Received: 29 August 2023 | Accepted: 20 June 2024

DOI: 10.1002/pan3.10708

PEOPLE AND NATURE | BRITISH ECOLOGICAL SOCIETY

RESEARCH ARTICLE

Play biotopes put into practice—Creating synergies between children and nature

Marcus Hedblom[1] | Fredrika Mårtensson[2] | Åsa Ode Sang[3] | Björn Wiström[3] | Anna Litsmark[4]

[1]Department of Urban and Rural Development, Swedish University of Agricultural Sciences, Uppsala, Sweden

[2]Department of People and Society, Swedish University of Agricultural Sciences, Uppsala, Sweden

[3]Department of Landscape Architecture, Planning and Management, Swedish University of Agricultural Sciences, Uppsala, Sweden

[4]Department of Architecture and Built Environment Urbanity, Housing, Environment, Lund University, Lund, Sweden

Correspondence
Marcus Hedblom
Email: marcus.hedblom@slu.se

Funding information
Horizon 2020 Framework Programme, Grant/Award Number: 2021YFE93100 and 821016; The REGREEN Nature-based Solutions project

Handling Editor: André Mascarenhas

Abstract

1. Global urbanisation reduces greenery and species richness (biodiversity) and limits opportunities for most children to gain experiences of nature. Disconnecting children from nature has implications for their play, health, well-being, and comprehension of ecological systems, as well as their engagement with the environment as adults.
2. In the competition for land for built infrastructure, the preservation of remaining greenery is essential to fulfill multiple functions. One way forward is to look for synergies between conservation of biodiversity and children's need for outdoor environments of high quality.
3. In this paper, we synthesize the existing literature on how to understand the many interfaces between children and nature, suggesting perspectives and tools for the management and design of nature-based play settings. We frame this transdisciplinary perspective using 'play biotopes', as a conceptual framework in which both children's play and species are taken into account.
4. We exemplify how the play biotope framework can be put into practice as part of (1) an overall approach to landscapes made more useful to both children and other species, (2) affordances for play in nature such as branches from dead wood, and (3) a design process of a playground by giving input to nature-based solutions.
5. A conclusion is that play biotopes as a conceptual framework within nature-based solutions can help increase play and biodiversity by promoting structures for climbing, making huts and biotopes otherwise overlooked in urban planning.

KEYWORDS
children's play, environmental psychology, health promotion, landscape architecture, landscape ecology, nature conservation, nature-based solution, outdoor education

1 | INTRODUCTION

Global urbanisation reduces accessibility to nature in cities, affecting biodiversity, people's ability to experience nature and public health and well-being (Aronson et al., 2014; Marselle et al., 2021; Seto et al., 2012). Today, half of all children live in cities (1.18 billion in cities and 2.38 billion children globally; UN, 2023; UNICEF, 2022) and access to nature is important, affecting children's physical and mental health, socioemotional development and the development of general life competencies (Dadvand et al., 2015; Vujcic & Tomicevic-Dubljevic, 2018). International studies show that biodiversity in cities is still rather high but is rapidly diminishing (Aronson et al., 2014) and that children's opportunities to experience plants and animals vary greatly depending on regional and local circumstances (Freeman et al., 2018). Exposure to nature during childhood fosters pro-biodiversity behaviour in adulthood (Soga & Gaston, 2023), highlighting concerns regarding increasing 'plant blindness' among younger generations. This phenomenon refers to the inability to recognise the importance of plant life for the biosphere and human well-being (Nyberg & Sanders, 2014).

Plant and animal biodiversity provides health benefits for humans in general (Aerts et al., 2018) and for children in particular (Puhakka et al., 2019). Combining children's playgrounds with biodiversity conservation would be an important way of increasing the multifunctionality of urban green areas. This is challenging when decreasing numbers of remaining green areas must fulfil the demands of a diverse population (Elbakidze et al., 2023), and when children and nature often come in second in planning after the needs of adults (Vidal & Seixas, 2022). However, in current scientific literature, there is no framework or guiding conceptualisation on how to upgrade outdoor environments for children (i.e. play settings, play spaces, playgrounds and landscapes for play) through nature-based solutions. Suggestions for how to design new areas that combine habitats for non-human species and children's outdoor play are also lacking. Taken together, if no action is taken, the present trend of from disconnecting nature will lead to further deterioration of natural settings on a global scale in ways that undermine children's traditional play habitats and children's outdoor play culture at large (Gaston & Soga, 2020).

Providing outdoor play areas with high biodiversity, aside from connecting children to nature, also serves to safeguard conservation areas. These areas could, if properly planned and designed, provide areas for play with many ecosystem services. The importance of safeguarding biodiversity for humans and other species in cities is highlighted in international policies addressing the Convention on Biological Diversity (Ainsworth, 2022). Despite this, cities are struggling to implement biodiverse spaces for humans and other species; for example, the intergovernmental science-policy platform on biodiversity and ecosystem services conducting a global assessment of knowledge on biodiversity state that '…there is progress towards the target but at an insufficient rate, due in part to either not knowing how to incorporate nature and nature's contributions to people into city planning or that not enough cities have made the effort to do so' (IPBES, 2019).

One suggested solution for the increasingly high competitiveness of existing urban green spaces is to plan, design or manage urban green areas so they are multifunctional (Lovell & Taylor, 2013). We know that multifunctional landscapes can provide beneficial functions across ecological and cultural dimensions, but few studies deal with how to implement such multiple functions. Available literature often only touches on the benefits of multifunctional urban green infrastructure in general terms (Hansen & Pauleit, 2014; Lovell & Taylor, 2013; Pauleit et al., 2021). However, existing policies that emphasise the multiple uses of green spaces in cities rarely mention children (WHO, 2017) and if they do (see Sustainable Development Goal [SDG] 11.7), little is said about implementation and issues such as the size or quality of green urban spaces supporting different play activities for children.

The creation of biodiverse play spaces is rare in urban planning and leads to reduced biodiversity in development. New play settings are increasingly artificial, using equipment, fences and plastics (the so-called 'kit-fence-carpet approach'; see Figure 1). These artificial playgrounds are challenged in theory (Pitsikali & Parnell, 2020; Woolley, 2007; Woolley & Lowe, 2013), but prevail in practice. Kit-carpet-fence play settings are static and are not able to adapt to new circumstances, such as increased temperatures or rainfalls, nor are they flexible enough to meet the needs and aspirations of new generations of children. Many schoolyards house too many children in too small a space, causing the vegetation to suffer from their wear and tear, making it less abundant over time (Boverket, 2015; Kylin & Bodelius, 2015; Figure 2), a development that gives priority to artificial playgrounds in everyday settings. Although there seems to be a trend towards creating species-poor green playgrounds, this is not always the case; see, for example, a schoolyard in Germany in Woolley (2007).

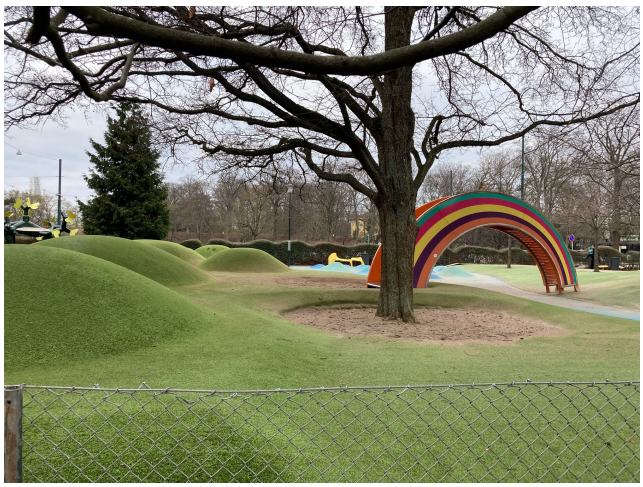

FIGURE 1 A playground in the city of Malmö with plastic hills and plastic rainbow surrounded by fence (referred to as ´kit-carpet-fence´by (Woolley, 2007; Photograph: Fredrika Mårtensson).

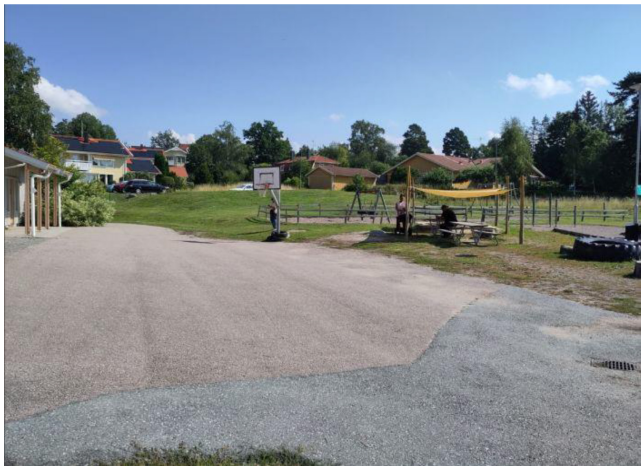

FIGURE 2 A schoolyard in Uppsala covered with asphalt and a worn lawn with a piece of fabric for shade, providing low affordances overall and only few ecosystem services. (Photo: Marcus Hedblom).

