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PERSPECTIVE

Bringing nature back into cities

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Abstract

1. Protecting nature is a fundamental aspect of local and Indigenous cultures that has more recently become an urban sustainability goal. The benefits provided by nature to people and other species have sparked an upsurge in research exploring how best to manage existing nature in urban environments. Here we expand this focus by drawing attention to an emerging pathway of research and practice that is engaged with the idea of bringing nature back into cities (BNB).
2. We argue that BNB could be a vital force of the 21st century urban-sustainability agenda. However, the enthusiasm of practitioners and policymakers for incorporating BNB objectives into local and global strategies remains uneven. As interdisciplinary scholars involved with the theory and practice of caring for urban nature, we believe that the time is ripe to present a fresh perspective on seven key areas that can unlock the potential of actions to bring nature back into cities.
3. Specifically, we: (a) argue that the sovereignty of local and Indigenous knowledge-systems be acknowledged and respected; (b) contend that the choice of bringing nature back actions should be driven by inclusive decision-making; (c) discuss advances in ecology that need to be addressed to facilitate the return of nature into cities; (d) outline how the diffusion of innovation theory may assist communication of BNB actions to stakeholders; (e) discuss how built-environment professionals can demonstrate the value of urban infrastructure for BNB; (f) call for longitudinal research to understand, quantify and qualify the benefits of BNB actions and (g) consider solutions needed to address concerns about potential risks and disservices associated with actions to bring nature back into urban environments.
4. Taken together, these perspectives, and the transdisciplinary framework that emerges from them, embody theoretical innovation regarding how to bring nature back into cities and a holistic view of how to make this happen in practice. Bringing nature back into cities has the potential to become an environmentally just and culturally inclusive dimension of the 21st urban sustainability agenda upon which future generations of city-dwellers rely.

KEYWORDS
Caring for Country, conservation biology, decision science, diffusion of innovation, local and Indigenous knowledge-systems, transdisciplinary research, urban biodiversity, urban ecology

1 | INTRODUCTION

Protecting and caring for nature has been a fundamental aspect of local and Indigenous cultures for tens of thousands of years and has more recently become a sustainability goal of cities around the world. The tremendous range of spiritual, cultural, social and ecological benefits provided by nature, together with the recognition of how colonial settlements and other types of unbridled urban growth have alienated and stunted nature's agency to thrive in cities, are generating a renewed awareness of the meaning and significance of conserving every aspect of urban nature—from safeguarding clean air, water and soil to maintaining the complexity of city-wide metanetworks of interacting species (Cox et al., 2017; Davydova, 2005; Dearborn & Kark, 2010; Hartig & Kahn, 2016; Kumar & Hundal, 2016; Maller, Mumaw, & Cooke, 2018; McDonnell & MacGregor-Fors, 2016; Nowak & Heisler, 2010). Not surprisingly, a wide array of theoretical and empirical research has focused on how best to manage existing nature in urban environments to maximize positive outcomes both for people (Dadvand et al., 2015; Flies et al., 2017; Hartig, Mitchell, Vries, & Frumkin, 2014; Keniger, Gaston, Irvine, & Fuller, 2013) and other species (Aronson et al., 2017; Baldock et al., 2019; Beninde, Veith, & Hochkirch, 2015; Lepczyk et al., 2017; Mata et al., 2017; Ossola & Niemelä, 2017; Parris et al., 2018; Soanes et al., 2019; Threlfall et al., 2017).

In addition, an emerging pathway of research and practice has been advocating for the active return of nature into cities. The idea of 'bringing nature back into cities' has been explored by researchers (Clarkson, Wehi, & Brabyn, 2007; CUR, 2020), professionals (CIS, 2017; Wohlitz, 2017) and the media (Becker, 2014; Berg, 2016; Schmidt, 2019), and is an increasingly appreciable dimension of sustainability and biodiversity conservation in urban environments. In the simplest terms, bringing nature back into cities (henceforth BNB for brevity) embodies any set of actions that encourage the return of local, native species—from soil bacteria to charismatic vertebrates—to areas within urban environments where they have become rare or locally extinct. The definition encompasses the idea that species may be brought back: (a) as individuals or populations, but also grouped into ecological communities; (b) either by self or human-mediated agency and (c) to either remnant or designed habitats within the public and private domains of urban environments. Although this definition focuses on the living dimension of nature (i.e. species), we recognize that in its broadest sense nature may also comprise the non-living natural phenomena of the physical world. We further note that we expand the conceptual spatial extent conventionally associated to the term 'locally extinct' (i.e. a large geographical region such as a city or metropolitan area) to also include smaller patches such as urban green spaces and waterbodies.

In this sense, BNB is often a key feature of (a) urban sustainability approaches, including greening, public landscaping, urban forestry, green infrastructure and other related nature-based solutions focusing on the benefits and services provided by nature to people and (b) biodiversity conservation approaches such as ecological restoration, rewilding and eco-engineering as applied to urban environments. Indeed, in many instances, the term BNB may be considered an encompassing way to collectively refer to these approaches. We highlight below, however, some minor, but in cases critical, points of difference between BNB and some of these approaches. For instance, while urban greening actions are usually conceptualized to include positive outcomes for non-plant biodiversity, they remain, however, predominantly focused on plant species, and on how to use these as physical structures (i.e. infrastructure) to engineer nature-inspired solutions (e.g. trees as storm water management devices and providers of human thermal comfort; Berland et al., 2017; Coutts, White, Tapper, Beringer, & Livesley, 2016). To achieve these and other non-biodiversity objectives, urban greening actions also often do not discern plant origin as a key factor (e.g. a non-native tree may be deemed the most resilient option under a given climate change scenario; Esperon-Rodriguez et al., 2019; but see FAO, 2016). Actions to BNB on the other hand are not primarily focused on plants—they may in fact target any taxa from soil fungi to parasitic wasps, from frogs to cockatoos—and are exclusively concerned with local, native (i.e. indigenous) species, considering plants and all other species as living organisms that belong and deserve to exist within cities on their own right. Likewise, BNB may extend beyond the scope traditionally associated with ecological restoration practices. Restoration projects in urban and other environments are traditionally aimed at recovering degraded ecosystems to resemble historic or novel reference ones (Gann et al., 2019; Hobbs, Higgs, & Harris, 2009). Seminal examples of how restoration may contribute to bring indigenous plant communities back into urban environments are provided in Clarkson et al. (2007). Beyond these and other examples of community-level initiatives, however, BNB actions may be aimed specifically at bringing particular species back at the population or even individual level (e.g. a gardener planting a single individual of a rare or locally extinct indigenous plant species in her/his mixed native/non-native garden). Finally, some key aspects of BNB veer away from rewilding in significant ways. While both approaches involve species reintroductions, rewilding operates in areas of minimal or no human influence (but see Jepson, 2016; Jørgensen, 2015; Maller et al., 2018), focusing primarily on large mammals (Seddon, Griffiths, Soorae, & Armstrong, 2014). In contrast, BNB actions embrace any taxon, and are specifically conceptualized to be carried out in urban areas. Most importantly, BNB recognizes that the areas occupied by most modern cities around the world were and continue to be the realm of Indigenous peoples, departing starkly from the notion that present-day urban environments

were wild, in a state of wilderness or not actively managed by humans before colonial settlement (Ward, 2018).

