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RESEARCH ARTICLE

Creating nature-based play settings for children through looking, listening, learning and modifying in a Swedish landscape laboratory

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Abstract

Children's outdoor play and access to nature are important for their health and development of environmental agency but there is a global decline of green spaces available to them. The aim is to explore the possibilities of creating nature-based outdoor settings for play and learning which benefit children as well as the wildlife and wider ecosystems. A fieldwork on developing nature based play settings in an outdoor landscape laboratory in Sweden involved university students (3 days) and children, two groups of 3–5 years olds (8 days) and one group of 6-year-olds (4 days). Field notes from ethnographic work was at the core of the process and involved practitioners and scholars in landscape architecture, vegetation design, ecology and environmental psychology. An iterative place-based process of learning guided the process, including following phases: (1) looking and listening attentive to the physical environment and to the children´s activities in a setting (2) transdisciplinary learning based on results from the analysis of field notes and the dialogues, and, (3) modifications of settings. In two of the five settings investigated an intervention to improve the setting was set up, followed by further investigations, illustrating the iterative character of the process with elements of co-creation. The results reveal the potentials in collaborative work setting out to develop features in nature as woodland, meadow, water and paths, so that they align well with children´s needs as well as nature conservation. The material should be useful in efforts to make natural environment more accessible to children and to the conceptual development of play biotopes, useful in the design and management of sustainable living environments.

Keywords Nature-based solutions · Urban planning · Children's play · Landscape laboratory · Environmental psychology · Outdoor education

1 Introduction

One of the challenges of planning is to stay responsive to children's place preferences, achieving the human-environmental fit (Moser 2016) critical for health and life satisfaction (Kyttä and Broberg 2014) in human settlements. Children's outdoor play and access to nature are considered essential for healthy childhoods and environmental stewardship (Aasen et al. 2009; Chawla 2015, 2020; Maes et al. 2021; Mygind et al. 2019; Puhakka et al. 2019; Wales et al. 2022). Green and varied outdoor spaces support vigorous and varied play (Fjørtoft and Sagie 2000; Mårtensson 2004; Sallnäs Pysander et al. 2023), with documented restorative characteristics that support children's self-regulation, well-being and overall development (Kuo and Faber Taylor 2004; Mårtensson et al. 2009; Mygind et al. 2019). The presence of nature is key for making outdoor spaces attractive (e.g. Moore 1990; Johansson et al. 2020; Mårtensson 2004; Wales et al. 2022). Its abundance of loose parts (Fjørtoft and Sagie 2000; Nicholson 1971) and its ambiguous, ever-changing character (Sebba 1991) captivate children, encouraging them to use and explore their surroundings (Kahn 1997).

If no action is taken, current trends of nature degradation on a global scale will lead to further undermining of

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children's traditional play habits (Gaston and Soga 2020; Imai et al. 2019). More artificial play settings of the 'kit-carpet-fence' model, adapted to denser urban conditions, tend to become a substitute for play in nature (Pitsikali et al. 2020; Woolley and Lowe 2013). Although Sustainable Development Goal (SDG) 11.7 emphasises how children need access to green space, there is a lack of knowledge on how to incorporate nature into city planning (IPBES 2019, p. 466), and adult perspectives tend to dominate in the development of recreational infrastructure (Jansson et al. 2020).

The amount of time children spend playing outdoors has diminished over time (Skår 2009, pp. 339–354) because of socioeconomic factors, lifestyle changes, parental practices and demographic shifts (Karsten 2015). Nevertheless, independent mobility among children is greater in Sweden than in many other regions (Shaw et al. 2015, p. 15). Outdoor play is much more frequent in some neighbourhoods than in others (Sandberg 2012, p. 162), but occasionally, one finds urban woodlands with huts made by children (Hedblom and Söderström, 2008).