The concept or theory of *affordances* is often used in relation to children's play environments and refers to how aspects of the environment can offer different opportunities for action use (Little & Sweller, 2015). Building on Turvey (2013) and Wagman (2020) describes how affordances emerge in the relationships between any animal and an environment and describe these as '…active specific meanings of the surroundings'. Originally, affordances were presented as the result of 'immediate perceptions' in action as human beings experience their surroundings (Gibson, 1979). Later, Heft (1988) distilled these contextual relationships into specific functions for children which are now commonly used to evaluate the play value of a site. When applied to a play environment, this suggests that attributes like open ground, sloping terrain, shielded places, rigid fixtures, moving fixtures, loose objects, loose material, water and creatures are affordances offering children opportunities for meaningful action facilitating a particular activity, such as climbing, sliding and jumping (Lerstrup & van den Bosch, 2017).

However, there is limited knowledge on how to create rich play settings based on existing habitats to ensure rich biodiverse landscapes. Earlier pioneering work on urban biotope creation was never mainstream and tended to focus on the restoration of specific communities or aesthetic aspects (Kingsbury, 2004; Ruff, 1987). The rare biotope design projects emphasising play have, over time, become standardised to fit conventional park ideals (Gustavsson, 2004; Ruff, 1987). Furthermore, instead of using existing habitats or planting new biotopes, it is common practice to order single-park trees and equipment from a catalogue with rigid fixtures. In addition, there is a lack of knowledge about how to conduct landscape management of existing green areas to promote play compatible with biodiversity.

The aim of this paper was to synthesise the existing literature on (1) how children interact with nature during outdoor play; (2) how the outdoor environment affects children's health and developing abilities; and (3) the possibilities and potential synergies in managing and designing playgrounds that are beneficial to children's play and the conservation of other species. Due to the transdisciplinary nature of this approach, combining literature from different research domains, we do not meet the criteria for scoping or systematic reviews. We use the literature to reflect on the interface between children and nature—given nature's potential for children's health and development, and its synergies with benefits for other species and overall biodiversity. Furthermore, we focus on dead wood as a nature-based solution for children's play and nature conservation and a case study where the conceptual framework of play biotopes has been applied. The 'play biotope' framework is based on landscape ecological assessments (Fjørtoft, 2012) to investigate the possibilities to create more multifunctional nature-based outdoor environments for children.

2 | THE PLAY BIOTOPE AS FRAMEWORK

These 'play biotopes' differ from traditional kit-carpet-fenced areas and include natural characteristics that allow play for other nonhuman species. The notion of a 'play biotope' was launched to create a theoretical and practical tool to conserve or upgrade the biological assets of a place, making the place compatible with high-quality outdoor environments for children (Fjørtoft, 2012). Referencing corresponding concepts in landscape ecology, Fjørtoft (2012) elaborates on landscape ecology characteristics of biotope, habitat and niche. In ecology, a 'biotope' is an area with a characteristic plant and animal population, such as a deciduous forest, and is similar to an ecosystem, in which many species can live. In ecology, a 'habitat' refers to the array of resources, both physical (soil, moisture and temperature) and biotic (plants, animals and bacteria) factors that are present in an area and support the survival and reproduction of a particular species. In ecology, a 'niche' refers to what a species lives off of or does in a specific habitat to survive. Further, a niche (in ecology) is the match of a species to a specific environmental condition. It describes how an organism or population responds to the distribution of resources. Niche is also a concept with two sides which are not so tightly related: One concerns the effects environment has on a species, and the other concerns the effects a species has on the environment (Polechova & Storch, 2019). Thus, a habitat can have many niches. A 'play biotope' is linked to a specific landscape where children play. As such, a tree-dominated landscape, or 'play habitat' could be the array of resources, physical and biotic factors present in an area that support the activities of children. A 'play niche' is the match between children and a specific environmental condition. It describes how children respond to the distribution of resources by performing a particular type of activity (Fjørtoft, 2012). A 'play niche' could represent a particular activity by using specific features inside a tree-dominated habitat, such as branches for tree climbing or branches for the building of huts (Figure 3). It could also, similar to the ways highlighted in ecological 'niches', mean that children affect their environment through wear and tear.

The original idea of play biotopes was to provide a holistic perspective on children and nature that is useful when addressing

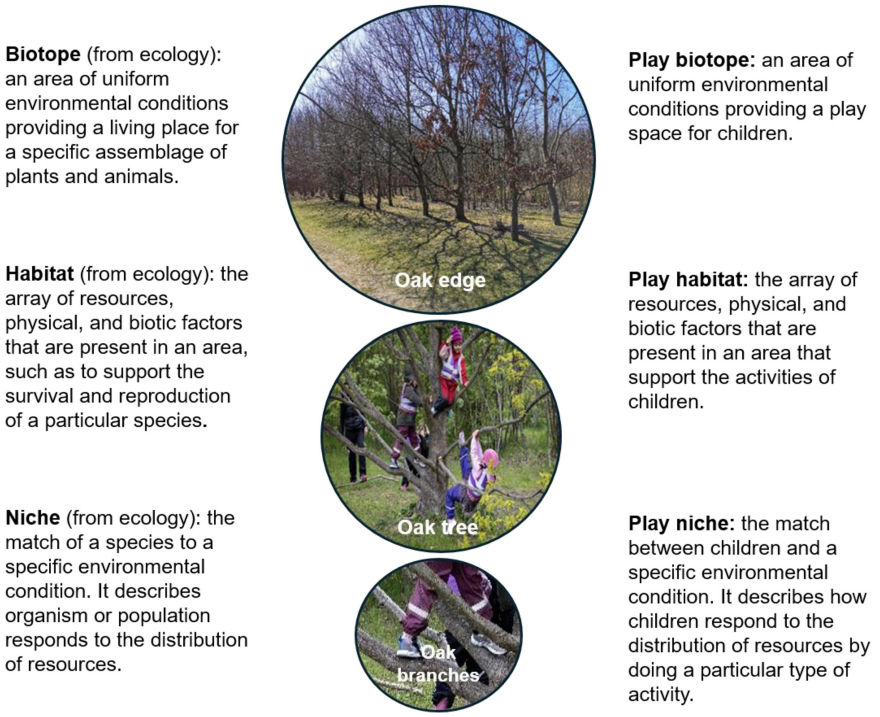

FIGURE 3 Play biotope—a conceptual framework combining ecology and play affordances in the mapping of children's outdoor environments. Photograph: Lars Brundin.

expectations of the positive health benefits of a landscape, particularly in regard to children's motor development (Fjørtoft & Sageie, 2000). We need a conceptual framework to understand the exchange of children with green urban space to be able to relate this to the landscape levels of a play biotope; more specifically, their relationship to place, niches and habitats. Although the play biotope was promoted as a tool by Fjørtoft and Sageie (2000), we use it here in the context of a conceptual framework for combining children's play and the conservation of species.

3 | APPROACHES TO OUTDOOR ENVIRONMENTS FOR CHILDREN

3.1 | The dynamic interface between children and nature

Childhood has, to a large extent, moved indoors (Bassett et al., 2015; Gao et al., 2022). It is argued that there is now a backseat generation where children are escorted to and from schools and other events organised by adults (Karsten, 2005). By 2004, studies revealed that mothers in the United States recognised a multitude of benefits of outdoor play, yet television, computers and safety concerns kept their children indoors (Clements, 2004). The loss of connection to nature leads to a lack of knowledge about nature. Balmford et al. (2002) found that eight-year-old children could more easily identify characters from the Japanese card-trading game Pokémon and the related TV series than common neighbourhood flora or fauna. In the debate, (Louv, 2008) argued that there was a new generation whose direct experiences with nature were being replaced by indirect experience through electronic media and machinery. This distance from nature can be seen as an ongoing alienation from nature that has been called the 'extinction of experience' (Soga & Gaston, 2016, 2023).

The study of peoples' bonds with place in terms of a 'sense of place' or 'place attachment' has been an interest in landscape studies for a long time, pointing out the need for seclusion, quiet areas, complexity and opportunities for children to encounter the natural world (Wilson, 1997). In studies of the relationships between children and nature, particular attention has been paid to the 'child–nature interface' and the implications of children having intimate relationships with physical environments as a part of normal development (Bartos, 2013; Chawla, 2020; Martensson, 2004; Nordström, 1990; Noschis, 1992). This includes experiences of free play outdoors, which tend to create a lifelong imprint, reinforcing individuals' affinity with nature (Bixler et al., 2002; Bixler & Floyd, 1997; Martensson, 2004; Sandberg, 2002; Wells & Lekies, 2006).

Humans perceive their environment with multiple senses such as vision, hearing, smell, taste and touch (Hedblom et al., 2019). However, children are assumed to be engaged in a more sensory-driven way than adults, who are thought to be more intellectually engaged in their environment (Rodaway, 1994; Tuan, 1977). Tuan (1977) explains how '…the child knows the world more sensuously than does the adult' and therefore is more likely to connect with a place through the present moment (1977:185). Bartos (2013) further elaborates on the use of senses, highlighting that vision may not be as dominant for children as it is for adults; instead, children may draw on their tactile and olfactory senses to orient their visual experience of a place.