We argue that BNB can become a vital force of the 21st century urban-sustainability agenda. Currently, however, the enthusiasm of planning, landscape, design, health and biodiversity practitioners and policymakers for incorporating BNB objectives into local and global strategies remains uneven. Most of the relevant policy efforts are predominantly focused on either managing and protecting existing nature (e.g. preventing damage caused by invasive insect pests to native trees) or climate change and green infrastructure oriented urban greening (e.g. community grants to encourage the uptake of green roofs by residents; Griggs et al., 2013; ICLEI, 2015; Nilon et al., 2017; UN, 2017). The literature does offer a few examples that illustrate the budding interest of local governments to BNB. For example, in Canada the City of Calgary (2017) has enacted policy whose implementation has led to a series of naturalization actions specifically targeted at bringing native plant species back into the municipality's green spaces. Similarly, in Australia the City of Melbourne (2017) has recently launched its *Nature in the City* strategy, which includes targets aimed at achieving a net increase in biodiversity by 2027 via increasing understorey plant cover by 20% with a palette that includes native, local species. Indeed, in a review of the biodiversity and ecosystem services attributes included in 135 policy plans from 40 cities globally, Nilon et al. (2017) found that approximately 40% of the plans included specific objectives to promote native biodiversity, and as much as 20% included quantitative targets for particular native plant and animal taxa.

Advances in basic and applied research have provided some support for the practice of BNB. For instance, biodiversity and conservation theoreticians have been exploring the pathways linking urban design, planning, engineering, architecture, development and management across multiple spatial and temporal scales with positive biodiversity outcomes (Ahern, 2013; Beatley, 2011; Bergen, Bolton, & Fridley, 2010; Felson et al., 2013; Goddard, Dougill, & Benton, 2010; Gonzalez, Thompson, & Loreau, 2017; Ignatieva, Stewart, & Meurk, 2011; Müller, Ignatieva, Nilon, Werner, & Zipperer, 2013; Parris et al., 2018). This includes applications of ecological principles to develop biodiversity-friendly and animal-aide recommendations for practitioners and policymakers (Dethier, Toft, & Shipman, 2017; Garrard, Williams, Mata, Thomas, & Bekessy, 2018; Ignatieva, 2017; Ikin et al., 2015; Lovell & Johnston, 2009; Parris et al., 2018; Weisser & Hauck, 2017). A parallel, yet limited, body of applied research has focused on providing evidence of the positive benefits of BNB actions. For example, a recent study assessing the insect and spider community of a pop-up park that brought a native grassland back into central Melbourne for 6 weeks found that the temporary vegetation sustained almost twice as many native insect species as the site's pre-existing vegetation (Mata et al., 2019). Despite these theoretical and empirical advances, much work is needed to tackle the complexities involved in translating BNB research into practice (McDonnell & Hahs, 2013; Ossola & Niemelä, 2017). A key challenge remaining for scientists interested in providing guidance for practitioners and policymakers, beyond merely informing BNB practice with ecological principles, would be to conceptualize and implement experimental approaches that can demonstrate the positive outcomes of BNB actions; thus setting pathways for BNB projects to support evidence-based practice, policy and decision-making.

While it is generally accepted that nature in cities can benefit people and other species, the more nuanced question of whether the distribution of the benefits of nature in cities can transcend social and economic privilege has become a critical issue in urban environmental justice scholarship and practice. Many studies have been published, for example, emphasizing how (a) inequitable green space access may have negative social implications (Byrne, Wolch, & Zhang, 2009; Jennings, Gaither, & Gragg, 2012); (b) greening improvements may lead to green gentrification (Anguelovski, Connolly, Masip, & Pearsall, 2018; Gould & Lewis, 2017) and (c) regulatory codes prohibiting gathering practices associated with local food and traditional medicines in urban forests may prevent less-privileged residents from accessing just and sovereign food and health alternatives (Poe, McLain, Emery, & Hurley, 2013). These and other studies converge in the idea that most strategies aimed at delivering nature's benefits to people in urban environments are not socially inclusive or sustainable (Haase et al., 2017; Rutt & Gulsrud, 2016; Wolch, Byrne, & Newell, 2014). Beyond this, a remaining challenging issue is to understand how the diversity of physically co-occurring voices representing the culturally heterogeneity of urban environments can be guaranteed access and agency to meaningfully engage in the decision-making process regarding how the benefits of nature in cities can be best planned for, managed and potentially brought back. A diverse group of voices that have always strongly advocated for the vitality, agency and interconnectedness of nature, and to which we draw attention in this paper, are the voices of Indigenous peoples (James, 2013; Simpson, 2020; Todd, 2016).

2 | UNLOCKING THE POTENTIAL OF ACTIONS TO BRING NATURE BACK INTO CITIES—SEVEN KEY PERSPECTIVES

As interdisciplinary scholars engaged with the theory and practice of caring for nature in urban environments, we believe that the time is ripe to present a fresh perspective on seven key areas that need to be considered to fully unlock the potential of actions and projects aiming to bring nature back into cities. Specifically, we: (a) argue that the sovereignty of local and Indigenous knowledge-systems be acknowledged and respected, and highlight the urgent need for Indigenous and non-Indigenous perspectives on BNB to engage in partnership; (b) contend that the choice of any action to bring nature back into cities should be driven by an inclusive decision-making process; (c) discuss theoretical and methodological advances in the field of ecology, including topics revolving around ecological networks, species translocations, landscape connectivity and use of novel resources, that need to be considered to facilitate the return of nature into cities; (d) outline how the diffusion of innovation theory may assist our understanding of how innovative BNB actions

can be efficiently communicated to all relevant stakeholders; (e) discuss how built-environment professionals can help demonstrate the value of urban infrastructure for BNB; (f) call for longitudinal research to understand, quantify and qualify the multiple benefits of BNB actions and (g) consider solutions needed to address concerns of practitioners, regulatory bodies, animal-welfare groups and members of the public about potential risks and disservices associated with actions to bring nature back into urban environments.

2.1 | Acknowledging and respecting the sovereignty of local and Indigenous knowledge-systems

The custodianship of nature is deep-rooted in local and Indigenous knowledge-systems, including the intricate familiarity and connectedness of local biodiversity and ecology that nurtures responsible sustainability behaviours (CBD, 2019; Mauro & Hardison, 2000; Pascoe, 2014; Rose, 1996; UNESCO, 2017). Yet only recently has a budding section of the conservation, climate change and resource-management community begun to recognize the gains of bridging the gap between different knowledge-systems, the value of fostering relationships between non-Indigenous and Indigenous scholars and practitioners and the challenges of appropriately—or the paradoxes of inappropriately—engaging local and Indigenous individuals, populations and communities in pro-sustainability actions (Adams et al., 2014; Alexander et al., 2011; Ban et al., 2018; Brondizio & Le Tourneau, 2016; Etchart, 2017; Housty et al., 2014; Jardine, 2019; Kelbessa, 2013; Lee, Thorley, Watson, Reid, & Salomon, 2018; Lyver & Tylianakis, 2017; Mazzocchi, 2018; McLeod, Schmider, Creighton, & Gillies, 2018; Mistry & Berardi, 2016).

