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REVIEW

The potential of nature-based solutions to deliver ecologically just cities: Lessons for research and urban planning from a systematic literature review

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Abstract Planning for and implementing multifunctional nature-based solutions can improve urban ecosystems' adaptation to climate change, foster urban resilience, and enable social and environmental innovation. There is, however, a knowledge gap in how to design and plan nature-based solutions in a nonanthropocentric manner that enhances co-benefits for humans and nonhuman living organisms. To address this gap, we conducted a systematic literature review to explore how an ecological justice perspective can advance the understanding of nature-based solutions. We argue that ecological justice, which builds on the equitable distribution of environmental goods and bads, social–ecological interconnectedness, nature's agency and capabilities, and participation and inclusion in decision-making, provides a transformative framework for rethinking nature-based solutions in and for cities. A qualitative analysis of 121 peer-reviewed records shows a highly human-centred worldview for delivering nature-based solutions and a relationship to social justice with no direct reference to the dimensions of ecological justice. There is, however, an underlying recognition of the importance of nonhumans, ecosystem integrity and well-being, and a need to consider their needs and capacities through multispecies nature-based solutions design and planning. We conclude with a discussion of the critical aspects for designing and planning ecologically just cities through nature-based solutions and future research directions to further integrate these fields.

Keywords Capabilities · Cities · Ecological justice · Nature-based solutions · Planning · Urban

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INTRODUCTION

Cities require scalable solutions to deal with climate change, ensuring that new urban developments and infrastructure renewal respond to socioeconomic needs and liveable environments (Kabisch et al. 2016). Many cities have invested in improving urban ecosystems and embracing nature-based solutions for climate adaptation and for improving urban resilience (Kabisch et al. 2016; Pancost 2016; Lafortezza et al. 2018; Frantzeskaki et al. 2019). Nature-based solutions are systemic solutions to the urban environment that are inspired by nature, use nature, strengthen and/or are supported by nature (Frantzeskaki 2019) that are designed to specifically address various environmental challenges through delivery of multiple benefits (Faivre et al. 2017). Recent research on nature-based solutions showcases their potential in climate resilience (Arkema et al. 2017; Hernandez-Morcillo et al. 2018), in cooling cities and dealing with heat island effect (Sun et al. et al. 2012; Ellison et al. 2017; Yang et al. 2018), biodiversity conservation and restoration (Brink et al. 2016; Herzog 2016; Keesstra et al. 2017), improving human health and well-being (Egorov et al. 2018; Kondo et al. 2018), and in transforming places and sense of place in cities (Kabisch and van den Bosch 2017; Frantzeskaki 2019). Nature-based solutions have been advocated and evinced in delivering multiple ecosystem services (Raymond et al. 2017) and as such, being distinguished from grey infrastructure solutions by being multifunctional solutions (Frantzeskaki et al. 2019). In addition to this, multifunctionality serves as an entry point for promoting and advocating for nature-based solutions relevance in cities, where space is limited, and green space is constantly under pressure from development.

The multifunctionality of nature-based solutions is generally understood on two distinct levels. First, the functional performance and measurement of ecosystems, such as nutrient cycling, tree biomass, or material decompositions. Second, the many contributions of nature to humans (Manning et al. 2018), including multiple economical, ecological, and social benefits (Raymond et al. 2017), and responding to environmental/climate and biodiversity plans in cities (Hansen and Pauleit 2014; Hansen et al. 2019). While the former is based on objective measurements, the latter is primarily driven by the values people place on nature. This distinction is important to discussions of justice, because understanding multifunctionality of nature-based solutions is directly related to who benefits and how they benefit.

In both of these approaches, it is assumed that nature-based solutions automatically lead to socially just results (Haase 2017). Several scholars argue that nature-based solutions and their scaling can lead to social segregation, displacement, and unequal distribution of benefits for marginalised and disadvantaged groups (Haase 2017; Anguelovski et al. 2018). It is assumed that nature-based solutions, when providing benefits for humans, are also providing benefits for nonhuman nature. Here we refer to nonhuman nature as nonhuman living organisms (Wolch 1996) and ecosystems (Washington et al. 2018). These assumptions, however, are inaccurate and require a better understanding. Nature-based city planning, with its largely human-centred lens, lacks a more integrated approach in its design and implementation processes that supports and enables nonhuman, multispecies representation, and inclusivity (Bush and Doyon 2019; Pineda Pinto 2020). Moreover, planning reform and implementation is an inherently contested process where multilevel political economies shape the translation from justice-based concepts to practical implementation. In this context, planning for multifunctionality becomes a critical planning goal that can connect and be guided by environmental and ecological justice concerns. For nature-based solutions to deliver social–ecological just outcomes, it needs to be assessed first, through a deeper understanding of the synergies and trade-offs of the multiple functions and benefits (Haase 2017; Hansen et al. 2019), and second, by considering different ways of valuing their contributions to humans and nonhumans (Wolch 1996; Stephens et al. 2019; Yaka 2019).

Understanding how nature-based solutions can be delivered from design to implementation is a critical issue for their scaling up and mainstreaming in cities (Andersson et al. 2014; Matthews et al. 2015; Wang and Banzhaf 2018; Hansen et al. 2019). In order to address this, we agree and build on the argument of Engström et al. (2018) and Wang and Banzhaf (2018) that understanding the interconnectedness of social–ecological functions and their co-benefits from an integrated perspective can progress our understanding of their multifunctionality and its design and delivery. With a limited focus on ecological justice within the nature-based solutions literature, we argue for such a perspective as an epistemological reframing for conceptualising and guiding the design and planning of nature-based solutions in cities. An ecological justice perspective extends the community of justice to humans and nonhumans alike. It extends the dimensions of justice to social–ecological processes: *recognition* of social–ecological interactions, *participation* of nature in sociopolitical processes, understanding nonhumans and ecosystems' *capabilities and agency*, as well as in ensuring a fair and equitable *distribution* of benefits to both humans and nonhumans (Schlosberg 2005, 2013; Washington et al. 2018). We further argue that effectuating such a reframing of nature-based solutions can be achieved by incorporating nonhuman nature's agency and noninstrumental valuation through a relational-value focus and multiscalar approaches, improving the ways in which multifunctionality is designed and implemented.

Drawing on these dimensions, this research explores the conceptual and design advancements that an ecological justice perspective brings to research and planning practice of nature-based solutions. Our main research question is: how is an ecological justice perspective informing research and planning of nature-based solutions in cities? We evaluate this question based on a systematic literature review of nature-based solutions and ecological justice. In the following sections, we present the theoretical background, followed by the methodology section. This section describes the systematic review protocol (literature search, screening, identification, and analysis steps). The final sections discuss key findings, critical aspects for bridging nature-based solutions with ecological justice, and implications for future research directions.

THEORETICAL BACKGROUND: ECOLOGICAL JUSTICE

Ecological justice originates within the field of environmental justice. Environmental justice emerged as a grassroots movement. It was constructed from different perspectives primarily concerned with environmental impacts or burdens and the resulting social injustices. These include: the distribution of environmental bads and goods on vulnerable human populations, and unequal exposure to pollutants and climate change-related disasters (Schlosberg 2012; Walker 2012; Shoreman-Ouimet and Kopnina 2015). Some perspectives argue for human rights, right to development and environmental rights (Schlosberg

2012). They include the right not to suffer due to climate change and other environmental harms and impacts (negative rights), the right to flourish and develop in all capacities (positive rights), and the right to an environment that provides the basic needs and services that allow for a healthy life (Low and Gleeson 1998; Schlosberg 2013). Environmental justice was subsequently re-conceptualised along three dimensions critical for understanding justice (Fraser 2007; Walker 2012; Schlosberg 2013): the initial distributional dimension, representation or participation, and recognition.

Ecological justice conceptually builds on the same dimensions of justice (distribution, participation, and recognition), but extends these to the nonhuman living world, and adds a fourth dimension—capabilities. Thus, ecological justice is based on the same foundational notions of environmental justice, but shifts the social/human focus, to one that includes nonhuman nature. Nonhuman nature is thus not just an instrument for delivering social justice, but an entity both in itself and symbiotically linked with human nature. Critically, ecological justice argues that in addressing social injustices it is essential to recognise and understand how nonhumans and ecosystems' equity and protection relates to mitigating environmental impacts on human health and well-being (Washington et al. 2018).

Although the theoretical beginnings of the field of ecological justice were based around the unidimensional notion of justice in terms of the distribution of environmental goods and bads on humans and nonhumans (see Low and Gleeson 1998), some authors argued for a more comprehensive, multidimensional view on ecological justice (Fulfer 2013; Schlosberg 2013; Kortetmäki 2016; Washington et al. 2018). These scholars argued that pursuing environmental justice based on rights and distributional issues alone (societal fairness and equality) limits its application to nonhumans and ecosystems, and interactions between human and nonhuman systems (Schlosberg 2005, 2013). These authors therefore call for ecological justice based on respect-based theory (Low and Gleeson 1998; Baxter 2005; Weston 2012), precautionary approaches (Taylor and Jamieson 2011), and a capabilities or agency-based theory (Nussbaum 2006; Schlosberg 2012; Kortetmäki 2016). These approaches not only consider the rights and fair treatment of human, nonhuman and ecosystems that have been marginalised and neglected, but also that social and ecological systems have the capacity to flourish and exist on their own right (Nussbaum 2006; Schlosberg 2012).

