

Concept Paper

From One to Many Natures: Integrating Divergent Urban Nature Visions to Support Nature-Based Solutions in Australia and Europe

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Abstract: Urban nature and ways of protecting, designing and even mimicking natural processes are some of the most popular themes inspiring humanities and natural science studies in different disciplines around the globe. Urban nature, green infrastructure and nature-based solutions are three intertwined concepts. This paper will highlight some of the many visions for urban nature (e.g., four urban natures: native, cultivated, designed/horticultural and spontaneous natures) and interpretations of nature-based solutions. While there are some similarities in the interpretation of urban natures by different disciplines, some significant differences exist. This paper analyses and synthesises knowledge from divergent theoretical concepts of urban natures in Europe and Australia, and the associated ecological concepts of novel and designed ecosystems. The complexity of urban natures and native landscapes has fostered the development of several typologies that often lead to misunderstanding between discipline areas and difficulties with practical implementation, such as in urban planning or landscape design. We argue that differences in interpreting the scope of urban nature are often underlined by the specific socio-political, historical, cultural and ecological contexts of a country or region (e.g., Australia and Europe). By applying an interdisciplinary approach, we explore the concept of urban natures by analysing and synthesising links between different disciplines. A transdisciplinary perspective is an important premise for collaboration between ecological sciences and landscape architecture in many restoration projects, or when social and ecological sciences jointly address societal challenges with the help of nature-based solutions co-created using participatory approaches. The latter highlights the role of transdisciplinary research to link practitioners, policymakers and scientists, helping to engage with citizens and inform design. The analysis of several examples from Europe and Australia allowed us to depict different approaches to existing urban natures and methods of their design, enhancement and conservation. These examples highlight that different urban natures are sources of inspiration for nature-based solutions that can be successfully implemented in contemporary landscape and planning practice.

Keywords: urban nature; green infrastructure; nature-based solutions; native nature; designed nature; spontaneous nature; novel ecosystems; urban biodiversity; many natures



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1. Introduction

Urban nature and ways of preserving, protecting, using, designing and restoring nature are some of the most important research themes in natural science and humanities around the globe. Rapid urbanisation since the mid-twentieth century has precipitated challenges associated with degraded natural biomes, decreasing urban green spaces and reduced human contact with nature. The challenge of maintaining or restoring diminishing urban nature has increased the interest in urban and peri-urban landscapes and various

disciplines seek opportunities for creating a more sustainable urban environment. This paper will highlight some of the many visions for urban nature, concepts that are intended to mitigate the tension between urbanisation, industrialised society and the protection of urban nature. The scope and the interpretation of urban nature is also influenced by specific disciplines (ecology, geography, conservation biology or social sciences) and research that links theory and practice (e.g., urban design and planning, landscape architecture, etc.) when dealing with nature design and conservation.

In general, urban nature is associated with urban greenery (plants) and non-human animals [1]. Geographers, urban designers and urban planners mostly apply the term “urban nature” in a broad sense that includes a wide range of urban green spaces/habitats for different species, for example, urban parks, gardens, forests, wetlands and abandoned industrial lands [2]. For urban planning and policy, a broad approach to “one” urban nature works well since it is applied mostly with reference to open space, large scale urban green infrastructure, master planning and urban greening. However, the complexity of urban nature and its many facets is also recognised by spatial planning policy and practice which must integrate the ecological dimension and, at the same time, address current societal challenges such as climate change, disaster risk reduction, human health, etc. [3–5]. Geographers, urban planners and designers, as well as environmental/sustainability scientists, employ the concept of nature-based solutions (NBS) as a practical tool for transferring cities into nature-positive places by bringing nature to cities and people closer to nature.

Urban nature, green infrastructure and NBS are three intertwined concepts that share similar terminology and visions (Figure 1). The concepts of urban nature and NBS are closely related to the concept of urban green infrastructure, i.e., an interconnected network of different green spaces (natural, seminatural, designed and informal/spontaneous) [6]. Based on the main ideas of green and blue infrastructure, ecosystem services and biomimicry, NBS is a broad concept itself which is an urban design and planning tool for ecologically sensitive urbanism. NBS include several more narrow and practical approaches, such as the ecosystem-based approach, water-sensitive design, urban forest, urban agriculture and biodiverse ecological design [5].

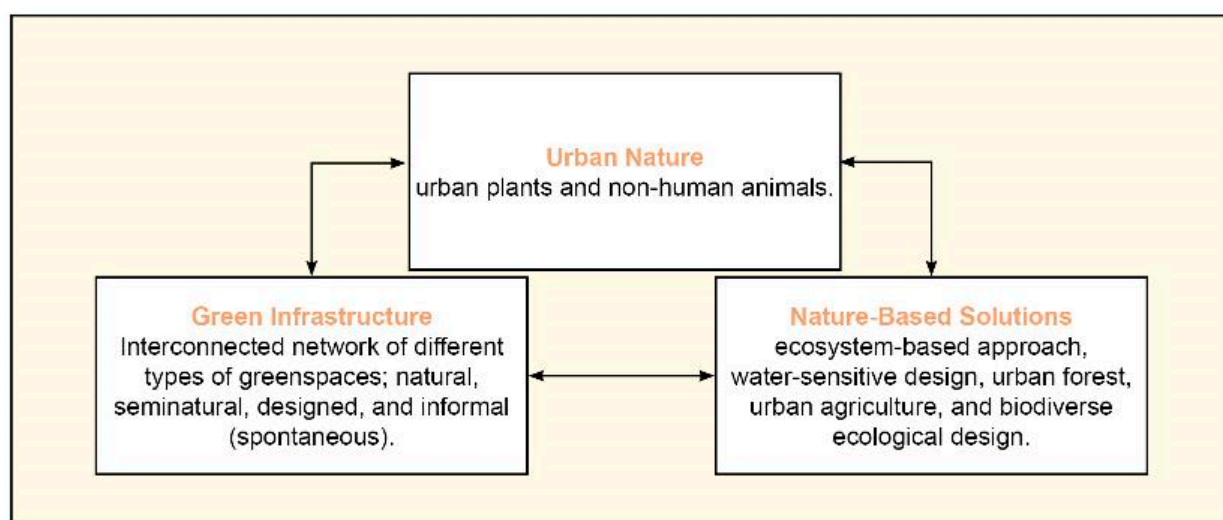


Figure 1. Terminology and connections between urban nature, green infrastructure and nature-based solutions.

Numerous concepts of urban nature have been introduced by ecologists over the last 15 years. German urban ecologist Ingo Kowarik described four natures [7,8]. In parallel to this European vision, Australian and American ecologists working mostly with unique native ecosystems suggested that the concept of novel and designed ecosystems is

based on the intensity of human-induced changes in native ecosystems under increasing anthropogenic pressure [9,10].

Landscape architects, who design and plan urban green spaces, have also reflected on the complexity of urban nature. Designed plant assemblages are plant communities that follow natural processes but are designed using combinations of plantings that reflect socio-cultural demands of society, historical factors, aesthetics and symbolism [6,11]. Landscape architecture works mostly with the concept of three natures [12], but by the end of the twentieth century included spontaneously growing plants as a part of design strategy [13].

Urban ecologists view urban nature through the prism of biodiversity patterns and ecological processes. Ecosystems in cities are highly diverse in size, structure, composition and origins, as well as being fragmented through different types of land use. Urban ecologists also employ concepts and knowledge from the social sciences, acknowledging humans as the primary force of urban ecosystem change [7]. In the past decade, understanding urban biodiversity and its value for human well-being and public health has been one of the major themes in urban ecology and urban design research under the umbrella of “ecosystem services”. This has contributed to creating a particular vision of urban nature as a heterogeneous multifaced phenomenon.

Thus, while there are some general similarities in the interpretation of urban natures by different disciplines, there are significant differences between disciplines and geographic regions. As an example, the original meaning of novel ecosystems introduced by ecologists [9,14] does not correspond with the understanding of “novelty” by other disciplines (e.g., landscape architecture) and in other regions. For example, designed and managed urban green spaces and spontaneous plant communities in urban areas (the most common types of urban plant communities) are not included by ecologists in the scope of novel ecosystems, particularly in countries such as Australia [14], while in other disciplines (and in Europe) the novel ecosystem scope is generally broader. Novelty from an ecologist’s point of view refers to changes in existing biophysical conditions as a consequence of the human-induced degradation of a native ecosystem (e.g., significant changes of the original pool of plants because of invasive species intrusion) and not because of newly designed plant palettes [10]. However, novel ecosystem is a term widely used by landscape architects in relation to designed plant communities.

In the Australian context, NBS from an ecologist’s perspective often refers to the use of native nature with the aim of restoration and conservation. This contrasts with European perspectives where NBS also includes designed and spontaneous nature. Conceptual plurality regarding urban nature between regions and disciplines can inhibit the interdisciplinary collaboration often necessary for achieving common goals and working toward more resilient and sustainable cities. The main goal of this paper is to analyse and discuss the urban nature phenomenon that has been subject to multiple and divergent interpretations influenced by disciplinary background. Here we present the research, analysis, clarification and comparison of different concepts and definitions of urban natures by four disciplines that are most commonly associated with urban nature studies (geography, ecology, urban ecology and landscape architecture), aiming to offer a new research platform for divergent visions and perspectives between disciplines and different countries to work toward a more integrated vision of urban nature.

2. Concepts and Methods

The detailed methodological-analytical framework of this article is presented in Figure 2.

We critically analysed each conceptualisation of nature from four disciplines and compared them by analysing the key scholarly publications that first introduced a particular urban nature concept in a particular discipline, as well as the subsequent scholarly publications that critically reflected and synthesised the given concept. These publications are listed in Table 1 in the “core reference” row. The concepts are discussed in Sections 3–5.