Outdoor environments for children are dominated by paved areas for sports, manufactured playground equipment and lawns (Dyment & Bell, 2008). This tends to restrict children's

opportunities to sensuous natural experiences and their play turns becomes more static, less elaborate and more dominated by repetitive movements (Martensson, 2013). Lynch and Banerjee (1976) identified that children frequently asked for more trees in their neighbourhood. This is confirmed by Jansson and Persson (2010), revealing that children want access to forested woodland areas. Kahn and Kellert (2002) identified that children classify nature as being highly important to them and that their preferred play spaces are outside (Moore, 1986). Nature can also be an important feature in allowing children to seek solitude from adults (Burke, 2005; Wales et al., 2024).

3.2 | Biodiversity and health-promoting play

Biodiversity is a cornerstone of human health and well-being (Marselle et al., 2021). Yet, biodiversity per se is complex, including the diversity, identity and abundance of species, genera and ecosystems. Furthermore, biodiversity can affect health through multiple pathways, such as through the subjective perceived increased well-being that occurs when seeing and hearing biodiversity (Randler et al., 2023); increased physical well-being through the reduction of stress (Hedblom et al., 2019); and also directly, through increased biodiversity of gut bacteria (Puhakka et al., 2019; Roslund et al., 2020).

Some research points out the synergies that exist between creating a green and varied outdoor environment and health promotion in children (Boldemann et al., 2006; Fjørtoft & Sageie, 2000). Furthermore, children tend to be more physically active in terms of steps/minute when playing in a forest than on a traditional playground (Pysander et al., 2024). Contact with nature is also supportive of children's cognitive development and school achievement, making it easier for them to regulate attention and exercise self-discipline (Dadvand et al., 2015; Martensson et al., 2009; Taylor & Kuo, 2009). Furthermore, there are indications that contact with nature while young is beneficial for children's socioemotional development in general (Mygind et al., 2021), decreasing the risk of mental illness (Engemann et al., 2019). However, most of these studies do not define 'nature', and if biodiversity is included, they do not describe the extent and type of this biodiversity.

Studies that focus on the hazards of inactivity highlight the importance of outdoor play for children in sustaining physical activity (Cooper et al., 2015; Gray et al., 2015). Children need physical activity in certain amounts and intensities, but the quality of this activity is also important. More versatile and adventurous activities, so-called 'risky play' include mechanisms, which has caught the particular interest of scholars in psychology (Herrington & Brussoni, 2015; Sandseter, 2010). Risky play is a type of open-ended activity, changing while evolving, which is common when children play outdoors (Dyment & Bell, 2008; Martensson, 2004; Martensson et al., 2009). Crude variables such as the 'outdoors', 'green play settings', 'loose parts' and particular affordances such as 'climbable' and 'runnable' have so far been attributes connected with health-promoting play in children (Jansson et al., 2018; Lerstrup & van den Bosch, 2017; Woolley & Lowe, 2013). However, there has been very little focus on the more particular biological (or morphological/geological) content of play settings. To exemplify this, the importance of 'loose parts' (first highlighted by Nicholson (1971)) is a basic principle when creating attractive play settings. The focus is, however, on loose parts in early learning environments (four- to five-years-old; see Flannigan and Dietze (2017)), rather than on all the loose parts associated with biodiverse settings. Houser et al. (2019) reviewed the few existing studies on loose parts ($n = 16$), revealing that manufactured parts such as recycled tires and buckets dominates the literature. However, Pysander et al. (2024) reveals that children use available play material in a specific setting, such as chestnuts, leaves, sand, water and mud, together with a few small buckets in a traditional playground, and sticks, forest litter, moss, pinecones, stones, berries, mushrooms and half-detached lumps of wood in a forest. One of the few existing studies on direct links between biodiversity and children's health and play are studies on the natural forest floor in Finland (Puhakka et al., 2019). They measured play and microorganisms on a lawn and gravel-dominated kindergarten that was later turned into a forest floor (by moving forest vegetation into the area). The introduction of these new natural materials diversified the physical activity of children, adding rolling, creeping, crawling, and doing somersaults and cartwheels, activities not enjoyed by children in the former schoolyard (Puhakka et al., 2019). The new materials were also inspired by pretend play and role-play, in which plants, sticks, cones, and twigs became play artefacts. Perhaps even more interestingly, this setting also improved children's immune regulation and the health-associated commensal microbiota among preschool children (Roslund et al., 2020).

3.3 | Mapping landscapes for children's play

A large body of literature highlights that the natural environment and natural elements provide attractive outdoor spaces for children (Hart, 1979; Herrington & Brussoni, 2015; Lerstrup & van den Bosch, 2017; Moore, 1986). As highlighted above, there is an increasing amount of literature that describes children's need for play and the actual characteristics of the landscape (habitat and niches), needed for this. The current literature mapping children's play in nature is rather dispersed and rarely provides particular species or elements of biodiversity. Yet, Fjørtoft and Sageie (2000) illustrate how specific landscape structures affording particular functions in children's more versatile play can be described. The site they described was a small forest (7.7 ha) that complements a kindergarten in Norway. When mapping the woodland they described a mosaic of 34 patches of different types of woodland, and nine different vegetation types, including an enumeration of the plant species (see Fjørtoft & Sageie, 2000). They further describe the roughness, slopes and the physiological characteristics of a green setting, such as how shrubbery with coniferous vegetation triggers children to pretend play. Fjørtoft and Sageie (2000) illustrates a landscape

ecological approach in mapping linking landscape habitats, vegetation and affordances to play.

Another suggested way of mapping outdoor environments for children is 'The Outdoor Play Environment Categories (OPEC)', which evaluates the composition of the overall configuration of outdoor settings and how it sets the stage for vigorous activity (Martensson, 2013). For example, high-scoring OPEC landscapes are spacious, contain a substantial number of trees, shrubs and hilly terrain, and have a layout with a mixture of more closed and open surfaces well-distributed across the space. Additionally, Woolley and Lowe (2013), Heft (1988), Lerstrup and van den Bosch (2017) and (Jansson & Anderssson, 2018) list and emphasise a number of more specific characteristics and functions suggested to be useful in the evaluation of playgrounds (see Table 1).

The various approaches to mapping children's outdoor environments aim at various purposes in research and practice and are also coloured by discipline. However, the above examples lack more fine-grained attention to the biodiversity of a setting; in which case, the concept of a play biotope could prove helpful. However, biotopes must be placed in the context of the larger landscape.

3.4 | Play biotope synergies between nature and child

There are surprisingly few efforts elaborating on the connection between child and nature, and intentionally work for a play setting design that can enhance contact and strengthen the interdependence between children and nature. Boldemann et al. (2006) discovered how physical activity and a healthy dose of sunlight were combined in spacious play areas where children also had access to more dense shrubbery. Further, Fjørtoft (2012) found forest areas with some complexity encouraged children to engage in versatile play that had positive effects on their motor development. In a school project, (Ito et al., 2018), created a more biodiverse schoolyard over the course of 12 years, including ecological learning, increased play and the ecosystems of vegetation and water. They pointed out the interdependence between the structural aspects of a landscape and its carrying capacity when it comes to various habitats for children, flora, and fauna. They had no outspoken ambition to create synergies between children and flora and fauna in particular places in this project. However, Ito et al. (2018) describes how the children—of their own accord—adapted their everyday routines so that their play did not disturb the fauna.

Instead of relying so much on plastic and steel, the use of nature-based solutions supports both humans and other species (van den Bosch & Sang, 2017). Thus, a play-biotope fulfils the prerequisites of being a nature-based solution: such as (1) being inspired and powered by nature (consisting of more natural elements than kit-carpet-fence); (2) addressing (societal) challenges or resolving problems (increased connection to nature and the conservation of nature); (3) providing multiple services/benefits, including biodiversity gain (increased play and conservation and increased biodiversity); and (4) are highly effective and economically efficient (might be cheaper than buying steel and plastic—although few studies exist comparing costs) (Sowinska-Swierkosz & García, 2021).

4 | PLAY BIOTOPES IN PRACTICE

There is a consensus in the scientific literature that green urban environments, especially those with high biodiversity, are important for children's health, learning abilities and the conservation of species. However, urban green spaces, especially areas with high

TABLE 1 Overview of the literature related to potential mapping features of play settings (inspired by Lerstrup & van den Bosch, 2017).