For city planners and dwellers, ecological justice provides a theoretical approach that allows new ways of understanding our territories, decision-making processes, and recognition and awareness of the different players. It reveals invisible networks that shape and modify our territories and ecologies. Ecological justice also seeks the recognition, participation, and acknowledgement of the capabilities of vulnerable and marginalised human and nonhuman communities, and their ecologies (Schlosberg 2005, 2013). The capabilities perspective departs from the idea that all members, human and nonhumans, not only have an intrinsic right to exist, pursue a fulfilling life and be active agents in decision-making processes, but that there is also a recognition of interspecies and intergenerational respect (Page 2007; Weston 2012). Ecological justice aligns with theoretical approaches that propose to dissolve nature–culture dichotomies, arguing for the conceptualisation of humans and nonhumans as part of nature. To define ecological justice, Kortetmäki (2016) and Schlosberg (2013) draw on the principles of recognition of social and ecological interactions, participation in political processes, and the inclusion of nature as an active agent. From a review of the literature in the theory of ecological justice, we outline four main ecological justice dimensions that provide a framework to analyse the nature-based solutions literature for this review.

Distribution, from an ecological justice perspective, is concerned with equitability between human and nonhuman interests when assessing the distribution of environmental bads and goods (Low and Gleeson 1998; Yaka 2019). The impact on nature is not just a residual effect that planning should minimise, but instead treat the same as human interests are cared for.

Recognition is about acknowledging different and diverse, especially vulnerable and marginalised, social and ecological groups and individuals, across multiple scales and within diverse governance structures. A first step in recognising is identifying the relationships, values, and interconnections between ecological processes, humans, and nonhumans (Wolch 1996; Chan et al. 2016; Washington et al. 2018). This then provides a knowledge (infrastructure) base from where synergies and trade-offs can be assessed and evaluated (Wolch 1996; Haase 2017).

Participation refers to the equitable, transparent, legitimate, and empowering collaboration and exchange in decision-making and planning processes. Participation requires the inclusion and recognition of nature's agency in urban policy and planning processes. It further supports the exchange of knowledge and education (Schlosberg 2005; Washington et al. 2018). Recognition and participation, thus, are about emancipating and empowering nature's agency.

Capabilities refers to the abilities that all living beings must have (humans and nonhumans) to live in a state of well-being, with health, integrity, fulfilment, and with access to conditions that are conducive to a flourishing life (Schlosberg 2005, 2013; Nussbaum 2006; Fulfer 2013).

Nature-based solutions planning needs to include a capabilities approach that recognises nonhuman vulnerabilities and needs (Schlosberg 2012; Wienhues 2017), adaptive capacity, and ecosystems' integrity (Kortetmäki 2016). Across cities, the capability of nature to flourish differs as a result of natural conditions and human activity/legacy. Ecological justice in urban development and planning is about ensuring human and nonhumans' capability for well-being is sustained and enhanced.

To facilitate the understanding of this theory, in Table 1 we provide a synthesis of ecological justice's main dimensions. This table summarises selected keywords that are crucial for analysing the literature and understanding how this lens is currently informing, and how it can better inform, nature-based solutions. We used these dimensions and related keywords (Table 1) to analyse the literature and synthesise main lessons (see "Analytical approach (of selected papers)" section).

RESEARCH METHODS

Review approach

Figure 1 summarises our systematic literature review method. The three coding levels to search for papers were: i. terms relating to nature-based solutions and green infrastructure; ii. concept of multifunctionality; and iii. concept of ecological justice and justice dimensions. Following the PRISMA protocol, screening was conducted in successive steps (Liberati et al. 2009). The search in four databases (Fig. 1) generated a total of 1058 journal references. Elimination of duplicates reduced this number to 926. Screening one consisted of reading the titles and abstracts. This yielded 501 records for inclusion. Screening two involved reading the full text of the 501 manuscripts as a first step. This reduced the number of included records to 289. These 289 records were further reviewed through ecological justice's four dimensions to ensure they were being addressed in the literature. This second step finalised with an inclusion of 121 records (inclusion/exclusion reasons provided in Supplementary Material — S1.2 (Table S3)). The 121 papers were qualitatively analysed using NVivo to synthesise concepts and themes. The analysis was guided with the ecological justice keywords identified in Table 1 (see "Analytical approach (of selected papers)" section). A list of the bibliographical references for the final included records can be accessed in Supplementary Material (S1.3 (Table S4)).

Analytical approach (of selected papers)

The selected papers were analysed against ecological justice's main dimensions: participation, recognition, distribution, and capabilities. Specifically, the following question guided the qualitative analysis: How is ecological justice and its dimensions informing nature-based solutions in cities? After a full-text review of the papers, data was categorised through NVivo software and analysed through the main dimensions of ecological justice and the synthesised keywords presented in Table 1. A thematic analysis was conducted to further understand each concept, their

Table 1 Summary of ecological justice theory and keywords used in coding and analysis of the selected papers

Ecological justice dimensions	Definition	Keywords	Sources
Distribution	Human–nonhuman equitability in allocation of environmental goods and bads, ecological functions, and benefits.	Equity, fairness, co-benefits, distribution	Low and Gleeson (1998), Schlosberg (2005, 2013), Washington et al. (2018), Yaka (2019)
Recognition	Identification of social–ecological interconnectedness, value, and interests. Acknowledging, appreciating, respecting, and acting in nature's interest (nature's agency).	Acknowledgment; non(utilitarian), intrinsic, adaptive capacity; flourish; agency; social–ecological interconnectedness	Baxter (2005), Schlosberg (2005, 2013), Strang (2017), Washington et al. (2018), Yaka (2019)
Participation	Inclusion of nature in procedural, decision-making processes, where nature is an active agent, and where humans and nonhumans reciprocate and negotiate in a relational exchange.	Decision-making; dispute resolution; synergies-trade-offs; relational processes	Schlosberg (2005, 2013), Strang (2017), Washington et al. (2018), Yaka (2019)
Capabilities	Ensuring human and nonhumans' well-being capability is sustained and enhanced in accordance to fundamental ecological processes, functions, and structures.	Flourishing; integrity; well-being; health; adaptive capacity	Nussbaum (2006), Fulfer (2013), Schlosberg (2013), Kortetmäki (2016), Washington et al. (2018)

Guiding Research Question:

How is ecological justice and its dimensions informing nature-based solutions in cities?

1. Search terms: "green infrastructure" OR "blue infrastructure" OR "green spaces" OR "nature-based" OR "water-sensitive" AND "multifunctionality" OR "multiple benefits" OR "multiple services" OR "co-benefits" OR "eco* process" OR "eco* function" AND "ecological justice" OR "environmental justice" OR equal* OR fair* OR distribution OR participa* OR recogni* OR capability*

Three levels of coding were used to narrow down the database search. The first level included terms related and/or similar to nature-based and green infrastructure. The second level of search was related to multifunctionality, and the third level consisted of justice-related concepts.

2. Database search: Web of Science, Scopus, Ebsohost, and Proquest Central. These four main databases were selected for their breadth and depth in social sciences, sciences, and related fields of knowledge.

3. Collection of all records in a reference management software.
All records were categorised and organised in Mendeley Desktop Referencing software. These records were accessed and shared by all authors.

4. Screening process: the screening process included an initial screening of titles and abstracts. Through a second screening (full-text reading), only relevant papers were included.

4.1 Screening process 1	# of Records Included
Initial count:	1,058
Included after elimination of duplicates:	926
Included after Screening 1 (reading titles and abstracts):	501
4.2 Screening process 2	
Step 1: reading full texts; included:	289
Step 2: review through the lens of ecological justice's four dimensions (see SM1.2 for exclusion/ inclusion reasons); for final qualitative synthesis:	121

5. Qualitative synthesis through coding and thematic analysis.
For the final phase, 121 records were uploaded to NVivo. This software allowed the coding and identification of themes and concepts with the use of the ecological justice keywords summarised in Table 1.

Fig. 1 Protocol and analytical framework for conducting the systematic literature review (following the methodology outlined by Liberati et al. (2009), Gough et al. (2012)

relationship, and relevance (Braun and Clarke 2006). To have a deeper understanding of the ways in which ecological justice is and/or could be framed in the literature, we used the identified keywords (see Table 1) to search for underlying meanings, assumptions, and similar theoretical approaches. Keywords such as agency, flourishing, integrity, decision-making, social–ecological, and equity provided an analytical lens. In addition to answering the main research question, other important aspects were captured in this review. These aspects included previous identified gaps to assess and deliver multifunctionality, as well as future research directions and/or recommendations. The later was especially relevant as it suggests important elements to consider for the field of nature-based planning.

RESULTS

The review of the literature revealed key findings in relation to understanding how ecological justice is informing

nature-based solutions design, planning, and implementation. Our results reveal three key insights from the literature:

a. Nature-based solutions are framed and evaluated through an anthropocentric lens;
b. Nature-based solutions do not explicitly relate to ecological justice or to its justice dimensions: participation, recognition, distribution, and capabilities;
c. Current research on nature-based solutions recognises the need for inclusive governance and the need to include social–ecological justice perspective/considerations to planning of and with nature-based solutions in cities.

Nature-based solutions are framed and evaluated through an anthropocentric lens

Our review reveals that nature-based solutions are framed and evaluated through an anthropocentric lens. This explains the limited representation of ecological justice in planning for nature-based solutions in cities. This human-centred focus is largely due to a conceptual, planning, and evaluation framework built around an ecosystem services understanding. This leads to a valuation of nature in terms of the services it provides to society, with little recognition of a nonhuman imperative or existence. It is the very focus of 'multifunctionality for whom' that requires a broader perspective in designing, planning, and implementing nature-based solutions in cities. The majority of records focussed on the multifunctional performance of nature-based solutions in terms of the benefits it provides to humans, ranging from economic, to health, recreation, and well-being. Specifically, multifunctionality is seen as a system condition that ensures improvement of quality of life (Selman 2009; Chou et al. 2017), green space quality and provision (Wu et al. 2018), and only to a limited extent, urban ecosystem health (Sinnet et al. 2018). Very rarely were benefits considered for both humans and nonhumans, and none considered them from an ecological justice perspective.