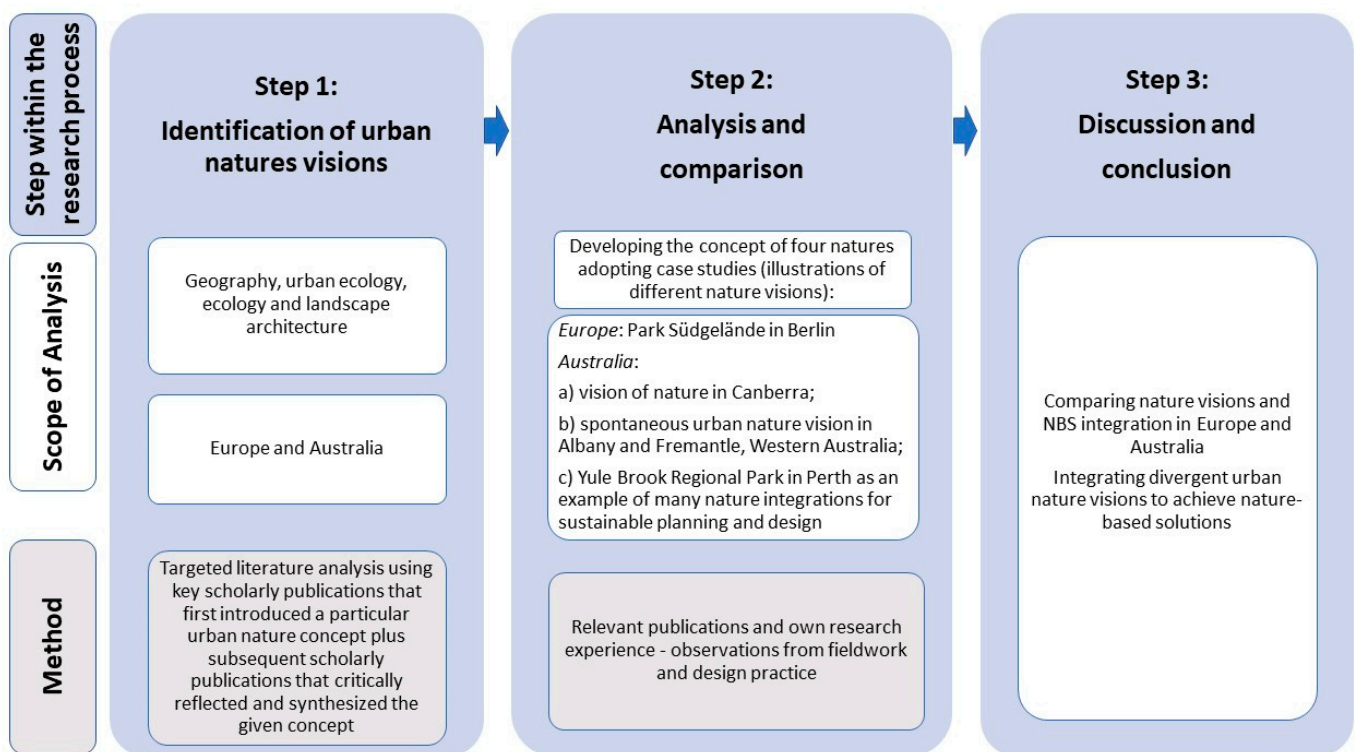


Figure 2. The methodological-analytical framework of this research.

Critical analysis of each type of nature concept is supported by case studies from Europe and Australia. These implemented examples also show how re-greening and designing urban nature using the NBS concept could be successfully executed in modern landscape design and urban planning practice to reintroduce, redesign and redefine urban natures.

In this paper, we analyse and compare the meaning and understanding of different “natures” in Australia and Europe. The differences in geographical and cultural aspects resulted in different visions and interpretations of urban natures. For example, the Australian biota has experienced rapid and dramatic changes since European colonisation. In Australia, at least 60,000 years of unbroken Aboriginal and Torres Strait Islander culture, was ruptured by rapid disturbance and degradation. Imposing European urban and agricultural patterns introduced new biota and specific natures very different from the ancient nature.

This paper has the following structure: it starts with the explanation of three natures’ vision in landscape architecture (Section 3), followed by the discussion of urban nature concepts among ecologists (novel and designed ecosystems developed by R. Hobbs and E. Higgs [9,10,14] and four natures and novel urban ecosystems by I. Kowarik [7,8], Section 4) based mostly on European and some Australian examples. Section 5 is dedicated to the analysis of the vision of urban nature in Australia, which has not been previously discussed in depth from an interdisciplinary point of view. We decided to fill this gap by including a debate on native and designed natures. This section is supported by examples from Canberra (Section 5.3) and Western Australia (Section 5.5), which are based on original ongoing research (recently published works and field observations). The final section argues for the role of NBS in reintroducing, redesigning and reinterpreting urban natures to address societal challenges and provide multiple benefits. It is based on examples from Europe and Australia (Section 6, including Yule Brook Regional Park in Perth).

Table 1. Understanding and scope of urban natures by different disciplines.

| Type of Nature | Disciplines | | | |
|-----------------|--|---|--|---|
| | Geography, Urban Planning | Urban Ecology | Ecology * | Landscape Architecture |
| Nature 1 | Urban nature: Vision as one nature | Native (pre-urban) landscapes | Historic native (pre-urban) ecosystems * If historic native ecosystems are modified by human influence (deliberate or inadvertent) but self-appeared by forces of nature, they are recognised as Novel Ecosystems. New species combinations do not depend on continued human maintenance. | Native (pre-urban) landscapes |
| Nature 2 | Vision as one nature | Agricultural cultivated lands | Abandoned agricultural fields, orchards and plantations reverted back to native ecosystems or into novel ecosystems | Cultivated landscapes (orchards, agricultural fields) |
| Nature 3 | Vision as one nature | Design intervention: combination of plants according to design, e.g., parks and gardens, other types of managed urban green spaces | Designed ecosystems: revegetation/restoration of native ecosystems through design intervention, e.g., green roofs, wetlands, rain gardens | Design intervention. Combination of plants according to design. Garden as an art. Control of nature through maintenance, e.g., parks and gardens |
| Nature 4 | Vision as one nature | Spontaneous industrial and urban nature | Not included but recently considered and acknowledged for ecological novelty | Spontaneous nature included in some landscape designs in the end of 20th century in Europe |
| Core references | [1–3,5] | [7,8,15] | [9,10,14,16] | [12,13,17,18] |

* Note: Though mostly related to non-urban landscapes, these do address anthropogenic factors.

3. From Two to Three Natures in Landscape Architecture

From a European perspective, the agricultural revolution is often seen as a starting point in separating natures, when humans began cultivating food, creating settlements and creating gardens for pleasure. Marcus Tullius Cicero, Roman scholar and philosopher, described “first” nature as a nature unaltered by human efforts and “second” nature as the cultural landscape: “We sow corn, we plant trees, we fertilise the soil by irrigation, we confine the rivers and straighten or divert their courses. In short, by means of our hands we try to create as it were a second nature within the natural world” [12,17]. Cicero’s two natures reflect the horticulture, agriculture and gardening idea that nature can be changed and improved to fulfil human needs.

It is not surprising that the division between natures appeared particularly in Roman times. Pragmatism and a materialistic view of the natural world resulted in native landscapes being seen as something separate and suitable for exploitation by human technological power. Roman poet Publius Papinius Statius (45–96 AD) wrote about the association of “wild” with “unlovely” [19]. In Roman gardens, the concept of beauty was linked with the concept of human ownership of nature. Gardens became a special place for human well-being and pleasure.

Garden historian J.D. Hunt argued that a garden is the “third nature” in contrast to “first” and “second” natures [12]. Hunt’s main argument for a third nature was aesthetic, relating to the capability of artists to shape nature according to physical and spiritual human needs and perceptions. The garden as a “third nature” was a paradise and a symbolic representation of human civilisation and prosperity.

At the same time, the garden is a place for humans to achieve harmony with nature. Landscape architectural history has considered the existence of several natures as being anthropogenically driven where the art and the human skills to transfer natural landscapes into a garden are the main criteria. A gardener’s role is to be a steward of nature (Figure 3).



Figure 3. Gardens with controlled vegetation as a representation of third nature, the symbol of modern civilisation: (a) Villa Lante, 16th century, Italy; (b) garden of the Zwinger Gallery in Dresden, Germany (photos: M. Ignatieva, D. Dushkova).

Gardens and other designed green spaces have often been inspired by surrounding landscapes and natural patterns. Gardens themselves have a dual nature, shaped by both human forces (design and management) and natural forces where living plants follow natural processes [6].

The industrial revolution, post-World War II urbanisation and dramatic degradation of the environment in the twenty-first century pushed landscape architecture to look for new interpretations of nature and integration of concepts and knowledge from different professions. Today most landscape architects recognise ecology and its principles as an important source of knowledge for landscape design [17]. Concepts such as “novel ecosystems” [9,20], “designed ecosystems” [10,16] and “four urban natures” [7,8,15] are among the most debated theories in landscape architecture. Design with Nature [21] and NBS [22] are examples of interpreting ecological processes and re-applying them to landscape planning and design.

4. Emergence of Urban Nature Concepts among Ecologists

Ecologists are interested in exploring native biomes and ways of conserving and restoring them in the face of dramatic natural ecosystems losses as a result of human activities. However, ecologists have focussed on cities only recently by crystallising the field of study referred to as urban ecology. Urban ecology was born in Western Europe where natural landscapes were modified over the history of human settlement. European researchers actively studied urban areas after World War II because of simultaneous destruction and expansion in many cities [7,23]. From this context, urban nature emerged as a heterogeneous and complex phenomenon. This vision of urban nature includes all types of urban biotopes—remnants of native plant communities, semi-natural modified forests, meadows, designed urban parks, small community gardens and abandoned self-grown wastelands, as well as cracks in walls and pavements [1,24]. In Europe, all forms of urban nature are still dominated by native flora.

