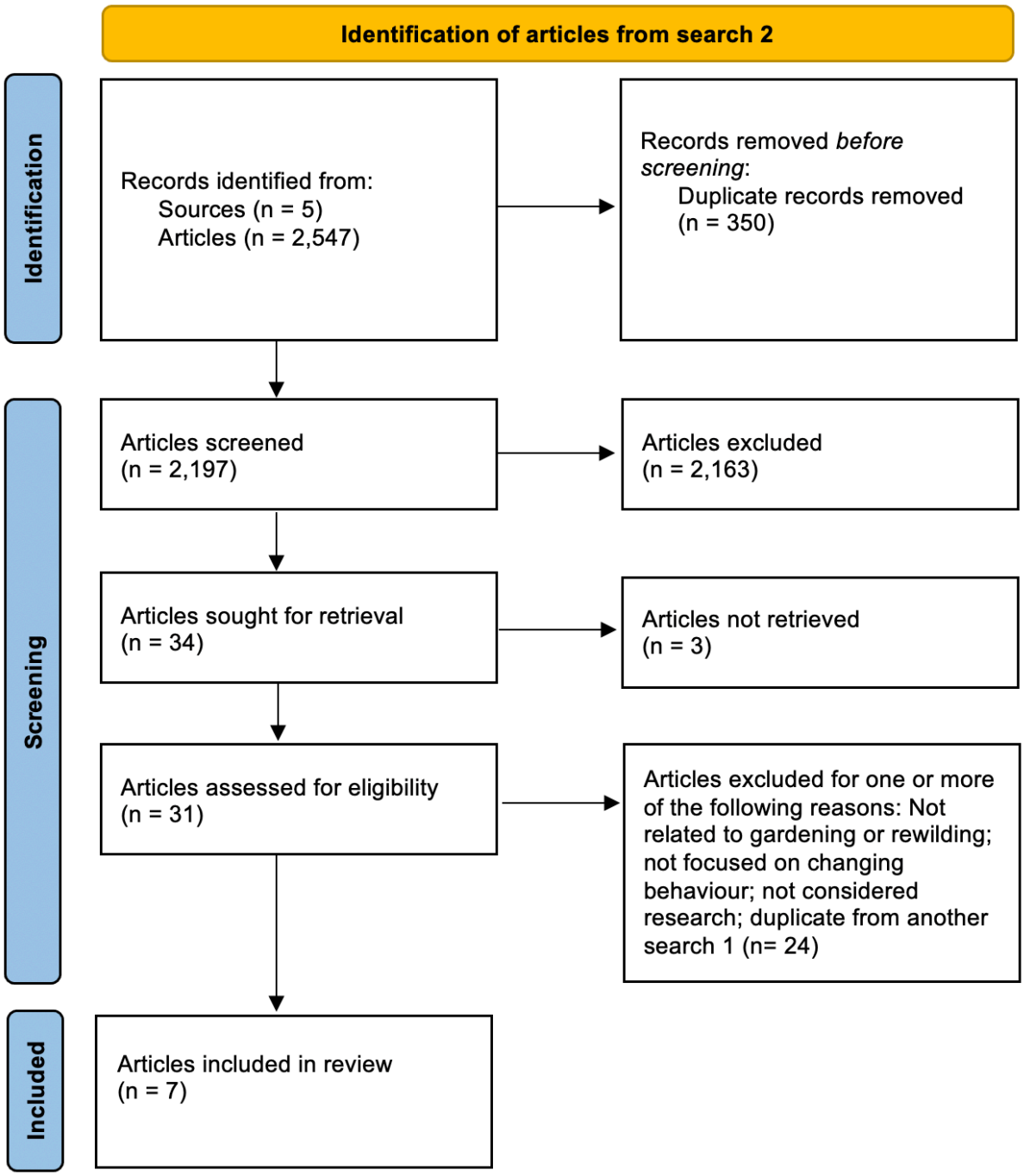

Figure 2: Articles identified in Search 2

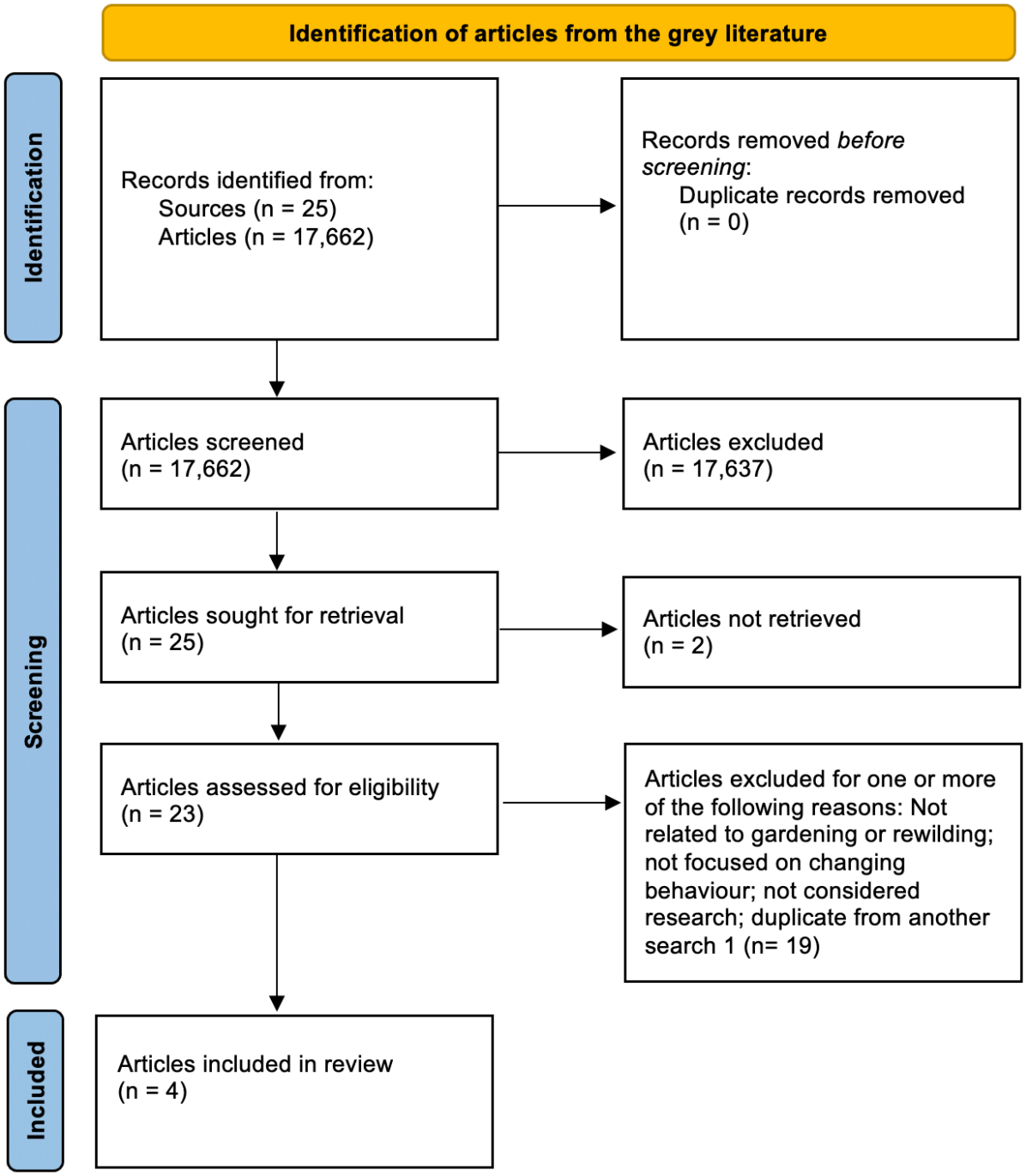

Figure 3: Articles identified in the third search

Figure 4 presents the frequency of publications on *influencing* urban rewilding behaviour. The first paper identified in this review was published in 2008. Greater focus has been placed

on this area since 2019, with 9 articles identified in this year, and 4 in 2020. However, this is clearly still an under-researched subject area.