However, several papers highlight this separation of humans from nature, when arguing for a negotiation of ecosystem services and biodiversity protection or conservation. Although there is a broad recognition of the importance of ecological systems and social–ecological dynamics, the discourse remains anthropocentrically centred. Within the many discussions of the multifunctionality of nature-based solutions there was an implicit assumption that delivering nature-based solutions to improve people's health and liveability, also results in benefits to nonhumans and ecosystems (Fenner 2017; Vasseur et al. 2017; Xiang et al. 2017). Even though the generalised definition of nature-based solutions argues for the provision of co-benefits to both humans and nature (Albert et al. 2019), our findings reveal that multifunctionality assessments focus mostly on (how and whether) benefits are delivered to humans. Without the recognition of its intrinsic value, nonhuman nature is not recognised as a direct beneficiary of nature-based solutions multiple benefits (Arias-Arévalo et al. 2018).

Nature-based solutions do not explicitly relate to ecological justice and its dimensions

Our literature review revealed that nature-based solutions do not explicitly relate to ecological justice. Our review also shows a knowledge gap in the science of nature-based solutions. Distribution and participation in the literature had a human-centred focus, with most articles arguing for a fair and equal access to high-quality green space and for the inclusion of diverse, including disadvantaged, groups in planning and decision-making processes. Recognition and capabilities offer more indications as to whose capabilities need to be considered and recognised, in terms of ecosystems and multiple species. The following sections present the main findings in terms of how the literature relates to ecological justice's dimensions (see S1.4 (Table S5) for a synthesis of these findings and all analysed material).

Distribution

Distribution as a matter of distributive ecological justice is scarcely mentioned in the literature. In planning nature-based solutions, distribution is a concept related to the physical distribution of green spaces, infrastructure, or other environmental assets, rather than the distribution of environmental impacts from land use changes on nonhuman nature. Distribution in this sense is related to balancing green space to increase environmental or social justice. Human-centred issues under discussion are justice of socially disadvantaged groups, and equity in access to green urban space in terms of proximity, quantity, and quality (Barbosa et al. 2007; Byrne and Wolch 2009; Al-Kofahi et al. 2019; Boyer et al. 2019). The literature argues that distribution, regarding the allocation and access to high-quality nature-based solutions, requires analysis of participation and user preferences and lower income groups' willingness to participate (Dawes et al. 2018). Byrne and Wolch (2009) propose a deeper unpacking of this unevenness of green space by tracing the social, historical, and political practices in planning, including sources of pollution, user perceptions, demographic, and biophysical characteristics. This 'tracing' offers an alternative to revealing issues of justice in connection to which

disadvantaged and marginalised groups do not have equal access to the multiple benefits offered by green spaces.

Recognition

Recognition of ecological systems, the social and spatial context, and the interconnection of scales are identified as important aspects of nature-based solutions (Gibson and Quinn 2017; Nanda et al. 2018; Woroniecki 2019). The literature argues that recognising the interconnection of scales exposes the interrelationship of social and ecological dynamics and their change through time (Schindler et al. 2016; Leone and Raven 2018). It reveals social–ecological patterns and processes in terms of functional connectivity and interactions (Alexander et al. 2019). Recognition of the social, spatial, and biophysical context can provide vital information for decision-making. This includes acknowledging human dependency on biophysical conditions, considering environmental impacts, ecological functions, as well as nonhuman capabilities (Mukherjee et al. 2015; Konijnendijk van den Bosch 2016; Horta et al. 2018). This needs to be positioned in a multilayered and complex systems view, that needs to be recognised and addressed in order to plan for nature-based solutions.

Participation

Participation is extensively discussed in the reviewed literature. Public and multiple stakeholder engagement is deemed crucial for planning and delivering nature-based solutions. Participation is understood also as the bridge between science and practical or policy relevance (Brink et al. 2016). To achieve participatory processes that deliver sustainability outcomes, methods such as planning with future scenarios through GIS and modelling technology are recurrent in the reviewed literature (Gibson and Quinn 2017; Richards and Friess 2017; Rall et al. 2018; Lanzas et al. 2019; López-Valencia 2019). Planning with future scenarios is promoted as a way to develop alternatives, identify conflicts, synergies and trade-offs, and deliver informed decision-making. Also crucial is the inclusion of different forms of knowledge to ensure equity, transparency, and cultural appropriateness through education and knowledge exchange (Fürst et al. 2014; Kati and Jari 2016). Notwithstanding the prevalence of participation discussions, the inclusion of nonhuman nature in participatory processes is not addressed. A few studies do, however, propose ways to overcome limitations in 'multispecies' participatory processes and issues such as power imbalances, representativeness and misrecognition. For instance, Calcagni et al. (2019) argue that social media platforms are a means to exchange and build knowledge, co-construct cultural ecosystem service values, and potentially assist in the identification and negotiation of ecosystem service synergies and trade-offs.

Capabilities

In addressing nonhuman capabilities, the review reveals a limited understanding of capabilities. Our analysis exposes two main understandings of capabilities. First, a focus on ecosystem capabilities as providing ecosystem services to humans. The health and well-being of ecosystems was considered solely for the quality of services it provides to the urban population (Andersson et al. 2016; Jenerette 2018; Korn et al. 2018; Robinson and Breed 2019). The second understanding relates to how urban ecosystems and other infrastructures' capabilities can be improved to ensure the resilience of people and cities (Wootton-Beard et al. 2016; Verdú-Vázquez et al. 2017; Sinnett et al. 2018). A city's susceptibility to change and shocks and its capacity to recover to an adequate state, is considered to depend on the capability of nature-based solutions to deliver ecosystem services over time (Mussinelli et al. 2018; Bush and Doyon 2019). This understanding of capability is also related to limitations and competition, as nature's capabilities (human and nonhuman) are hindered if there is limited space (Brink et al. 2016; Li et al. 2019), or where cities exhibit considerable variation in natural, climatic, topological, and geological conditions (Artmann and Sartison 2018; Egerer et al. 2018). Thus, one of the challenges in delivering ecologically just cities is competition for limited space and negotiating competing social and ecological values. Several studies, especially those from urban and/or landscape ecology disciplines, focussed on species' and ecosystems' capabilities (Wootton-Beard et al. 2016; Mugwedi et al. 2017; Horta et al. 2018). Considering the health, integrity and adaptive capacity of nature is considered a fundamental component for planning and implementing nature-based solutions in cities.

Current research on nature-based solutions points to implicit recognitions of the need to include ecological justice

This review exposes a shallow recognition of the need to include ecological justice in the design of nature-based solutions. While there is an underlying acknowledgement of ecological justice, there remains a lack of deeper understanding of what an ecological justice perspective means for urban transitions, or what role multifunctional nature-based solutions can play in urban transitions. A number of records highlight the importance of ecological integrity, ecosystem and species' capabilities, and distributional equality and equity in terms of natural resource allocation (Bush and Doyon 2019; Marshal et al. 2019).

This recognition, however, remains superficial, with brief mentions of the importance of addressing issues of ecological justice, but with no further engagement throughout the methodological, analytical, or discussion phases of the research. It is on this basis that we consider a number of studies to have an implicit, rather than explicit ecological justice approach.

Implicit social–ecological recognition

Although there is no specific reference to ecological justice, several studies' underlying approach was based on the recognition of social–ecological interconnectedness (Larson et al. 2013; Vasseur et al. 2017; Winter et al. 2019) and of the importance of studying the ecologies of species and ecosystems to better plan and design (urban) space that allows multiple species to flourish and establish. For instance, by studying birds' feeding preferences, breeding, and nesting sites, and plant-attracting assemblages, Deng and Jim (2017) propose a green-roof design based not on ornamental features, but on a 'naturalistic ecological' habitat that contributes to enriching the ecology of cities. Horta et al's (2018) study of the Toco Toucan's distribution, home range, flight, seed dispersal patterns, and other capabilities, provides a powerful environmental tool for maintaining urban forest patches and creating connected green areas.

Tree capabilities are also expressed as inherent to a species success in adapting to environmental factors. Rarely mentioned capabilities, such as solar tracking, and bending and folding in response to light (Wootton-Beard et al. 2016), highlight the recognition of nonhuman nature's extraordinary capacities. This has implications for how the built environment affects patterns of light and shadows throughout the day. Creating refuges for species to develop their capabilities was also mentioned as a necessary consideration to further deliver urban greenery from an understanding of plants' biology and diversity (Mugwedi et al. 2017; Nero 2019; Tresch et al. 2019). These studies interestingly stand out by offering a noninstrumental strategy that focuses nature-based planning and design based on the functions and capabilities of nonhumans and their supporting ecosystems.

Thus, while the current literature lacks explicit references to ecological justice dimensions, we nevertheless identify 43 papers that retain an implicit ecological justice dimension. These studies, and the respective ecological justice dimensions they are concerned with, are detailed in Table 2.

The implicit ecological justice dimensions highlight critical intersections between ecological justice as an approach to urban transitions and nature-based solutions. In the following section we explore these findings, specifically in finding ways in which nature-based solutions can include nonanthropocentric ways of valuing nature and exploring how the identified interactions between the fields can lead to comprehensive, inclusive, and just ways of designing and implementing nature-based solutions.

DISCUSSION: CRITICAL ASPECTS FOR DESIGNING AND PLANNING ECOLOGICALLY JUST CITIES WITH NATURE-BASED SOLUTIONS

An ecological justice perspective can contribute to diagnosing, exposing, and preventing the social and ecological injustices that play out in the complex and contradictory urban landscapes. As such, it also provides urban planning with a guiding framework for assessing multifunctionality of nature-based solutions. In this part of the paper, we present our reflection from the literature review and analysis.

Based on the above analysis, our proposal is to position ecological justice as a core design principle. This enables a reframing of nature-based solutions as a planning tool for urban transitions and justice. Explicit human and nonhuman design and planning are deliverable through the multifunctionality of nature-based solutions. An ecological justice lens can be institutionalised through a relational-value and multiscalar approach to urban transitions. Such an approach provides guidance for planning priorities, including stakeholder inclusion and co-design principles, identification of functions and co-benefits, and recognition of synergies and trade-offs.