The ecology of European and North American native biomes is connected to the extensive glaciations of the Pleistocene era (2,580,000 to 11,700 years ago) that dramatically modified the landscape. European native ecosystems developed in the post-glaciation period and experienced numerous natural and human-induced disturbances. Thus, plants developed effective adaptation and recovery mechanisms for disturbed ecosystems. There are many European plants with pioneer (ruderal) strategies that use seed banks to regrow in disturbed areas [18,24,25].

There is a rich history of exotic plant introductions to the European continent. However, due to the character of the landscape, the degree of their naturalisation and biological invasion is still low. For example, according to Müller and Sukopp [26], in Europe,

12,000 plant species have been introduced since 4000 BC and only 2.3% have been naturalised. The succession process has allowed wastelands and disturbed sites to go through recovery stages quickly. Many native pioneer species are present in urban soil seed banks and are able to colonise abandoned or disturbed areas in a relatively short period. Native plants are dominant in natural reserves as well as in disturbed urban areas. In Europe, many urban and agricultural weeds are native, originating from naturally disturbed areas [27].

Increasing human-induced changes in natural systems (e.g., fragmentation, land clearing for future urban development, an increase of invasive species that naturalised in native systems (Figure 4) and declining rare native species) pushed ecologists and nature conservationists to develop a new theoretical vision of urban nature that could explain the complexity of ecosystem dynamics to find more effective ways of protecting and restoring such urban ecosystems.

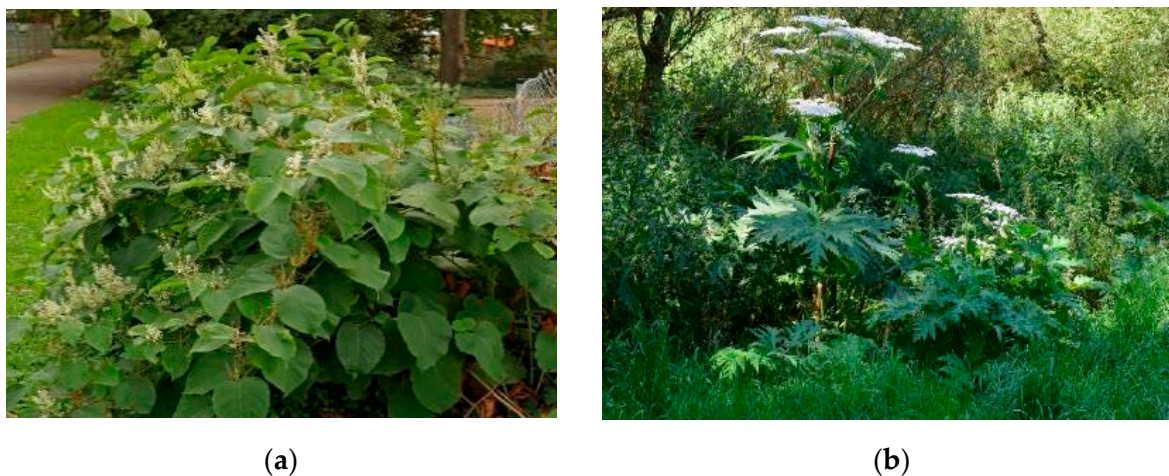


Figure 4. Invasive species in a German city: (a) Japanese knotweed (*Fallopia japonica*) forms toxins in the root area, which weaken and displace other plants, so that many animals that are dependent on this displaced native vegetation also disappear; (b) giant hogweed (*Heracleum mantegazzianum*), in Leipzig’s forest park, plant poisoning from which can cause blindness, allergy and skin irritation (photos: D. Dushkova).

The two most significant concepts—novel ecosystems and four natures—were developed by ecologists almost at the same time in different parts of the world.

4.1. Novel and Designed Ecosystems

“Novel ecosystems” was a term introduced by ecologists Chapin and Starfield in the U.S.A. as an attempt at explaining the dramatic changes in natural ecological systems [20]. Chapin and Starfield investigated the response of the boreal North American forest to current and future climatic changes. For them, novel ecosystems were those that differ in plant composition and function from present and past native systems [20]. Later, this concept was developed further by Australian ecologist R. Hobbs [9] who used “novel ecosystems” for describing significant changes in abiotic factors and species composition resulting from local extinctions (particularly due to exotic invasive species) in native historic ecosystems [9]. Hobbs’s novel ecosystems concept is based on many examples from different natural biomes, including South Africa, New Zealand and particularly Australia. The latter targeted native ecosystems that have experienced dramatic changes since European colonisation. The key feature of the “novelty” is new species combinations and related changes in ecosystem performance as the results of “deliberate or inadvertent human actions” [9] (p. 2). In the southern hemisphere, with its unique native plant communities, novel biotic elements, such as the introduction of invasive species, dramatically changed native landscapes. Hobbs’s novel ecosystems targeted the pathway toward conservation and restoration of native ecosystems, and also raised questions about the value of con-

serving novel ecosystems in their own right. This concept of novel ecosystems questions how far the existing species pool has been affected by changes. It questions whether it is possible (or not) to re-establish and return pre-existing native species assemblages and restore historic ecosystems. Hobbs also questioned how conservation concern should be directed toward novel ecosystems. Novel ecosystems are self-assembled [10] and they show novel qualities without intensive human management [14]. Thus, deliberately designed parks, gardens, cemeteries, playgrounds, sport fields, etc., are not included in the novel ecosystems framework because of their intensive management (Figure 5).



Figure 5. Example of a novel ecosystem in Perth, WA. Nicholson Road Bushland (Bush Forever site 456), Perth, Australia. Native banksia woodland (*Banksia attenuata*) invaded by South African Veldt Grass (*Ehrharta* spp.) changing the pre-existing plant species assemblages (Photo: M. Ignatieva).

The concept of novel ecosystems has continued to develop further [14,28] and has been revised [16,29] and critiqued [30] by several ecologists and conservationists from different countries. One of the main critiques of the concept is the exclusion of urban landscapes in the scope of novel ecosystems, as highlighted by European scholars [7]. For example, modified remnants of native forests or grasslands in Australian cities can be considered “novel ecosystems” but not the created ecosystems in an urban park or private garden.

However, ecologists responsible for developing the novel ecosystem concept have moved toward broadening its scope by acknowledging that the range of urban novel ecosystems may include abandoned demolition and industrial sites and degraded native vegetation fragments in urban areas [31].

Some ecologists have embraced the concept of “designed ecosystems” [10,16] as a step toward recognising the diversity of human-modified landscapes. In Higgs’s vision [10], the main criterion of designed ecosystems is an intentional creation of ecosystems using ecological principles and then sustaining them to serve human interests (ecosystem services). Higgs connects his “designed” ecosystems mostly to restoration ecology precedents (e.g., mining restoration, wetland restoration, agroecological green roofs); however, he has also acknowledged their value for landscape architecture. Here we can see the reference to selected types of urban ecosystems that aim to restore lost native biodiversity (Figure 6).



Figure 6. Biodiverse green roof in London as an illustration of “designed” ecosystems in Higgs’s vision. The main aim here is to restore lost native biodiversity (flowering plants) and associated pollinators (honeybees and other insects) (Photo: M. Ignatieva).

An extended analysis of the novel ecosystems concept conducted by European researchers [32] highlighted that the novel ecosystems concept has mainly focused on non-urban areas and targeted mostly nature restoration and conservation biology audiences. The authors argued that “novel” should also apply to urban areas.

Teixeira et al. [33] argue for the importance of applying these important concepts of “Novel Ecosystems” and “Novel Urban Ecosystems” into landscape architecture to implement the theoretical knowledge of landscape design principles and bridge the gap between theory and practice. This move would encourage landscape architects to understand how to design with natural processes using these concepts and vice versa—for ecologists to see the opportunities of landscape design principles that can be applied for the restoration of urban ecosystems.

4.2. Four Natures and Novel Urban Ecosystems

German urban ecologist Kowarik further developed the concept of “novel urban ecosystems” and “four urban natures” [7,8,15] aimed at biodiversity conservation in the urban environment. Some essential aspects of these four natures overlap with the landscape architecture vision of three natures previously discussed. Some types of nature also correspond with Hobbs’s and Higgs’s visions of novel and designed ecosystems (Table 1).

Kowarik’s “four urban natures” concept is based on urban ecological principles. Urban ecosystems are seen as highly fragmented and heterogeneous due to certain planning and design approaches that created a mosaic of different urban habitats, for example, fragments of native forests and wetlands, parks, railways, industrial areas and abandoned wastelands. The goal of “four urban natures” is to understand the complex mosaic of urban ecosystems, to observe the degree of changes induced by human activity and to recognize that urban nature exists in many forms. Thus, the degree of transformation, gradient of ecological novelty and occurrence of native and non-native species of plants (urban biodiversity) and related “urban wilderness potential” are the pillars of “four urban natures”.

Nature of the first kind includes remnants of original native vegetation within the urban boundaries, landscapes that do not have obvious evidence of human intervention or the presence of technological or industrial development. It can be forests, grasslands or wetlands. Nature of the first kind corresponds with Hobbs’s “historical ecosystems” as well as with the “first nature” of Cicero and garden historian Hunt (Figure 7).



Figure 7. Nature 1. Examples from (a) Berlin-Zehlendorf (Berlin) original forest and (b) Leipziger Auwald (Leipzig), with remnants of floodplain riparian forest (photos: D. Dushkova).

Nature of the second kind is associated with patches of agricultural landscape such as fields and orchards, plant nurseries, managed pasturelands and turf farms or forests created from silviculture. This form of urban nature also parallels well with the “second nature” described by Cicero and Hunt (Figure 8).