An 'affordance' perspective on children's outdoor environments provides a foundation for developing biodiverse, nature-based outdoor spaces adapted to what children "tell" us through their actions (Clark and Statham 2005; Clark and Percy-Smith 2006; Hultgren and Johansson 2019). The concept of affordance is used to explain how children, through 'direct perception', recognise opportunities for specific activities in a landscape (Gibson and Pick 2000), e.g. how flat ground encourages running, sloping terrain encourages rolling, shielded shrubbery encourages dwelling, and trees encourage climbing (Heft 1988, p. 33). The concept has also been adapted to children of preschool age (Lerstrup 2017, p. 54), with literature documenting how a landscape is playing with the children as they move around, creating meaning in their immediate response to different environmental features available in a setting (Mårtensson 2004, p. 122).

The notion of 'play biotope' conceptualises how children depend on the content and structure of a particular landscape during outdoor play by borrowing terminology from landscape ecology and adapting it to children (Fjørtoft 2012 pp. 69–70). A 'habitat' refers to an area with an array of physical (e.g. soil, moisture, and temperature) and biotic (e.g. plants, animals, and bacteria) resources that support the survival and reproduction of a particular species, and a 'niche' refers to what this species lives off and does to survive in this habitat (Polechová and Storch 2018, pp. 4–5). When applied to children's play, the terms are used to describe how particular features, contents and structures in a landscape accommodate children's activities. A 'play biotope'(Fjørtoft 2012) is a setting housing a wide repertoire of play for children by containing "play habitats" for distinct types of play (such as pretend play or 'hide and seek'). These play habitats are subsettings which depend on the presence of 'play niches' supportive of the many distinct activities which children engage in during a particular play or game when using branches for climbing, shrubbery for hiding, etc. These ideas have advanced as an approach to how biological assets can be handled in green space management for children (Hedblom et al. 2024) through developments in a landscape laboratory (Wiström et al. 2024), a public park in Sweden (Mårtensson et al. 2022) and a "school biotope" in Japan (Ito et al. 2016, pp. 197–202).

The work takes on a perspective on the planning, design, and maintenance of outdoor spaces where learning is an integral part of social practice (Lave and Wenger 1991). It is an approach that considers what particular situations afford and how they affect people, which is especially useful when we need to accelerate transformation in societies, creating new and alternative worlds compatible with a sustainable future (Kopljar 2016, pp. 31). In this context, children's perspectives offers particular opportunities associated with particular challenges. Children's relations with places are embedded in social constructions about childhood, schooling, and family life but evolves in distinct ways through their engagement with the material world of particular places (see, for example, Kraftl 2013; Alderson and Yoshida 2016). We know that children's dependence on and the very embodied use of their physical surroundings make their transactions loaded with emotions (Bartos 2013; Hackett 2016) with implications for their place preferences (Lerstrup and Bosch 2017; Woolley and Lowe 2013; Johansson et al. 2020) opening up for particularly intricate and complex relationships in natural environments (Sallnäs Pysander et al. 2023). It is a perspective, which requires dual attention to the agency of the physical environment and to the agency of children (Fenwick et al. 2012) during research.

The literature on more collaborative forms of exchange during the development of outdoor environment for children suggests that there are many opportunities (Derr et al. 2018; Fors et al. 2021; Winge and Lamm 2019) but also challenges (Nguyen et al. 2024; Hölscher et al. 2024; Fors et al. 2021; Mahmoud et al. 2021). A case study methodology (Johansson 2007) drawing on microethnography (Taplin et al. 2002, pp. 87) opens up for collaboration during the process, but is also adapted to the conditions of working in a planning situation with multiple stakeholders on a short term. Explored in this multidisciplinary project is how one can combine established research methods for the study of human-environment interactions, with learning within a wider iterative process involving children as well as professionals now and then using modifications of the physical environment to highlight interdependencies between children and place. It is a response to the complexity inherent to systems containing both nature and children pointed out above (Bartos 2013).