Despite this interest, most academics, practitioners and policy-makers involved in setting objectives aimed at protecting or BNB have failed to meaningfully engage with local and Indigenous individuals, communities and organizations, while concomitantly neglecting to integrate local and Indigenous voices, perspectives, interests and concerns into their decision-making protocols (Langton & Rhea, 2005; Porter & Arabena, 2018). A striking case of this disjuncture can be appreciated in the continued widespread use of the term 'rewilding'. In the Australian context, for example, the idea of rewilding fails to recognize that there is no place in Australia which Indigenous peoples consider 'wild', and is therefore at odds with the available evidence, much of which has only been scientifically proven, explored and accepted in relatively recent times (Gammage, 2012; Langton, 2013; Pascoe, 2014). It is worth highlighting, however, the effort by the Intergovernmental Platform on Biodiversity and Ecosystem, Services' Task Force in Indigenous and Local Knowledge Systems to consider local and Indigenous knowledges in the global policy-science arena (e.g. Baptiste, Pacheco, Carneiro da Cunha, & Diaz, 2017; Lyver, Perez, Carneiro da Cunha, & Roué, 2015). Yet, most agendas of cross-cultural collaborations that have emerged over the last 30 years have focused on remote, non-urban areas (Robin, Morton, & Smith, 2014).

Drawing attention to Indigenous knowledge-systems and the Indigenous World (IWGIA, 2018) specifically, we note that as many as half of the 370 million First Nations, Aboriginal and other Indigenous people across the world currently live in urban environments (Etchart, 2017; UN-HABITAT, 2019). Notable examples of cities thriving with Indigenous populations include Auckland, Brisbane, Broome, Guatemala City, Lima, Mexico City, Nuuk and Winnipeg (Daley, 2016). Importantly, many urban environments around the world—certainly most cities in the American continent and all cities in the Australian continent—have been developed on unceded Indigenous land and have, at least in the Australian context, Traditional Owners who are still present and actively practicing culture (State of Victoria, 2017). Unfortunately, however, the legacy of shocking historical erasures—the practice of dominant political ideologies and/or academic methodologies to efface, marginalize, ignore or otherwise invisibilize the knowledges, traditions and achievements of colonized peoples (e.g. Bruchac, 2007)—has ensured that urban environments are not seen as Indigenous places. There is therefore an urgent need to set ethical pathways to recognize and forefront the historical heritage of Indigenous peoples (Birch, 2016), a critical step towards the goal of decolonizing any potential actions to BNB.

For the reasons presented above, we argue that acknowledging and respecting the sovereignty of local and Indigenous knowledge-systems should be a pressing priority when conceptualizing and putting into practice BNB actions. It is time we finally began to meaningfully engage with local and Indigenous worldviews in all aspects of ecological and conservation planning, and in doing so, move away from approaches that use local and Indigenous knowledge as a 'sprinkling on top' as opposed to a guiding framework (Kennedy, 2017). We stress that BNB will require the voices of different knowledge-systems to engage in an equal partnership. Therefore, local and Indigenous communities should not be treated as ad hoc ancillary actors; their perspectives and aspirations should be actively informing actions and strategies from the outset. Bringing local and Indigenous narratives into the conversation enables counterdiscursive styles of thinking that may contribute to abate the generative processes driving the environmental crisis we so urgently seek to remedy (Reddekop, 2014).

To highlight local and Indigenous knowledge-systems within the discourse around BNB would be to finally tap into the resources and knowledge flowing from thousands of generations of careful custodianship (Weir, 2016). It is imperative to appreciate, however, that local and Indigenous knowledge is not a commodity, and that is not always meant to be knowable or freely exchangeable (L. Porter, pers. commun.). In the same way, the application of local and Indigenous knowledge systems will require cross-cultural awareness and processes whereby the dominant philosophies and lifeways can actively work to privilege local and Indigenous ways of knowing (Ens, Finlayson, Preuss, Jackson, & Holcombe, 2012). Here we draw our attention to Australian pan-Aboriginal worldviews to reflect in more detail on two aspects of Indigenous knowledge, namely *Caring for Country* and the *Cultural significance of species* (Box 1), that bear a strong connection with the BNB ideas discussed here.

BOX 1 Australian pan-Aboriginal worldviews

In this box, we introduce two Australian pan-Aboriginal worldviews to highlight the strong connections between Indigenous knowledges and the BNB ideas discussed in this paper.

In *Caring for Country*, we first define 'Country' and discuss why we believe it should be a key driver structuring any BNB framework. We then deliberate on the damages inflicted on Australian First Peoples as a result of historical erasures that have prevented them from appropriately practicing 'Caring for Country'. We finish by arguing how bringing indigenous plants and other species back into cities can be understood as a fundamental reparation act.

In *Cultural significance of species*, we begin by introducing the idea that in their right context, all species have cultural significance. We then contrast this perspective with the dominant Western worldview that allows for the asymmetrical valuation of species and discuss pathways to integrate both views. We finish by arguing that any action to bring nature back that recognizes that all local, indigenous species are of equal cultural significance is an enactment that transforms the action into an Indigenous-led enterprise.

Caring for Country

Country is a term that describes the lands with which Australia's First Peoples have a traditional attachment or relationship with (Weir, Stacey, & Youngetob, 2011). Country is widely multi-faceted concept that, in the words of Australian ethnographer Deborah B. Rose,

> ...consists of people, animals, plants, Dreamings; underground, earth, soils, minerals and waters, surface water, and air. There is sea country and land country; in some areas people talk about sky country. Country has origins and a future; it exists both in and through time. (Rose, 1996, p. 8)

Caring for Country has its basis in the laws, customs and ways of life that Australian First Peoples have inherited from their ancestors and ancestral beings, embodying a philosophy that reaches beyond the physical management of a given area to embrace activities that nurture relationships with the cultural, social, economic and spiritual dimensions of the environment (Altman, Buchanan, & Larsen, 2007; Kinnane, 2002; Weir et al., 2011). A dramatic shift in the way many non-Indigenous people view Country is needed to address the vast sustainability problems, both in cities and elsewhere, faced by Indigenous and non-Indigenous people alike. The respect embedded within Australian First Peoples' relationship with Country, a relational ontology which views Country as kin to be looked after and actively loved, should be a driving principal of BNB. By providing Indigenous Australian groups the right and just pathways to lead the BNB discourse within their appropriate local contexts, we can establish a robust platform for the custodianship and Caring for Country knowledge that has been safeguarded across thousands of generations so it can flourish in a moment when it is urgently needed to address the world's urban sustainability issues.

Deliberating on gains to be made by the establishment of frameworks and approaches to bring nature back into cities, we believe it is important to consider the continued damage being inflicted on the psychological and physical health of Australian First Peoples as a result of erasures. For example, the ecological knowledge of, and the agricultural and cultural practices associated with, indigenous plant species, including many Indigenous staple foods (Figure 1), have been largely subsumed by the machine of colonization. This machine continues its violence when Australian First Peoples cannot live amongst their plants, tell the stories embedded within them, pass these stories to the next generations and enjoy the health benefits of consuming and connecting with them (Zola & Gott, 1992).