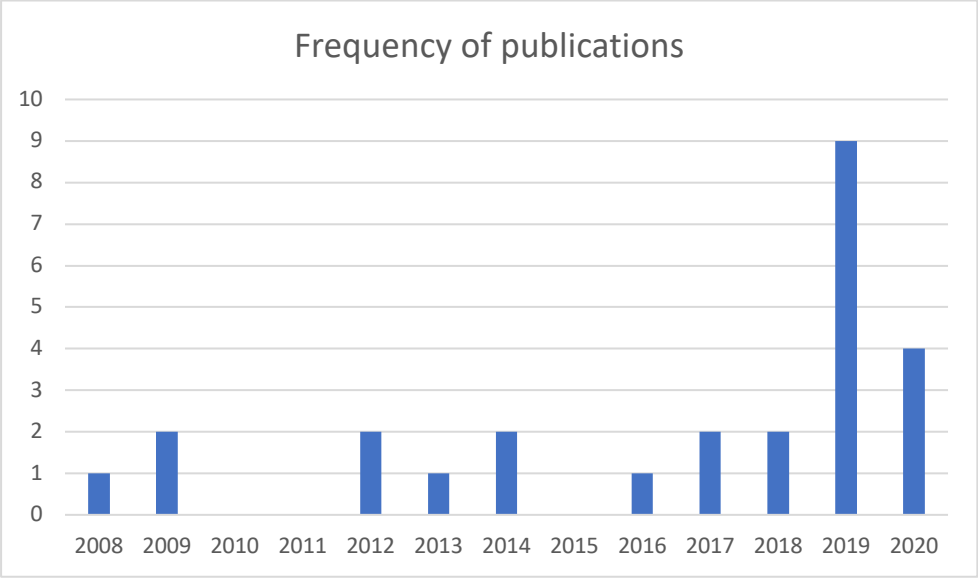

Figure 4: Frequency of publications

Eight of the included articles were literature reviews. In most cases, these reviews included literature focused on the psychology of rewilding and conservation behaviours (Bauer & von Atzigen, 2019; Clayton, 2019; DEFRA, 2008, 2020; Kidd, Bekessy and Garrard, 2019; Kusmanoff *et al.*, 2020; Owens & Wolch; 2019; Sweeney et al., 2019). When assessing these papers for intervention functions and strategies only factors related to urban rewilding were considered.

The remaining articles were primary research (Bauer et al., 2009; Bell *et al.*, 2019; Beumer, 2018; Canuel *et al.*, 2014; Coisnon et al., 2019; DEFRA, 2018 [unpublished]; Deguines et al., 2020; Goddard et al., 2013; Greenway, 2009 [unpublished]; Hobbs & White, 2016; Lewis & Townsend, 2014; Maller & Farahani, 2018 [unpublished]; Moxon, 2019 [unpublished]; Mumaw & Bekessy, 2017; Nova et al., 2020; Shwartz et al., 2012; van Heezik et al., 2012; van der Jagt et al., 2017). Many made use of survey data (n=6). Three articles used mixed methods, seven were qualitative studies and two were case study reports. 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=1) and the UK (n=5), with three studies conducted across multiple European countries.

Seventeen articles identified in the searches were published in research journals (Australasian Journal of Environmental Management, n=1; Conservation Biology, n=2; EcoHealth, n=1; Ecological Economics, n=1; Ecology and Society, n=1; Environmental Research, n=1; Environmental Research and Public Health, n=1; Gaceta Sanitaria, n=1; Journal of Environmental Management, n=1; PLoS ONE, n=2; Science of the Total Environment, n=1; Social Science Research, n=1; Trends in Ecology and Evolution, n=1; Urban Forestry and Urban Greening, n=1; Wildlife Research, n=1; with 3 book chapters, 2 conference papers, 2 government documents, a consultation paper and a PhD thesis).

Influencing urban rewilding in relation to urban private gardens

Analysis of the literature against the BCW intervention functions of education, training, persuasion, incentivisation, coercion, enablement, modelling, environmental restructuring and restriction is presented in Table 2.

Analysis of the literature for the BCW policy categories of environmental/social planning, communication/marketing, legislation, service provision, regulation, fiscal measures and provision of guidelines related to urban rewilding in private gardens is presented in Table 3.

All BCW intervention functions and policy categories were found in the literature with multiple factors that could potentially influence urban rewilding.