Figure 8. Nature 2. Examples from (a) Wörlitz agricultural fields and (b) turf farm within the Perth metropolitan area in Western Australia (photos: D. Dushkova and M. Ignatieva).

Nature of the third kind includes “designed urban greenspaces”. This category is the most complicated and related to the activity of landscape architects, urban planners and horticulturalists who use design intent to combine plants in assemblages using a wide range of native and exotic species. Kowarik’s understanding of nature of the third kind also includes remnants of native vegetation that have been transformed by human activities and those that appeared after the clearance of original habitats as well as the planting of new plant communities (for example, parks and gardens). Therefore, transformed native forests fit within Hobbs’s “novel ecosystems” paradigm. Nature of the third kind partly parallels the “third” nature of Hunt; however, Hunt sees it as a metaphorical representation of the garden—the highest achievement of humans in their search for harmony with nature (Figure 9).

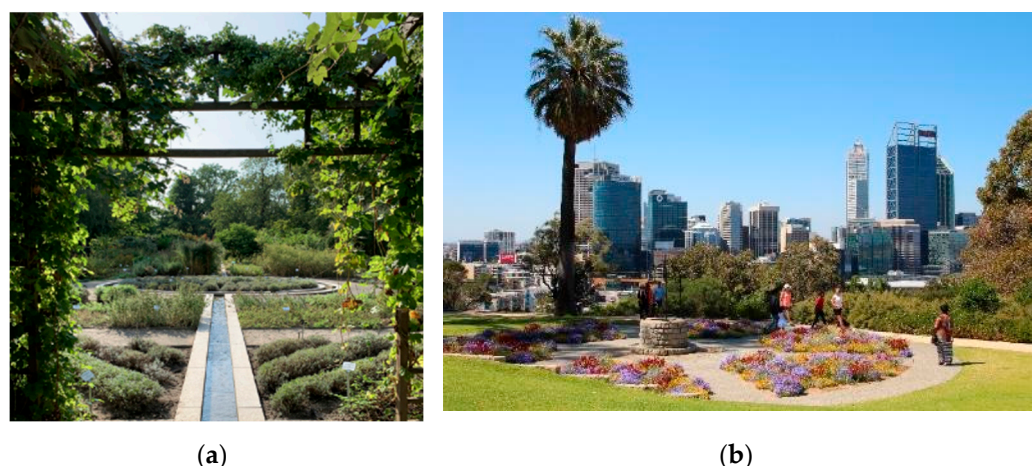


Figure 9. Nature of the third kind. Examples of parks from Europe and Australia: (a) Botanical Garden in Leipzig; (b) Western Australian Botanic Garden at Kings Park in Perth (photos: D. Dushkova and M. Ignatieva).

Nature of the fourth kind includes urban sites such as post-industrial sites, vacant lots and wastelands, where plants spontaneously appear (self-assembled). Kowarik named them “novel wild urban ecosystems” and granted these plant communities a high level of “urban wilderness potential” (almost the same as of the first kind) even though the number of non-native species is often higher than all other types of urban natures. Kowarik also referred to these highly disturbed habitats as “novel ecosystems” because, despite their unique plant assemblages, they follow natural processes (e.g., succession). The introduction of this fourth nature by urban ecologists reflects the dramatic modifications in urban areas and a lack of natural vegetation along with an attempt to search for “wildness” in urban areas. This spontaneous “wild” urban nature has received much attention from European urban ecologists and landscape architects. For example, “spontaneous vegetation” and the “go wild” approach [13,33] aim to contribute to the conservation of biodiversity in urban areas and “novel opportunities for wilderness” [8,18].

Rupprecht et al. [34] analysed research papers related to examples of this fourth nature, such as brownfields, street or railway verges and vacant lots. They found that research related to the biodiversity aspects of “informal urban green space” has increased in the last 15 years. However, spontaneously vegetated spaces were given less attention by ecologists and other researchers compared to naturally vegetated spaces. The interest in this field of research has stemmed from, and been inspired by, the post–World War II era where European cities were full of ruins and disturbed sites for urban botanists and ecologists to explore the potential of spontaneous vegetation that appeared there [13,23,34].

Berlin is considered to be the “cradle” of urban ecology that provides numerous examples of urban ecological innovations and biotope preservation policies in a local context [35]. One of the most famous examples of nature of the fourth kind is the Nature Park Südgelände, an 18-hectare park in the Berlin district of Schöneberg. The park was developed on a former rail yard and railway stations as a result of natural succession after closing the railyard in 1952. In 1999, the park obtained nature and landscape protection status. The park is characterized by the combination of decaying railway facilities, designed pathways and new art installations (Figure 10). The park reflects the significant political, social and physical restructuring after the fall of the Berlin Wall, as well as increasing regrowth of the population. Here, a “wasteland” has become an area of ecological diversity, greenspace access and cultural heritage [36]. This park is often defined as a natural object co-produced by science, politics and public and urban nature (see [35–38]). Other examples of Berlin’s parks where spontaneous processes were the major driven force are Gleisdreieck Park, Nordbahnhof and Tempelhofer Felder. Today, urban nature of the fourth kind is finally an official part of Berlin’s green space network [39,40]. According to the definitions

of many researchers, Nature Park Südgelände can be described as a model of “pure urban nature” [35,41], an example of how perceived vacancy can serve as an opportunity to reimagine what urban nature is [39].



Figure 10. Nature of the fourth kind. Examples from EuropeNature Park Südgelände, Berlin, Germany (a,b) (photos: D. Dushkova).

5. A Vision of Urban Nature in Australia

Compared to Europe, Australian landscapes developed under different environmental and cultural conditions that have led to unique perspectives of urban nature. Human occupation of Australia dates back at least 60,000 years and is associated with a range of landscape and ecological changes over that time [42,43]. Since European colonisation, human impacts have significantly and rapidly removed or modified many native ecosystems [28]. Seddon [27] (p. 12) believed that “No other, highly urbanised and industrial country is as ecologically vulnerable as Australia”. The original plant communities were cleared or modified to give way to new settlements with exotic vegetation based on English planning, architecture and garden styles. Many species introduced through agriculture and horticulture (intentionally and accidentally) and have since been declared invasive. In many urban areas, native Australian plants have not been able to compete with these new arrivals. Thus, many native ecosystems have transformed into new systems (novel ecosystems in Hobbs’s understanding) that are very different from the original native complexes.

5.1. Native Nature

There are many remnants of native nature (forests, shrublands, grasslands and wetlands) that have survived within the boundaries of Australian cities. From the outset of colonial activity, there has been a division between “the bush” (the Australian term for remnant vegetation broadly) and the city, which was “civilised” and “beautified” by familiar lawns, parks and gardens with fruit and decorative plants from the northern hemisphere. Urban settlements were planned and designed according to European canons where nature was neat and freshly green [44]. Andrea Gaynor [45] (p. 66) noted that in Perth, “cultivated and irrigated gardens were understood as the antithesis of (and vastly superior to) indigenous landscapes and cultures”.

Newly created urban nature was associated with lawns and private gardens, sports fields and roadsides [46]. Thus, we can see that historical and socio-cultural conditions have led to the existence of two separate natures: native and designed nature. Designed nature used new assemblages of plants and species that have no similarities to native ecosystems and which are maintained.

In the 1970s, Australia experienced a strong environmental movement that drew attention to the value and conservation of the unique native biodiversity that had dramatically declined and degraded due to accelerated suburbanisation [47]. Consequently,

biologists began to understand the character and the uniqueness of Australian native flora and fauna and the gravity of native ecosystem loss. Today, native ecosystems are important in providing a sense of place and a source of inspiration for environmental design. For example, in Melbourne, the environmental movement to restore and preserve unique native grasslands has grown since the 1980s [44]. The establishment of national funding programs for conservation efforts, such as the National Land Care Program and the National Heritage Trust in the 1990s, coincided with the growth in establishment of a significant number of community-driven organisations focused on native urban nature restoration and preservation activities [48].

A review of scholarly papers on urban ecology and particularly urban biodiversity in Australia revealed that the term “urban nature” relates most often to native nature remnants of native vegetation [49,50]. This vision of native nature corresponds to nature of the first kind as envisioned by Kowarik. Since the late 1990s and early 2000s, ecologists have shown a great interest in understanding pristine and degraded native nature. The novel ecosystem concept was an important point in this process [9,14]. Ecologists have also researched urban remnant patches, for example, research on grassy woodlands along an urban-rural gradient in Melbourne [51] or the change of composition in King’s Park native woodlands in Perth [52]. The idea of bringing nature back into the city aims to return native species and biodiversity (flora and fauna) to the urban environment, where they have disappeared or become rare, and protect them [53]. This goal is achieved through designing new habitats (e.g., restoration of waterways and wetlands) or retrofitting existing urban habitats by planting selected native species in public parks and road verges, etc.

Other important reasons for the focus of Australian urban ecology on remnant native ecosystems are the economic, political, cultural and environmental changes that have occurred since the early 2000s in terms of an increasing awareness of native nature conservation values. For example, Perth, Western Australia, is in one of 35 global biodiversity hotspots and has undergone a dramatic loss of unique endemic banksia woodlands and other native plant communities due to sprawling urbanisation. There has been rising concern over such loss in recent decades as scientific and community awareness has grown [54]. Today, endemic nature is strongly associated with “belonging” to a place and strongly connected to concepts of ecological restoration. This theme has also become an important research pathway among social scientists [55].