Heft (1988)	Woolley and Lowe (2013)	Lerstrup and van den Bosch (2017)	Jansson (2018, translated from Swedish)
Flat, relatively smooth surface	Range of fixed play equipment	Open ground	Area
Relatively smooth slope	Movable equipment	Sloping terrain	Complexity
Graspable/detached object	Open space allowing for activities	Shielded places	Playground equipment
Shelter	Different sizes and types of space	Rigid fixtures	Different materials
Aperture	Vegetation/trees	Moving fixtures	Nature
Attached object	Loose materials	Loose objects	Prerequisites for hide and seek, physical play, huts, fantasy and social play
Climbable object	Natural materials	Loose material	
Non-rigid attached object	Water and sand	Creatures	
Graspable/detached object	Obvious physical boundaries such as fencing	Fire	
Mouldable material	Seating opportunities		
Water			

biodiversity, are constantly being reduced. Apparently, there is a lack of understanding on how to combine urban nature with human well-being. Here, we suggest combining areas for children's play with areas of high biodiversity to create a win–win situation in multifunctional areas.

4.1 | Linking play biotopes to the larger landscape context

The existing literature on species often highlights the importance of a habitat in the larger urban context; for example, the surrounding matrix or amount of greenery in the city (Sidemo-Holm et al., 2022). However, the current literature on children and playgrounds rarely mentions adjacent habitats (habitats in close vicinity to playgrounds) or to the management of existing habitats. Thus, there is a need to place play biotopes into the larger context of landscape planning, management, and design. At the landscape and city scale, the connection of a habitat to a surrounding landscape-matrix is central for wide range of species; that is, many butterflies use several habitats during their life cycle, and many species have limited dispersal ranges (Soderstrom & Hedblom, 2007). In the same way, children use multiple environments and settings in their play, but often also have limited mobility on a city scale. Accordingly, mapping and analysing the extent, placement and connectivity of different biotopes on a city scale, can provide insights were biotopes are available as well as lacking in relation to children everyday life. It is recommended that people in general should not be more than 300 m away from nearest urban green area (van de Bosch et al., 2016), but younger children have supposedly an even shorter range and are dependent on the immediate surroundings of their school and home.

The size of a biotope is central to the numbers of a certain species it can support (Qiu et al., 2010). Similar to children's play, the size in relation to the number of children matters; both for the kind of play that is possible and also in relation to the total carrying capacity of the biotope. In the same way that many biotopes can benefit or at least not change severely within an intermediate to low disturbance regime (see the 'intermediate disturbance hypothesis'; Connell, 1978), a too-high disturbance level can degrade ecosystem function and habitat values. For example, low impact grazing often supports many species within a European context, but if a system is overgrazed, the system degenerates (Fraser et al., 2022). By increasing the available play-habitat, such negative effects can be reduced while at the same time increasing the total amount of habitats in the landscape. It also points towards that systems especially adapted to intermediate disturbances like coppice, wooded pastures, and shrub lands, which could be extra suitable as references for play biotopes and have synergies between play and biodiversity. See Table 2 for some of the main aspects of the information needed to map play biotopes, as well as for mapping species at different spatial levels.

Armed with knowledge of important requirements for target species and children's needs for play, mapping inventories would allow the identification of play areas and biodiversity concerns (Table 2). Target areas would include areas with different needs, such as biotope and play values reconstruction, biotope and play values rehabilitation (restoration), and conservation of existing biotope and play values (Table 3). These existing values are functions that could be improved through design and construction, management and maintenance, and monitoring and assessment (see Stanturf et al., 2014 see also Table 3). Thus, there is a possibility of identifying areas of conflicts and synergies—for example, areas with high biodiversity values that might be less suitable for increasing play if carrying capacity for play is low—whereas in other places, play values, through changed management, can be beneficial for both biodiversity and play. Based on this, suitable strategies departing from ecological restoration and conservation could be adapted to common actions and resources within urban landscape management (Table 3).

Depending on the location and content of a given biotope, it can have low or high values as a habitat for certain species or play activities. High biodiversity habitats or rare biotopes are often set aside for conservation with or without management actions. Similar existing biotopes of high playability often can be maintained with low resource management but require protection from urban development. In contrast, there exist places with clearly degraded or no biodiversity values such as lawns, where habitat creation through ecological restoration would be suitable with some adaptation towards a biotope design. This means focussing on creating specific vegetation structures and configurations that support play, as this could give rise to increased biodiversity and landscape connectivity while at the same time providing important play habitats and

Spatial level	Inventories needed for mapping play biotopes	Inventories needed for mapping biotopes for biodiversity
City	Landscape configuration—closeness to children, mobility of children	Landscape configuration—connectivity to other habitats and biotopes
District (within the city)	Size—carrying capacity for play (number of children that can play on a specific area before wear and tear occurs)	Size—carrying capacity for the species in question (size need for the species within a larger area)
Biotope (within the district)	Structure and composition—possibilities for different play	Structure and composition—ability to host and support different species

TABLE 2 Illustrating a theoretical overview of how to conduct inventories, analyses, strategies, and actions in a play biotope. Inventories and analyses conducted at different spatial levels (city, district, and biotope) needed for mapping play biotopes.

TABLE 3 Strategies and actions needed in a play biotope depending on whether it is a constructed (designed area), a natural area, or an area that is neither designed nor natural but in need of rehabilitation. The general need for different actions is ranked according to 'LOW', 'MID' or 'HIGH' to illustrate the assumed resource allocation in relation to different strategies.

Actions needed	Reconstruction of biotope & play areas	Rehabilitation of biotope & play areas	Conservation of biotope & play areas
Design & Construction	HIGH When suitable biotopes are lacking they need to be re-constructed from scratch	MID The quality of the biotope could be restored through enrichment planting, specific paths, etc.	LOW Since qualities are already high, creation of new elements is low and can focus on reducing negative effects
Management & Maintenance	HIGH To enable the establishment but also to direct the systems there is often a need for adequate management operations	HIGH Management is often essential in directing the biotope in the desired direction, through change cutting regimes, thinning, etc.	MID Management can often focus on maintaining existing qualities
Monitoring & Assessment	MID Monitoring can focus on making sure the overall development of the biotope follows overall aims and targets	MID Monitoring is needed to adapt management over time to support development in the desired direction	HIGH Monitoring is needed to avoid loss of existing qualities

niches. In between these extremes of high value biotopes and degraded lands is existing nature, like small forest remnants or similar (Hedblom & Soderstrom, 2008). Here, habitat rehabilitation of ecological values through, for example, changed cutting regimes of grasslands (Nassauer, 1995), veteranization (pollarding of relatively young trees), coppices or enrichment planting of flowering shrubs or field layer species can give rise to higher biodiversity values while creating important play settings. For example, Heyman et al. (2011) showed that managing a forest for increased recreational purposes (making it patch-wise and more open) did not change the overall biodiversity of birds. In the same way, existing small forest remnants often include many play values and settings, but these can also be enhanced or rehabilitated by management, for example by creating more loose material and complex vegetation structures.

As such, when developing play biotopes, it is beneficial to consider the different aspects presented in Table 3, to be able to understand where different actions give the most effect and can support synergies between play and biodiversity. Construction and rehabilitation especially could be of extra importance, since our overview suggests that within some categories it is more likely that both biodiversity and play values would benefit from these actions. However, only by first safeguarding and maintaining existing high biodiversity and play values is overall sustainability on a landscape scale possible. When developing such approaches, it is important to recognise that there is a need for adapting existing inventory and analytical approaches to capture both biodiversity and play value aspects. This would also enable the possibility to address the need for different resources and approaches depending on a given context, where construction will require larger investments in construction/landscaping and initial management compared to rehabilitation. Whereas the protection and preservation of high biodiversity values will often require less management and landscaping, but have a larger need for monitoring how specific species are effected.

4.2 | The affordance of dead wood as a play biotope

Dead wood is the most important factor influencing forest biodiversity in boreal, temporal and tropical forest (Jonsson et al., 2016). Approximately 7500 species are saprophytic (obtaining nourishment from the products of organic breakdown and decay), and dependent on dead trees in Nordic countries, mainly fungi and invertebrates (Jonsson et al., 2016; Stokland et al., 2012). Dead wood is often removed from existing forests, which are therefore missing a substrate in many parts of the world. At the same time, a piece of dead wood could be equal to a 'play niche' for children to balance on, climb onto, or build huts out of, and an 'ecological niche' for beetles and fungi. Dead wood provides an element in a play habitat for children by supporting particular types of play as exploration, positive and negative play, and physical play, as they investigate the texture of the piece of timber, carry it around, and attend to the insects living in it. Dead wood provides a niche with particular affordances, as the children climb on them, arrange them in a selection of positions, jump over or onto them, or sit by them for longer times, as it contributes to their overall attachment to the place (Figure 4).