Relational-value approach for designing multifunctional nature-based solutions in cities

The traditional approach to delivering social and ecological outcomes through nature-based solutions' multifunctionality focuses on an instrumental management of ecosystems. A relational-value framing offers a different way of assessing and supporting planning of multifunctional nature-based solutions. Ecological justice argues for nature's agency and intrinsic value; however, the integration of these concepts to the practical character of nature-based solutions requires bridging elements that are more responsive to human-nonhuman relations and the pluralistic values associated with notions living a good life, of justice, reciprocity, and virtue (Chan et al. 2016; Klain et al. 2017). For instance, from an ecosystem services perspective or an anthropocentric perspective, nature is a means to an end (for humans), or servicing humans. In an ecological justice perspective, there is not only a pursuit for equity across human and nonhuman nature, but a

Table 2 Implicit recognition of ecological justice dimensions in the NBS literature (Source: authors)

Nature-based solutions (NBS)	Ecological justice dimensions			
	Distribution	Participation	Recognition	Capabilities
Designing habitat for species to flourish in urban spaces requires studying species' needs, behaviours, and ecologies (Snep and Ottburg 2008; Nielsen et al. 2015; Kajihara et al. 2016; Deng and Jim 2017; Mugwedi et al. 2017; Nero 2019; Talal and Santelmann 2019; Tresch et al. 2019).				●
Capacity of vegetation to flourish despite contamination and lack of fundamental nutrients (Spencer et al. 2014; Artmann and Sartison 2018; Draus et al. 2019).				●
Increasing NBS multifunctionality, flexibility, adaptability, and connectivity can increase 'carrying, adaptive and regenerative capacities of urban landscape systems' (Schlee et al. 2012; Horta et al. 2018; Silver et al. 2019).				●
Social–ecological awareness, perceptions and values within inclusive, democratic, and adaptive governance systems that include and/or represent diverse stakeholders (Larson et al. 2013; Andersson et al. 2014; Burton et al. 2018; Dawes et al. 2018; Mattijssen et al. 2018; Diep et al. 2019).		●	●	
Connecting fragmented urban habitat for species flow, mobility, and functional diversity (Caynes et al. 2016; Cannas et al. 2018; Alexander et al. 2019).			●	●
Nature's integrity in relation to local urban social–ecological patterns and processes (Schlee et al. 2012; Wootton-Beard et al. 2016; Mugwedi et al. 2017; Talal and Santelmann 2019).	●			●
Noninstrumental valuation of cultural and ecological systems (Horta et al. 2018; Bush and Doyon 2019).			●	●
Develop care, stewardship and pro-environmental behaviours through awareness and ecological knowledge of biodiversity and ecological processes in cities to promote biodiversity protection and conservation through multispecies design strategies (Andersson et al. 2014; Gungor et al. 2018; White et al. 2018; Calcagni et al. 2019).		●	●	
Ecosystem integrity through justice, equity and/or power imbalances recognition in design and ecology science exchange processes (Childers et al. 2015; Brink et al. 2016).	●	●		●
Adoption of alternative methods in urban planning to represent and 'give a voice' to nature (Horta et al. 2018; Bush and Doyon 2019).		●	●	
Identify biodiversity and distribution patterns of often neglected ecological processes, systems and/or species that actively contribute to NBS (Schlaepfer 2018; Li et al. 2019; Marshall et al. 2019; Tresch et al. 2019).	●		●	
Multiscalar understanding to unpack the local, regional, and global social–ecological impacts and effects (Chan et al. 2006; Musacchio 2009; Fletcher et al. 2014; Childers et al. 2015; Pezzoli and Leiter 2016).	●		●	
Multiple ecosystem functions and benefits in balancing needs of humans and nonhumans (Chan et al. 2006; Fletcher et al. 2014; Cannas et al. 2018; Draus et al. 2019).			●	●
Spatial distribution of ecosystem services and biodiversity with scenario planning and other tools to identify trade-offs and prioritise conservation areas (Snäll et al. 2016; Dagenais et al. 2017; Fenner 2017; Mandle et al. 2017; Lanzas et al. 2019).	●	●		
Recognise the biophysical baseline of ecosystems as supporting of all life (Andersson et al. 2014; Dobbs et al. 2014; Albert et al. 2017; Tahvonen and Airaksinen 2018).			●	●

recognition of their symbiotic links. A relational-value perspective also recognises the intrinsic value in the relationship between human and nonhuman natures of cities (Yaka 2019). Pluralistic approaches to understanding nature-based solutions, in which relational and intrinsic values are complementarily understood and articulated (Himes and Muraca 2018), are key to enabling the operationalisation of ecological justice. These pluralistic valuation methods expose power imbalances and systemic injustices which reflect the intrinsic relationship and capabilities of human and nonhuman nature (Himes and Muraca 2018). This allows, through actions and policies, the design of multifunctional nature-based solutions that co-benefit and respond to both human and nonhuman nature's needs and capabilities.

We agree with Calcagni et al's (2019) definition of relational approach, which points to the importance of relational values to understand human behaviour within

social–ecological interactions, which embody ideas of justice as reciprocity, distribution, recognition, and procedure. We see implications in our research, in which these ideas have direct implications in the co-construction and negotiation of cultural ecosystem services and allow for the valuation of nature and nonhumans from a noninstrumental perspective (Himes and Muraca 2018). These implications, in turn, extend to the political economy of planning reform and processes. Operationalising relational values is therefore crucial in translating issues of justice into assessments of multifunctionality. In Fig. 2 we propose key nature-based planning and design strategies to operationalise a relational values approach to ecological justice in urban planning.

First, creating a solid foundation of knowledge of ecosystems, biological processes, nonhuman species, and sociocultural differences in multicultural cities is critical. More research on specific species, such as that on the Toco Toucan (Horta et al. 2018), and their roles in the urban landscape, can highlight their critical importance and can make them 'silent' participants in the planning and design processes. For example, work in cities through the lens of pollinators, their needs and relations to human and nonhuman species, has been put into practice across the globe. In Oslo, Norway, people and bees exchange, engage, and relate to improve habitat quality, foraging passages, and food availability (Stange et al. 2018). The planning vision and model developed for Curridabat, a municipality in the metropolitan urban area of Costa Rica, is an example where a city model was developed on the pollinators and other species as 'prosperity agents' and members of the community (Municipalidad de Curridabat 2017). This requires institutionalised ways of translating ecological knowledge, raising awareness, and building social capital that explicitly enhances recognition and participation of nonhuman nature in decision-making processes. In the same vein, the City of Edmonton in Canada regenerated urban water drainage infrastructure prioritising ecological corridors for small animals.

Making relational values part of multifunctionality assessments can assist people in improving their capacity to link biophysical processes to the perception of values and benefits (Fürst et al. 2014). This, however, needs to come from a solid foundation of knowledge on ecosystems, biological processes, nonhuman species, and sociocultural differences in multicultural cities. Promoting values of care and stewardship through restoration and conservation activities in urban landscapes and measuring changes in environmental behaviours and ecological knowledge from those activities can start to include justice issues when planning nature-based solutions. Developing knowledge and skills that link ecological knowledge with peoples' values (Wild et al. 2019), as well as finding ways to operationalise relational values, are strategies to inform multifunctionality assessments of nature-based solutions through an ecological justice lens.

Multiscalar approach to institutionally embed multifunctional nature-based solutions

Assessment of multifunctionality and enhanced outcomes are dependent on scales. Nature-based solutions support

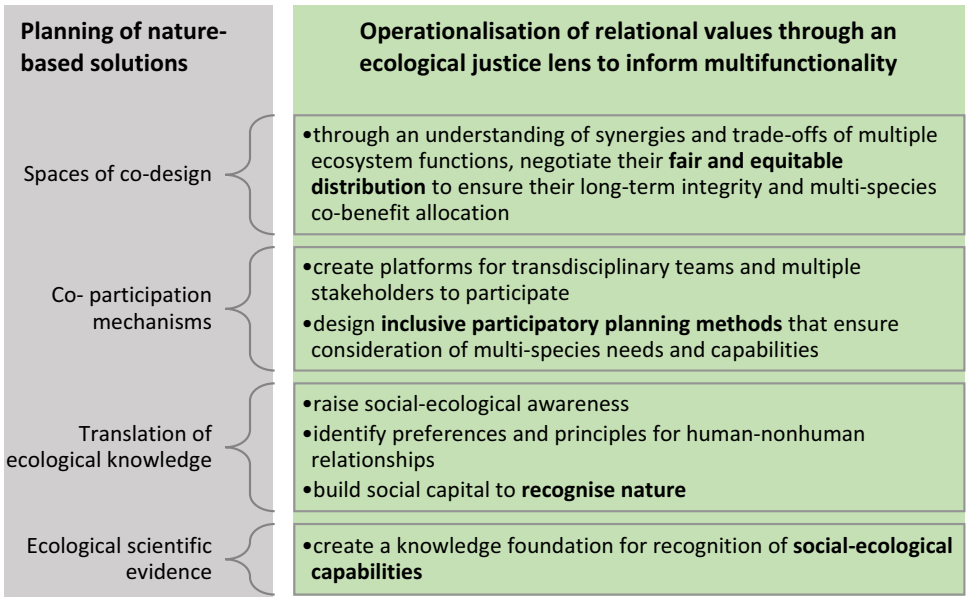

Fig. 2 Key planning and design strategies to operationalise relational values, guided through an ecological justice lens, to inform nature-based solutions' multifunctionality

and restore ecological flows and functions and as such need to be assessed on the multiple ways they deliver on biodiversity and ecosystems' health beyond their immediate place to be (re)considered as urban nature telecouplings (Haase 2019). With this in mind, multifunctionality assessments must be broadened to consider teleconnections and scalability of multiple benefits. Pezzoli and Leiter (2016) argue that sustainability requires the integration of policies and plans at different geographical scales, especially the bioregional scale. A bioregional scale more appropriately addresses the social–ecological interactions and conflicts as it better represents interactions between social, economic, and ecological components (Pezzoli and Leiter 2016).