Intervention functions

Table 2: Intervention functions that could influence urban rewilding

Intervention function	Application found within the literature
Education	Nature education within schools [3, 9, 11, 12, 13, 14]
	Passing on local knowledge of human-wildlife interactions [17]
	Educating on opportunities for involvement [14]
	Raising awareness of wildlife-gardening practices and the benefits of rewilding [4, 9, 11, 12, 22]
	Educating on biodiversity through observation [22]
	Educating on conservation activities [22]
	Educating on sustainable behaviours e.g., water saving [5, 7]
	Educating on sustainable cities [18]
	Building on public interest in rewilding e.g., native plants & liked species [6, 23, 25]
	Customised information based on attitudes towards nature within the local context [1,19], using psychological theories with message impact testing [10]
	Knowledge imparted during council meetings [10]
Training	Training through neighbourhood gardening meetings [24]
	Volunteering in local nature programmes [10, 14, 19, 20]
	Local environmental activities to increase knowledge and skills [22]
	Enhancing skills to implement activities as daily habits [22]
	Activities combining science, personal observations, games and emotions [22]
	Developing radio tracking skills to monitor wildlife [14]
	Training through citizen-science and wildlife-gardening programmes [10, 19]
Persuasion	Tailoring persuasive conservation messages [15, 16]
	Providing people with encouragement [8]
	Government mandates for action [8, 9]
	Positive communication using ‘triple-win’ thinking (i.e., benefits to health, equity, and environmental sustainability) [3]
Incentivisation	Tax incentives to support the rewilding of urban gardens [4]

	Addressing the cost of greener products [8]
	Highlighting personal benefits [16]
	Socio-economic incentives for garden design and maintenance [4]
Coercion	Volumetric water charging [5]
	Tax increases [4]
Enablement	Provision of garden assessments [19]
	Provision of design toolkits [18]
	Social digital gardening applications [22]
	Access to wildlife monitoring equipment [14, 21]
	Linking volunteers to rewilding opportunities [14]
	Creating communities that support urban rewilding and facilitating community cohesion [4, 14]
	Inclusive initiatives [3]
	Provision of regular opportunities to experience the natural environment [9]
	Access to grants [19]
	Access to government funding [3]
	Resident crowdfunding [5, 18]
	Funding by businesses [24] or a hybrid business model (including funding from public, private and collaborate sources) [3]
Modelling	Use of role models [2]
	Modelling by other households [12, 25]
	Councils leading by example [4, 19]
Environmental	Government advice, support, and planning [9]
Restructuring	Using public health as a pathway to enhance community gardening [20]
	Supporting small changes such as patio ponds, bird boxes, feeders, insect hotels and punctured fences forming mammal corridors [18]
Restriction	Setting clear gardening rules (what practices should and should not be performed) [24]

[1] Bauer et al., 2009; [2] Bauer & Atzigen, 2019; [3] Bell, 2019; [4] Beumer, 2018; [5] Canuel et al., 2014; [6] Clayton, 2019; [7] Coisnon et al., 2019; [8] DEFRA, 2008; [9] DEFRA, 2020; [10] Deguines et al., 2020; [11] Goddard, Dougill, & Benton, 2010; [12] Goddard et al., 2013; [13] Greenway, 2009; [14] Hobbs & White, 2016; [15] Kidd et al., 2019; [16] Kusmanoff et al., 2020; [17] Maller & Farahani, 2018; [18] Moxon, 2019; [19] Mumaw & Bekessy, 2017; [20] Nova et al., 2020; [21] Owens & Wolch, 2019, [22] Schwartz et al., 2012; [23] Sweeney et al., 2019; [24] van der Jagt et al. 2017; [25] van Heezik et al., 2012.

Education, training, and enablement were the intervention functions most often found in the literature. A number of educational interventions were proposed. Those focused on children included creating opportunities to observe and take part in rewilding activities, particularly in school (Bell *et al.*, 2019; DEFRA, 2020; Goddard *et al.,* 2013; Greenway, 2009; Hobbs and White, 2016); and teaching schoolchildren about nature through 'nature tables' in classrooms and the provision of bird feeders on school grounds (Goddard, Dougill and Benton, 2013).

Suggestions aimed at educating the wider public advocated raising awareness of wildlife-gardening practices (Beumer, 2018; DEFRA, 2020; Goddard, Dougill and Benton, 2013; Shwartz *et al.*, 2012) including through biodiversity observations and continuing education in conservation (Shwartz *et al.*, 2012) and building on existing public interest by imparting information about native plants (Clayton, 2019; van Heezik, Dickinson and Freeman, 2012) and species tolerated by humans (Sweeney *et al.*, 2019). Education focused on urban rewilding was suggested to ensure specificity for inhabitants of towns and cities (Bauer, Wallner and Hunziker, 2009; Mumaw and Bekessy, 2017). Others suggested offering broader environmental advice by promoting sustainable behaviours to urban households (Coisnon, Rousselière and Rousselière, 2019), such as reducing water consumption (Canuel *et al.*, 2014) and communicating the benefits of sustainable cities (Moxon, 2019).