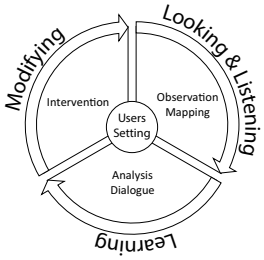

Fig. 1 Learning from looking and listening to children's activities integrated into the professional practice of green space design and management. This suggests an iterative process where the observation and mapping of children's use and activities are centrepieced. The results from analysing these data are input to dialogues with practitioners and scholars as preparation for modifying a setting. An intervention is followed by new fieldwork, and the process is repeated

A design and management of outdoor settings attuned to the processes of nature (weather, growing, etc.) imply the involvement of users is stretched out over time (Wiström et al. 2024) and carried out at the site which is object for development (Cele 2006; Schultz and van Etteger 2017, pp. 179–193).

2 The approach

This study is an investigation of how to develop nature-based play settings for children. It was set up as fieldwork (De Walt and De Walt 2011) with a place-based approach (Fors et al. 2021) involving a multidisciplinary team including scholars in ecology, environmental psychology and vegetation design and management.

The overall idea was to apply an iterative process in which the identification of nature-based play settings were followed by systematic investigations into children's use and preferences drawing on established research approaches for fieldwork in landscape research. The idea was that professional *learning* on how to design and manage nature-based play settings can benefit from carefully *looking and listening* to children's transactions and perceptions of particular settings. The suggestions for *modifying* a setting would be the outcome of dialogues with scholars and practitioners in the field informed by the results from the fieldwork. Sometimes, children's use after modifications part of an intervention became the focus of further fieldwork. Illustrated in Fig. 1 is the iterative character of the process described above applied in this development.

The case study is a common approach in landscape architecture research (Johansson 2007) as it allows rich descriptions of place and practice. Fieldnotes make up the core of a data collection result of mapping peoples' everyday use and activity, often in combination with walking interviews and other types of interaction in the setting investigated (Brink et al. 2017; Taplin et al. 2002). There are particular procedures developed to map children's activity in settings outdoors (Loebach and Cox 2020; Sallnäs Pysander et al. 2023) and to graphically represent their use of vegetation (Gustavsson 2009, pp. 42–43; Franch 2018, pp. 56–67).

A selection of scholars was informed of the results from fieldwork and engaged in dialogues on the potential development of nature-based play settings, discussing distinct features and alternatives to their current design and management. *The focus was on how to modify settings to children´s use and preferences focussing on their actualised and potential affordances and contribution to overall play dynamics.* The ambition were solutions compatible with, or improving the conditions also for other species in the laboratory.

3 The study area

The study took place in a landscape laboratory established from 1983 to 1998 at the Alnarp campus of the Swedish University of Agricultural Sciences in southern Sweden. The laboratory includes 20 hectares of woodland stands, edges, roadside plantations, meadows, wetlands, and water bodies (Gustavsson et al. 2023a, p. 63–67). The area used in this research covers nine hectares established in 1994, called Alnarp Västerskog, which is a part of the laboratory used for experimentation in education and research but is also open to the public for recreation, dog walking, foraging, and school visits (see Fig. 2).[1]

4 The participants

The following groups of participants visiting the landscape laboratory were engaged in the study (a–d):

[1] Here you find more information about the landscape laboratory where the field work of this study was carried out The Alnarp Landscape Laboratory | Externwebben (slu.se).