The overall landscape configuration that allows for this kind of play is dependent on trees in various degrees of decay after cutting. Dead wood is an important indicator of old-growth forests and high biodiversity value (FOREST EUROPE, UNECE and FAO, 2011). Standing dead trees, lying dead trees and branches are all important for lichens, insects and birds feeding on insects. An example of a near-threatened species is *Cucujus cinnaberinus*, whose larvae need inner bark in recently dead wood. *Cucujus cinnaberinus* can use more than 30 different species of wood (Eckelt et al., 2014), dwell in urban areas as well as pristine forests, and can use stems that are small (Hörren & Tolkiehn, 2016). The age

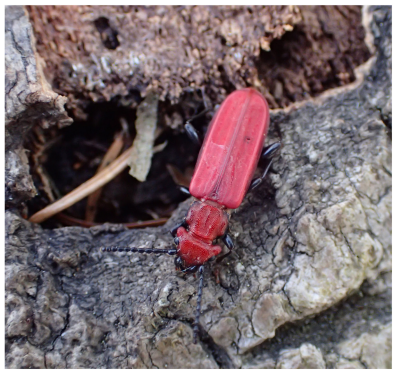

FIGURE 4 Left, hut built by children in the Landscape Laboratory at the SLU campus Sweden. Photo: Marcus Hedblom. Right—the beetle *Cucujus cinnaberinus* requires small or large dead lying or standing wood in its larva stage to survive. Photo by Niklas Lönnell/SLU/Artdatabanken.

and size of the stems or logs that are needed vary depending on the species and their niche.

Results from Heilmann-Clausen and Christensen (2004) reveal that not only large trees are important for fungal species biodiversity, but also, smaller trees and branches appear to be more species-dense and support considerably higher number of species per volume unit than larger specimens. (Heilmann-Clausen & Christensen, 2004) further suggest that the cheapest and most efficient way to increase saprophytic diversity in managed forests is to increase the amounts of small-diameter dead wood. In peri-urban forests in Sweden (up to 5000 m from the city border), there is a higher proportion of deadwood than the average forested landscape in Sweden (Hedblom & Soderstrom, 2008). Closest to the city centre, there is a lesser proportion of dead wood than in the average forested landscape in Sweden. However, on an urban–rural gradient from the peri-urban to the city centre in 34 Swedish cities and 474 urban forests, there were increasingly more children's huts made of dead branches closer to the city centre than in the peri-urban areas in Swedish cities (Hedblom & Soderstrom, 2008).

To allow dead wood in cities, it is necessary to change the normative conception of dead wood away from something non-aesthetic or 'messy'. This goes for any 'messy' ecosystem, and Nassauer (1995) suggested we put nature into 'orderly frames'. As for meadows, they can be cut along the edges or allow higher grass, as long as there are cut paths in the middle (Nassauer, 1995). Thus, piles of dead wood or huts made by children would be referred to as 'orderly frames'. However, acceptance of dead wood among young adults is quite high (Heyman, 2012) and positively affected by information of its benefits (Gundersen et al., 2017). Furthermore, seeing the place from the perspective of the play biotopes, it becomes more evident to planners and managers that dead wood is an essential part of both biodiversity and play for children.

4.3 | Applying theories into practice—Case study of play biotope

The development of a transdisciplinary project in the city of Örebro (population 126,000) in Sweden in 2020–2022 had an outspoken goal of developing play biotopes in line with overall city policies to make playgrounds more nature-based. The focus of the development was on material from nature and a dedication to work with natural processes, including different seasons and successions. The vision was not to create a pristine natural site, but elaborations and interpretations of nature by making use of the particularities of soil, mud water, trees, herbs and other elements. Additionally, the idea was that traditional playgrounds are often considered boring and that free play outdoors should be more adventurous and also allow the inclusion of the so-called 'risky play' (Örebro, 2017).

The process of establishing play biotopes did not follow common practice for developments of a public place, which is based on an exact blueprint drawing from a landscape architect and built accordingly. Instead, the work involved a more hands-on approach in a dynamic process using general sketches and in situ meetings discussing actual solutions and additional online digital seminars on topics like establishment, the design of nature-based play landscapes, and co-creation with children (Mårtensson et al., 2022). For example, during the construction of the 'meadow hills', children from a nearby kindergarten played in the area overseen by teachers, a city planner and a researcher. The process was highly multidisciplinary and involved researchers (environmental psychology, ecology, vegetation and design) and municipal staff (ecologists and landscape engineers together with landscape architects) in close dialogue with the people on excavators doing the job in the field. The general approach was to incorporate some already existing landscape features such as an existing ditch and a small woodland in the sketches. Then general sketches of play biotopes were made by a consulting landscape architect company (Figure 5; Beckman et al., 2022). Illustrative of the dynamic process was, for example, when officials worked together with staff manning excavators in the field to fine-tune and adapt the design to the actual conditions at the site. Thus, major changes in the design were made in situ and sometimes involved local project managers, project leaders, the landscape architect doing the sketches, and researchers from the university. For example, the form of the manufactured hills and topography was adapted on site to take advantage of a surplus of soil and large rocks from a nearby road construction project.

This dynamic process allows some critique against established work procedures in municipalities. Traditional playgrounds are developed separate from the actual conditions of a particular site, which means that they do not take into consideration the surrounding

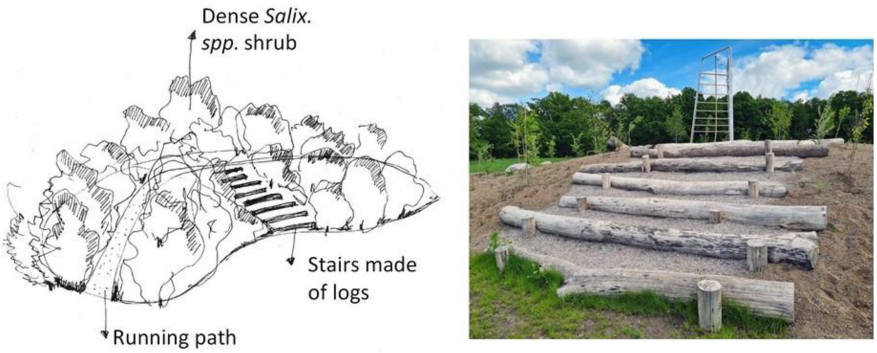

FIGURE 5 Left—Sketch on a hill made by Landscape architect. Right, an example of implemented sketch. Photo and copyright URBIO.

landscape or existing features of a place such as ponds, large trees, minor woodlands, or hills. In Örebro, the landscape architect elaborated on the design in the field, making it easier for professionals of various backgrounds to add potential information and increase collaboration. This more dialogue-based and hands-on design seems necessary, thanks in large part to the complexity involved in creating play biotopes.

This approach also made it possible to use different site-specific approaches spanning some of the approaches suggested in Table 3. For example, very low impact measures (conservation) were used for a small wetland thicket to add boardwalks. Furthermore, rehabilitation and improvement of play values were executed by thinning the existing woodland patch to promote a more varied edge structure, which often also is positive for many species. Lastly, the construction of new biotopes, such as those illustrated in Figure 5 of existing poor grasslands created more flower-rich vegetation with exposed sand patches.

5 | CONCLUSIONS

In this paper, we highlight the potential of combining children's play, learning skills and health with species habitats by designing and managing multifunctional green spaces. Children are increasingly disconnected from nature leading to more knowledge of, for example TV series than local flora and fauna. Yet, children who engage in free play outdoors form a lifelong affinity with nature. There seems to be a consensus in the scientific literature that urban green environments—especially those with high biodiversity—are important for children's health, learning abilities and species conservation. However, play settings are almost never designed and rarely manage to create synergistic effects between rehabilitating habitats and conserving them for species as well as promoting children's play, learning and health. We suggest a path forward regarding how best to achieve this by highlighting the conceptual framework of a 'play biotope'. A play biotope refers to concepts in biology, elaborating on 'habitat', representing a particular area for a particular type of play, while 'niche' could denote the particular activities that occur inside said habitat. The concept of play biotopes is supportive of the work involved in creating multifunctional green outdoor areas. We illustrate the play biotope concept by highlighting dead wood as a substrate for conserving beetles and fungi, as well as affordances for children in balancing, climbing or making huts. We further illustrate the challenges to overcome in practice with a case study. The case study revealed the need for a dynamic non-traditional planning process using general sketches, in situ meetings discussing actual solutions, seminars on establishment—plantation—and nature-centric design based play landscapes and co-creation with children; all of which are necessary to make play biotopes a reality.

AUTHOR CONTRIBUTIONS

Marcus Hedblom, Fredrika Mårtensson, Åsa Ode Sang, Anna Litsmark and Björn Wiström conceived the ideas and provided the concept of the manuscript. Marcus Hedblom and Fredrika Mårtensson equally engaged in the main writing of the manuscript with substantial support from Åsa Ode Sang, Anna Litsmark and Björn Wiström. All authors contributed critically to the drafts and gave final approval for publication.

ACKNOWLEDGEMENTS

We would like to thank Sally Anderson at Aarhus University in Denmark for her valuable input and thorough review of the manuscript, Örebro municipality, and, in particular, Mimmi Beckman, Gustav Älgå, and Emma Simonsson at URBIO. This study was funded by the REGREEN Nature-based (regreen-project.eu/), which enabled inter- and transdisciplinary collaboration. The REGREEN Nature-based Solutions project received funding from the Horizon 2020 Framework Programme in EU under grant agreement no 821016.

CONFLICT OF INTEREST STATEMENT

No conflict of interest.

DATA AVAILABILITY STATEMENT

The manuscript does not include any data.