Notably, these plant species are often the most sustainable and nutrient-rich crops that can be grown, requiring less water and no fertilizers while providing essential food and habitat resources for their associated biodiversity (Pascoe, 2014; Sultanbawa & Sultanbawa, 2016). When the plants of First Peoples are reinstated to the environments they have thrived in for thousands of generations, the shutting down of culture, custodianship and sovereignty enacted by historical erasure becomes instead an opening up of narratives with the potential to strengthen and bolster Indigenous knowledge-systems. This opening provides opportunities for Indigenous ecological knowledge and sustainability practices to be respected, shared and embraced. Furthermore, it invites all peoples to learn more about the country they call home. At its best, the opening of the narratives and perspectives of First Peoples may be a conduit through which the wider public can feel a sense of knowing and belonging that enables them to embrace their role as custodians, to begin to intimately know Country, and to love Country in a way that can heal and protect it (Pascoe, 2007). Bringing indigenous plant and other species back into cities can therefore be seen as a necessary act of reparation—not only a tangible way to support biodiversity, but also a way of improving the psychological wellbeing of Indigenous peoples, whose histories, knowledges and languages have been actively erased by the relentless march of colonization. Importantly, we note that none of these knowledges are completely lost: many are merely sleeping, and only acts of reparation can germinate these seeds of sustainability knowledge, heavy with the bounty they offer to all.

Cultural significance of species

A fundamental Australian pan-Aboriginal worldview truism is that all species, in the context of a given community associated with a given territory, have cultural significance. From an Aboriginal perspective all species have agency; all species are entities and have

BOX 1 (Continued)

FIGURE 1 Examples of plant species that could be brought back to Australian urban environments. (a) Kangaroo grass *Themeda triandra* was a widespread staple food for Indigenous Australians prior to European settlement. Still widely distributed across the continent, it would be an excellent food crop to be brought back in urban areas within its range. (b) Spiny-head mat-rush *Lomandra longifolia* is a hardy plant that is used as a food source by Indigenous Australians, and that provides materials for technologies and crafts such as eel-traps, baskets and mats. It is also an important food and habitat resources for native butterflies, making it a desirable plant species to be brought back into relevant urban environments. (c) Cumbungi *Typha orientalis* is a wetland species growing along the edges of rivers and lakes. It was the most important staple food for the Aboriginal people of the Murray-Darling river system and used for technologies and cultural items such as nets, waist-belts, brow bands and bags. The species also provide quality habitat for multiple wetland species, making it a favourable candidate to be brought back into urban waterways of southeastern Australia. (d) Murnong *Microseris walteri* was the most important staple food for Aboriginal people in southeastern Australia. Murnong tubers are rich in dietary fibres known to provide a wide range of positive health outcomes, making it a particularly beneficial plant to be brought back into cities falling within the species range

person (Watts, 2013). Aboriginal stories form part of an interconnected ecology, where all species and every single character and aspect within this story has meaningfulness to the way in which Australian First Peoples construct their philosophies. Species stories are an intertwined sustainability roadmap that guides Australian First Peoples in their overarching mission of keeping everything around them alive (Presland, 2010). This worldview that always values and validates species, whether human or non-human, equally, and that recognizes the cultural significance of all local, indigenous species seems to contrast sharply with dominant Western worldviews in which, in the face of resource scarcity, value may be assigned asymmetrically across species based on cost-effectiveness, prioritization, optimization, originality and other related analyses (Arponen, Heikkinen, Thomas, & Moilanen, 2005; Bottrill et al., 2008; Brooks et al., 2006; Marris, 2007; Pascual et al., 2017; Pavoine, Ollier, & Dufour, 2005).

Despite the obvious differences embedded in these worldviews we contend it is possible to integrate both views to help stakeholders make informed decisions around which species are best suited to be brought back into cities. In Australia, for example, local government decision-makers advocating for the place of the First Peoples, who in fact are the Traditional Owners of the Land presently under their jurisdiction, are in a position to weigh alternative BNB actions in favour of the wide range of indigenous species—species that are or once were native to the area under consideration, and therefore part of the area's pre-colonization ecology—that are currently rare or locally extinct in the area for which the action is envisaged. From that starting point, the BNB action follows a theoretical framework that places the First Peoples first, and therefore any other consideration involved in the decision-making process, whether ecological, social or economic, becomes secondary. These secondary factors can then be evaluated using Western worldview decision-making tools and protocols, as discussed in the following section.

Importantly, this recognition of vital Aboriginal knowledges and perspectives as the first consideration—in this case, that all local, indigenous species are of cultural significance, and that all species have agency, entity and person, and thus that they are all equally valuable—is an enactment that transforms the BNB into an Indigenous-led enterprise. We emphasize, however, that Indigenous-led does not mean necessarily that there has to be an Aboriginal person or community stakeholder guiding and influencing each action. Stakeholdership, in this context, is also given to any indigenous species that is connected to the spaces or places that would be influenced by the potential BNB (J. Kennedy, pers. commun.).

These aspects of pan-Aboriginal worldviews distinctly emphasize that all local, indigenous species have cultural significance and that they all have inherently equal value. Thus, rather than asking 'does a species have cultural significance?', we should be articulating that it does and have the humility to understand that any pre-colonization nature is going to have cultural significance. Beyond the stories embedded in every aspect of nature, there are practical uses for every species within the Indigenous ecology. Every single species has a role to play—a purpose that will need to also be brought back. A critical advance will be to establish mutually beneficial and socially just pathways for Indigenous and non-Indigenous stakeholders to engage in the necessary dialogue needed to identify the particular significance of each species from a cultural perspective.

2.2 | Inclusive decision-making

Decision science provides a sound body of theory and quantitative methods to inform decision-making. The field's ultimate concern is to provide decision-making tools to guide sound choices under uncertainty. Decision science is therefore ideally suited to address critical energy, climate, natural resource, biodiversity and other sustainability issues (Conroy & Peterson, 2013; Moser & Ekstrom, 2010; Pohekar & Ramachandran, 2004; Polasky, Carpenter, Folke, & Keeler, 2011). Not surprisingly, decision-making frameworks are being used to inform environmental and conservation decisions revolving around, for example, forests, fisheries and threatened species (Marcot et al., 2012; Mardle & Pascoe, 1999; Pérez et al., 2012). Ultimately, decision frameworks and tools can empower decision-makers to improve the policies and practices aimed at addressing society's core problems—particularly those concerning complex, stakeholder-diverse domains such as urban environments.

Yet no decision-making framework is presently available to help individuals, communities and organizations assess which species are most appropriate to be brought back into our cities. With so much riding on each decision, careful and systematic thought should inform each potential action under consideration, and the decision-making process should be conducted in an inclusive way. In Box 2 we introduce the foundations of a decision-making framework specifically tailored to gauge the suitability of species to be brought back to urban environments. We suggest that the criteria by which species are assessed should encompass the following five dimensions: cultural value, social acceptability, conservation significance, ecological feasibility and economic viability (Figure 2a). We believe these dimensions reflect the minimum set of high-level societal foci required to ensure that the major facets of a species suitability are included and, just as important, the values, preferences, beliefs, voices and aspirations of all stakeholders are meaningfully considered. The cultural-value dimension is critical to guarantee that the decision-making process accounts for the plurality of worldviews present in many urban environments. In Australian cities, for example, the cultural-value dimension serves to represent Indigenous stakeholders' voices and aspirations, which, as described in the previous section, would drive the decision-making towards securing the selection of culturally and therefore place-specific local, native species. We note, though, that the context of each urban environment should determine the appropriate formulation of cultural-value criteria given the beliefs of the corresponding co-occurring worldviews. The social acceptability dimension seeks to capture any physical and mental health concerns, both real and perceived, associated with species that could be brought back into cities, as well the perceived attractiveness and charisma of species. The conservation-significance dimension recognizes expected synergies between bringing nature back into cities and strategies designed to protect threatened species. This synergy will play a crucial role for threatened species with ranges that overlap with the footprint of urban areas (Ives et al., 2016; Soanes & Lentini, 2019). The ecological feasibility dimension considers how knowledge about species interactions, both with each other and with the environment, can be used to explore the likely success of potential bringing nature back actions. The economic viability dimension acknowledges that BNB actions need to be financially sustainable, that invested resources are compatible with current and predicted economic constraints and that the ecosystem service benefits that could potentially be provided by targeted species are considered.