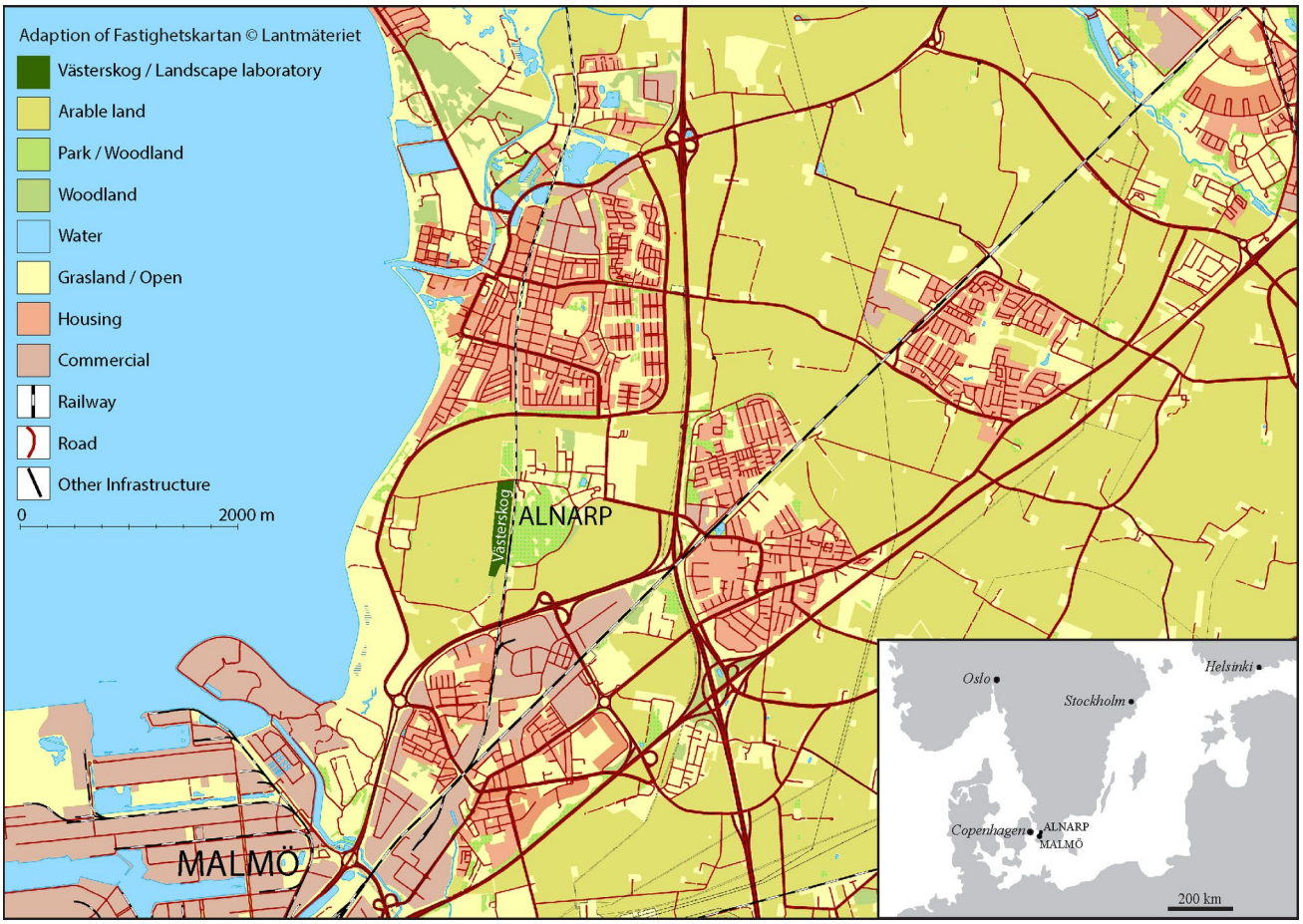

Fig. 2 Infrastructure of the Alnarp Landscape Laboratory and its location in southern Sweden

a. *Master's students in environmental psychology* (25 students, 2 days) who investigated the laboratory from a child perspective, identifying settings and attributes deemed attractive for children's play, social interaction, and learning. The 16 settings identified via this process are listed in Fig. 4.
b. *Master's students in vegetation design* (24 students, 1 day) who analysed the structure and character of vegetation in the settings identified by the master's students in environmental psychology (described above) and then developed design concepts for particular play biotopes.
c. *Preschool children 3–5 years* of age who visited the laboratory one day per month for a total of eight days, with their play and activity mapped and documented in ethnographic field notes.
d. *A class of 6-year-olds* (intermediary preschool class before school) who visited the laboratory for a total of four days, with their play and activity mapped and documented in ethnographic field notes. One group of children in this class was also engaged in modifying settings in the laboratory.

