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## Results

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# A Nature-based Social Prescribing Impact Pathways Framework (NabSPIP): applying the One Health perspective

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**Abstract**

The need for a planetary approach to healthcare is widely recognised at national and international levels. Social prescribing is becoming an increasingly popular strategy for meeting contemporary social, physical and mental health needs as well as tackling health inequalities. As this is a relatively new and emerging healthcare intervention, a comprehensive and accurate understanding of its impact is essential to support continued improvements in care, develop strategies for scale-up and delivery and justify further funding and investment. Nature-based Social Prescribing (NBSP) has unique potential to affect animal and environmental outcomes as well as human health. The One Health perspective can be used to operationalise and evaluate NBSP. This article presents the Nature-based Social Prescribing Impact Pathways (NaBSPIP) framework, which can be used to guide NBSP design and evaluation to leverage maximum benefit for humans, animals and the environment that we share.

### What this article adds:

1. Identifying NBSP as a type of social prescribing that can support human health and sustainability goals.
2. Introducing the NaBSPIP framework to guide design and evaluation of NBSP.
3. Summary of evidence in relation to the NaBSPIP framework outcomes.

## Introduction

### *Social prescribing and its importance*

Social prescribing happens when a person is referred to a community project or group by a health or well-being professional. SP is high on the political healthcare agenda and incorporates the aims of the 2019 UK National Health Service (NHS) Long-Term Plan to deliver 'personalised care' (NHS, 2019) with professionals and patients working together to identify options that match patients' interests and needs. The human health and social benefits of social prescribing include reducing health inequalities, engaging people at high risk and giving them a say in their care, as well as developing communities' health infrastructure and resilience. The literature surrounding NBSP also typically focuses on these human-level impacts (Chatterjee et al., 2018; Leavell et al., 2019; Fixsen and Barrett, 2022; Wood et al., 2022). While development and investment in social prescribing gathers momentum, in some ways implementation is outpacing evidence, and we are left asking questions about how to maximise SP benefit (Husk et al., 2020).

### *Nature-based Social Prescribing and its importance*

Nature-based Social Prescribing (NBSP) (also known as Green Social Prescribing) can be defined as any socially prescribed activity that involves nature or natural spaces. This engagement can take different forms such as direct contact through, for example, growing food, recreation in nature, for example, yoga or walking, nature-based arts and crafts or simply viewing, listening to or being in nature (Mughal et al., 2022; Kenyon et al., 2023). The unique value of nature, and by extension, NBSP, for health and well-being is well-evidenced (Jackson et al., 2021; Poortinga et al., 2021; Jevtic et al., 2022; Mughal et al., 2022; Lenda et al., 2023) and includes benefits for more vulnerable groups (Darcy et al., 2022). Moving beyond an anthropocentric perspective, NBSP offers multi-level benefit by contributing to wider environmental and healthcare sustainability goals and interlocking human health and ecological benefit.