5.2. Designed and Managed Nature

Designed nature in Australia, such as lawns and exotic decorative planting in public parks and gardens, has become the subject of public open space (POS). The Western Australian definition and classification of a POS provided by the Department of Local Government, Sport and Cultural Industries is “parklands, play areas, playing fields, bushland, greenways and other similar spaces people use for recreation, sport and social interaction” (<https://www.dlgsc.wa.gov.au/> (accessed on 28 August 2022)). The classification framework was prepared in consultation with urban planners, landscape architects, horticulturalists and managers. Thus, in Australia, POS is mostly the domain of planning, determined as a part of urban infrastructure and managed by local and state governments.

Research related to the designed and managed urban environment is less of a focus for Australian ecologists and conservationists in comparison to those in Europe and the U.S.A. Instead, it is urban planning, landscape architecture and the social sciences who target the provision of ecosystem services, human health and well-being [56]. Since 2010, POS research has also included the mitigation of urban climate change impacts. For example, planted urban forests dominated by a mix of native and exotic species are an important part of mitigating the urban heat islands in Australian cities. Cultivated trees, groves and native remnant forests and woodlands are included in the category of “Urban Forest” or “Urban Tree Canopy” that “provides environmental, social, psychological and recreational benefits in our cities and towns” (<https://www.wa.gov.au/government/document->

[collections/better-urban-forest-planning-perth-and-peel#urban-forest-mapping](#) (accessed on 3 September 2022)).

In Australia, there is currently very little empirical research on the plant biodiversity (native and exotic) or structure and typology of urban parks and other POS. The most dominant element of urban public spaces in Australia is lawn. Lawns, particularly turfs, have been the subject of extensive horticultural research regarding growing commercial turf and maintenance and management practices in public spaces. Only recently have Australian lawns been acknowledged as a part of the urban ecosystem and been researched as an ecological and cultural phenomenon from an inter- and transdisciplinary perspective [46].

Research from the U.S.A. working in urban landscapes similar to Australia, with extended suburbia of private single-residential houses with gardens and public parks, highlights the importance of studying designed urban biotopes (referred to as “cultivated landscapes”) because of their importance for planning sustainable urban ecosystems. For example, Avolio et al. [57] have researched the urban plant diversity of cultivated landscapes in Los Angeles (like Perth, a sprawling Mediterranean city in a biodiversity hotspot) and acknowledged that the biodiversity of urban parks and residential gardens is different from those in natural remnants. Cultivated landscapes are part of urban biodiversity and these spaces need the attention of ecologists. Without studying the composition, structural peculiarities and dynamics of public open spaces, it is impossible to understand urban ecosystems and propose ecologically sensitive design and planning. We suggest calling this type of urban nature (nature of the third kind) “designed and managed nature” [46] (Figure 11).



(a)



(b)

Figure 11. Example of “native” and “designed and managed” urban natures in Perth, Australia (a,b) (photos: M. Ignatieva).

In Australia, native nature and designed and managed nature are treated differently within urban green space policy and practical applications (governmental strategy, design and management strategies) [58]. The initial strategic plan for the Perth Metropolitan Area, Western Australia, in 1955 focused on providing public open space as places for community sport, meaning provision for wide expanses of lawn. For example, the plan stipulated that 85% of the public open space within a suburban area was to be provided as sporting fields [59].

While the range in design of public parks in Perth has expanded to include water management, woody meadows, native habitats and other design options that cater for values beyond recreation, the public preference for designed nature with expanses of lawn for active recreational activities is still strongly evident. This is perhaps drawn from Perth’s active outdoor recreational culture, and perhaps the tradition of Perth’s park planning as influenced by the British Parks movement, where urban parks were designed with the

intention of providing a healthful influence on city dwellers. This meant expanses of lawn, ordered gardens, neat ponds and winding, tree-lined pathways [60,61].

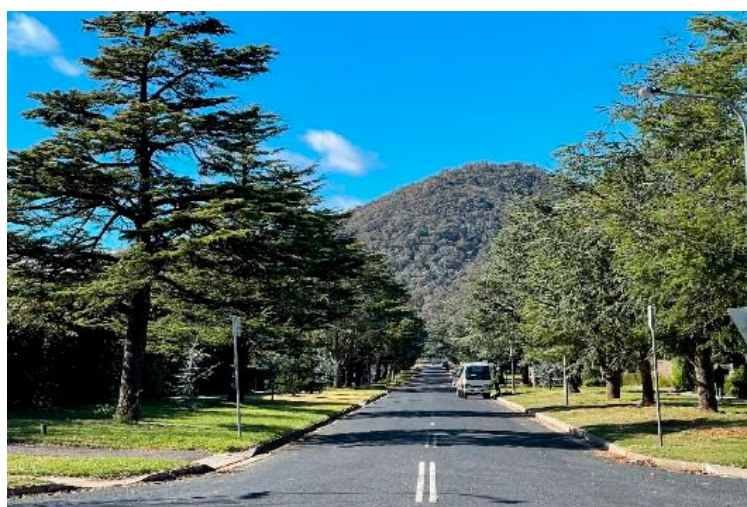
5.3. Planning with Many Natures in Canberra

Canberra, designed in the twentieth century to function as the national capital of Australia, is a very good example of how native nature and designed nature are intertwined and at the same time separated in the urban design and development process. These two salient types of nature are also reflected in the delineation of urban planning strategy and relevant policy documents [62]. For example, the ACT Nature Conservation Strategy 2013–2023 aims to connect the native habitat to urban areas, aiming to enhance the city's resilience [63]. Meanwhile, the ACT Native Grassland Conservation Strategy was delineated to protect and manage the remnants of native grasslands from urban development pressure as well as the urban edge effect for those of them located within the urban footprint or on the urban edge [64].

Although Canberra's urban landscape includes significant exotic vegetation, the remnants of native vegetation were the pivot point in Canberra's urban design and planning. The structure of Canberra's urban form was inspired by the topography of the native forested hills and mountains. As described by Freestone [65], the environmental setting was in the DNA of Canberra's concept and design as Canberra's image was based on the vision of "a city within the landscape that celebrates its bushland setting" [66] (p. 13).

A grassland plain with scattered Eucalyptus trees, which used to be grazing land after European settlement on the valley in the 1820s, gradually turned into a city known as a garden city, and recently colloquially referred to as the "bush capital". The transition of first nature (native landscape) to second nature (grazing land) in the nineteenth century was directed to another pathway in the twentieth century, which introduced a different identity to the area. The residential suburbs, inspired by the Garden City movement, became extensively green through the planting of mainly exotic trees in public open spaces such as parks and streets. In less than five decades, more than 8 million trees (native and exotic) were planted in the city and its surroundings [67]. This massive planting project and its continuation in the following decades led to the emergence of Canberra's urban forest. The bold exotic character of early urban forest being surrounded by bushlands (Figure 12), however, became more balanced by planting native trees after 1944, when Lindsay Pryor became the superintendent of the Parks and Gardens Department in Canberra. The inauguration of the Australian National Botanic Garden in 1970, which exhibited native plants from all parts of Australia, amplified the native landscape symbolism in the Australian capital. This botanic garden has served people with pleasure and education to impart knowledge regarding the Australian native flora and represent native nature [68]. The smooth approach toward nativeness in the urban forest could be seen by the mid-1960s in new suburban developments. They developed a more native green space character, as opposed to the exotic urban forest of the suburbs located in central Canberra and manicured landscapes in the institutional precincts. Accordingly, Canberra's character encompasses a combination of third nature (designed manicured landscape, urban forest with a significant percentage of exotic trees) with first nature (nature reserves within the urban footprint and bushlands and natural landscapes in the surroundings).

The key role of the native landscape in Canberra's design that symbolically represented the national identity was accentuated by the introduction of the National Capital Open Space System (NCOSS) in the 1960s. The NCOSS was delineated as a planning framework to protect the nationally significant open space and the visual backdrop of the city, which includes native-forested hills, mountains, ridges and buffers and major river corridors, as well as the constructed lake landscape (Lake Burley Griffin), alongside urban features [69]. These areas are not only critical for their ecological values but they are also symbolic and cultural. The management of NCOSS areas is the responsibility of a national agent called the National Capital Authority (NCA).



(a)



(b)

Figure 12. (a) A street in Central Canberra with exotic street trees terminating to a forested mountain covered by native vegetation; (b) native vegetation, spontaneous vegetation and exotic trees in Canberra in one frame (photos: F. Mofrad).

Significant areas of remnant species and native habitats are located within or on the edges of the urban boundary and are part of the urban forest, which is an opportunity and a challenge. The opportunity is the unique characteristic of native grasslands and bushlands within and around the city, which not only serve as a rich habitat for fauna but also provide people with easy access to nature. The challenge, however, is the preservation of these spaces in the face of climate change (fire, flood and mitigating the urban heat island effect). Another challenge is the invasion of exotic grasses into the native grasslands. The exotic grasses are controlled in Canberra through the ACT Weeds Strategy due to the risk of losing native grasslands to weed succession [64].

As a result of increasing attention to the environmental values of native trees over the past three decades, the planting efforts have been concentrated on preserving and enriching the original character and increasing habitat for native fauna. At this time, retaining and conserving native hollow-bearing trees are realised to be critical for native fauna, ecological connectivity and having a diverse gene pool [66]. Moreover, green space benefits and ecosystem services are gaining greater attention as movements such as urban agriculture emerge in Australian cities and towns [70,71]. In Canberra, gardening in private gardens was a hobby for early European settlers for ornamental purposes as well as fruit and vegetable production [72]. This opportunity has been considered with respect to using the available lands within the neighbourhood or on the edge of the urban footprint (e.g., Canberra City Farm) for food production, social engagement and enhancing community stewardship.

5.4. Spontaneous Urban Nature

Rupprecht et al. [34] undertook a systematic review of informal urban spaces and their value for biodiversity, analysing 174 research papers. Most studies came from Germany, followed by the U.K., U.S.A. and Japan. Australia was represented by only four papers, and the majority of them were dedicated to suburban road verges biota (birds and invertebrates).