ORCID

Marcus Hedblom https://orcid.org/0000-0003-1594-8665
Åsa Ode Sang https://orcid.org/0000-0003-0982-0155
Björn Wiström https://orcid.org/0000-0002-0179-0062

REFERENCES

Aerts, R., Honnay, O., & Van Nieuwenhuyse, A. (2018). Biodiversity and human health: Mechanisms and evidence of the positive health effects of diversity in nature and green spaces. *British Medical Bulletin*, *127*(1), 5–22. https://doi.org/10.1093/bmb/ldy021

Ainsworth, D. (2022). *Nations Adopt Four Goals, 23 Targets for 2030 In Landmark UN Biodiversity Agreement*.

Aronson, M. F. J., La Sorte, F. A., Nilon, C. H., Katti, M., Goddard, M. A., Lepczyk, C. A., Warren, P. S., Williams, N. S., Cilliers, S., Clarkson, B., Dobbs, C., Dolan, R., Hedblom, M., Klotz, S., Kooijmans, J. L., Kühn, I., Macgregor-Fors, I., McDonnell, M., Mörtberg, U., … Winter, M. (2014). A global analysis of the impacts of urbanization on bird and plant diversity reveals key anthropogenic drivers. *Proceedings of the Royal Society B: Biological Sciences*, *281*(1780), 20133330. https://doi.org/10.1098/rspb.2013.3330

Balmford, A., Clegg, L., Coulson, T., & Taylor, J. (2002). Why conservationists should heed Pokemon. *Science*, *295*(5564), 2367.

Bartos, A. E. (2013). Children sensing place. *Emotion, Space and Society*, *9*, 89–98. https://doi.org/10.1016/j.emospa.2013.02.008

Bassett, D. R., John, D., Conger, S. A., Fitzhugh, E. C., & Coe, D. P. (2015). Trends in physical activity and sedentary behaviors of United States youth. *Journal of Physical Activity & Health*, *12*(8), 1102–1111. https://doi.org/10.1123/jpah.2014-0050

Beckman, M., Simonsson, E., & Eriksson, E. (2022). Lekotoper - en vägledning för naturlika gröna leklandskap. https://movium.slu.se/media/uvcfot2b/lekotoper_vagledning.pdf

Bixler, R. D., & Floyd, M. F. (1997). Nature is scary, disgusting, and uncomfortable. *Environment and Behavior*, *29*(4), 443–467. https://doi.org/10.1177/001391659702900401

Bixler, R. D., Floyd, M. F., & Hammitt, W. E. (2002). Environmental socialization—Quantitative tests of the childhood play hypothesis. *Environment and Behavior*, *34*(6), 795–818. https://doi.org/10.1177/001391602237248

Boldemann, C., Söderström, M., Mårtensson, F., Moore, R., Cosco, N., Bieber, B., Pagels, P., Raustorp, A., & Wester, U. (2006). The health-promoting potential of preschool outdoor environments: Linking research to policy. In *Revisiting "social factors": Advancing research into people and place*. Cambridge Scholars Publishing.

Boverket. (2015). Boverkets allmänna råd (2015:1) om friyta för lek och utevistelse vid fritidshem, förskolor, skolor eller liknande verksamhet (Swedish).

Burke, C. (2005). Play in focus: Children researching their own spaces and places for play. *Children, Youth and Environments*, *15*(1), 27–53.

Chawla, L. (2020). Childhood nature connection and constructive hope: A review of research on connecting with nature and coping with environmental loss. *People and Nature*, *2*(3), 619–642. https://doi.org/10.1002/pan3.10128

Clements, R. (2004). An investigation of the status of outdoor play. *Contemporary Issues in Early Childhood*, *5*(1), 68–80.

Connell, J. H. (1978). Diversity in tropical rain forests and coral reefs—High diversity of trees and corals is maintained only in a non-equilibrium state. *Science*, *199*(4335), 1302–1310. https://doi.org/10.1126/science.199.4335.1302

Cooper, A. R., Goodman, A., Page, A. S., Sherar, L. B., Esliger, D. W., van Sluijs, E. M. F., Andersen, L. B., Anderssen, S., Cardon, G., Davey, R., Froberg, K., Hallal, P., Janz, K. F., Kordas, K., Kreimler, S., Pate, R. R., Puder, J. J., Reilly, J. J., Salmon, J., … Ekelund, U. (2015). Objectively measured physical activity and sedentary time in youth: The international children's accelerometry database (ICAD). *International Journal of Behavioral Nutrition and Physical Activity*, *12*, 113. https://doi.org/10.1186/s12966-015-0274-5

Dadvand, P., Nieuwenhuijsen, M. J., Esnaola, M., Forns, J., Basagana, X., Alvarez-Pedrerol, M., Rivas, I., López-Vicente, M., De Castro Pascual, M., Su, J., Jerrett, M., Querol, X., & Sunyer, J. (2015). Green spaces and cognitive development in primary schoolchildren. *Proceedings of the National Academy of Sciences of the United States of America*, *112*(26), 7937–7942. https://doi.org/10.1073/pnas.1503402112

Dyment, J. E., & Bell, A. C. (2008). Grounds for movement: Green school grounds as sites for promoting physical activity. *Health Education Research*, *23*(6), 952–962. https://doi.org/10.1093/her/cym059

Eckelt, A., Paill, W., & Straka, U. (2014). Viel gesucht und oft gefunden. Der Scharlachkäfer Cucujus cinnaberinus (Scopoli,1763) und seine aktuelle Verbreitung in Österreich. *Wissenschaftliches Jahrbuch der Tiroler Landesmuseen*, *7*, 145–159.

Elbakidze, M., Dawson, L., van Ermel, L. E. K., Mikuski, G., Hedblom, M., Korohoda, N., Kruhlov, I., Smaliychuk, A., Kurdadze, T., Ugrekhelidze, K., Ongena, Y., Sayadyan, H., Galstyan, M., & Grodzinska, O. (2023). Understanding people's interactions with urban greenspace: Case studies in Eastern Europe. *Urban Forestry & Urban Greening*, *89*, 128117. https://doi.org/10.1016/j.ufug.2023.128117

Engemann, K., Pedersen, C. B., Arge, L., Tsirogiannis, C., Mortensen, P. B., & Svenning, J. C. (2019). Residential green space in childhood is associated with lower risk of psychiatric disorders from adolescence into adulthood. *Proceedings of the National Academy of Sciences of the United States of America*, *116*(11), 5188–5193. https://doi.org/10.1073/pnas.1807504116

Fjørtoft, I. (2012). Barnas lekebiotoper – ett landskapsekologiskt perspektiv på barns bruk av uteområder. In A. Krogstad, G. K. Hansen, K. HØyland, & T. Moser (Eds.), *Flerfaglige perspektiv på barnehagens fysiska miljö*. Bergen Vigmostad och Björke AS.

Fjørtoft, I., & Sageie, J. (2000). The natural environment as a playground for children—Landscape description and analyses of a natural playscape. *Landscape and Urban Planning*, *48*(1–2), 83–97. https://doi.org/10.1016/S0169-2046(00)00045-1

Flannigan, C., & Dietze, B. (2017). Children, outdoor play, and loose parts. *Journal of Childhood Studies*, *42*(4), 53–60.

FOREST EUROPE, UNECE and FAO. (2011). State of Europe's Forests 2011. Status and Trends in Sustainable Forest Management in Europe. https://unece.org/fileadmin/DAM/publications/timber/Forest_Europe_report_2011_web.pdf

Fraser, M. D., Vallin, H. E., & Roberts, B. P. (2022). Animal board invited review: Grassland-based livestock farming and biodiversity. *Animal*, *16*(12), 100671. https://doi.org/10.1016/j.animal.2022.100671

Freeman, C., Stein, A., Hand, K., & van Heezik, Y. (2018). City children's nature knowledge and contact: It is not just about biodiversity provision. *Environment and Behavior*, *50*(10), 1145–1171. https://doi.org/10.1177/0013916517732108

Gao, F., Guo, Q., Wang, B. B., Cao, S. Z., Qin, N., Zhao, L. Y., Jia, C., & Duan, X. L. (2022). Distributions and determinants of time spent outdoors among school-age children in China. *Journal of Exposure Science & Environmental Epidemiology*, *32*(2), 223–231. https://doi.org/10.1038/s41370-021-00401-w

Gaston, K. J., & Soga, M. (2020). Extinction of experience: The need to be more specific. *People and Nature*, *2*(3), 575–581. https://doi.org/10.1002/pan3.10118

Gibson, J. (1979). *The theory of affordances*. Houghton Mifflin.

Gray, C., Gibbons, R., Larouche, R., Sandseter, E. B. H., Bienenstock, A., Brussoni, M., Chabot, G., Herrington, S., Janssen, I., Pickett, W., Power, M., Stanger, N., Sampson, M., & Tremblay, M. S. (2015). What is the relationship between outdoor time and physical activity, sedentary behaviour, and physical fitness in children? A systematic review. *International Journal of Environmental Research and Public Health*, *12*(6), 6455–6474. https://doi.org/10.3390/ijerph120606455

Gundersen, V., Stange, E. E., Kaltenborn, B. P., & Vistad, O. I. (2017). Public visual preferences for dead wood in natural boreal forests: The effects of added information. *Landscape and Urban Planning*, *158*, 12–24. https://doi.org/10.1016/j.landurbplan.2016.09.020

Gustavsson, R. (2004). *Exploring woodland design: Designing with complexity and dynamics—Woodland types, their dynamic architecture and establishment*. Taylor&Francis.