5 Methods

The development of nature-based play settings was carried out over four phases, as described in Fig. 3. The process involved not only university students and children as participants in fieldwork but also scholars and practitioners who were updated on the results through workshops on how to develop nature-based play settings and the conceptualisation of play biotopes (Mårtensson et al. 2021). Parallel research on the topic (Beckman et al. 2023), earlier documentation of the laboratory (Gustavsson et al. 2023b; Nielsen 2011; Wiström et al. 2023) and material with conceptual developments of play biotopes (Beckman et al. 2022) were other inputs in the process. Four of the settings in the laboratory underwent interventions, and the outcome of these modifications was followed by further fieldwork, according to the iterative process described in Fig. 1.

5.1 Identification of settings

This *first phase* served the purpose of identifying areas in the laboratory containing potential affordances for children's

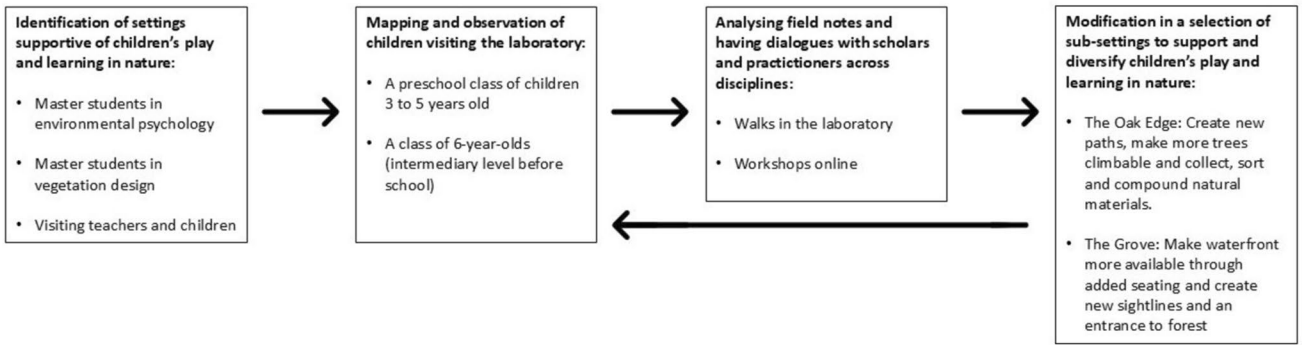

Fig. 3 The development of nature-based play settings was carried out over four phases with the results from fieldwork with students and children in the laboratory forming the groundwork. The identification of settings was followed by observations and mapping documented in field notes and scrutinised during analysis and dialogues. This process resulted in ideas for specific settings in the laboratory and contributed to the development of play biotopes for broader application in green space management. Some settings were modified, and the outcomes were scrutinised through additional observations and mapping

play and how these identified settings could be developed to create biotopes with play value.

First, *master's students in environmental psychology* (25 students, 2 days) investigated the laboratory from a child perspective, identifying settings and attributes deemed attractive for children's play, social interaction, and learning (assignment carried out by the authors AL and FM). The students received instructions to explore the area from a child perspective by trying to put themselves in the position of a child (Sommer et al. 2009). More specifically, the assignment focussed on the potential perceptions, experiences, and actions of children visiting the area to identify useful settings and those that could end up as favourite places for children. In groups of three to five, the students moved around in the landscape laboratory in an attempt to experience the landscape through "the eyes of children" to validate its usefulness and improve their understanding of how these settings could be perceived by children. The students marked places and potential affordances with simple sketches on maps illustrating potential activities and narratives from a child perspective. To stimulate the process, the students were invited to move around while socialising, engaging in playful activities and setting up games. All in all these students identified 16 different settings across the laboratory potentially attractive to children. See Fig. 4.

Second, *master's students in vegetation design* (24 students, 1 day) were informed of the results from their peers (above) and were tasked with elaborating on the settings that these students had identified (assignment carried out by the author BW). The students registered and analysed the structure and character of the vegetation graphically (e.g. profile diagrams with crown projections) for each type of setting. On this basis, they developed design concepts (prototypes) for how the spatial composition of vegetation and landforms could be developed to create biotopes with play value (Nielsen et al. 2023, pp. 84–93; Gustavsson et al. 2023b, pp. 106–114).