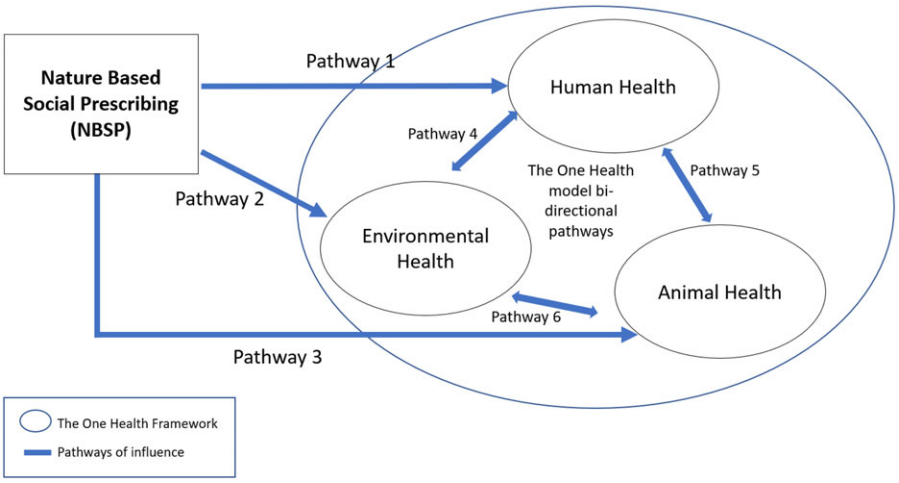


**Figure 1.** Nature-based Social Prescribing Impact Pathways (NaBSPIP) framework.

### *Nature-based Social Prescribing (NBSP) and the One Health perspective*

The One Health (OH) perspective is an interdisciplinary approach incorporating animal, ecological and human factors with the aim to protect and promote health, recognising that human health lies within the dynamic interconnections between humans, animals and the environment (Davis et al., 2017; Rabinowitz et al., 2018). A recent One Health expert-led panel defined One Health as '. . . an integrated, unifying approach that aims to sustainably balance and optimise the health of people, animals and ecosystems. It recognises the health of humans, domestic and wild animals, plants and the wider environment (including ecosystems) are closely linked and interdependent'. (Adisasmito et al., 2022, p. 2). As such, the OH perspective is ideally placed to guide NBSP.

Traditional OH approaches have been criticised for a tendency to view animals predominantly as a source of risk and zoonotic disease rather than a valuable and rightful part of the ecosystem, (Kingsley and Taylor, 2017; Felappi et al., 2020), with few studies measuring the functioning of ecosystems except as a risk to human health (Charron, 2012). Similar to the anthropocentric perspectives described previously, this diminishing of the importance of animal and environmental health belies their importance for supporting human health and life, however, more recent OH perspectives recognise animal health as an independent outcome domain with potential to simultaneously augment human health (Lebov et al., 2017; Walton et al., 2020). This more inclusive approach that overcomes traditional anthropocentric perspectives, can further contribute to achieving wider sustainability goals while at the same time enhancing human health and well-being (Rüegg et al., 2017).

This article presents the Nature-based Social Prescribing Impact Pathways (NaBSPIP) Framework which applies the OH perspective to outline multifaceted system of influence of NBSP. It explores the wider impact of these projects, and additional human benefits manifested through the animal-human-environmental interactions that transcend an anthropocentric perspective. The framework is used as a heuristic for elucidating the potential impact of NBSP projects. The NaBSPIP may be used to 1) support planners and policymakers in designing NBSP projects that deliver maximum benefit to animals, environments and humans and 2) to evaluate their holistic potential to support animal, environmental and human health and 3) how NBSP can support a sustainable public health agenda. To the author's knowledge, this is the first published exploration of holistically applying the OH approach to NBSP.

## Methods

This section shows how the OH perspective has been used to develop the NaBSPIP Framework. It considers how transdisciplinary and co-production, proclivities of the OH approach, can be used to inform NBSP. The OH perspective, alongside systems theory and an adapted version the causal pathways methods described by Greenland et al. (1999) has been applied to outline a framework of causal pathways outlined in the Nature-based Social Prescribing Impact Pathways (NaBSPIP) chart in Figure 1.

### *Methods: Overview*

In their expert-led panel review of the One Health perspective, Adisasmito et al. (2022) identify its five key underlying principles:

1. **Equity** between different sectors and disciplines.
2. **Stewardship & Responsibility** of humans to protect and preserve animals, biodiversity and ecosystems.
3. **Transdisciplinarity & Collaboration**, including multiple perspectives and forms of knowledge
4. **Parity** between people, including sociopolitical and cultural groups, and proactive consideration of marginalised communities and voices.
5. **Equilibrium in the interactions** between animals, environment and humans. Recognition of the intrinsic value of living things.

Adapted from Adisasmito et al., (2022, p. 3).

Impact pathways 1–3 show the potential of NBSP to influence the three OH domains of animal environmental and human health. The cyclic loops in Pathways 4–6 show interactions between these domains which are typically included in depictions of OH domains as using overlapping Venn diagram segments, interlocking jigsaw pieces, or connecting lines or as bidirectional arrows (Amuasi et al., 2020).