There is no research on plant biodiversity of vacant lands (wastelands and urban post-industrial spaces) in Australia. In contrast to Europe and other northern hemisphere countries, this type of urban vegetation is not often considered as part of urban nature. Non-native urban biotopes are not recognised as being complex ecosystems with specific relationships between urban plants, soil, wildlife and humans. Such “informal green spaces” in most Australian cities are developed in highly disturbed habitats (most native soils are

destroyed and covered by new substrates) where the original resources of seed banks have been destroyed and replaced by non-native species which are seen as undesirable weeds. Australian ancient flora are not strong competitors to alien pioneer plants from the northern hemisphere that were developed as a response to the disturbance of glaciation.

Compared to Europe, urban spontaneous nature in Australia is almost 95–100% dominated by non-native plants. Thus, this “new wilderness” does not share many features with native wilderness. Many Australian native plants are highly specialised to suit their endemic region and have specific needs for regeneration (e.g., fires), meaning that the possibility of returning to native nature in the urban setting is very low. The reality of the urban environment in Australian cities is that the existing native vegetation and soils in most scenarios are removed from the site and replaced with new soils for designed and managed nature. In such conditions, native plants cannot compete with exotic plants adapted to the disturbance conditions. In southwestern Australia, the climate is Mediterranean and therefore pioneer plant species from South Africa, the U.S.A. (California) and Mediterranean Europe have successfully adapted to the pool of exotic species present in urban soils and spontaneous nature (Figure 13).

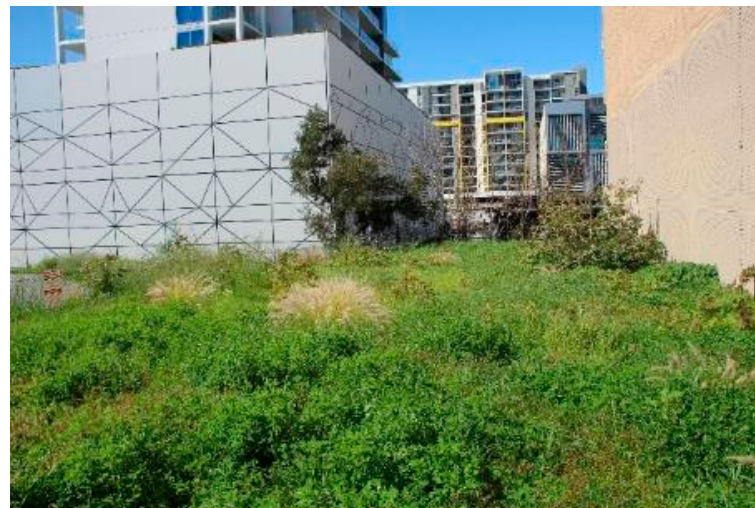


Figure 13. Spontaneous nature in Perth, Australia. All plants are non-native (Photo: M. Ignatieva).

Spontaneous nature dominated by non-native plants is considered less ideal than native ecosystems in the Australian urban context. Spontaneous nature may be associated with an untidy aesthetic appearance consisting of undesirable species (weeds). Consequently, local city councils use herbicides and other means to control or eliminate areas of spontaneous nature. The limited literature on spontaneous nature in Australia focusses mainly on road verges. Road verges are less highly maintained compared to traditional public open spaces (e.g., parks) and are often left to the spontaneous succession process to some degree. Some road sites, for example along highways, still have some patches of surviving native soils and are a potential source for the revegetation of native plants. Spontaneous self-assembled plant communities can also appear in temporary vacant suburban lots and railways.

Some Australian authors from the humanities contribute to the debate on “nativeness” and “belonging” to place as a means to understand personal and societal value systems and the reasons behind “embracing or rejecting particular forms of nature” [55] (p. 1). For example, Australian nativeness may be associated with a sense of freedom or even lawlessness, that is, an untamed place that offers escape from authoritarian strictures associated with urbanised living [73]. In addition, native nature may encourage feelings of community pride in terms of the association between endemic and unique native plant species and sense of place [74]. More recently, Krapez et al. [75] found that the perceived nativeness of two urban parks in Western Australia was positively associated with a range

of personal benefits, including as places for escaping the urban environment and connecting with nature. Alternatively, designed urban nature can be seen as a place that provides a safe and predictable space to access and recreate in, as opposed to the unpredictable and “messy” Australian native nature [76]. Maller et al. [77] also noted a positive community perception of urban designed nature in Australian city urban parks and gardens, associated with places that improve subjective well-being through opportunities for physical activity and socialisation. These examples of values associated with native or designed nature are not so much about embracing or rejecting particular forms of nature, but more about the perception of different values associated with each form.

When it comes to urban spontaneous nature, it appears that plants that are desirable when used in a designed nature context may be viewed as undesirable when growing spontaneously in the urban environment. In Western Australia, the plants that populate spontaneous nature are generally a mixture of species present in a European first nature, with those of a colonial second and third nature. This European first nature can be seen in species such as Shepherd’s purse (*Capsella bursa-pastoris*), docks and sorrels (*Rumex* spp.), Chickweeds (*Stellaria* spp.) and Goosefoots (*Chenopodium* spp.) [78]. The second nature includes plants of pasture, crops and orchards such as oats, barley, lupins, *Medicago* spp., *Trifolium* spp., olives, grapes, *Ficus* spp., fennel and legumes. The third nature is present in garden escape plants such as lawn species (*Cenchrus clandestinum*, *Cynodon dactylon* and *Stenotaphrum secundatum*) along with other ornamental species such as *Watsonia* spp., *Zantedeschia aethiopica*, *Nerium oleander* and *Pelargonium* spp., all of which have been introduced by colonial arrivals from around the 1830s to the end of the nineteenth century [79].

The introduction of these plants from other biogeographical regions mirrors that of immigration, trade routes and urban development, as well as social and cultural changes in industry and aesthetic aspirations [80,81]. Spontaneous urban plants are indirect evidence of land use and gardening practices in a city [82], although they are not considered as part of the cultural or natural heritage of Australian cities.

Two recent Australian-based studies have investigated the ecological and design potentials of spontaneous urban vegetation [83,84]. These studies compared spontaneous green spaces in Brisbane with those of Sapporo in Japan. They considered urban areas (e.g., vacant lots) and assessed their habitat for flora and fauna, vegetation structure, spatial distribution and accessibility. This study found that spontaneous nature spaces potentially enhanced diversity in urban green spaces and plant species diversity in addition to parks and conservation areas in both cities, though the authors acknowledged challenges in implementing this potential. Spontaneous natures already exist in Australian urban environments and more research into the complexities of the ecological and cultural aspects of this type of urban nature should be pursued in the future.

5.5. Ecological Aspects of Spontaneous Urban Natures in Southwest Australia

There is no published literature on the ecological aspects of spontaneous urban natures in southwest Australia. This is largely due to a focus on native and horticultural natures in the current literature. As part of a larger research project, vegetation surveys of spontaneous vegetation biotopes in two cities in southwest Australia, Fremantle and Albany, were conducted during 2022. Surveys of pavement cracks, walls, margins (path and road verges) and wastelands were carried out in each city. Over the year, the appearance, development and succession of plants was monitored. Evidence of maintenance practices at each site, and their use as habitat and forage areas for wildlife, was also observed. It is clear from the fieldwork data that these urban biotopes, while largely dominated by exotic plants, have ecological aspects that contribute to the urban nature of these cities.

For example, the first set of survey data recorded over 100 different species across survey sites. Of these species, nearly 60% of those in Albany and around 35% of those in Fremantle appeared at only one site. There was also only a small number of species shared between the two cities. This demonstrates that many species are site-specific and bound to a geographical location, while others adapt to a wider range of urban environments. In

subsequent surveys, the appearance and disappearance of many annual species became clear, while perennial species displayed different phenological stages throughout the year. This demonstrates a natural ecological succession in these biotope types, though some natural successive processes were interrupted by maintenance methods.

During one round of fieldwork, many of the sites in Albany exhibited mostly dead or dying plants. At one “wall” site, a sign warned that glyphosate was currently being used in the area. However, during the next round of fieldwork, there was significant regrowth of plants on the wall site with no visible evidence of the previous glyphosate application. A concerning observation regarding the use of herbicides on wasteland blocks during the vegetation surveys was the number of insects and birds observed foraging in them after herbicides had been used. On one visit to a wasteland site in Fremantle, a Willie Wagtail (*Rhipidura leucophrys*) was observed darting around for insects in large clumps of recently sprayed clover for the entire time the area was being surveyed.

One of the most interesting observations in Albany was witnessing a native King Skink (*Egernia kingii*) exit native bushland adjacent to a survey site to eat some exotic spontaneous plants (*Conyza canadensis* and *Oxalis corniculata*) growing in a gravelled area. In Fremantle, a Singing Honeyeater (*Lichenostomus virescens*) was observed extracting nectar from a large crown of flowers on a *Conyza parva* plant that had grown out of a crack in the kerb of a car park. During the surveys, many animals were noted occupying these spaces. For example, ants, European honey bees, wasps, hoverflies, flies, aphids, moths, butterflies, cicadas, spiders, lizards, rats and many native bird species were all observed in survey sites. The sites of spontaneous urban nature surveyed during this research clearly demonstrate that each is part of the habitat available to urban wildlife, exhibits ecological processes, contributes to urban biodiversity and is a part of the greater urban ecology of a city (Figure 14). The research also indicates that the current disregard for research into the ecological aspects of spontaneous plants and natures is not appropriate for a true understanding of the urban ecology of southwest Australian cities and a new approach is needed to further expand this area of research.



Figure 14. Spontaneous urban nature survey sites: (a) a limestone wall in Fremantle; (b) the corner of a wasteland block in Albany (photos: K. Stewart).