When fully operationalized as a quantitative-based tool, and appropriately parameterized in a relevant spatio-temporal context, we contend that this framework could help solve complex decision-making problems related to the return of nature to cities. By providing high-level dimensions that reflect the plurality of societal domains and worldviews, and means to weight criteria according to stakeholders' priorities, the framework offers a platform for inclusive decision-making. Beyond this, the flexibility of assessment criteria, mapping, scoring and weighting embedded in the framework allows decision-makers to explore a diversity of outcomes. For individuals there is a case for contemplating altruistic action and discovering decision pathways not directly aligned with their own preferences. For organizations, there is a case for supporting decisions that respect the perspectives of all pertinent worldviews. Our framework provides an urgently needed decision-making platform for individuals, communities and organizations seeking to meet the challenges of BNB.

2.3 | Ecology in action

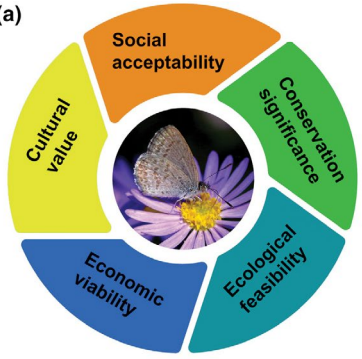
How can individuals, communities and organizations set about returning nature to cities? We draw attention to the range of urban sustainability actions that were initially designed to deliver benefits to people and which have now evolved to also or primarily support biodiversity. For instance, nature-based solutions such as urban forests, green roofs and bio-swales, initially conceived to address economic revitalization, amenity provision, energy efficiency, storm water management and heatwave mitigation, amongst other types of social and environmental concerns, have been increasingly infused with ecological thinking to provide food resources and habitat

BOX 2 Bringing nature back into cities decision-making framework

The framework is based on the assessment of one or more species being considered for a potential BNB action on a series of qualitative and quantitative criteria. The problem of deciding which species to bring back, where S alternative species are assessed by C criteria, can be described by a S × C decision matrix (Figure 2b). Each matrix element X_{ij} represents the performance of species *i* on criterion *j*. Criteria assessments, which begin as answers to hypothesis-driven questions, are mapped by mathematical and logical functions that transform the original numerical values and categorical levels into a predetermined scoring system. Crucially, each criterion can be independently weighted to account for their relative importance within the decision-making process. Once the criteria assessment, mapping and weighting stages have been completed, the sum of scores for each species can be ranked and compared, revealing the top-scoring species.

We include in our example a non-native species to highlight how the framework can also work to trade-off species targeted for BNB actions against other types of actions which would result in the movement of species outside their native range. Examples of the latter include cases in which non-native species may be introduced to (a) boost the delivery of priced ecosystem services such as pollination and pest control (e.g. bumblebees into continental Australia); (b) satisfy the preferences of recent migrants (e.g. gardening practices that add non-native culinary herbs into residential gardens) and (c) execute ex-situ conservation programmes (e.g. translocation of Western Australian threatened plant species into Victorian botanic gardens).

(a)



(b)



			A: Butterfly		B: Dragonfly		C: Social bee	
		Species:						
		Origin:	Indigenous to bioregion		Indigenous to bioregion		Non-indigenous to bioregion	
		Status:	Locally extinct		Locally rare		Common	
Criteria	**Variable**	**Mapping**	**W%**	**Value**	**Weighted score**	**Value**	**Weighted score**	**Value**	**Weighted score**
Is the species locally indigenous to the area?	Species indigenuity (Yes/No)	Yes → 100 No → 0	51	Yes	51	Yes	51	No	0
Does the species have the potential to cause human injury?	Incidence ratio (Injuries/Population)	0 → 100 0.00–0.01 → 80 0.01–0.02 → 60 0.02–0.03 → 40 0.03–0.04 → 20 >0.05 → 0	19	0	19	0	19	0.02	15
Will expanding the threatened species' range into the targeted urban environment contribute to the species core conservation strategy?	Conservation synergy (Yes/No)	Yes → 100 No → 0	5	Yes	5	No	0	No	0
Are the disturbance factors that drove the species to local extinction still present?	Disturbance factors (Yes/No)	No → 100 Yes → 0	15	No	15	No	15	No	15
How much will it cost per annum to provide new, suitable habitat for the targeted species?	Habitat cost (m$/year)	0 → 100 0.00–0.01 → 80 0.01–0.05 → 60 0.05–0.20 → 40 0.20–0.50 → 20 >0.50 → 0	10	0.02	6	0.04	6	0	10
		Score			**96**		**91**		**40**

FIGURE 2 (a) The five dimensions: cultural value, social acceptability, conservation significance, ecological feasibility and economic viability of our bringing nature back into cities decision-making framework. (b) A developed hypothetical example of the framework as applied to three species under consideration for an action aimed at bringing nature back in the context of a continental Australian city and its associated Traditional Owners: a butterfly (Indigenous, locally extinct), a dragonfly (Indigenous, locally rare) and a social bee (Non-native, not currently present). For simplicity only one criterion is included for each dimension. In the 'Mapping' column, elements to the left of the arrow indicate the corresponding variable levels, while elements to the right indicate the score to which they map to (the score range is set to range from 0 to 100). The W% (weighting) column gives the weight as a percentage given to each criterion

BOX 2 (Continued)

Within the cultural-value dimension, the key criterion answers the question 'Is the species locally indigenous to the area?'. Decision-makers wishing for the action to fall within the BNB framework and therefore honour the Indigenous-worldview preference embedded within this framework would then map 'yes' to the maximum prescribed score, and 'no' to zero, and assign the relative criterion weight to >50%. This formulation generates a scoring system that guarantees that evaluated indigenous species score higher than non-indigenous ones. Importantly, the asymmetrical valuation generated amongst indigenous species is not imposed on the Indigenous perspective but attributable only to the remaining, non-Indigenous dimensions of the framework.

Within the social-acceptability dimension, criteria will be typically formulated as 'Does the species have the potential to cause human death, disease or injury?'. An incidence ratio could be used to determine the probability of occurrence of a given condition in the targeted population within a given period, which could then be mapped to the agreed scoring system. Other relevant criteria, such as 'How charismatic is the species?' or 'Can the species act as a flagship species?', could be assessed through charisma proxies, for example, by ranking species-specific public donations to NGO conservation campaigns (Smith, Veríssimo, Isaac, & Jones, 2012) or, alternatively, by applying research findings from human preferences studies based on market research techniques (Macdonald et al., 2015).

An example criterion with which the conservation-significance dimension could be assessed is 'Will expanding the threatened species' range into the targeted urban environment contribute to the species core conservation strategy?'. Mapping this and other similar criteria would need to carefully consider how the range expansion could contribute to demographic parameters such as reproduction and survival, while accounting for potential detrimental effects of the expanded urban range acting as an evolutionary trap.