### *Ecological justice and transdisciplinary*

Research at the intersection of nature and health typically adopts an anthropocentric approach, in which nature is a tool to support human health rather than an interconnected part of a wider system (Rabinowitz et al., 2018). This risks 'missing the wood for the trees' in

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terms of the role of nature in maintaining human health and well-being outcomes. However, more recently there have been calls to recognise that firstly, our survival depends on natural environments and other living organisms, so human health and well-being should be regarded as integral to, rather than separate from, environment and other species' health (Rupprecht et al., 2020). Secondly, after the COVID-19 pandemic, ecosystem restoration is increasingly recognised as a public health imperative (J. M. Robinson et al., 2022; T. Robinson et al., 2022). This approach is in line with an ecological justice framework that recognises equity of the value, role and agency of non-human organisms and the moral, as well as practical, importance of equitable distribution of benefits among human and non-human entities (Pineda-Pinto et al., 2021). The NaBSPIP circumvents anthropocentric approaches to health interventions by recognising the equity between the different domains within the OH perspective and stewardship as well as our responsibility to protect animals, biodiversity and ecosystems (Principles 1 and 2 outlined in the summary of OH principles above).

The OH perspective values transdisciplinary research that enhances knowledge by examining issues through multiple perspectives, transcending traditional disciplinary and professional silos to augment understanding and leverage innovative solutions (Lebov et al., 2017; Rüegg et al., 2017; Amuasi et al., 2020; Walton et al., 2020; Willems et al., 2021) in line with principle 3 in the summary of OH principles mentioned above. Due to the diverse nature of outcomes considered within the NaBSPIP framework, transdisciplinary approaches and teams should be involved in NBSP design and evaluation and may include disciplines such as psychology, medicine, public health, environmental management, landscape design, agriculture, zoology, epidemiology, engineering and policy development as well as professionals delivering and designing NBSP the services, healthcare practitioners and the participants themselves. Different subcategories of impact can be measured within the three OH domains. In their exposition of the contemporary One Health model, Rabinowitz et al. (2018) describe how the OH model can be viewed as a continuum from Engel's biopsychosocial model; however, where Engel focused on human health as a series of incremental steps of increasing complexity (Engel, 1977), the authors describe how all three One Health influences in human, animal and environmental spheres can be conceptualised as increasing levels of complexity. Animal health can be measured, for example at individual, herd and population levels and environmental levels including habitat and ecosystems. Human health outcomes can be measured at personal, family and community levels. NBSP projects should include design and evaluation expertise from across relevant sectors to ensure that adequate data within each of these domains is collected. This article has used cross-disciplinary resources to inform the section on Results and considers outcomes at multiple scales of influence.

As well as embedded in transdisciplinarity, an OH perspective challenges traditional power structures and is aligned with feminist and post-colonial approaches (reflected in principle 4 of the summary of OH principles). OH, research typically involves participatory research design and stakeholder involvement from inception to completion (Lebov et al., 2017; Rüegg et al., 2017; Walton et al., 2020). The importance of co-production in health services is increasingly recognised as essential for service design, delivery and improvement (CQC, 2018; Fusco et al., 2023; Redman et al., 2021; Smith et al., 2022) and evaluation (Fusco et al., 2023). Incorporating a service user perspective into assessing value is an essential part of understanding whether that service was appropriate and valuable for the participants as the value of outcomes are contextually dependent. The diversity of socially prescribed activities and their ability to be adapted for local contexts is part of what makes social prescribing projects flexible to local contexts and needs. However, this means there is no one-size-fits-all which underscores the need for stakeholder engagement. However, a recent review of co-creation in healthcare found that multi-stakeholder perspectives in healthcare intervention evaluations are rare despite being a key for successful service development (Fusco et al., 2023). NBSP projects should include a proactive approach to including voices that are heard less often, or have a legacy of being overlooked (Van Patter et al., 2023).

A key tenet of the One Health approach is interactions between and within the domains of animals, environments and human health (Adisasmito et al., 2022) and endorsement of the intrinsic value of living things (principle 5 of the OH Principles outlined earlier). The interactions between these domains form a complex system of reciprocal influences between animals, environments and humans (Amuasi et al., 2020). Variables can influence and be influenced by one another in 'feedback loops' and there are multiple levels of interactions within a system. Each pathway of influence can be termed a pathway of impact, or causal pathway, as it can be understood as one factor contributing to or causing the outcome. Such systems are evolving and contingent, it's not possible to predict exact outcomes because the subtleties of the multiple interactions are variable and contingent upon contexts (Plsek, 2001). The NaBSPIP shows these interrelations and the potential of causal feedback loops as part of a systemic approach to the multiple, nonlinear and interacting chains of influence and cause and effect.