The value of collaboration in delivering effective educational interventions was highlighted by calls for nationwide campaigns across councils to share ideas and communicate the benefits of rewilding gardens (Beumer, 2018), targeting key audiences through cooperation across the private, public and third sectors or community-based action (DEFRA, 2008; DEFRA, 2020), with co-design of rewilding campaigns by biologists and psychologists (Deguines *et al.*, 2020). Council meetings, related to nature and the local environment, were also suggested to impart knowledge about rewilding (Deguines *et al.*, 2020).

Opportunities for the imparting skills through training included participation in urban gardening (Nova *et al.*, 2020). Other interventions that developed skills included participation in neighbourhood gardening meetings (van der Jagt *et al.*, 2017) and volunteering with

conservation programmes (Deguines *et al.*, 2020), including community-gardening initiatives on council land (Mumaw and Bekessy, 2017). There was a suggestion that regular local environmental activities combining psychology and nature observation increased knowledge and encouraged habit formation (Shwartz *et al.*, 2012). More advanced training, namely in audio tracking of wildlife, was also suggested to enhance rewilding attitudes and behaviour (Hobbs and White, 2016). Training that might persuade residents to rewild included experiencing regular contact with nature by taking part in wildlife-gardening (Mumaw and Bekessy, 2017) and citizen-science programmes (Deguines *et al.*, 2020).

Interventions that enabled people to engage in urban rewilding by increasing their capability beyond education and training, and their opportunities to get involved, included provision of on-site garden assessments with one-to-one, site-specific advice (Mumaw and Bekessy, 2017). Other suggestions targeted whole communities by offering tools, including social media and digital applications (Shwartz *et al.*, 2012), a web-based design toolkit (Moxon, 2019) and access to biodiversity monitoring equipment (Hobbs and White, 2016; Owens and Wolch, 2019). Fostering better community cohesion promoted resource sharing (Hobbs and White, 2016).There were aspirations that any initiatives should be inclusive (Bell *et al.*, 2019). Those interested in rewilding should be linked to local opportunities (DEFRA, 2020; Hobbs and White, 2016). Funding and grants to support urban rewilding could create more opportunities for involvement and help with challenging gardening activities (Bell, 2019; Canuel *et al.,* 2014; Moxon, 2019; Mumaw & Bekessy, 2017; van der Jagt *et al*., 2017) with funding from governements, resident crowdfunding, or a combination of public and private contributions.

Financial interventions that could incentivise urban rewilding included tax discounts for residents with greener gardens (Beumer, 2018) and addressing the cost of greener products (DEFRA, 2008). Similarly, socio-economic incentives for sustainable design and maintenance practices in gardens had a positive impact (Beumer, 2018). Purely social incentives included highlighting the personal benefits of rewilding, as opposed to community or environmental ones (Kusmanoff *et al.*, 2020), and feeling part of a likeminded socio-economic community (Beumer, 2018).

To persuade people to get involved in urban rewilding, strategies included tailoring communications with conservation messages to suit the intended audience (Kusmanoff *et al.*, 2020), for example considering whether they should be framed in a positive or negative manner (Kidd, Bekessy and Garrard, 2019). Moreover, it was seen as important for governments to have a mandate for action to provide encouragement to the public to adapt their lifestyles to become more sustainable (DEFRA, 2008; DEFRA, 2020); 'Triple-win' thinking, which highlights health and equity benefits alongside environmental sustainability, was called for (Bell *et al.*, 2019).

Measures related to coercion included imposing volumetric water charges, which lead to water-saving behaviour (Canuel *et al.*, 2014), and tax increases for residents with less vegetated gardens (Beumer, 2018).

Interventions pertaining to modelling recognised the value of role models to influence rewilding behaviour (Bauer and von Atzigen, 2019), with residents being inspired to improve their wildlife-gardening practices to keep up with other households (Goddard, Dougill and Benton, 2013; van Heezik, Dickinson and Freeman, 2012). Councils should model rewilding through marketing and communication strategies (Mumaw and Bekessy, 2017), and encourage community involvement in greenspace stewardship through participatory policies (Beumer, 2018).

The behaviour of urban rewilding in itself includes restructuring the environment. Adaptations to terraces, gardens and streetscapes can create a haven for wildlife by providing patio ponds, bird boxes and feeders, insect hotels, and the puncturing of fences to link up back gardens, forming mammal corridors. Provision of government advice and support for environmental projects with a strong consumer dimension can influence environmental planning (DEFRA, 2020). In addition, creating pathways to community gardening through

public health systems could help to restructure local environments to create opportunities for urban rewilding (Nova *et al.*, 2020).