Understanding local issues needs to be positioned within a larger geographical scale to understand the social, economic and ecological dynamics. In their study of ecosystem service modelling, Grafius et al. (2016) show the assessment of functions is dependent on, and sensitive to, scales. Balancing capabilities and feasibility in small, complex scales is one of the challenges for nature-based solutions (Grafius et al. 2016; Wang and Banzhaf 2018; Hansen et al. 2019). However, an integrated approach to spatial planning that recognises and represents social–ecological systems in a functional (Lafortezza et al. 2013), inclusive, and just way can have more transformative change. This means unpacking the interconnected and interdependent social–ecological dynamics (telecouplings) and their impacts and/or benefits of both humans and nonhumans. The following are two multiscalar considerations that we suggest are critical when planning ecologically just nature-based solutions:

1. Urban mobility should be integrated to nature-based solutions planning as it offers (at local, metropolitan, and bioregional scales) different ways of connecting pathways through social–ecological corridors, coupled infrastructure providing accessibility and new habitats to different people and multiple species, and improving connectivity to nature. This requires considering multispecies' needs in terms of mobility through ecological habitats, the overall ecosystem corridor's health, and integrity to support different uses.
2. Embed circular economy concepts in nature-based planning, which can help to identify solutions based on their levels of exploitation or restoration of ecosystems and considers the cyclical processes and regenerative qualities that create value and multiple benefits for multiple species by improving the capacity of social–ecological systems to close loops and regenerate (Prieto-Sandoval et al. 2018).

An ecological justice perspective for planning nature-based solutions will strengthen and enhance multifunctionality in terms of delivering benefits and addressing the needs and capabilities of both human and nonhuman nature. At the same time, multifunctionality of nature-based solutions can enable ecological justice by considering and bringing together the pluralistic values that reveal systemic injustices. The integration of the multifunctionality of nature-based solutions in planning processes and assessments provides a means of enhancing human and nonhuman capabilities, through ecological knowledge and awareness, recognition, and participation. Being mindful of the risk that multifunctionality of nature-based solutions can become a means of reproducing existing inequities, where effective, it potentially provides a counterbalance to more established political economy processes and moves us a step closer to delivering urban ecological just transitions.

CONCLUSION

The aim of this paper is to understand how an ecological justice perspective is informing research and planning of nature-based solutions in cities. Our systematic literature review reveals that, notwithstanding a growing literature around nature-based solutions and multifunctionality in cities, the literature and practice remains anthropocentric-driven, and lacks an explicit incorporation of ecological justice dimensions. There is, nevertheless, an implicit inclusion of key ecological justice dimensions in some of the literature. These studies enable us to identify intersections between ecological justice as an approach to urban transitions and nature-based solutions that can be institutionalised through relational-value and multiscalar principles. Ecological justice through relational-value and multiscalar principles shifts the basis upon which urban living is planned, developed, and assessed. Nature-based solutions for social justice outcomes will not assess, design, and deliver the same outcomes as nature-based solutions for ecological justice. As Schlosberg (2012, p.447) argues, we require "a framework of justice for the Anthropocene". One that includes the nonhuman dimension.

A key direction for future research is how to recognise the capabilities and needs of nonhuman living beings, and enable space for their participation and agency in decision-making and co-design processes. This can be achieved by enabling transdisciplinary teams working around co-design and co-participatory frameworks, with particular inputs from ecology science throughout the design and decision-making processes. The potential to enhance multifunctionality provided by nature-based solutions is one of the most important research and planning aims for our cities and territories (Ahern et al. 2014). However, it requires evidence-based analyses of ecosystems' long-term integrity

by clearly understanding the links to the multiple functions and benefits from an ecological justice multispecies approach. Key to achieving benefits for both humans and nonhumans are nature-based solutions co-design and planning processes that consider the provision of multiple ecosystem functions fairly and equitably among the many city inhabitants.

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Declarations

Conflict of interest The authors have no competing interests to declare.

REFERENCES

Ahern, J., S. Cilliers, and J. Niemelä. 2014. The concept of ecosystem services in adaptive urban planning and design: A framework for supporting innovation. *Landscape and Urban Planning*. 125: 254–259. https://doi.org/10.1016/j.landurbplan.2014.01.020.

Albert, C., C. Neßhöver, M. Schröter, H. Wittmer, A. Bonn, B. Burkhard, J. Dauber, R. Döring, et al. 2017. Towards a National Ecosystem Assessment in Germany: A plea for a comprehensive approach. *Gaia* 26: 27–33. https://doi.org/10.14512/gaia.26.1.8.

Albert, C., B. Schröter, D. Haase, M. Brillinger, J. Henze, S. Herrmann, S.P. Gottwald, Guerrero, et al. 2019. Addressing societal challenges through nature-based solutions: How can landscape planning and governance research contribute? *Landscape and Urban Planning* 182: 12–21. https://doi.org/10.1016/j.landurbplan.2018.10.003.

Alexander, J., D.A. Ehlers Smith, Y.C. Ehlers Smith, and C.T. Downs. 2019. Drivers of fine-scale avian functional diversity with changing land use: An assessment of the effects of eco-estate housing development and management. *Landscape Ecology* 34: 537–549. https://doi.org/10.1007/s10980-019-00786-y.

Al-Kofahi, S.D., A.A. Gharaibeh, E.Y. Bsoul, Y.A. Othman, and R.S. Hilaire. 2019. Investigating domestic gardens' densities, spatial distribution and types among city districts. *Urban Ecosystems*. 22: 567–581. https://doi.org/10.1007/s11252-019-0833-7.

Andersson, E., S. Barthel, S. Borgström, J. Colding, T. Elmqvist, C. Folke, and Å. Gren. 2014. Reconnecting cities to the biosphere: Stewardship of green infrastructure and urban ecosystem services. *Ambio* 43: 445–453. https://doi.org/10.1007/s13280-014-0506-y.

Andersson, K., S. Dickin, and A. Rosemarin. 2016. Towards "sustainable" sanitation: Challenges and opportunities in urban areas. *Sustainability* 8: 1289. https://doi.org/10.3390/su8121289.

Anguelovski, I., J. Connolly, and A.L. Brand. 2018. From landscapes of utopia to the margins of the green urban life: For whom is the new green city? *City* 22: 417–436. https://doi.org/10.1080/13604813.2018.1473126.

Arias-Arévalo, P., B. Martín-López, and E. Gómez-Baggethun. 2018. Exploring intrinsic, instrumental, and relational values for sustainable management of social-ecological systems. *Ecology and Society*. https://doi.org/10.5751/ES-09812-220443.

Arkema, K.K., R. Griffin, S. Maldonado, J. Silver, J. Suckale, and A.D. Guerry. 2017. Linking social, ecological, and physical science to advance natural and nature-based protection for coastal communities. *Annals of the New York Academy of Sciences*. https://doi.org/10.1111/nyas.13322.

Artmann, M., and K. Sartison. 2018. The role of urban agriculture as a nature-based solution: A review for developing a systemic assessment framework. *Sustainability*. https://doi.org/10.3390/su10061937.

Barbosa, O., J.A. Tratalos, P.R. Armsworth, R.G. Davies, R.A. Fuller, P. Johnson, and K.J. Gaston. 2007. Who benefits from access to green space? A case study from Sheffield, UK. *Landscape and Urban Planning*. 83: 187–195. https://doi.org/10.1016/j.landurbplan.2007.04.004.

Baxter, B. 2005. *A Theory of Ecological Justice*. New York: Routledge, Ebook Central (Proquest).

Boyer, A.-L., E. Comby, S. Flaminio, Y.-F. Le Lay, and M. Cottet. 2019. The social dimensions of a river's environmental quality assessment. *Ambio* 48: 409–422. https://doi.org/10.1007/s13280-018-1089-9.

Braun, V., and V. Clarke. 2006. Using thematic analysis in psychology. *Qualitative Research in Psychology* 3: 77–101. https://doi.org/10.1017/CBO9781107415324.004.

Brink, E., T. Aalders, D. Adam, R. Feller, Y. Henselek, A. Hoffmann, K. Ibe, A. Matthey-Doret, et al. 2016. Cascades of green: A review of ecosystem-based adaptation in urban areas. *Global Environmental Change*. 36: 111–123. https://doi.org/10.1016/j.gloenvcha.2015.11.003.

Burton, V., M.J. Metzger, C. Brown, and D. Moseley. 2018. Green Gold to Wild Woodlands; understanding stakeholder visions for woodland expansion in Scotland. *Landscape Ecology*. https://doi.org/10.1007/s10980-018-0674-4.

Bush, J., and A. Doyon. 2019. Building urban resilience with nature-based solutions: How can urban planning contribute?'. *Cities*. https://doi.org/10.1016/j.cities.2019.102483.

Byrne, J., and J. Wolch. 2009. Nature, race, and parks: Past research and future directions for geographic research. *Progress in Human Geography* 33: 743–765. https://doi.org/10.1177/0309132509103156.

Calcagni, F., A.T.A. Maia, J.J.T. Connolly, and J. Langemeyer. 2019. Digital co-construction of relational values: Understanding the role of social media for sustainability. *Sustainability Science*. https://doi.org/10.1007/s11625-019-00672-1.

Cannas, I., S. Lai, F. Leone, and C. Zoppi. 2018. Green infrastructure and ecological corridors: A regional study Concerning Sardinia. *Sustainability (Switzerland)*. https://doi.org/10.3390/su10041265.