Combining this component of the OH paradigm, and causal diagrams (Greenland et al., 1999), the Nature-based Social Prescribing Impact Pathways (NaBSPIP) Framework is a conceptual model of the interactions between the three One Health domains and NBSP. In the NaBSPIP, these show the recursive properties of the system; the relationships between the domains are dynamic and interactive and so the impact of NBSP can also be recursive, evolving and dynamic. Causal feedback loops and multidirectional cause-effect relationships are considered to better represent the 'messy' reality of cause-effect relationships, in health research (Borrell-Carrió et al., 2004; Law, 2004). However, as noted by Greenland et al. (1999) cyclic loops are not logically meaningful in causal relationships because cause must precede effect and the cyclic loop implies simultaneous cause and effect. For the purposes of research, linear approximations of causality can be used to measure causal pathways within complex systems (Borrell-Carrió et al., 2004), and the recursive properties of a whole system can then be considered using multiple individual causal pathways. Causal DAGS (Directed Acyclic Graphs) can also be used to explicitly model causal feedback loops on a smaller scale using multiple nodes to represent the same variable at different points in time (Igelström et al., 2022). This could be effectively used to show influences on and from a particular variable or multiple variables in future research within a specific NBSP project. In this article, the different pathways of impact are structured according to the impact pathways outlined in the NaBSPIP framework and discussed in the Results section.

## Results: Applying the One Health Perspective to NBSP

Using the NaBSPIP Framework can elucidate pathways, co-benefits and interacting influences of NBSP. The following section synthesises evidence of impact pathways in accordance with the NaBSPIP framework.

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### *Pathway 1 – NBSP impact on human health*

There is wide recognition that NBSP can support human health and well-being (Pathway 1 in the NaBSPIP framework). These form five broad categories; mental health and well-being; physical health; social and community health, healthcare systems and health inequalities. The mental and well-being benefits of accessing and engaging with nature are well recognised. Previous work in NBSP has identified benefits in improvements for common mental health conditions such as anxiety (Tester-Jones et al., 2020) and improvements in overall well-being. Participation in NBSP taking place in natural environments or simply 'being' in nature can support feelings of restoration, peace and replenishment, a sense of purpose, 'spark' and self-determination (Kenyon et al., 2023). These improvements in mental health and well-being are supported by the biophilia hypothesis which is the idea of humans have an innate affinity and connection with nature (Wilson, 1984; Barbiero and Berto, 2021). However, it is important to recognise that outcomes are not all positive, for example a study into experiences of nature for people with common mental health conditions found that perceived social pressure to visit nature was associated with higher visit likelihood, but also lower motivation to visit and when visits occurred, lower visit happiness and higher anxiety (Tester-Jones et al., 2020).

Nature-based Social Prescribing has been associated with positive physical health outcomes. Outdoor-based activities such as walking, gardening and yoga can increase physical activity levels and associated improvements in mortality and morbidity, particularly for chronic conditions such as diabetes and cardiovascular diseases (J. M. Robinson et al., 2022) and positive associations between exposure to nature and immunoregulation (J. M. Robinson et al., 2022; Roviello et al., 2022). Furthermore, simply being in natural spaces also seems to confer benefit, for example, there is evidence that physical activity that takes place outside has greater health impact that indoor activities (Rogerson et al., 2016). Interventions that include an element of food growing can improve mental and physical well-being by increasing perceived self-efficacy, improving physical activity levels as well as supporting healthy eating through accessing and learning about healthy food and eating and supporting food security (Marselle et al., 2021; Kenyon et al., 2023; Ghogomu et al., 2024).

The literature also evidences the protective effect of exposure to nature natural environments suggesting that exposure to microbial diversity of environmental and animal microbes such as house dust mites, cat antigens and pollen can improve human health outcomes by boosting immune systems and offering a protective effect for certain conditions such as allergies and asthma, particularly when exposure occurs in childhood (Aerts et al., 2018).