6. Nature-Based Solutions as a Tool for Implementing Many Natures

Nature-based solutions (NBS) is one of the main concepts which has been developed in order to operationalise an ecosystem-based approach within spatial planning policies and practices, to fully integrate the ecological dimension (e.g., practical aspects of conserving, restoring and designing different urban natures) and, at the same time, to address current societal challenges in the time of climate change [4,22,85]. Moreover, NBS exceeds the bounds of traditional approaches that aim “to protect and preserve” by considering the

enhancing, restoring, co-creating and co-designing of new green networks with nature that are characterized by multifunctionality and connectivity [5].

The NBS concept is European in origin, developed in the late 2000s by the World Bank and IUCN. It was adopted by the European Commission in the research programme Horizon 2020 with a focus on urban areas [86]. NBS is understood as “actions to protect, sustainably manage, and restore natural and modified ecosystems that address societal challenges effectively and adaptively, simultaneously benefiting people and nature” [86]. In this context, NBS includes the main ideas of green and blue infrastructure, ecosystem services and biomimicry concepts, and is considered to be an urban design and planning tool for ecologically sensitive urban development [22]. We can see that the NBS concept has been defined quite broadly, which corresponds to the vision of urban nature by geography, urban planning and design research. NBS is even considered an overarching concept to other concepts, such as ecosystem-based adaptation, urban green infrastructure and ecosystem services, since NBS is the broadest and the newest among these four concepts [87].

NBS includes a variety of interventions/actions which can be classified according to the scale of implementation or scope: (a) building-scale interventions; (b) interventions in public spaces; (c) interventions in water bodies and drainage systems; (d) interventions in linear transport infrastructures; (e) interventions in natural areas and land management; and (f) ecological education and awareness raising—related interventions (for more detail see [5]) (Figure 15). NBS not only emphasises biodiversity conservation and nature restoration, but is also linked to more ecological thinking and the promotion of sustainable living [5,22,87]. The final target of NBS is the implementation at the level of urban planning to transform urban development, planning and design policies, as well as community practices. However, NBS means practising inter- and transdisciplinary approaches in all types of urban natures and implementing different innovative practices driven by natural processes (e.g., water cycles, plant succession, biodiversity), with the close collaboration between a wide range of stakeholders and a high degree of citizen participation. NBS targets habitat restoration from the urban pocket park to the revitalisation of urban river valleys, or the organisation of green roofs [2,88]. One of the NBS activities in Europe includes creating urban biodiverse grasslands that diversify the traditional urban lawns and return biodiverse native plant communities to the city [46]. Another important European version of NBS is the implementation of the “go spontaneous” approach and “leave nature alone” (as was demonstrated in the example of Nature Park Südgelände) when landscape architects employ the principle of inspiration from natural ecosystems and knowledge of the ecosystem’s functioning. Another important social and ecological impact of NBS is the contribution to sustainable living through responsible consumption and production, increased resource efficiency, etc. For example, environmental awareness is raised through community gardens, ecological education projects for citizens and ecological festivals [5].

In Australia, the concept of NBS has been adapted only in the last decade. NBS prioritises water-sensitive and native biodiversity design as opposed to the usual engineering solutions and built infrastructure [2]. Water-sensitive design, conserving and restoring native biodiversity and protecting natural landscapes are prioritised in Australian cities (Figure 16).

Despite the recent promotion of “nature-positive cities” in Australia, as “truly nature-positive cities would allow all forms of nature in, to be experienced by urban dwellers” [2], some types of nature (e.g., spontaneous nature) have not been evaluated and considered (Figure 17).



Figure 15. Examples of NBS implemented in Europe: (a) greening facades in Halle; (b) urban community gardens in abandoned land of Berlin; (c) revitalisation of former industrial area in the southern part of Leipzig; and (d) annual ecological weeks and festival in Leipzig (photos: D. Dushkova).



Figure 16. Nature Based Solutions: Water Sensitive Design (a): swale, Queen Elizabeth Olympic Park, London, and (b) swale in Canberra (photos: M. Ignatieva).

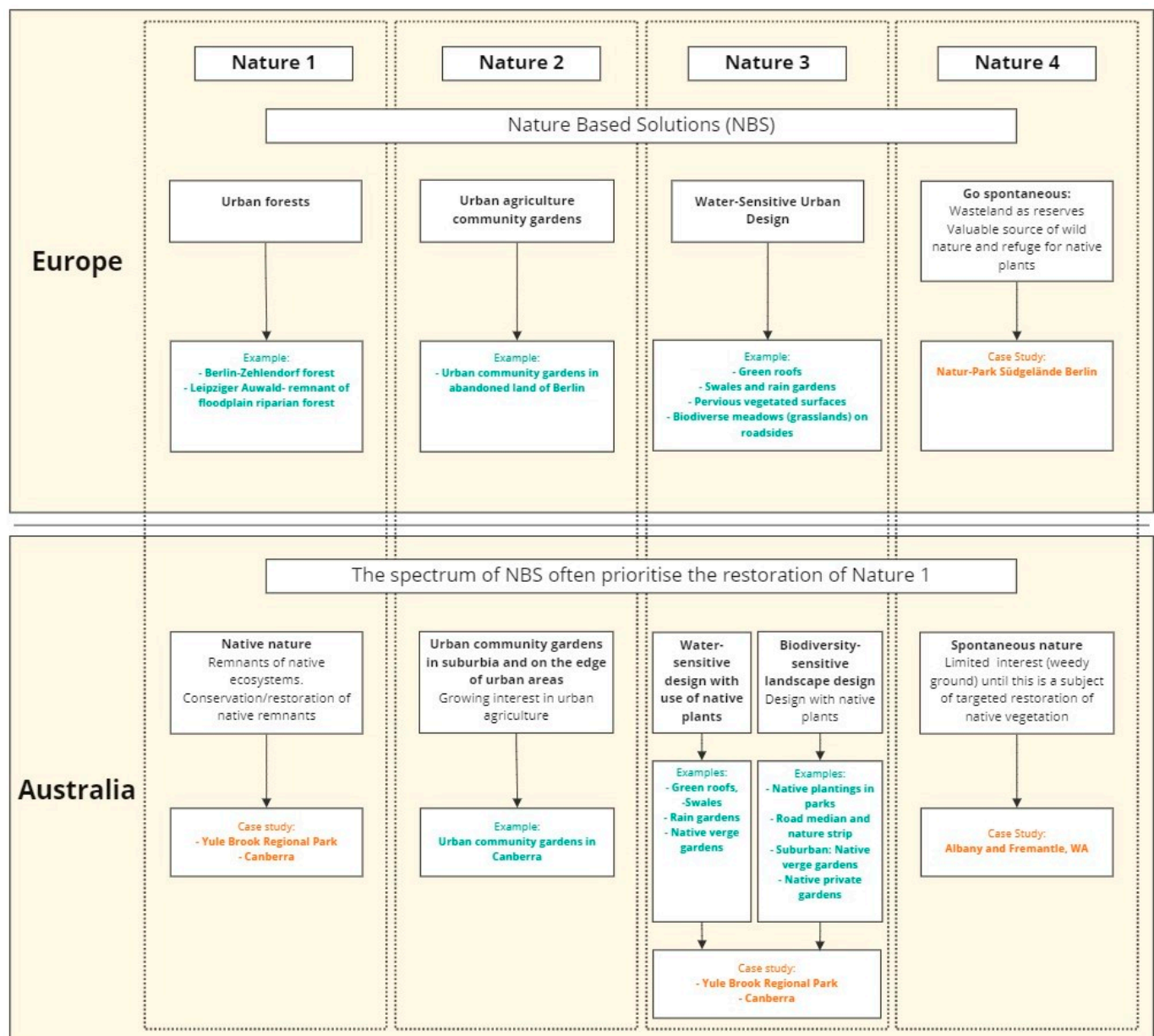


Figure 17. Nature-based solutions for different types of nature in Europe and Australia. Case studies and examples used in this article are positioned in appropriate boxes.

The Example of the Future Yule Brook Regional Park in Perth, Australia

In Perth, Australia, landscape architects often have to consider and intervene in “many urban natures” without a lexicon to describe or understand them. These include high-fidelity “remnant nature”, alongside areas of “spontaneous nature” and “designed nature”. There is very little demonstrated in research or practice about how to knit these spaces together and have them work as one connected gradient of urban nature. Here, in a future Yule Brook Regional Park, there is an opportunity for many natures to knit together through a continuum of landscape thinking (Figure 18).

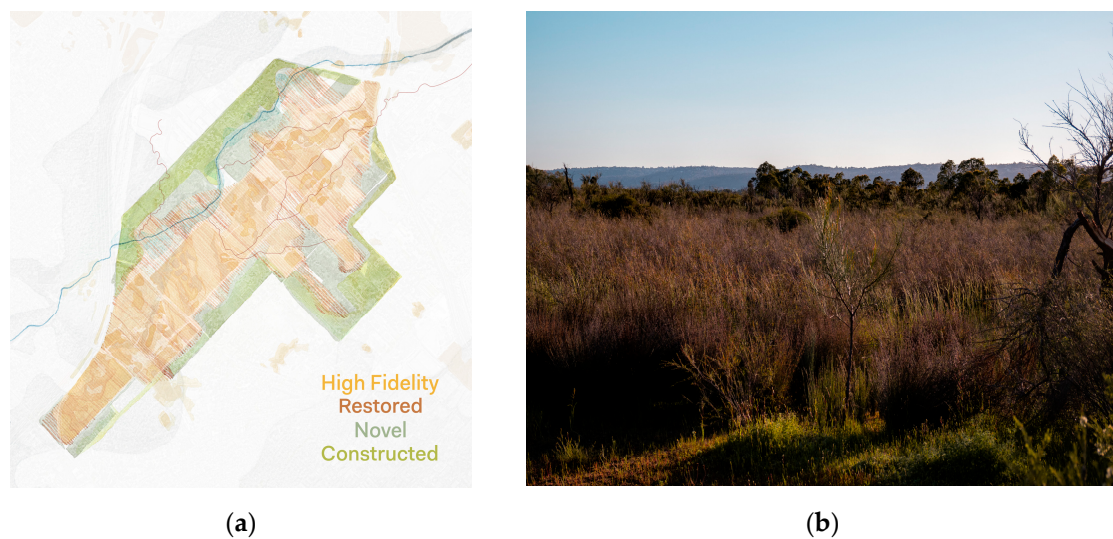


Figure 18. A plan drawing of the gradient of many natures informs the strategy for Mandoorn and its buffer landscape: (a) a photograph of the claypan ecotones of Mandoorn and (b) some of the area’s 857 floral taxa (drawing: D.J. Martin and A. Ford; photo: D.J. Martin).