Within the ecological feasibility dimension, criteria will be typically formulated as 'Are the disturbance factors that drove the species to local extinction still present?'; 'If the targeted species is strictly dependent on other known species either through mutualistic or antagonistic interactions for its long-term persistence, are those species present?'; 'How many of the species' habitat requirements are met?' and 'Does the species have the potential to be translocated into the targeted range?'. These criteria could be assessed and mapped through literature-based data, for example, information on the translocation success rate of the same or similar taxa in other areas, net increase in required habitat or estimated prey abundance. Another possibility would be to use expert elicitation (McBride et al., 2012), particularly when knowledge from past empirical studies is not available, and new studies are not a practical or viable option.

Within the economic viability dimension, criteria would be typically formulated to capture the cost and benefit trade-offs associated with the BNB action under consideration; for example, 'How much will it cost per annum to provide new habitat, or alter the management regime of existing, suitable habitat for the targeted species?' and 'Which benefits could the targeted species generate in the form of ecosystem services?'. The availability of financial resources across time should be carefully considered, setting a minimum standard to secure the success of the BNB action in the long term.

refugia for non-human species in cities (Dover, 2015; Lepczyk et al., 2017; Madre, Vergnes, Machon, & Clergeau, 2013).

We argue that their design could be further adapted to concomitantly foster the return of locally indigenous species. For example, stream renaturalization projects, which are traditionally engineered to improve the ecohydrology of urban rivers (Neale & Moffett, 2016), could also be designed to facilitate the return of rare and locally extinct riparian species or provide new suitable habitat into which these species may be translocated. Likewise, green roofs of high structural complexity—those with multiple vegetation strata, including, for example, mosses, succulents, herbs and shrubs—have been reported to provide habitat for numerous indigenous insect and spider species, including rare taxa associated with locally extinct ecosystems occurring at present outside the studied urban areas (Madre et al., 2013). This latter example highlights how green roof design may be specifically tailored to promote the self-mediated dispersal of arthropod species from remnant habitats back into urban environments. Ecological principles that promote the return of indigenous species into cities also permeate the practice of *Gardens for Wildlife* programmes (e.g. G4W program in Knox, Australia; Mumaw, 2017), *urban meadows* (e.g. Meadow Bristol project in Bristol, United Kingdom; City of Bristol, 2019) and Indigenous-led regenerative placemaking events (e.g. The Living Pavilion in Melbourne, Australia; Beer et al., 2019; Figure 3a). These and other similar initiatives led by 'community gardens' and 'friends of parks' groups (Krasny & Tidball, 2015), and Indigenous scholars and practitioners, embody the way in which individuals, communities and organizations can contribute to the return of locally indigenous species to our cities.

Another suite of actions could be designed to bring back multiple trophic levels simultaneously. This is an important approach, as multitrophic richness and abundance is known to drive ecosystem multifunctionality (Soliveres et al., 2016). For instance, plant palettes initially conceptualized for thermal comfort, water retention or greening objectives may be rethought to promote certain interspecific interactions. An intimate knowledge of who interacts with whom, that is, of the intricate network of ecological interactions linking organisms in a given spatio-temporal context, is needed to inform multitrophic

FIGURE 3 (a) The Living Pavilion was a recyclable, biodegradable, edible and biodiverse event space that took place at the University of Melbourne, Australia. It was an Indigenous-led platform for revealing and celebrating past, current and future ecologies as well as hosting events and performances by local Indigenous and non-Indigenous leaders, artists, knowledge-sharers and scientists. (b) The kaka parrot *Nestor meridionalis*, which was successful reintroduced to the urban ecosanctuary Zealandia, has colonized and is thriving in adjacent urban areas of Wellington, New Zealand. (c) An indigenous sweet bee (*Lasioglossum* sp.) collecting pollen from the non-native cape dandelion *Arctotheca calendula* in a patch of disturbed inner-city public lawn in Melbourne, Australia. (d) The residential apartment buildings of the project 'Bosco Verticale' (vertical forest) in Milan, Italy is an example of how architects are responding to the challenge of providing habitat for plants and animals in urban environments. (e) A group of citizen scientists recording plant–pollinator interactions in one of Westgate Park's (Melbourne, Australia) 'Pollinator Observatories', as part of the park's reconnecting with nature programme. (f) Members of the public engaging with 'Refugium', an ecoscenography participatory event that created a bush refuge for people and other species in the heart of Melbourne, Australia. The event included workshops to make 'kokedamas', a technique consisting of wrapping plants in moss and string to transform them into sculptural art pieces

level actions (Harvey, Gounand, Ward, & Altermatt, 2017; Memmott, 2009; Tylianakis & Morris, 2017; Figure 4a). While we are aware that constructing accurate ecological networks remains an unresolved impediment to the wider uptake of network approaches (Jordano, 2016; Morales-Castilla, Matias, Gravel, & Araújo, 2015), we hope that future studies will undertake the challenge of better understanding how species interact in space and time across fragmented urban landscapes. Until then, the structure of urban ecological metanetworks will remain largely unknown, as well as our ability to predict how actions aimed at BNB scale up to influence the link between network structure and ecosystem function at the level of a whole city.

An additional promising pathway to bring nature back into cities may be to adapt translocation programmes, originally envisaged to improve the conservation status of threatened species (Seddon et al., 2014), to reintroduce species into urban environments. Indeed, a few successful reintroductions of threatened