Caynes, R.J.C., M.G.E. Mitchell, D.S. Wu, K. Johansen, and J.R. Rhodes. 2016. Using high-resolution LiDAR data to quantify the three-dimensional structure of vegetation in urban green space. *Urban Ecosystems*. 19: 1749–1765. https://doi.org/10.1007/s11252-016-0571-z.

Chan, K.M.A., P. Balvanera, K. Benessaiah, M. Chapman, and S. Díaz. 2016. Why protect nature? Rethinking values and the environment. *PNAS* 113: 1462–1465. https://doi.org/10.1073/pnas.1525002113.

Chan, K.M.A., M.R. Shaw, D.R. Cameron, E.C. Underwood, and G.C. Daily. 2006. Conservation planning for ecosystem services. *PLoS Biology* 4: https://doi.org/10.1371/journal.pbio.0040379.

Childers, D.L., M.L. Cadenasso, J.M. Grove, V. Marshall, B. McGrath, and S.T.A. Pickett. 2015. An ecology for cities: A transformational nexus of design and ecology to advance climate change resilience and urban sustainability. *Sustainability*. 7: 3774–3791. https://doi.org/10.3390/su7043774.

Chou, R.-J., C.-T. Wu, and F.-T. Huang. 2017. Fostering multifunctional urban agriculture: Experiences from the champions in a revitalized farm pond community in Taoyuan, Taiwan. *Sustainability (Switzerland)*. https://doi.org/10.3390/su9112097.

Dagenais, D., I. Thomas, and S. Paquette. 2017. Siting green stormwater infrastructure in a neighbourhood to maximise secondary benefits: Lessons learned from a pilot project. *Landscape Research.* 42: 195–210. https://doi.org/10.1080/01426397.2016.1228861.

Dawes, L.C., A.E. Adams, F.J. Escobedo, and J.R. Soto. 2018. Socioeconomic and ecological perceptions and barriers to urban tree distribution and reforestation programs. *Urban Ecosystems.* 21: 657–671. https://doi.org/10.1007/s11252-018-0760-z.

Deng, H., and C.Y. Jim. 2017. Spontaneous plant colonization and bird visits of tropical extensive green roof. *Urban Ecosystems* 20: 337–352.

Diep, L., D. Dodman, and P. Parikh. 2019. Green infrastructure in informal settlements through a multiple-level perspective. *Water Alternatives.* 12: 554–570.

Dobbs, C., C.R. Nitschke, and D. Kendal. 2014. Global drivers and tradeoffs of three urban vegetation ecosystem services. *PLoS ONE*. https://doi.org/10.1371/journal.pone.0113000.

Draus, P., S. Lovall, T. Formby, L. Baldwin, and W. Lowe-Anderson. 2019. A green space vision in Southeast Michigan's most heavily industrialized area. *Urban Ecosystems.* 22: 91–102. https://doi.org/10.1007/s11252-018-0765-7.

Egerer, M.H., S.M. Philpott, P. Bichier, S. Jha, H. Liere, and B.B. Lin. 2018. Gardener well-being along social and biophysical landscape gradients. *Sustainability* 10: 96. https://doi.org/10.3390/su10010096.

Egorov, A.I., P. Mudu, M. Braubach, and M. Martuzzi (eds.). 2018. *Urban green spaces and health: A review of evidence*. Copenhagen: World Health Organization.

Ellison, D., C.E. Morris, B. Locatelli, D. Sheil, J. Cohen, D. Murdiyarso, V. Gutierrez, M. van Noordwijk, et al. 2017. Trees, forests and water: Cool insights for a hot world. *Global Environmental Change.* 43: 51–61. https://doi.org/10.1016/j.gloenvcha.2017.01.002.

Engström, R., M. Howells, U. Mörtberg, and G. Destouni. 2018. Multi-functionality of nature-based and other urban sustainability solutions: New York City study. *Land Degradation and Development* 29: 3653–3662. https://doi.org/10.1002/ldr.3113.

Faivre, N., M. Fritz, T. Freitas, B. de Boissezon, and S. Vandewoestijne. 2017. Nature-based solutions in the EU: Innovating with nature to address social, economic and environmental challenges. *Environmental Research* 159: 509–518. https://doi.org/10.1016/j.envres.2017.08.032.

Fenner, R. 2017. Spatial evaluation of multiple benefits to encourage multi-functional design of sustainable drainage in Blue-Green cities. *Water (Switzerland)*. https://doi.org/10.3390/w9120953.

Fletcher, T.D., G. Vietz, and C.J. Walsh. 2014. Protection of stream ecosystems from urban stormwater runoff: The multiple benefits of an ecohydrological approach. *Progress in Physical Geography* 38: 543–555. https://doi.org/10.1177/0309133314537671.

Frantzeskaki, N. 2019. Seven lessons for planning nature-based solutions in cities'. *Environmental Science & Policy* 93: 101–111. https://doi.org/10.1016/j.envsci.2018.12.033.

Frantzeskaki, N., T. McPhearson, M.J. Collier, D. Kendal, H. Bulkeley, A. Dumitru, C. Walsh, K. Noble, et al. 2019. Nature-based solutions for urban climate change adaptation: Linking science, policy, and practice communities for evidence-based decision-making. *BioScience* 69: 455–466. https://doi.org/10.1093/biosc/biz042.

Fraser, N. 2007. Re-framing justice in a globalizing world. In *(Mis)recognition, Social Inequality and Social Justice : Nancy Fraser and Pierre Bourdieu*, ed. T. Lovell, 1st ed., 17–35. Routledge.

Fulfer, K. 2013. The capabilities approach to justice and the flourishing of nonsentient life. *Ethics & the Environment.* 18: 19–42.

Fürst, C., P. Opdam, L. Inostroza, and S. Luque. 2014. Evaluating the role of ecosystem services in participatory land use planning: proposing a balanced score card. *Landscape Ecology* 29: 1435–1446. https://doi.org/10.1007/s10980-014-0052-9.

Gibson, D.M., and J.E. Quinn. 2017. Application of anthromes to frame scenario planning for landscape-scale conservation decision making. *Land*. https://doi.org/10.3390/land6020033.

Gough, D.A., S. Oliver, and J. Thomas. 2012. *An Introduction to Systematic Reviews. Systematic Reviews*. London: SAGE.

Grafius, D.R., R. Corstanje, P.H. Warren, K.L. Evans, S. Hancock, and J.A. Harris. 2016. The impact of land use/land cover scale on modelling urban ecosystem services. *Landscape Ecology* 31: 1509–1522. https://doi.org/10.1007/s10980-015-0337-7.

Gungor, B.S., J. Chen, S.R. Wu, P. Zhou, and G. Shirkey. 2018. Does plant knowledge within urban forests and parks directly influence visitor pro-environmental behaviors. *Forests*. https://doi.org/10.3390/f9040171.

Haase, A. 2017. Nature-Based Solutions to Climate Change Adaptation in Urban Areas. In *Nature-Based Solutions to Climate Change Adaptation in Urban Areas Linkages between Science, Policy and Practice*, ed, Kabisch, N., Korn, H., Stadler J., and A. Bonn, 221-236. Cham: Springer.

Haase, D. 2019. Urban Telecouplings. In *Telecoupling,* ed, C. Friis, and J. Ø. Nielsen, 261–280. Cham: Palgrave Macmillan. https://doi.org/10.1007/978-3-030-11105-2_14.

Hansen, R., A.S. Olafsson, A.P.N. van der Jagt, E. Rall, and S. Pauleit. 2019. Planning multifunctional green infrastructure for compact cities: What is the state of practice? *Ecological Indicators* 96: 99–110. https://doi.org/10.1016/j.ecolind.2017.09.042.

Hansen, R., and S. Pauleit. 2014. From multifunctionality to multiple ecosystem services? A conceptual framework for multifunctionality in green infrastructure planning for Urban Areas. *Ambio* 43: 516–529. https://doi.org/10.1007/s13280-014-0510-2.

Hernandez-Morcillo, M., P. Burgess, J. Mirck, A. Pantera, and T. Plieninger. 2018. Scanning agroforestry-based solutions for climate change mitigation and adaptation in Europe. *Environmental Science & Policy* 80: 44–52. https://doi.org/10.1016/j.envsci.2017.11.013.

Herzog, C.P. 2016. A multifunctional green infrastructure design to protect and improve native biodiversity in Rio de Janeiro. *Landscape Design and Urban Biodiversity.* 12: 141–150. https://doi.org/10.1007/s11355-013-0233-8.

Himes, A., and B. Muraca. 2018. Relational values: The key to pluralistic valuation of ecosystem services. *Current Opinion in Environmental Sustainability*. https://doi.org/10.1016/j.cosust.2018.09.005.

Horta, M.B., T. Bhakti, P.F. Cordeiro, S.M. Carvalho-Ribeiro, G.W. Fernandes, and F.F. Goulart. 2018. Functional connectivity in urban landscapes promoted by *Ramphastos toco* (Toco Toucan) and its implications for policy making. *Urban Ecosystems.* 21: 1097–1111. https://doi.org/10.1007/s11252-018-0789-z.

Jenerette, G.D. 2018. Ecological contributions to human health in cities. *Landscape Ecology* 33: 1655–1668. https://doi.org/10.1007/s10980-018-0708-y.

Kabisch, N., and M.A. van den Bosch. 2017. Urban green spaces and the potential for health improvement and environmental justice in a changing climate. In *Nature-based solutions to climate change adaptation in urban areas, theory and practice of urban sustainability transitions*, ed. N. Kabisch et al. Springer: Berlin.

Kabisch, N., N. Frantzeskaki, S. Pauleit, S. Naumann, M. Davis, M. Artmann, D. Haase, S. Knapp, et al. 2016. Nature-based solutions to climate change mitigation and adaptation in urban areas: Perspectives on indicators, knowledge gaps, barriers, and opportunities for action. *Ecology and Society*. https://doi.org/10.5751/ES-08373-210239.