As well as benefit, projects that involve increased human-animal interactions or changing habitat boundaries may pose increased risk of transmission of zoonoses, posing risks to humans and wildlife health (Cox and Gaston, 2018; Nyhus, 2016). Zoonotic diseases remain an ongoing threat; 60% of emerging infectious diseases are zoonotic and 72% of these originate in wildlife making this risk an important consideration. Increasing biodiversity has been associated with increased risk of certain zoonoses and allergies (Aerts et al., 2018; Marselle et al., 2021).

NBSP projects have potential to foster improvements in community cohesion, community engagement and trust and support opportunities for social interaction and reduced social isolation which further leads to improvements in well-being (Leavell et al., 2019; Marselle et al., 2021). NBSP can complement exiting healthcare services and potentially reducing the need for pharmacological and surgical interventions and reduce General Practitioner and Accident and Emergency (A&E) demands (Kimberlee et al., 2017). Natural spaces can also provide a protective space and barrier between humans and animals reducing the risks of transmission of zoonoses (J. M. Robinson et al., 2022). Restoration, however, also carries risks to humans, such as increased risks of exposure to zoonoses and increased allergens from vegetation and so should be evaluated and managed carefully (J. M. Robinson et al., 2022), this is discussed in more detail under Pathway 1.

Ecosystem restoration can improve human social equity by providing access to nature for groups who are less likely to frequent natural spaces including people living in areas of high deprivation and minority ethnic groups (T. Robinson et al., 2022). There is also evidence to suggest these groups may disproportionately benefit from accessing natural spaces (Mitchell and Popham, 2008). As such NBSP can provide a mechanism to reduce health inequalities in line with the equigenesis theory, where time spent in nature is associated with smaller socioeconomic inequalities in well-being (Garrett et al., 2023). Incorporating this approach can further contribute to reducing inequalities through upskilling and education of participants which may support future employment opportunities. However, SP or NBSP is not a panacea and such individualised approaches to health such as SP have the potential to exacerbate inequalities since people from better-off backgrounds typically have greater resources to engage with health opportunities. A study of social prescribing in the North of England found that possession of capital shaped peoples' investment in SP interventions and their capacity to engage with it (Gibson et al., 2021). As such, SP runs the risk of benefiting only those with greater personal resources while leaving those with limited resources behind. SP must be accompanied by physical and cultural structural changes to support a holistic societal-level change rather than focus on individuals. Supporting the needs of the human population and an ecosystem requires effort at all levels. A single intervention to improve mental health and physical activity will not work in a community that is not perceived as safe or in a social and physical environment that is unsustainable and does not meet the needs of those living within it. NBSP has the capacity to contribute to this aim through community-level interventions that are visible and accessible to whole communities thus 'normalising' health behaviours and contributing to local cultural norms. At the same time, interventions must ensure that people are protected from potentially harmful social effects of 'greening' such as gentrification and displacement, through the creation of spaces that favour more affluent populations (T. Robinson et al., 2022).

This section has summarised the pathways of influence of NBSP projects on human health and those involved in designing and evaluating NBSP should consider physical, mental, social, economic health, health systems and health inequalities. Consideration should be given to the voices of those involved in NBSP planning and participation as it is important to capture stakeholder opinions at all stages through, for example co-production or participant evaluation (Alford, 2024).

### *Pathways 2 and 3 NBSP impact on animal and environmental health*

Interventions that enhance, develop, manage, maintain, or renovate natural spaces may enhance environments by supporting or increasing the existing vegetation and increasing biodiversity (Pathway 2). This can affect animal health by supporting and/or