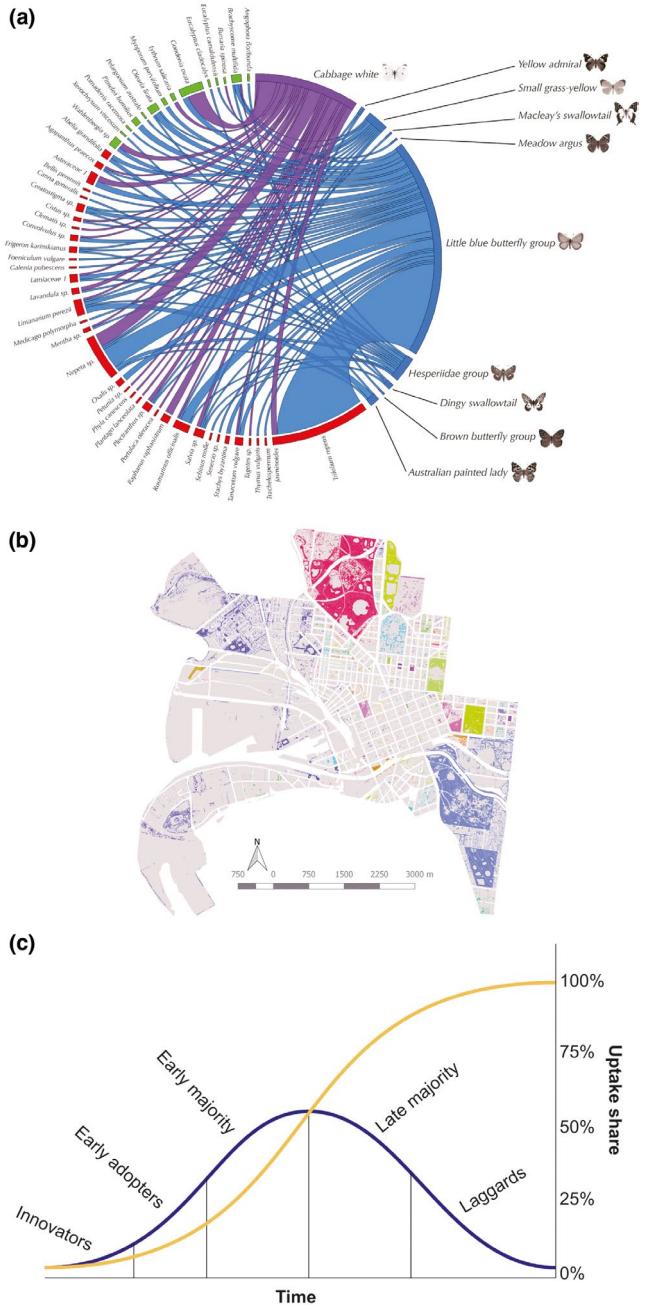


FIGURE 4 (a) A chord plot representing a city-wide metanetwork of interactions between flowering plants and adult butterflies (adapted from Kirk et al., 2017). (b) A map representing city-wide functional connectivity for insect pollinators, where each colour represents a patch of connected suitable habitat (adapted from Kirk et al., 2018). (c) A schematic representation of the diffusion of innovation theory, where the blue line represents the time at which different groups uptake a hypothetical innovative action and the yellow line how the innovation is increasingly uptaken over time (adapted from Rogers, 2003)

species have already occurred in urban environments; for example, at least nine animal species have been reintroduced into urban areas in which they had been previously locally extinct (Martell, Englund, & Tordoff, 2002; Recio, Payne, & Seddon, 2016; van Heezik & Seddon, 2018). Similarly, plant species and communities may be brought back into urban environments through restoration and rehabilitation approaches (McDonald, Gann, Jonson, & Dixon, 2016); for example, as many as 38 projects have been implemented across 20 cities in New Zealand with the objective of restoring vegetation cover by planting or reintroducing indigenous plant species (Clarkson & Bylsma, 2016; Clarkson & Kirby, 2016). Another exciting opportunity to bring locally extinct species back into cities is the potential spillover effects of reintroduction actions conducted within predator-free, fenced urban ecosanctuaries such as Zealandia in Wellington, New Zealand and Mulligans Flat in Canberra, Australia. For instance, reintroduced individuals of kaka, an endangered arboreal parrot reintroduced into Zealandia in 2002 (Figure 3b), have been documented foraging beyond the exclusion fence into the adjacent patches of suitable habitat within Wellington's urban matrix (Recio et al., 2016).

With the increasing recognition of how habitat loss and isolation can erode the stability of metapopulations and metacommunities (Hanski & Ovaskainen, 2000; Thompson, Rayfield, & Gonzalez, 2017), our attention is directed to habitat connectivity. We emphasize the pressing need to understand how the persistence of species with small or threatened populations within urban environments can be maintained and boosted by actions aimed at connecting suitable but isolated habitat patches. Theoretical advances highlighting the benefits of increasing habitat connectivity (Thompson et al., 2017) are only starting to be taken up by practitioners. For example, the Bee Highway project in Oslo, Norway was specifically designed to establish a biodiversity corridor to improve connectivity for urban bees (Polinatorpassasjen, 2019). At present, however, our knowledge of ecological connectivity in urban areas is constrained by geographically and taxonomically biased research and limited use of state-of-the-art genetic and biotelemetry techniques (LaPoint, Balkenhol, Hale, Sadler, & Ree, 2015). We argue that our capacity to imbue ecological connectivity principals into BNB actions could benefit from a more detailed understanding of the dispersal capabilities of species across urban environments and of the landscape elements acting as barriers or generating resistance to dispersal, and of how to best prioritize the selection of well-connected habitat patches.

Finally, we examine the idea of novel resource use. In urban environments, species are likely to utilize novel resources when the city (a) provides resources analogous to those found in native habitat, (b) provides novel resources that help ameliorate the effects of habitat change and (c) alters biotic interactions that previously limited an environment's suitability (Kennedy, Lach, Lugo, & Hobbs, 2013; Valentine et al., 2020; Figure 3c). From the perspective of BNB, the reintroduction of peregrine falcons into urban environments in the United States provides an example of how species may utilize novel food (non-native rock doves) and nesting (tall buildings) resources (Tordoff & Redig, 2001). Understanding the mechanisms by which species interact with novel resources, and the consequences of these interactions, is still in its infancy, but it is anticipated that these interactions will help shape how species survive (Becker, Streicker, & Altizer, 2015) and evolve (Thompson, Rieseberg, & Schluter, 2018) in cities.

2.4 | Uptake of innovative bringing nature back actions

Are the benefits of taking part in BNB actions obvious to everyone? While an emergent cluster of individuals, communities and organizations are leading the design and implementation of innovative actions that foster the return of nature to urban environments, many stakeholders remain either unaware or sceptical of the benefits potentially provided by these actions, requiring more time and/or information to eventually become adopters of these innovations. A common problem for all stakeholders interested in fully realizing the potential of BNB is then to understand how to best speed up the uptake of each ongoing or planned action.

This problem is by no means unique to the uptake of innovative BNB actions. Indeed, it can be outlined in terms of the diffusion of innovation theory—the study of the mechanisms, rates and patterns by which new ideas are adopted by the members of a social system (Rogers, 2003). As posited by this theory, adapters of innovation can be grouped into five main categories: innovators, early adopters, early majority, late majority and laggards, reflecting the increasing time at which the innovation is uptaken (Figure 4c). Diffusion of innovation theory has been applied extensively across the sciences (Haider & Kreps, 2004), including biodiversity conservation (Mascia & Mills, 2018). In our view, the opportunities offered by the methodological approaches derived from this theory would lend themselves well for use by BNB researchers and practitioners.

For example, 'Gardens for Wildlife' programmes (Mitchell, 2017; Mumaw, 2017), seeking to incentivize residential gardeners to use indigenous plant species known to attract indigenous insect and bird species that have become rare in a given neighbourhood, may wish to identify community members who are already enthusiastic about veering their gardening practices towards indigenous plants. The early identification and prompt incentivization of these 'champion' residents may play a key role in securing that planned wildlife gardening actions diffuse successfully throughout the targeted community—thus securing that the programme reaches critical mass and becomes self-sustainable in the long-term. We are optimistic that future research will contribute to elucidate the pathways leading to innovative BNB actions to be efficiently diffuse across urban populations and the mechanisms driving the uptake of these actions by all relevant stakeholders.

2.5 | Engaging with built-environment professionals

Can the non-green components of cities provide resources for non-human species? Bird-friendly windows, roof-cavity roost designs, nesting bricks, wall crevices, intertidal pits and subtidal holes are some of the ways through which architects, engineers, developers and planners are considering non-human species in the design of urban infrastructure (Browne & Chapman, 2011; Francis, 2010; Gunnell, Murphy, & Williams, 2013; Strain et al., 2018). At present, however, we contend that these and other similar innovations remain on the periphery of architectural, engineering, development and planning culture, and continue to be seen as impractical and often far-fetched by most built-environment practitioners. Notwithstanding, these concepts are gaining attention for their potential to contribute to the return of nature into cities, as the interest to BNB becomes more ingrained in sustainability and biodiversity conservation agendas. Not unexpectedly, built-environment professionals around the world are increasingly exploring the potential of buildings (Figure 3d), road, bridges, drains, seawalls and piers to provide key ecological resources that may foster the return of rare and locally extinct species into urban areas.