Kajihara, K., Y. Yamaura, M. Soga, Y. Furukawa, J. Morimoto, and F. Nakamura. 2016. Urban shade as a cryptic habitat: Fern distribution in building gaps in Sapporo, northern Japan. *Urban Ecosystems.* 19: 523–534. https://doi.org/10.1007/s11252-015-0499-8.

Kati, V., and N. Jari. 2016. Bottom-up thinking-Identifying socio-cultural values of ecosystem services in local blue-green infrastructure planning in Helsinki, Finland. *Land Use Policy.* 50: 537–547. https://doi.org/10.1016/j.landusepol.2015.09.031.

Keesstra, S., J. Nunes, A. Novara, D. Finger, D. Avelar, Z. Kalantari, and A. Cerda. 2017. The superior effect of nature based solutions in land management for enhancing ecosystem services. *Science of the Total Environment* 610–611: 997–1009. https://doi.org/10.1016/j.scitotenv.2017.08.077.

Klain, S.C., P. Olmsted, K.M.A. Chan, and T. Satterfield. 2017. Relational values resonate broadly and differently than intrinsic or instrumental values, or the New Ecological Paradigm. *PLoS ONE*. https://doi.org/10.1371/journal.pone.0183962.

Kondo, M.C., J.M. Fluehr, T. McKeon, and C.C. Branas. 2018. Urban green space and its impact on human health. *International Journal of Environmental Research and Public Health*. https://doi.org/10.3390/ijerph15030445.

Konijnendijk van den Bosch, C.C. 2016. Tree agency and urban forest governance. *Smart and Sustainable Built Environment.* 5: 176–188. https://doi.org/10.1108/SASBE-07-2015-0017.

Korn, A., S.M. Bolton, B. Spencer, J.A. Alarcon, L. Andrews, and J.G. Voss. 2018. Physical and mental health impacts of household gardens in an urban slum in Lima, Peru. *International Journal of Environmental Research and Public Health* 15: 1751. https://doi.org/10.3390/ijerph15081751.

Kortetmäki, M. 2016. Is broad the new deep in environmental ethics? A comparison of broad ecological justice and deep ecology. *Ethics and the Environment* 21: 89.

Lafortezza, R., J. Chen, C. Konijnendijk van den Bosch, and T.B. Randrup. 2018. Nature-based solutions for resilient landscapes and cities. *Environmental Research* 165: 431–441. https://doi.org/10.1016/j.envres.2017.11.038.

Lafortezza, R., C. Davies, G. Sanesi, and C.C. Konijnendijk. 2013. Green infrastructure as a tool to support spatial planning in European urban regions. *IForest.* 6: 102–108. https://doi.org/10.3832/ifor0723-006.

Lanzas, M., V. Hermoso, S. De-Miguel, G. Bota, and L. Brotons. 2019. Designing a network of green infrastructure to enhance the conservation value of protected areas and maintain ecosystem services. *Science of the Total Environment* 651: 541–550. https://doi.org/10.1016/j.scitotenv.2018.09.164.

Larson, K.L., A. Wiek, and L. Withycombe Keeler. 2013. A comprehensive sustainability appraisal of water governance in Phoenix, AZ. *Journal of Environmental Management* 116: 58–71. https://doi.org/10.1016/j.jenvman.2012.11.016.

Leone, M. F., and J. Raven. 2018. Metodi progettuali multiscalari e mitigazione adattiva per la resilienza climatica delle città TT - Multi-scale and adaptive-mitigation design methods for climate resilient cities. *Techne* 15: 299–310. https://doi.org/10.13128/techne-22076.

Liberati, A., D.G. Altman, J. Tetzlaff, C. Mulrow, P.C. Gøtzsche, J.P.A. Ioannidis, M. Clarke, et al. 2009. The PRISMA statement for reporting systematic reviews and meta-analyses of studies that evaluate health care interventions: Explanation and elaboration. *BMJ* 339: https://doi.org/10.1136/bmj.b2700.

Li, X.-P., S.-X. Fan, J.-H. Guan, F. Zhao, and L. Dong. 2019. Diversity and influencing factors on spontaneous plant distribution in Beijing Olympic Forest Park. *Landscape and Urban Planning.* 181: 157–168. https://doi.org/10.1016/j.landurbplan.2018.09.018.

López-Valencia, A.P. 2019. Vulnerability assessment in urban areas exposed to flood risk: Methodology to explore green infrastructure benefits in a simulation scenario involving the Cañaveralejo River in Cali, Colombia. *Natural Hazards* 99: 217–245. https://doi.org/10.1007/s11069-019-03736-8.

Low, N. and Gleeson B. 1998. Environmental Justice: Distributing environmental quality. In *Justice, society, and nature an exploration of political ecology*, 102-132. New York: Routledge.

Mandle, L., S. Wolny, N. Bhagabati, H. Helsingen, P. Hamel, R. Bartlett, A. Dixon, R. Horton, et al. 2017. Assessing ecosystem service provision under climate change to support conservation and development planning in Myanmar. *PLoS ONE*. https://doi.org/10.1371/journal.pone.0184951.

Marshall, A.J., M.J. Grose, and N.S.G. Williams. 2019. From little things: More than a third of public green space is road verge. *Urban Forestry & Urban Greening*. https://doi.org/10.1016/j.ufug.2019.126423.

Matthews, T., A.Y. Lo, and J.A. Byrne. 2015. Reconceptualizing green infrastructure for climate change adaptation: Barriers to adoption and drivers for uptake by spatial planners. *Landscape and Urban Planning.* 138: 155–163. https://doi.org/10.1016/j.landurbplan.2015.02.010.

Mattijssen, T., A. Buijs, and B. Elands. 2018. The benefits of self-governance for nature conservation: A study on active citizenship in the Netherlands. *Journal for Nature Conservation.* 43: 19–26. https://doi.org/10.1016/j.jnc.2018.01.006.

Mugwedi, L.F., M. Rouget, B. Egoh, S. Ramdhani, R. Slotow, and J.L. Rentería. 2017. An assessment of a community-based, forest restoration programme in Durban (eThekwini), South Africa. *Forests* 8: 255. https://doi.org/10.3390/f8080255.

Mukherjee, S., S. Banerjee, P. Basu, G.K. Saha, and G. Aditya. 2015. *Lantana camara* and butterfly abundance in an urban landscape: Benefits for conservation or species invasion? *Ekológia* 34: 309–328. https://doi.org/10.1515/eko-2015-0029.

Municipalidad de Curridabat 2017. *Plan Estratégico Municipal (PEM).* http://www.curridabat.go.cr/archivos/Plan%20Estrat%C3%A9gico%20Municipal%202018-2022.pdf.

Musacchio, L.R. 2009. The scientific basis for the design of landscape sustainability: A conceptual framework for translational landscape research and practice of designed landscapes and the six Es of landscape sustainability. *Landscape Ecology* 24: 993–1013. https://doi.org/10.1007/s10980-009-9396-y.

Mussinelli, E., Tartaglia, A., Bisogni, L., and Malcevschi S. 2018. The role of Nature-Based Solutions in architectural and urban design. *Techne.* 15:116–123. https://doi.org/10.13128/techne-22112 (In Italian).

Nanda, A.V.V., J. Rijke, L. Beesley, B. Gersonius, M.R. Hipsey, and A. Ghadouani. 2018. Matching ecosystem functions with adaptive ecosystem management: Decision pathways to overcome institutional barriers. *Water* 10: 672. https://doi.org/10.1108/SASBE-11-2014-0057.

Nero, B.F. 2019. *Woody species and trait diversity-functional relations of green spaces in Kumasi*. Ghana: Urban Ecosystems. https://doi.org/10.1007/s11252-019-00835-z.

Nielsen, A.B., M. van den Bosch, S. Maruthaveeran, and C.K. van den Bosch. 2015. Species richness in urban parks and its drivers: A review of empirical evidence. *Urban Ecosystems.* 17: 305–327. https://doi.org/10.1007/s11252-013-0316-1.

Nussbaum, M. 2006. The Moral Sentiments and the Capabilities Approach. In *Frontiers of Justice Disabilities Nationality,*

Species Membership. 408-416, Cambridge: Harvard University Press.

Page, E.A. 2007. Fairness on the day after tomorrow: Justice, reciprocity and global climate change. *Political Studies* 55: 225–242. https://doi.org/10.1111/j.1467-9248.2007.00649.x.

Pancost, R.D. 2016. Cities lead on climate change. *Nature Geoscience* 9: 264–266. https://doi.org/10.1038/ngeo2690.

Pezzoli, K., and R.A. Leiter. 2016. Creating healthy and just bioregions. *Reviews on Environmental Health* 31: 103–109. https://doi.org/10.1515/reveh-2015-0050.

Pineda Pinto, M. 2020. Environmental ethics in the perception of urban planners: A case study of four city councils. *Urban Studies* 57: 2850–2867. https://doi.org/10.1177/0042098019887932.

Prieto-Sandoval, V., C. Jaca, and M. Ormazabal. 2018. Towards a consensus on the circular economy. *Journal of Cleaner Production* 179: 605–615. https://doi.org/10.1016/j.jclepro.2017.12.22.

Rall, E., R. Hansen, and S. Pauleit. 2018. The added value of public participation GIS (PPGIS) for urban green infrastructure planning. *Urban Forestry and Urban Greening*. 40: 264–274. https://doi.org/10.1016/j.ufug.2018.06.016.

Raymond, C.M., N. Frantzeskaki, N. Kabisch, P. Berry, M. Breil, M.R. Nita, D. Geneletti, and C. Calfapietra. 2017. A framework for assessing and implementing the co-benefits of nature-based solutions in urban areas. *Environmental Science & Policy* 77: 15–24. https://doi.org/10.1016/j.envsci.2017.07.008.