On the eastern edge of the Swan Coastal Plain, the Mandoorn—Yule Brook waterway flows through the suburbs, beginning at the edge of the escarpment and extending to the Dyarlgarr—Canning River, flowing into the Bilya—Swan-Canning Estuary. The corridor is unique as it contains large areas of preserved high-fidelity ancient vegetation within the suburbs. The corridor passes through urban areas, agricultural areas, past industrial estates and rural residential areas, extending over 10 kilometres. Mandoorn is a place of exceptional biodiversity within the Perth and global context. A total of 857 native species, or around 47% of Perth’s native flora, occur within this 702-hectare corridor between escarpment and river [89]. Where many ancient geological systems meet, biodiversity skyrockets—loams and clays meet leached sand dunes, and igneous rocks meet riverine flows. Mandoorn is home to banksia woodlands, claypans, herblands and sedgelands making up dozens of ecotones, including at least 11 federally listed threatened ecological communities.

However, this corridor is without formal conservation protection, and it is subject to increasing urban pressures. As an ecological and hydrological system, comprised of many natures, Mandoorn requires examination and strategy at a territorial scale, to reveal future pressures in a holistic and strategic way. These include proposals for industrial estates many hundreds of hectares in size, new urban zonings, housing developments and upzoning surrounding the railway precinct to the south of the corridor. In Western Australia currently, the environmental planning and regulatory frameworks do not consider strategic systems and scales well. By tending to operate and assess piece-by-piece and within the limits of precinct and lot boundaries, planning and assessment can ignore systems-scale impacts as well as the cumulative impacts of many proposals together, both spatially and over time. A design, planning and biodiversity examination of Mandoorn at a territorial scale has generated a strategy for a future Yule Brook Regional Park. This idea was initiated by The Beeliar Group, a group of local scientists and academics who work as a voice for environmental responsibility [90].

Much of the “business-as-usual” development in Perth has shown that a hard edge is set to develop between Mandoorn and the urban area if these industrial plans progress. This would force a binary between nature and development. The small rural lots adjacent to Mandoorn would be cleared, drained and benched with sandy fill to many metres above the natural ground level. Encircling development will foreseeably constrict the corridor to a 400-metre width, leading to an increase in urban heat and a decrease in ground permeability and saturation across the corridor. Mandoorn sits on intricate layers of clay

and sand, forming a fragile hydroplain that connects to the deep aquifer system beneath Perth. Many of the ecological communities are dependent on these layers of water flowing laterally on clays from permeable rural areas nearby. The landscape relies upon water infiltration. There is substantial concern among scientists about these impacts.

Advocacy for a Yule Brook Regional Park would be impossible without expanding the scale at which conventional planning operates. Here, it has been the domain of synthesised environmental and design research to comprehend and formulate this strategy. The Yule Brook Regional Park strategy gathers a gradient of landscape areas to act as one cohesive urban ecological space, working across the many urban natures described in this article. This gradient of natures acts as a large buffer zone around the megadiverse Mandoorn “core”. A buffer helps protect the high-fidelity landscape from surface degradation in the form of invasive species, urban heat, industrial impacts and roads. As well as offering subsurface protection, enabling a space for aquifer flows and aquifer recharge continue to sustain the Mandoorn corridor. This buffer strategy extends from the “core” of high-fidelity ancient ecosystems, through an edge which might undergo ecosystem restoration or repair, into a band of preserved “novel ecosystems”—which include substantially modified environments with invasive species and degraded areas but “still worthy of conservation concern” [14]. Beyond this, the Yule Brook Regional Park strategy incorporates a constructed or designed landscape zone with parklands, playing fields, urban plantings, recreation spaces and gardens—offering a range of human uses, while ensuring ecological function of the whole is maintained. These constructed areas can bleed into development beyond, into sensitively designed housing regeneration and industrial development, to support a softer edge. Here, NBS is critical in designing to support the sensitive “core” environments of Mandoorn, which function under fragile hydrological, microclimatic and biotic regimes.

What emerges through this design strategy is a reciprocal corridor between development and ecosystem areas, with the many and varied uses that can emerge. Rather than a hard edge, the strategy has been to implement a gradient of many urban natures. Once the Yule Brook Regional Park can be incorporated into the metropolitan planning framework, the next step is to generate guidelines at lot scales that enable implementation. A concept of many urban natures should be central to this process. This is a vision that extends over many decades—with potentially dozens of projects and designers.

7. Discussion and Concluding Remarks

This paper has critically examined the plurality of opinions on what urban nature is and the different interpretations by different disciplines, noting that there are similarities in the visions of urban nature as a complex multifaceted phenomenon. The separation of native nature (first nature) and cultivated/designed natures (second and third natures) began early in human history. This delineation of natures is an attempt to understand the complexity of landscapes and the relationships between humans and nature. The current ecological crisis and dramatic loss of native nature as a result of urbanisation and industrialisation has motivated the search for effective nature conservation and restoration mechanisms not only in native but also in peri-urban and urban landscapes. The dynamic character of modern cities and the threat of diminishing nature spaces has resulted in valuing even small spontaneous islands of urban green and spontaneous nature.

Our analysis of case studies from Europe and Australia has highlighted different approaches to existing urban natures and the methods of their design, improvement and conservation. We revealed that divergent understandings and interpretations of urban nature are a direct consequence of the scope of different disciplines and their perspectives of nature, in combination with regionally specific socio-political, historical, cultural and ecological contexts. Our approach acknowledges the existence of many urban natures that should be understood in cities.

In Australia, more than two centuries of colonisation created precedents for two natures: native nature associated with pre-colonial nature and the designed nature based on

the vision of European nature that was introduced by colonists. Since European colonisation, the priorities and values toward urban natures in Australian cities have dramatically changed. In the nineteenth century, designed nature was a symbol of civilisation and was prioritised. Consequently, many native ecosystems were lost in the face of pastoral, mining and urban forces. However, since the late twentieth century, a shift in attitude has occurred whereby native nature has much greater protection, although native land clearing for a range of purposes continues across the continent. These debates in Australia are ongoing and acute. The concept of novel ecosystems is prevalent among Australian ecologists and urban ecologists and targets native nature conservation and restoration of native plant communities. In the 2020s, urban nature and “returning nature to the cities” in Australia is associated primarily with native nature, which is also reflected in governmental policies.

Compared to Europe, Australian urban designed nature has been delineated from native nature by including all types of designed and managed landscapes. Thus, parks, private gardens and street plantings become a part of the built infrastructure. Designed nature is seen mostly as a green asset that provides important ecosystem services. Such human-made and maintained urban plant communities are in the sphere of horticultural and landscape design studies but not ecological research. The fourth spontaneous urban nature component is almost non-existent in Australian urban ecological studies. Existing barriers to consideration of spontaneous urban nature relate to the emphasis on Australian urban POS as tidy and green, management and maintenance issues and the use of herbicides. This attitude toward urban-designed nature is different in many parts of Europe where a variety of measures/actions are developed in order to bring nature back into cities to support biodiversity and mitigate climate change. For example, the Urban Greening platform created by the European Commission presents the concept of a modern compact city promoting urban green spaces availability and multifunctional urban design that supports sustainability and restresses the importance of ecosystem services.

The analysis of implemented NBS and ongoing projects (Nature Park Südgelände, Canberra’s green space development, Yule Brook Regional Park and observations of spontaneous urban natures in southwest Australia) revealed similar approaches between Europe and Australia in terms of aiming to protect, reinforce and restore urban natures. Strategies such as water-sensitive urban design, aiming to work with natural processes to save, retain and return water to the urban ecosystems, are among the most widespread. However, we also highlighted the differences in approaches. In Australia, NBS is a practical tool for transferring cities into “nature-positive” places with the goal of protecting and restoring native biodiversity. European approaches such as “go spontaneous” and the potential of the nature of the fourth kind for rewilding cities are not widespread in Australian cities due to the unique ecological conditions and cultural perceptions. Acknowledging the full spectrum of urban natures and adopting common terminology and concepts in planning and policy (e.g., native nature, native biodiversity, designed nature) could facilitate more effective collaboration and enable more effective and efficient implementation strategies by practitioners, policymakers and other stakeholders.

We revealed that divergent understandings and interpretations of urban nature are a direct consequence of the scope of different disciplines and their perspectives of nature, in combination with the socio-political, historical, cultural and ecological peculiarities of a country or region.

In a century that is defined by the climate crisis and the accelerating loss of biodiversity, common understandings of urban nature and collaborative approaches to NBS have never been more urgent. This paper lays the groundwork for greater cooperation between disciplines—landscape architects, urban planners, geographers, ecologists and social scientists—as well as between science, practice and policy. This synthesis seeks to form the foundation for thinking and acting across the conceptual spectrum of urban natures, acknowledging the plurality of urban nature visions, and identifying common understandings for advocacy, care and repair across the many urban natures.

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