The only intervention strategy related to restriction was the imposing of wildlife-friendly maintenance rules, such as organic cultivation, as part of membership of a neighbourhood-gardening programme (van der Jagt *et al.*, 2017).

Policy categories

Table 3: Policy categories that could influence urban rewilding

Policy category	Application found within the literature
Environmental/Social Planning	Co-creation of spaces between policymakers, planners and citizens [2]
	Collaborative and community governance [9, 13, 15]
	Participatory monitoring and evaluation [13]
	Planning policies to create adequate urban green space [10] and human interaction with rewilded landscapes [4]
	Civic environmentalism [14]
Communication/Marketing	Highlighting the benefits as-well-as difficulties of rewilding [8]
	Targeted communication techniques and message content [5, 16]
	Market-based strategies can overlook key aspects of biodiversity [2]
	Co-creation of communications to boost residents' receptivity [9, 11]
	Communication across multiple and varied channels [5, 8, 9, 13]
	Messaging to support conservation for all [14]
	Coordinated national campaigns [2]
Legislation	Banning pesticides [3, 7]
	Controlling invasive species [5]
	Fines for illegal tree felling [6]

Service Provision	Access to environmental associations and horticultural societies [5]
	Equipment provision [9]
	Wildlife-recording schemes [9]
	Virtual access to rewilded landscapes [4]
Regulation	Use of the National Environmental Performance Index [5]
Fiscal Measures	Taxes related to garden vegetation [2]
	Help with the costs of rewilding [9]
	Fines and penalties for unwanted practices [6]
Guidelines	Statutory duty [6]
	Government bodies facilitating stakeholder engagement [1]
	Government advice [16]
	Toolkits for residents [12]
	Advice for public from conservation boards [10]

[1] Bell, 2019; [2] Beumer, 2018; [3] Canuel et al., 2014; [4] Clayton, 2019; [5] Coisnon et al., 2019; [6] DEFRA, 2018; [7] Deguines et al., 2020; [8] Greenway, 2009; [9] Hobbs & White, 2016; [10] Lewis & Townsend, 2015; [11] Maller & Farahani, 2018; [12] Moxon, 2019; [13] Mumaw & Bekessy, 2017; [14] Owens & Wolch, 2019; [15] Sweeney et al., 2019; [16] van Heezik et al., 2012.

Environmental and social planning, and communication/marketing were the policy categories most often identified in the literature; legislation, service provision, fiscal measures and guidelines were cited several times while regulation was cited only once.

Under environmental and social planning, there was a strong recommendation for civic environmentalism, participatory processes, and collaborative governance throughout urban-rewilding initiatives (Owens and Wolch, 2019). The literature advocates that this should start at the planning stage with co-creation of the environment between policymakers, planners and citizens (Beumer, 2018). Rewilding initiatives should be located on sites where they are likely to succeed through the stewardship of existing community conservation programmes (Sweeney *et al.*, 2019). Successful wildlife-gardening programmes included opportunities for collaborative governance, and participatory monitoring and evaluation of outcomes (Hobbs

and White, 2016; Mumaw and Bekessy, 2017). It was noted that planning policy should promote adequate urban green space (Lewis and Townsend, 2015) and the engagement of people with rewilded landscapes (Clayton, 2019).

Communication and marketing strategies were covered in terms of how and where to engage residents in rewilding their gardens. For how to engage residents, it was recommended to highlight both the benefits and potential difficulties of rewilding activities (Greenway, 2009). Further, the importance of developing communication techniques and tailoring message content to suit the target audience's knowledge, interests and needs (van Heezik, Dickinson and Freeman, 2012), even targeting specific households in response to local environmental issues (Coisnon, Rousselière and Rousselière, 2019), was recognised by some studies. However, others acknowledged that such market-based strategies that rely on individual homeowners taking action could result in some key aspects of biodiversity being neglected (Beumer, 2018). Nevertheless, engaging with residents to co-create knowledge can boost residents' receptivity to urban-greening projects (Hobbs and White, 2016; Maller and Farahani, 2018).