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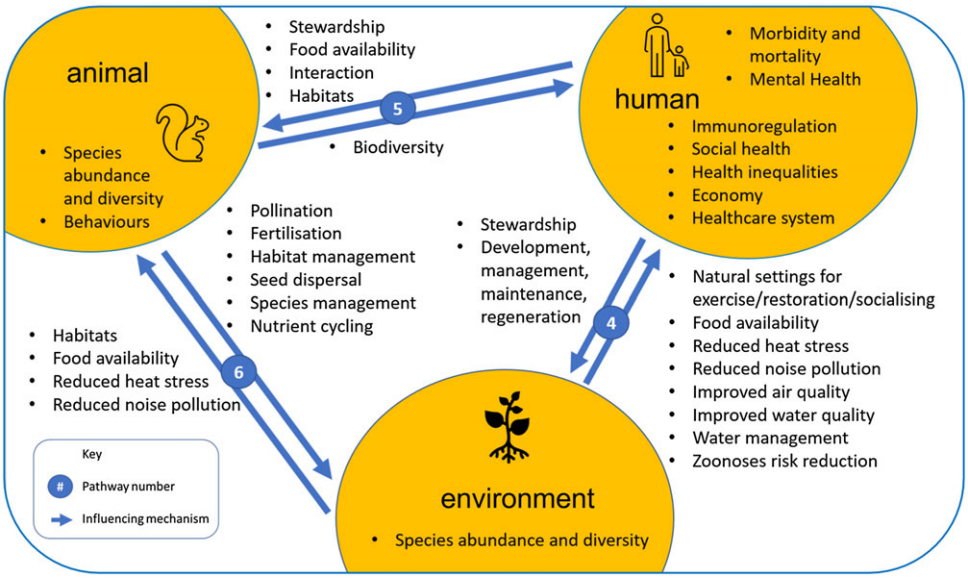


**Figure 2.** Enlarged detail view: Nature-based Social Prescribing Impact Pathways (NaBSPIP) framework pathways 4–6 showing measurable outcomes.

preserving habitats, food sources and enhancing species richness, abundance and biodiversity (Ghofrani et al., 2017; Felappi et al., 2020; Kenyon et al., 2023). Animal health measures may include special richness, abundance, parameters, behaviours and diversity indices (Felappi et al., 2020). However, these associations can also work in the opposite direction, where human interventions can deplete environments through damage or change to existing vegetation and associated impacts on animals. The effects of NBSP on environmental health can be measured through considering the health, percentage coverage and diversity of plants and health. The use of citizen science is expanding rapidly in the measurement of biodiversity and environmental monitoring (Pocock et al., 2017). Examples include the 'observatree' treehealth survey (Gupta et al., 2022) and Imperial College London Open Air Laboratories citizen science surveys (which include water, air, biodiversity, 'bugs', tree health, soil and earthworm and Polli:Nation) (Welden et al., 2018; Slawson and Moffat, 2020). Engaging in citizen science may contribute towards enhancing a sense of environmental stewardship discussed in more detail in subsequent sections.

There are feedback loops between the domains and these interrelationships are presented in more detail in the section below and summarised in Figure 2. which shows an enlarged view of impact pathways 4–6 with main outcomes from these pathways.

### *Pathway 4 (environment-human)*

Enhancement of natural environments leads to further feedback loops supporting human health outcomes through its impact on ecological systems. Green infrastructure, such as constructed wetlands and vegetated buffer strips, can effectively filter pollutants from stormwater runoff. These systems can improve quality of water bodies, rivers and streams (Ghofrani et al., 2017; Liao et al., 2017; Marselle et al., 2021). Greenery and water bodies can reduce urban heat stress (Doick et al., 2014) which is an increasing priority in the face of predicted increases in temperature and a shifting demographic with an increasing proportion of older adults who are most vulnerable to high temperatures (Meade et al., 2020; Marselle et al., 2021). Green and blue infrastructure, including increased vegetation that absorbs water and reduces surface runoff, the restoration of natural floodplains and creation of floodplain storage areas, can help to mitigate the increasing the risk of flooding in urban areas (Ghofrani et al., 2017). The carbon sequestration potential of green infrastructure is well known and can mitigate against climate change. The presence and diversity of plants can improve air quality (Aerts et al., 2018; Choe et al., 2020; Marselle et al., 2021) and associated health outcomes such as reduction in allergies, asthma, cardiovascular disease and premature mortality (Aerts et al., 2018). Ecological factors such as air pollution and, carbon sequestration and heat stress reduction can be measured quantitatively (Epelde et al., 2022) and the associated human health benefits inferred through these measures changes (see, for example, Choe et al. (2020).

By providing natural settings that support recreation and social health, participation in NBSP has been found to be associated with a sense of 'environmental stewardship', or pro-environmental behaviour, where people become more aware of the importance of and methods of preserving natural habitats, reducing pollution and conserving biodiversity and behave in ways that they feel will support these values (Krasny and Delia, 2015; Hahn, 2021; Capstick et al., 2022; Kiss et al., 2022). and measured through, for example, attitudes and intentions or reported stewardship behaviour (Turnbull et al., 2020). Learning about nature has also been found to be associated with environmental stewardship behaviours in humans (Otto and Pensini, 2017). These behaviours may result in a positive feedback loop by further enhancing and protecting environments.