Richards, D.R., and D.A. Friess. 2017. Characterizing coastal ecosystem service trade-offs with future urban development in a Tropical City. *Environmental Management* 60: 961–973. https://doi.org/10.1007/s00267-017-0924-2.

Robinson, J.M., and M.F. Breed. 2019. Green prescriptions and their co-benefits: Integrative strategies for public and environmental health. *Challenges* 10: 9. https://doi.org/10.3390/challe10010009.

Schindler, S., F. O'Neill, M. Biró, C. Damm, V. Gasso, R. Kanka, T. Sluis, A. Krug, et al. 2016. Multifunctional floodplain management and biodiversity effects: A knowledge synthesis for six European countries. *Biodiversity and Conservation* 25: 1349–1382.

Schlaepfer, M.A. 2018. Do non-native species contribute to biodiversity? *PLoS Biology*. https://doi.org/10.1371/journal.pbio.2005568.

Schlee, M.B., K.R. Tamminga, and V.R. Tangari. 2012. A method for gauging landscape change as a prelude to urban watershed regeneration: The case of the Carioca river, Rio de Janeiro. *Sustainability*. 4: 2054–2098. https://doi.org/10.3390/su4092054.

Schlosberg, D. 2005. Environmental and ecological justice: Theory and practice in the United States. In *The state and the global ecological crisis*, ed. R. Eckersley and J. Barry, 97–116. Cambridge: The MIT Press.

Schlosberg, D. 2012. Climate justice and capabilities: A framework for adaptation policy. *Ethics & International Affair*. 26: 445–461. https://doi.org/10.1017/S0892679412000615.

Schlosberg, D. 2013. Theorising environmental justice: The expanding sphere of a discourse. *Environmental Politics*. 22: 37–55. https://doi.org/10.1080/09644016.2013.755387.

Selman, P. 2009. Planning for landscape multifunctionality. *Sustainability: Science, Practice, and Policy*. 5: 45–52. https://doi.org/10.1080/15487733.2009.11908035.

Shoreman-Ouimet, E., and H. Kopnina. 2015. Reconciling ecological and social justice to promote biodiversity conservation. *Biological Conservation* 184: 320–326. https://doi.org/10.1016/j.biocon.2015.01.030.

Silver, J.M., K.K. Arkema, R.M. Griffin, B. Lashley, M. Lemay, S. Maldonado, S.H. Moultrie, M. Ruckelshaus, et al. 2019. Advancing coastal risk reduction science and implementation by accounting for climate, ecosystems, and people. *Frontiers in Marine Science* 6: 556. https://doi.org/10.3389/fmars.2019.00556.

Sinnett, D., G. Jerome, N. Smith, S. Burgess, and R. Mortlock. 2018. Raising the standard: Developing a benchmark for green infrastructure. *International Journal of Sustainable Development and Planning*. 13: 226–236. https://doi.org/10.2495/SDP-V13-N2-226-236.

Snäll, T., J. Lehtomäki, A. Arponen, J. Elith, and A. Moilanen. 2016. Green infrastructure design based on spatial conservation prioritization and modeling of biodiversity features and ecosystem services. *Environmental Management* 57: 251–256. https://doi.org/10.1007/s00267-015-0613-y.

Snep, R.P.H., and F.G.W.A. Ottburg. 2008. The "habitat backbone" as strategy to conserve pioneer species in dynamic port habitats: Lessons from the natterjack toad (Bufo calamita) in the Port of Antwerp (Belgium). *Landscape Ecology* 23: 1277–1289. https://doi.org/10.1007/s10980-008-9266-z.

Spencer, B., S. Bolton, and J. Alarcon. 2014. The informal urban communities initiative: Community-driven design in the Slums of Lima, Peru. *International Journal for Service Learning in Engineering*. 9: 92–107.

Stange, E., D.N. Barton, and G.M. Rusch. 2018. A closer look at Norway's natural capital—how enhancing urban pollination promotes cultural ecosystem services in Oslo. In *Reconnecting natural and cultural capital*, eds. M.L. Paracchini, P.C. Zingari, and C. Blasi. Brussels, Belgium: European Commission.

Stephens, A., A. Taket, and M. Gagliano. 2019. Ecological justice for nature in critical systems thinking. *Systems Research and Behavioral Science*. 19: 3–19. https://doi.org/10.1002/sres.2532.

Sun, R., A. Chen, L. Chen, and Y. Lu. 2012. Cooling effects of wetlands in an urban region: The case of Beijing. *Ecological Indicators* 20: 57–64. https://doi.org/10.1016/j.ecolind.2012.02.006.

Tahvonen, O., and M. Airaksinen. 2018. Low-density housing in sustainable urban planning—Scaling down to private gardens by using the green infrastructure concept. *Land Use Policy*. 75: 478–485. https://doi.org/10.1016/j.landusepol.2018.04.017.

Talal, M.L., and M.V. Santelmann. 2019. Plant community composition and biodiversity patterns in Urban Parks of Portland, Oregon. *Frontiers in Ecology and Evolution.*. https://doi.org/10.3389/fevo.2019.00201.

Taylor, P.W., and D. Jamieson. 2011. *Respect for nature: A theory of environmental ethics*. Princeton: Princeton University Press.

Tresch, S., D. Frey, R.-C. Le Bayon, P. Mäder, B. Stehle, A. Fliessbach, and M. Moretti. 2019. Direct and indirect effects of urban gardening on aboveground and belowground diversity influencing soil multifunctionality. *Scientific Reports* 9. https://doi.org/10.1038/s41598-019-46024-y.

Vasseur, L., D. Horning, M. Thornbush, E. Cohen-shacham, A. Andrade, E. Barrow, S.R. Edwards, P. Wit, et al. 2017. Complex problems and unchallenged solutions: Bringing ecosystem governance to the forefront of the UN sustainable development goals. *Ambio* 46: 731–742. https://doi.org/10.1007/s13280-017-0918-6.

Verdú-Vázquez, A., E. Fernández-Pablos, R.V. Lozano-Diez, and Ó. López-Zaldívar. 2017. Development of a methodology for the characterization of urban and Periurban green spaces in the context of supra-municipal sustainability strategies. *Land Use Policy*. 69: 75–84. https://doi.org/10.1016/j.landusepol.2017.08.040.

Walker, G. 2012. *Environmental Justice: Concepts, Evidence and Politics*. New York: Routledge. https://doi.org/10.4324/9780203610671.

Wang, J., and E. Banzhaf. 2018. Towards a better understanding of Green Infrastructure: A critical review. *Ecological Indicators* 85: 758–772. https://doi.org/10.1016/j.ecolind.2017.09.018.

Washington, H., G. Chapron, H. Kopnina, P. Curry, J. Gray, and J.J. Piccolo. 2018. Foregrounding ecojustice in conservation. *Biological Conservation* 228: 367–374. https://doi.org/10.1016/j.biocon.2018.09.011.

Weston, B.H. 2012. The theoretical foundations of intergenerational ecological justice: An overview. *Human Rights Quarterly.* 34: 251–266. https://doi.org/10.1353/hrq.2012.0003.

White, R.L., K. Eberstein, and D.M. Scott. 2018. Birds in the playground: Evaluating the effectiveness of an urban environmental education project in enhancing school children's awareness, knowledge and attitudes towards local wildlife. *PLoS ONE*. https://doi.org/10.1371/journal.pone.0193993.

Wienhues, A. 2017. Sharing the earth: A biocentric account of ecological justice. *Journal of Agricultural and Environmental Ethics* 30: 367–385. https://doi.org/10.1007/s10806-017-9672-9.

Wild, T.C., N. Dempsey, and A.T. Broadhead. 2019. Volunteered information on nature-based solutions—Dredging for data on deculverting. *Urban Forestry and Urban Greening.* 40: 254–263. https://doi.org/10.1016/j.ufug.2018.08.019.

Winter, P.L., P.E. Padgett, L.-A.S. Milburn, and W. Li. 2019. Neighborhood parks and recreationists' exposure to ozone: A comparison of disadvantaged and affluent communities in Los Angeles, California. *Environmental Management* 63: 379–395. https://doi.org/10.1007/s00267-019-01140-3.

Wolch, J. 1996. Zoöpolis. *Capitalism Nature Socialism* 7: 21–48. https://doi.org/10.1080/10455759609358677.

Wootton-Beard, P.C., Y. Xing, R.T.D. Prabhakaran, P. Robson, M. Bosch, J.M. Thornton, G.A. Ormondroyd, P. Jones, et al. 2016. Review: Improving the impact of plant science on urban planning and design. *Buildings.* 6: 48. https://doi.org/10.3390/buildings6040048.

Woroniecki, S. 2019. Enabling environments? Examining social co-benefits of ecosystem-based adaptation to climate change in Sri Lanka. *Sustainability (Switzerland)* 11: 772. https://doi.org/10.3390/su11030772.

Wu, H., L. Liu, Y. Yang, and Z. Peng. 2018. Evaluation and planning of urban green space distribution based on mobile phone data and two-step floating catchment area method. *Sustainability.* 10: 214. https://doi.org/10.3390/su10010214.

Xiang, P., Y. Wang, and Q. Deng. 2017. Inclusive nature-based solutions for urban regeneration in a natural disaster vulnerability context: A case study of Chongqing, China. *Sustainability.* 9: 1205. https://doi.org/10.3390/su9071205.

Yaka, Ö. 2019. Rethinking justice: Struggles For environmental commons and the notion of socio-ecological justice. *Antipode.* 51: 353–372. https://doi.org/10.1111/anti.12422.

Yang, J., D.I.M. Kumar, A. Pyrgou, A. Chong, M. Santamouris, D. Kolokotsa, and S.E. Lee. 2018. Green and cool roofs' urban heat island mitigation potential in tropical climate. *Solar Energy* 173: 597–609. https://doi.org/10.1016/j.solener.2018.08.006.

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