In terms of where to market rewilding, it was recommended to communicate with residents across multiple and varied channels (Mumaw and Bekessy, 2017), such as publications, open gardens and shows (Greenway, 2009), local papers, council websites, mailouts, seminars or event stalls (Mumaw and Bekessy, 2017), suppliers and local garden centres (Mumaw and Bekessy, 2017; Coisnon, Rousselière and Rousselière, 2019). This approach could aid inclusivity in promoting conservation access for all people (Owens and Wolch, 2019). Word of mouth through neighbours and friends was also acknowledged as an effective way to find out about local wildlife-gardening programmes (Mumaw and Bekessy, 2017).

Several studies found legislation to be a useful policy tool for influencing urban-rewilding behaviour in gardens, for example banning the sale of chemical fertilisers and pesticides for gardening (Canuel *et al.*, 2014; Deguines *et al.*, 2020), enabling the management of invasive species (Coisnon, Rousselière and Rousselière, 2019) and increasing fines for illegal tree

felling (DEFRA, 2018). Indeed, the existence of such legislation increased public awareness of and support for wildlife-friendly gardening methods (Coisnon, Rousselière and Rousselière, 2019).

There was a recommendation to support environmental associations and horticultural societies in the provision of services, acknowledging their central role as sources of information for residents seeking to rewild their gardens (Coisnon, Rousselière and Rousselière, 2019). Some studies also recommended the provision of equipment (Hobbs and White, 2016), access to wildlife-recording schemes (Hobbs and White, 2016) and virtual access to rewilded landscapes (Clayton, 2019).

For regulation policy, the global Environmental Performance Index, which ranks countries according to the environmental strength of their policies, was found to have a positive effect on residents' actions for biodiversity. Policies to protect biodiversity at a national level sent a clear message, motivating residents to leave space for wildlife in their own gardens (Coisnon, Rousselière and Rousselière, 2019).

Fiscal measures concerned tax discounts or incentives for residents to encourage rewilding (Beumer, 2018). Offering help with costs could increase residents' rewilding behaviour (Hobbs and White, 2016), whereas introducing stronger fines or penalties could prevent actions that oppose rewilding (DEFRA, 2018).

In terms of guidelines, governments' statutory duty was acknowledged (DEFRA, 2018), which could be fulfilled through government advice on managing ecosystems (van Heezik, Dickinson and Freeman, 2012), such as a tree strategy setting out best practice (DEFRA, 2018), or government bodies facilitating stakeholders' engagement in rewilding (Bell *et al.*, 2019). Recommendations for guidelines more specifically aimed at residents included advice for the public from conservation boards (Lewis and Townsend, 2015) and design toolkits, as already mentioned under the enablement intervention category (Moxon, 2019).

Discussion

This scoping review assessed the global literature, considered through a UK lens, on *influencing* urban rewilding, framed using the BCW intervention development framework. This review will support subsequent research phases to co-create an intervention strategy specific to London. However, it is also hoped that this review will support other decision makers operating in cities around the world in the development of evidence-based strategies to encourage urban rewilding in relation to gardens.

The results show that all BCW intervention functions and policy categories have utility in influencing urban-rewilding behaviour in private gardens. Recommendations are weighted towards some key actions, particularly the intervention functions of education, training, and enablement, and the policy categories of environmental/social planning and communication/marketing.

Co-creation between residents and other stakeholders in urban rewilding is an especially strong theme, which spans the intervention functions of education, persuasion and modelling, and the policy category of environmental/social planning. Effective communication with residents is another core takeaway, as it connects the intervention functions of education, persuasion, and incentivisation to the policy category of communication/marketing. Financial considerations are another recurring theme, uniting the intervention functions of incentivisation and coercion, and the policy categories of legislation and fiscal measures.

The state of the literature

The literature on influencing urban rewilding in relation to gardens is in its infancy with the first journal publication coming in 2008. The identified literature included peer reviewed publications, book chapters, government documents and grey literature; only 17 papers have been published in peer-reviewed journals since 2008 (up to June 2021). No one journal is dedicated to the topic of urban rewilding. 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.

Implications for practice and policy

Practice and policy will of course need to be tuned to local demographic factors and environmental issues, but this review has revealed important principles that should also be considered in the design of any intervention aimed at influencing urban-rewilding behaviour in private gardens. Any practice and policy intervention should pay particular attention to having co-creation and effective communication with residents at its heart.