A life course approach understands health outcomes as a cumulative process of exposure to positive and negative health events throughout the life course (Jones et al., 2019). Exposure to greenspace from the inter-utero period into childhood has been found to be protective for physical and mental health outcomes showing potential feedback loops throughout life and across generations. Early engagement with nature has been to be associated with increased likelihood of seeking nature and experiencing benefit from nature in adulthood. (Dzhambov et al., 2014; Grazuleviciene et al., 2015; Aerts et al., 2018; Yin, 2019). However, not all feedback loops will be positive, for example an experience of nature at a young age that was not positive may

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reduce, rather than encourage future participation. Consideration of the potential life course impact of NBSP interventions should form part of their planning and evaluation.

### *Pathway 5 (animal-human)*

As mentioned in the discussion of Pathways 2 and 3, NBSP activities can increase the number and diversity of animal species whereby wildlife-friendly habitats and food sources has been associated with increased numbers and diversity of animals (Cox and Gaston, 2018). This can lead to a positive cycle for animal health and resilience, for example, an increase in food sources for birds is associated with increased over-winter survival rates and egg and clutch sizes (Cox and Gaston, 2018). However, well-intentioned but clumsy restoration can at best be futile and at worst have unintentional negative consequences and feedback loops for animal health. Animal habitats are dynamic systems operating at multiple temporal and spatial scales and supporting animal health through restoration is more complicated than provision of habitat alone. Projects that involve changing habitat boundaries or patterns of interaction with wildlife may result in changes in animal populations that can disrupt ecosystem chains, for example, increases in predatory species which then impacts on other species population and disrupt existing symbiotic relationship between animals and habitas (see Pathway 6). Surroundings can also impact the success of rehabilitation for example, bird nest predation has been found to be higher in areas with higher density of surrounding human dwellings. Factors such as surrounding road density may affect the success of recolonisation projects and external patterns of nest predation and parasitism can be affected by surroundings, such as the area of forest cover at a far larger scale than individual restoration projects (up to 10,000 $km^2$) (George and Zack, 2001). To be successful, restoration attempts should take account of the complex and dynamic nature of animal habitats that operate at multiple scales.

Some NBSP projects can directly involve animal-assisted interventions in nature (Garside et al., 2020). People who take part in these can experience positive effects from animal interaction (Garside et al., 2020; Thomas et al., 2022), and also learn about animal welfare, animal care and the connections between animal and human health (Garside et al., 2020). In a similar way to that described in Pathway 4, this type of engagement can support the development of environmental stewardship, or pro-environmental behaviour, and positive impact on animal health such as the importance of and methods of preserving natural habitats and conserving biodiversity (Krasny and Delia, 2015; Hahn, 2021; Capstick et al., 2022; Kiss et al., 2022). In a continuum of the cycle, more species biodiversity is generally associated with subjective health and well-being outcomes such as improved perceived health and lower risk of depression and mortality in humans (Aerts et al., 2018; Marselle et al., 2021). However, these effects are not uniform and are likely to be mediated by interpersonal factors such as personal and cultural beliefs and values; if people have negative preconceptions about exposure to animals they may not experience these benefits (Aerts et al., 2018) and humans may fear and avoid areas where there are animals. Human-animal interactions are complex, and species abundance alone is not necessarily sufficient to leverage human health and well-being benefits (Cox and Gaston, 2018).

Human presence in natural spaces can discourage wildlife, for example, in areas such as mountainous trails or forests, human activities such as hiking or cycling has been associated with a reduction in wildlife (Taylor and Knight, 2003; Kays et al., 2017). This avoidance may also be temporal; a large global meta-analysis found a marked increase in nocturnal activity in areas of high human disturbance compared with areas of low human presence. This behavioural shift can affect predators' ability to hunt and cause changes along the food chain which may increase other animals' exposure to and risk from nocturnal predators. (Gaynor et al., 2018). Other evidence suggests that animals who have invested in settling in a given area may be less likely to abandon it but human presence may increase stress levels and aggression causing increases in energy expenditure and decreases in food intake and reproduction which may result in lower numbers, health and survival rates (Tablado and Jenni, 2017).