We draw attention to the Billion Oyster Project (2019) as an outstanding example of how built-environment professionals and scientists, along with educators, schoolchildren, volunteers and industry and government partners, are collaborating to bring back the Eastern oyster *Crassostrea virginica* to New York Harbor. To date more than 25 million oysters have been planted throughout sites across the harbour's urban shoreline, with the most recent evaluation indicating that, while most individuals are yet to achieve maturity and the population in general has not yet become self-sustainable, oyster growth is healthy and promising (McCann, 2018). This and other related actions encouraging the return of intertidal and tidal marine biodiversity to urban shorelines (Strain et al., 2018) are highlighting how BNB actions can deliver a wide range of positive ecological (e.g. improved water quality, carbon sequestration and nutrient cycling) and social (e.g. reconnecting people with their shoreline and the non-human species that share it with them) outcomes.

The potential to increase the benefits that non-green infrastructure can have for BNB, and positive interactions between human and non-human species is substantial. The picture is thus still incomplete—without further investigation into avenues such as those described above, built-environment professionals risk perpetuating attitudes that are detrimental for nature in cities. We invite architects, engineers, transport experts, developers and other urban design and planning practitioners to assist non-human species beyond green infrastructure, and encourage clients, research institutions and local governments to support them in doing so.

2.6 | Evaluating the success of bringing nature back actions

Are actions to bring nature back into cities working? We advocate for the pressing need to understand, quantify and qualify the multiple benefits of BNB actions. One approach could be to establish city-wide networks of study sites to assess socio-ecological baselines prior to actions, and then track how the benefits accrue over and beyond the life span of projects using, for example, before-after-control-impact experimental designs (Smith, Orvos, & Cairns, 1993; Conner, Saunders, Bouwes, & Jordanet, 2016). We believe this

approach may provide opportunities to study how BNB actions are implemented and, if successful, to elucidate how and why. Critically, it sets robust pathways for BNB projects to support evidence-based practice, policy and decision-making.

From the ecological perspective, we foresee that analytical methods specifically designed to forecast probability statements about demographic rates, for example through the use of integrated population models (Kéry & Schaub, 2012), will be key to assist decision-makers weight the action effectiveness of alternative bringing species back scenarios (e.g. how many individuals can be brought back given alternative budgets). Likewise, harnessing the theoretical advances of ecological network science (Kaiser-Bunbury & Blüthgen, 2015; Memmott, 2009), to quantify, for example, the before and after structure of mutualistic and antagonistic networks, is an available pathway that may provide the necessary evidence that urban ecosystems into which species and communities have been brought back are evolving towards desired states (Kaiser-Bunbury et al., 2017).

These methodological approaches—where the change of key population and ecosystem indicators is measured across time—will help to understand the timeframes involved for the putative benefits of BNB actions to become manifest and when the maximum benefits are realized. Regarding the fundamental question about how long to monitor in order to collect robust data, we side with the call for long-term studies (>10 years) as a minimum standard to provide unequivocal insights into the nature of complex ecological systems (Lindenmayer et al., 2012), and highlight as an example the exceptional long-term urban ecology research being conducted by the US Long Term Ecological Research (LTER) programme (Hobbie, Carpenter, Grimm, Gosz, & Seastedt, 2003).

2.7 | Overcoming barriers and addressing concerns

While the interest in BNB is salient amongst many researchers, professionals, government officials and community members, we argue that solutions need to be carefully considered to address concerns of practitioners, regulatory bodies, animal-welfare groups and members of the public about potential risks and disservices associated with actions to bring nature back into cities. We believe the strongest push-back could come from regulatory bodies worried about risks and hazards, environmental groups concerned about animal welfare and members of the public who find urban nature unpleasant.

The prospect of being able to overcome these unenthusiastic reactions to BNB serves as an incentive to consider available mitigation protocols and spur future research in areas where knowledge is currently lacking. For example, actions to bring rare or locally extinct indigenous species back will need to be prudently designed to mitigate, and eliminate when possible, the risk of species falling into evolutionary traps (Robertson et al., 2013). Another promising, albeit long-term, pathway with the potential to shift negative attitudes and behaviours regarding nature in cities (e.g. towards reintroducing species perceived as unpopular or a nuisance) may be to engage people in initiatives that harness the benefits of interactions between people and nature in cities (Hosaka, Sugimoto, & Numata, 2017), such as citizen science (Dickinson et al., 2012; Figure 3e) and ecoscenography (Beer, Fu, & Hernández-Santín, 2018; Figure 3f) participatory approaches.

3 | OUTLOOK

We have outlined seven distinct but interconnected perspectives that may serve to inform and guide individuals, communities and organizations when planning, developing and implementing actions to bring nature back into cities. By touching on the most relevant issues revolving around the theory and practice of BNB—from acknowledging the voices and aspirations of Indigenous stakeholders to suggesting how conceptual, methodological and empirical advances in decision-making, ecology, social science, built-environment professions and complex systems can be put into action—these perspectives embody theoretical innovation and a holistic view. When interwoven together, these perspectives can help outline a transdisciplinary, multi-knowledge system, conceptual framework for interdisciplinary researchers, built-environment professionals, managers, policymakers, community groups and members of the public to sketch, mould and forge actions to encourage the return of a rare locally extinct species back into our urban environments.

Importantly, this framework is a loud call to acknowledge and respect the sovereignty of local and Indigenous knowledge-systems. While many approaches seeking to address urban sustainability and conservation issues might indeed include native species as part of their suite of actions, BNB as delineated here may be contemplated as a framework to bring local and Indigenous culture to the fore. At the same time, we envision that our perspectives, and the framework that arises from them, illustrate promising pathways to solve the pending issue of how to conceptualize and implement BNB actions and projects that support evidence-based practice, policy and decision-making.

Finally, we are motivated by the idea that our perspectives and emerging framework may provide stimuli and encouragement for a diverse array of end users—from individuals to large organizations—to think creatively about the multiple ways in which rare and locally extinct species can be brought back into urban environments. From pop-up parks to creating new, permanent habitat, from reshaping the connectivity architecture of metropolitan-wide green space networks to conceptualizing large eco-engineering projects, from designing every aspect of a building to be hospitable for species other than humans to seeding a single seed of a locally extinct indigenous plant species in a residential garden—these are some of the actual and imaginable ways by which researchers, built-environment professionals, community groups and the general public are applying Western, local and Indigenous knowledge to foster the return of native species back into cities. Grounding these and any other potential action to bring nature back with a strong ethical

foundation and striving to provide evidence that their putative benefits are being effectively realized, are fundamental steps to guarantee that BNB objectives and targets continue to be considered by local, regional and global 'Nature in the city' strategies. We believe strongly that BNB has the backbone to become an environmentally just and culturally inclusive dimension of the 21st urban sustainability agenda. Current rates of urbanization, rural to urban migration and species loss make us certain that future generations of urban residents, both of humans and other species, are resolutely relying on it.

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CONFLICT OF INTEREST

The authors have no competing interest to declare.

AUTHORS' CONTRIBUTIONS

All co-authors contributed equally to conceptualize and write the paper. Co-authors are listed alphabetically by first name.

DATA AVAILABILITY STATEMENT

This study did not include any data.

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