The main focus of practice interventions should be on educating the public about the value and methods of rewilding private gardens. Education should start with children, through the school environment and learning activities, for example having wildlife features in the playground and lessons about local nature. It should continue into adulthood, with lifelong learning opportunities, such as wildlife-gardening activities, citizen-science programmes, volunteering schemes, gardening meetings and rewilding campaigns. These practical recommendations should be cemented in policy; the UK Government's proposal to introduce a Natural History GCSE by 2025 is an important step towards this (Department for Education, 2022).

Campaigns should take care over their communication with the public, using targeted, honest messaging informed by behavioural psychology. This can be framed in a positive or negative way, depending on the intended audience, and should capitalise on human preferences for rewilding by highlighting popular species and ecological functions. Similarly, it should spotlight personal benefits, as well as environmental ones, to help persuade people to act. Policy should also focus on targeted marketing, across multiple channels, to increase public knowledge of rewilding, highlighting the benefits and addressing the challenges of rewilding gardens.

Practice interventions that offer grants and free products to help with the cost of wildlife gardening are likely to be viewed favourably. In addition, interventions should provide free sources of inspiration and advice, such as websites, showing what can be achieved. Ideally this should include personalised advice, such as on-site garden assessments. Policy can also help with financial incentives, such as tax breaks in recognition of rewilding activity and fines for illegal practice. It can also offer strategic, publicly accessible guidance on rewilding gardens.

Practice interventions that are community-driven and underpinned by partnerships, across public and private sectors, are most likely to be successful. Effective policy will therefore centre on co-creating planning proposals for the local environment and rewilding interventions with residents. Furthermore, policy should seek to support community groups, such as conservation organisations, and local businesses, such as garden centres, to deliver and evaluate the outcomes of wildlife-gardening programmes.

It would be effective policy to introduce new legislation, including banning pesticides and chemical fertilisers for use in gardens, to raise awareness of harmful practices and send a strong public message in support of nature-friendly gardening methods. This message should be reinforced by robust national government commitments to rewilding and protecting biodiversity. In light of this, the UK government's decision to dilute and delay implementation of policy to protect wildlife and the environment is particularly troubling (The Wildlife Trusts, 2023). Furthermore, local and regional policy must ensure that a comprehensive approach to tackling biodiversity loss is not compromised by an onus primarily on resident action to deliver biodiversity improvements.

Implications for research

Given that research into urban rewilding in city gardens is in its infancy, the findings of this scoping review make an important contribution to this emerging field by offering a comprehensive review of existing literature from a cross-disciplinary perspective. This

scoping review provides a basis upon which other researchers can build, investigating urban rewilding across disciplines, both nationally and internationally, advancing an important and timely topic.

The findings from this review and the preceding review inform planned follow-up research from the authors across three additional stages (detailed below) focused specifically on urban rewilding in London's gardens (Webb & Moxon, 2021):

- Stage 2: No published research literature was found specific to the London context; therefore, mixed-methods primary research will investigate urban-rewilding behaviour in London.
- Stage 3: An intervention strategy to promote urban-rewilding behaviour in London will be co-created with Londoners guided by the preceding stages.
- Stage 4: The intervention strategy co-created in Stage 3 will be assessed for its reach and impact on urban rewilding in London.

These stages will also offer an opportunity to further explore the definition of urban rewilding in the context of private gardens. Further interdisciplinary research to investigate and refine the definition of urban rewilding in given contexts will be needed outside of this study.

Strengths and limitations of this paper

This, to the knowledge of the authors, is the first scoping review with a specific focus on influencing urban rewilding in relation to private gardens. 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 BCW model to categorise the intervention functions and policy categories relevant to *influencing* urban-rewilding behaviour, enabling intervention designers an easy progression to intervention strategy development using the BCW (Michie, Atkins and West, 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. 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 BCW framework and the two lead researchers discussing any points of contention. A deliberate limitation of the paper is that it covers only *influencing* urban-rewilding behaviour, as this aspect enables substantial debate in isolation. However, a companion paper following the same format has addressed *understanding* urban-rewilding behaviour (Moxon et al., 2023) and the two papers can be read either separately or together, depending on the reader's interests.

Conclusion

This scoping review has revealed an important body of work in the nascent field of influencing urban-rewilding behaviour in private gardens. The intervention functions and policy categories with potential to influence urban rewilding in private residential gardens have been identified. This will have ongoing value in providing a foundation for strategy development and further research in the field.

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, JW, AS and MS conducted the coding. SM, JW and AS conducted the analysis. All authors read and approved the final manuscript.

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