NBSP projects that may influence other aspects of animals' health should consider these types of pathways and consider measuring, for example, attitudes and responses to interactions with animals, changes in the frequency and type of human-animal interactions and consider impacts on animal territories and spatial, social, reproductive and temporal behaviours.

### *Pathway 6 (animal-environment)*

The symbiotic relationship between environments and animals results from the mutual unplanned system of reciprocal provision and species support. Animals, in turn, play a vital role in maintaining the balance and health of natural environments and can be measured through outcomes and activities such as pollination, nutrient cycling, habitat modification, seed dispersal and species species biodiversity (Methorst et al., 2021). Human activity, however, can lead to a breakdown of this system as described earlier, for example through the introduction of species that do not support the existing wildlife or damage to the existing balance of food supply and demand.

## Conclusions

The world is currently facing unprecedented ecological, social, economic and health challenges. COVID-19 brought to light the imperative to treat increasing levels of mental health conditions, while loneliness and social isolation are increasingly recognised as having a negative impact on health. Meanwhile as global temperatures rise, we face depleting species diversity and reduced vegetation cover. To pave the way to repair, we urgently need to develop strategies to support the changing health needs of populations whilst persevering and protecting ecosystems in line with the United Nation's Sustainable Development Goals.

The value of the NaBSPIP lies in its amalgamation of the ideas in the context of NBSP informed by the One Health perspective. The value of engaging with nature has potential mental, physical, social and economic benefit and according to the biophilia hypothesis, nature has unique ability to support human health potentially through our innate connection to and feeling for nature which engenders feelings of rest, relaxation and well-being. This article posits that the value of NBSP is further augmented by its capacity for holistically supporting animal and environmental health as well as human health and well-being. This framework aims to support healthcare practice by demonstrating the multiple pathways of benefit, as well as risk, from NBSP and is intended to be a heuristic and a catalyst to support ground-level approaches to sustainable healthcare through recognition of the multiple co-benefits of NBSP. This approach would require multi-stakeholder

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and multidisciplinary engagement in the design and delivery of projects.

The concept of valuing mutual human and ecological benefit from nature-based health interventions is not new, and the mechanisms and outcomes explored in this article are not an exhaustive list and do not account for the multiple intricacies and contingencies of individual NBSP projects. Nor does it address the challenges and barriers involved in recruiting people into schemes and sustaining their involvement nor the theoretical and practical challenges of behaviour change which are important for successful social prescribing yet beyond the remit of this article. This is not intended as a comprehensive checklist of impacts of NBSP projects, which would be impossible due to the diverse nature of NBSP projects and the contingency and complexity of the interacting influences. Social prescribing is not a magic bullet; and supporting holistic planetary animal, human and environmental health outcomes will require fundamental shifts at global and political level (Rabinowitz et al., 2018) and unprecedented change in the way that the majority of humans live and perceive their role in the world. However, Nature-based Social Prescribing is uniquely placed to support human and other species' health simultaneously, but this must be carefully planned, executed and evaluated.

Future research could apply the NaBSPIP framework to support the design and delivery of an NBSP project to facilitate more detailed empirical consideration of the pathways of impact and outcomes so that the framework can be refined and validated. NBSP is likely to be contextually and temporarily specific so future work should consider the local conditions that may facilitate maximum success of the projects. Detailing specific measures that can be used in conjunction with the NaBSPIP was beyond the scope of this paper, however, future research should develop a toolkit for measuring NBSP impact in line with the NaBSPIP Framework. Some toolkits already exist, for example the National Academy for Social Prescribing Green Social Prescribing toolkit (Alford, 2024) and NHS England's Nature-based Social Prescribing Evaluation toolkit which includes consideration of human outcomes (NHS, 2020). A toolkit based on the NaBSPIP would enable consideration of further impact and outcomes informed by the One Health perspective and could take the form of a database of data collection techniques and tools that can be applied within each of the domains and the potential impact pathways described above. Additionally, future work might employ the use of DAGs to understand the recurrent factors at play more precisely to augment the broad framework outlined here. Applying lessons learned and scaling up to continue to support the development of projects that value non-human outcomes and transitioning from theory to practice and policy would be the ideal trajectory from this framework.

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