Hansen, R., & Pauleit, S. (2014). From multifunctionality to multiple ecosystem services? A conceptual framework for multifunctionality in green infrastructure planning for urban areas. *Ambio*, *43*(4), 516–529. https://doi.org/10.1007/s13280-014-0510-2

Hart, R. (1979). *Children's experience of place* (H. Press (Ed.)). Irvington Publishers.

Hedblom, M., Gunnarsson, B., Iravani, B., Knez, I., Schaefer, M., Thorsson, P., & Lundstrom, J. N. (2019). Reduction of physiological stress by urban green space in a multisensory virtual experiment. *Scientific Reports*, *9*, 10113. https://doi.org/10.1038/s41598-019-46099-7

Hedblom, M., & Soderstrom, B. (2008). Woodlands across Swedish urban gradients: Status, structure and management implications. *Landscape and Urban Planning*, *84*(1), 62–73. https://doi.org/10.1016/j.landurbplan.2007.06.007

Heft, H. (1988). *Affordance of childrens environments, a functional approach to environmental description* (Vol. *5*, pp. 29–37). Denison University.

Heilmann-Clausen, J., & Christensen, M. (2004). Does size matter? On the importance of various dead wood fractions for fungal diversity in Danish beech forests. *Forest Ecology and Management*, *201*(1), 105–119. https://doi.org/10.1016/j.foreco.2004.07.010

Herrington, S., & Brussoni, M. (2015). Beyond physical activity: The importance of play and nature-based play spaces for Children's health and development. *Current Obesity Reports*, *4*(4), 477–483. https://doi.org/10.1007/s13679-015-0179-2

Heyman, E. (2012). Analysing recreational values and management effects in an urban forest with the visitor-employed photography method. *Urban Forestry & Urban Greening*, *11*(3), 267–277. https://doi.org/10.1016/j.ufug.2012.02.003

Heyman, E., Gunnarsson, B., Stenseke, M., Henningsson, S., & Tim, G. (2011). Openness as a key-variable for analysis of management trade-offs in urban woodlands. *Urban Forestry & Urban Greening*, *10*(4), 281–293. https://doi.org/10.1016/j.ufug.2011.07.003

Hörren, T., & Tolkiehn, J. (2016). Erster Nachweis von Cucujus cinnaberinus (Scopoli, 1763) in Schleswig-Holstein—Eine FFH-Art erschließt sich Lebensräume in Norddeutschland (Coleoptera: Cucujidae). *Entomologische Zeitschrift*, *126*, 208–210.

Houser, N. E., Cawley, J., Kolen, A. M., Rainham, D., Rehman, L., Turner, J., Kirk, S. F. L., & Stone, M. R. (2019). A loose parts randomized controlled trial to promote active outdoor play in preschool-aged children: Physical literacy in the early years (PLEY) project. *Methods and Protocols*, *2*(2), 27. https://doi.org/10.3390/mps2020027

IPBES. (2019). *Global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services*.

Ito, K., Sudo, T., & Fjortoft, I. (2018). *Ecological design: Collaborative landscape design with shool children* (A. Murnaghan & L. J. Shillington, LJ. (Ed.), pp. 195–209). Children, Nature, Cities Routledge.

Jansson, M., & Anderssson, C. (2018). *Lekplatsers kvalitet—verktyg för värdering och utveckling* (*Swedish*).

Jansson, M., Martensson, F., & Gunnarsson, A. (2018). The meaning of participation in school ground greening: A study from project to everyday setting. *Landscape Research*, *43*(1), 163–179. https://doi.org/10.1080/01426397.2017.1306623

Jansson, M., & Persson, B. (2010). Playground planning and management: An evaluation of standard-influenced provision through user needs. *Urban Forestry & Urban Greening*, *9*(1), 33–42. https://doi.org/10.1016/j.ufug.2009.10.003

Jonsson, B. G., Ekstrom, M., Esseen, P. A., Grafstrom, A., Stahl, G., & Westerlund, B. (2016). Dead wood availability in managed Swedish forests—Policy outcomes and implications for biodiversity. *Forest Ecology and Management*, *376*, 174–182. https://doi.org/10.1016/j.foreco.2016.06.017

Kahn, P., & Kellert, S. (2002). *Children and nature: Psychological, sociocultural, and evolutionary investigations*. The MIT Press.

Karsten, L. (2005). It all used to be better? Different generations on continuity and change in urban children's daily use of space. *Children's Geographies*, *3*(3), 275–290. https://doi.org/10.1080/14733280500352912

Kingsbury, N. (2004). *Contemporary overview of naturlastic planting design*. Taylor & Francis.

Kylin, M., & Bodelius, S. (2015). Riktlinjer för lek? Svenska kommuners arbete med planering av platser för barn (In Swedish). In *Reflektioner kring hur föreställningar om barn och barndom påverkar utformningen av staden*. Sveriges lantbruksuniversitet.

Lerstrup, I., & van den Bosch, C. K. (2017). Affordances of outdoor settings for children in preschool: Revisiting heft's functional taxonomy. *Landscape Research*, *42*(1), 47–62. https://doi.org/10.1080/01426397.2016.1252039

Little, H., & Sweller, N. (2015). Affordances for risk-taking and physical activity in Australian early childhood education settings. *Early Childhood Education Journal*, *43*(4), 337–345. https://doi.org/10.1007/s10643-014-0667-0

Louv, R. (2008). *Last child in the woods: Saving our children from nature deficit disorder*. Algonquin.

Lovell, S. T., & Taylor, J. R. (2013). Supplying urban ecosystem services through multifunctional green infrastructure in the United States. *Landscape Ecology*, *28*(8), 1447–1463. https://doi.org/10.1007/s10980-013-9912-y

Lynch, K., & Banerjee, T. (1976). Growing up in Cities. *New Society*, *37*(722), 281–284.

Marselle, M. R., Hartig, T., Cox, D. T. C., de Bell, S., Knapp, S., Lindley, S., Triguero-Mas, M., Böhning-Gaese, K., Braubach, M., Cook, P. A., de Vries, S., Heintz-Buschart, A., Hofmann, M., Irvine, K. N., Kabisch, N., Kolek, F., Kraemer, R., Markevych, I., Martens, D., … Bonn, A. (2021). Pathways linking biodiversity to human health: A conceptual framework. *Environment International*, *150*, 106420. https://doi.org/10.1016/j.envint.2021.106420

Martensson, F. (2004). *Landskapet i leken, En studie av utomhuslek på förskolegården (in Swedish)* (Agraria 464). Swedish University of Agricultural sciences.

Martensson, F. (2013). Guiding environmental dimensions for outdoor play. *Socialmedicinsk Tidskrift*, *4*, 658–665.

Martensson, F., Boldemann, C., Soderstrom, M., Blennow, M., Englund, J. E., & Grahn, P. (2009). Outdoor environmental assessment of attention promoting settings for preschool children. *Health & Place*, *15*(4), 1149–1157. https://doi.org/10.1016/j.healthplace.2009.07.002

Mårtensson, F., Litsmark, A., Wiström, B., & Hedblom, M. (2022). *Lekotoper—Platser där både barn och natur trivs*. Retrieved from: MOVIUM.

Moore, R. C. (1986). *Childhood's domain: Play and place in child development*. Routledege.

Mygind, L., Kurtzhals, M., Nowell, C., Melby, P. S., Stevenson, M. P., Nieuwenhuijsen, M., Lum, J. A. G., Flensborg-Madsen, T., Bentsen, P., & Enticott, P. G. (2021). Landscapes of becoming social: A systematic review of evidence for associations and pathways between interactions with nature and socioemotional development in children. *Environment International*, *146*, 106238. https://doi.org/10.1016/j.envint.2020.106238

Nassauer, J. I. (1995). Messy ecosystems, orderly frames. *Landscape Journal*, *14*(2), 161–170.

Nicholson, S. (1971). How not to cheat children: The theory of loose parts. *Landscape Architecture*, *62*, 30–35.

Nordström, M. (1990). *Barns boendeföreställningar i ett utvecklingspsykologiskt perspektiv* [*Children's notions of how they would like*

to live: *a developmental psychology perspective*]. Retrieved from: Gävle23.

Noschis, K. (1992). Child development theory and planning for neighbourhood play. *Children's Environments*, *9*, 3–9.

Nyberg, E., & Sanders, D. (2014). Drawing attention to the 'green side of life'. *Journal of Biological Education*, *48*(3), 142–153. https://doi.org/10.1080/00219266.2013.849282

Örebro. (2017). *Riktlinjer för Örebro kommuns lekplatser*. https://www.orebro.se/download/18.5343a44a16a31b1864f27bb/1557387286219/Riktlinjer%20f%C3%B6r%20%C3%96rebro%20kommuns%20lekplatser.pdf

Pauleit, S., Hansen, R., Rall, E. L., & Rolf, W. (2021). URBAN GREEN INFRASTRUCTURE Strategic planning of URBAN green and blue for multiple benefits. In *Routledge Handbook of Urban Ecology* (2nd ed., pp. 931–942). Routledge.

Pitsikali, A., & Parnell, R. (2020). Fences of childhood: Challenging the meaning of playground boundaries in design. *Frontiers of Architectural Research*, *9*(3), 656–669. https://doi.org/10.1016/j.foar.2020.03.001

Polechova, J., & Storch, D. (2019). Ecologcial Niche. In B. Fath (Ed.), *Encyclopedia of ecology* (Vol. *3*, pp. 72–80). Elsevier.

Puhakka, R., Rantala, O., Roslund, M. I., Rajaniemi, J., Laitinen, O. H., Sinkkonen, A., & ADELE Research Group. (2019). Greening of day-care yards with biodiverse materials affords well-being, play and environmental relationships. *International Journal of Environmental Research and Public Health*, *16*(16), 2948. https://doi.org/10.3390/ijerph16162948

Pysander, E. L. S., Martensson, F., Waern, A., Litsmark, A., Hedblom, M., Raustorp, A., Ghilagaber, G., & Zhu, H. (2024). Nature and digitalization challenging the traditional playground. *Urban Forestry & Urban Greening*, *93*, 128148. https://doi.org/10.1016/j.ufug.2023.128148

Qiu, L., Gao, T. A., Gunnarsson, A., Hammer, M., & von Bothmer, R. (2010). A methodological study of biotope mapping in nature conservation. *Urban Forestry & Urban Greening*, *9*(2), 161–166. https://doi.org/10.1016/j.ufug.2010.01.003

Randler, C., Diaz-Morales, J. F., Jokimaki, J., Ortiz-Pulido, R., Staller, N., De Salvo, M., Tryjanowski, P., Tsai, J. S., de Almeida Barbosa, R., & Kaisanlahti-Jokimaki, M. L. (2023). Birding recreation specialization—A test of the factorial invariance in eight languages. *Journal of Leisure Research*, *54*(3), 330–336. https://doi.org/10.1080/00222216.2022.2117578

Rodaway, P. (1994). *Sesous geographics*. Routledge.

Roslund, M. I., Puhakka, R., Gronroos, M., Nurminen, N., Oikarinen, S., Gazali, A. M., Cinek, O., Kramná, L., Siter, N., Vari, H. K., Soininen, L., Parajuli, A., Rajaniemi, J., Kinnunen, T., Laitinen, O. H., Hyöty, H., Sinkkonen, A., & ADELE Research Group. (2020). Biodiversity intervention enhances immune regulation and health-associated commensal microbiota among daycare children. *Science Advances*, *6*(42), eaba2578. https://doi.org/10.1126/sciadv.aba2578

Ruff, A. R. (1987). *Holland and the ecological landscape 1973–1987*. Delft: Delft University Press.

Sandberg, A. (2002). *Vuxnas lekvärld: en studie om vuxnas erfarenheter av l*. Gothenburg University.

Sandseter, E. B. H. (2010). 'It tickles in my tummy!' understanding children's risk-taking in play through reversal theory. *Journal of Early Childhood Research*, *8*(1), 67–88. https://doi.org/10.1177/1476718x09345393

Seto, K. C., Guneralp, B., & Hutyra, L. R. (2012). Global forecasts of urban expansion to 2030 and direct impacts on biodiversity and carbon pools. *Proceedings of the National Academy of Sciences of the United States of America*, *109*(40), 16083–16088. https://doi.org/10.1073/pnas.1211658109

Sidemo-Holm, W., Ekroos, J., García, S. R., Söderström, B., & Hedblom, M. (2022). Urbanization causes biotic homogenization of woodland bird communities at multiple spatial scales. *Global Change Biology*, *28*(21), 6152–6164. https://doi.org/10.1111/gcb.16350

Soderstrom, B., & Hedblom, M. (2007). Comparing movement of four butterfly species in experimental grassland strips. *Journal of Insect Conservation*, *11*(4), 333–342. https://doi.org/10.1007/s10841-006-9046-5

Soga, M., & Gaston, K. J. (2016). Extinction of experience: The loss of human-nature interactions. *Frontiers in Ecology and the Environment*, *14*(2), 94–101. https://doi.org/10.1002/fee.1225

Soga, M., & Gaston, K. J. (2023). Nature benefit hypothesis: Direct experiences of nature predict self-reported pro-biodiversity behaviors. *Conservation Letters*, *16*(3), e12945. https://doi.org/10.1111/conl.12945

Sowinska-Swierkosz, B., & García, J. (2021). A new evaluation framework for nature-based solutions (NBS) projects based on the application of performance questions and indicators approach. *Science of the Total Environment*, *787*, 147615. https://doi.org/10.1016/j.scitotenv.2021.147615

Stanturf, J. A., Palik, B. J., & Dumroese, R. K. (2014). Contemporary forest restoration: A review emphasizing function. *Forest Ecology and Management*, *331*, 292–323. https://doi.org/10.1016/j.foreco.2014.07.029

Stokland, J., Sitonen, J., & Jonsson, B. G. (2012). *Biodiversity in deadwood*. Camebridge University Press.

Taylor, A. F., & Kuo, F. E. (2009). Children with attention deficits concentrate better after walk in the park. *Journal of Attention Disorders*, *12*(5), 402–409. https://doi.org/10.1177/1087054708323000

Tuan, Y. F. (1977). *Space and place: The perspective of experience*. University of Minnesota Press.

Turvey, M. T. (2013). *Ecological perspective on perception-action: What kind of science does it entail?* (pp. 139–170). Action Science: Foundations of an Emerging Discipline.

UN. (2023). *Population under age 18*. United Nations, Department of Economic and Social Affairs, Population Division (2022). World Population Prospects 2022. Online Edition. https://data.unicef.org/how-many/how-many-children-under-18-are-in-the-world/

UNICEF. (2022). *Strategic note on UNICEF'S work for children in urban settings*.

van de Bosch, M. A., Mudu, P., Uscila, V., Barrdahl, M., Kulinkina, A., Staatsen, B., Swart, W., Kruize, H., Zurlyte, I., & Egorov, A. I. (2016). Development of an urban green space indicator and the public health rationale. *Scandinavian Journal of Public Health*, *44*(2), 159–167. https://doi.org/10.1177/1403494815615444

van den Bosch, M., & Sang, A. O. (2017). Urban natural environments as nature based solutions for improved public health—A systematic review of reviews. *Journal of Transport & Health*, *5*, S79. https://doi.org/10.1016/j.jth.2017.05.230

Vidal, D. G., & Seixas, E. C. (2022). Children's green infrastructure: Children and their rights to nature and the City. *Frontiers in Sociology*, *7*, 804535. https://doi.org/10.3389/fsoc.2022.804535

Vujcic, M., & Tomicevic-Dubljevic, J. (2018). Urban forest benefits to the younger population: The case study of the city of Belgrade, Serbia. *Forest Policy and Economics*, *96*, 54–62. https://doi.org/10.1016/j.forpol.2018.08.006

Wagman, J. B. (2020). A guided tour of Gibson's theory of affordances. In J. B. Wagman & J. J. C. Blau (Eds.), *Perception as information detection: Reflections on Gibson's ecological approach to visual perception* (pp. 130–148). New York: Routledge.

Wales, M., Hoff, E., Mårtensson, F., & Englund, J. E. (2024). The quality of Swedish adolescents' outdoor life and its relationship with self-esteem and well-being. *Landscape and Urban Planning*, *246*, 105023. https://doi.org/10.1016/j.landurbplan.2024.105023

Wells, N. M., & Lekies, K. S. (2006). Nature and the life course: Pathways from childhood nature experiences to adult environmentalism. *Children, Youth and Environments*, *16*(1), 1–24.

WHO. (2017). *Urban green spaces: A brief for action*. World Health Organization. Retrieved from Regional Office for Europe.

Wilson, R. (1997). A sense of place. *Early Childhood Education Journal*, *24*(3), 191–194.

Woolley, H. (2007). Where do the children play? How policies can influence practice. *Proceedings of the Institution of Civil Engineers: Municipal Engineer*, *160*(2), 89–95. https://doi.org/10.1680/muen.2007.160.2.89

Woolley, H., & Lowe, A. (2013). Exploring the relationship between design approach and play value of outdoor play spaces. *Landscape Research*, *38*(1), 53–74. https://doi.org/10.1080/01426397.2011.640432

How to cite this article: Hedblom, M., Mårtensson, F., Sang, Å. O., Wiström, B., & Litsmark, A. (2024). Play biotopes put into practice—Creating synergies between children and nature. *People and Nature*, *6*, 2046–2059. https://doi.org/10.1002/pan3.10708