Finally, the teachers from the two master's courses conducted a walking dialogue across the laboratory to validate the selection and demarcations of the settings deemed attractive for children by comparing the outcomes of the assignments for each student group.

5.2 Mapping and observation

The *second phase* consisted of participatory observation (De Walt 2011) with systematic observation and mapping of children's activities. The observations included verbatim notes of children's ongoing doings, sayings, and emotional expressions in different settings. A typology for outdoor play behaviour (Loebach and Cox 2020) was applied to facilitate the swift documentation of children's intermittent and particularly rapid activity when outdoors. The field notes were combined with inventories of the physical environment, documenting the structure and composition of vegetation (Sallnäs Pysander et al. 2023).

A preschool with children 3–5 years of age visited the laboratory one day per month. *An initial series* of observations from March to May 2020 was organised over *four days* from 9 am to 2 pm (by AL and FM). The children visited the mosaic landscape (4), the meandering valley (8), the hornbeam forest (10), the oak edge (14), the gathering place (15), and the routes and paths in between. The oak edge (14) also became an object of intervention, with follow-up observations of the children's play and activities. The observations resulted in 33 pages of field notes, photos and maps.

A second series of observations with the same preschool was carried out (by AG) over *eight days,* from October to November 2020. The preschool visited the mosaic landscape

Fig. 4 A map of the Alnarp Landscape Laboratory with photos showing the vistas of the surroundings and a list of 16 settings identified as potentially attractive to children: 1. hazel (Corylus avellana) rows; 2. half-open grassland; 3. ash (Fraxinus excelsior) and larch (Larix × eurolepis) stand; 4. mosaic landscape; 5. hybrid aspen (Populus × wettsteinii) stand; 6. alder (Alnus glutinosa) shoreline; 7. beech (Fagus sylvatica) and birch (Betula pendula) stand; 8. meandering valley; 9. beech (Fagus sylvatica) stand; 10. hornbeam (Carpinus betulus) forest; 11. alder (Alnus glutinosa) and hazel (Corylus avellana) stand; 12. grove; 13. linden (Tilia cordata) stand; 14. oak (Quercus robur) edge; 15. gathering place; and 16. species-rich oak forest. Children visiting the laboratory spent time along the paths (pink lines), and in settings 2, 4, 8, 9, 10, 12, 14, 15, and 16 (black text). Interventions were made in two of the settings: numbers 12 and 14. Photos: Anna Litsmark

(4), hornbeam forest (10), grove (12), oak edge (14), and gathering place (15) (Fig. 4)**.** The observations resulted in 100 pages of field notes and photos.

A school class with 6-year-olds (intermediary preschool class before school) was involved in the research from September to February (2020–2021) (LH and JÅ). Observations were carried out in the following settings: half-open grassland (2), mosaic landscape (4), meandering valley (8), beech stand (9), grove (12), oak edge (14), and species-rich oak forest (16) (Fig. 4). The observations resulted in photos, sketches, and 18 pages of field notes.

5.3 Analysis and dialogues

The *third phase* required a more focussed study of a more limited amount of settings. The procedure for selection took departure in the 16 settings identified by the students. The teachers of the preschoolers examined the settings they had chosen during their visits and articulated and justified their choices and preferences. The results of this walk confirmed that some settings have more potential than others and was also helpful in delimiting the scope of the project to resources.

For the settings in the laboratory finally selected, the data from *phase two* underwent thematic analysis, focussing on the particular affordances for children's play and activity (Braun and Clarke 2006). To further promote the process of situated learning (Lave and Wenger 1991), we expanded the circle of professionals scrutinising the material by organising workshops on the design and management of nature-based play settings with practitioners and researchers from across the country. The extension of the professional network served the process by adding experience, insights and knowledge. Some workshops took place online and was documented separately (Mårtensson et al. 2021). The objective of these dialogues was to understand how particular features and attributes in a specific type of natural setting are perceived and used by children and, on the basis of these findings, to determine how modifications and adaptations of the physical environment could benefit children. Nature conservation was part of the overall framework of these dialogues, with the goal of creating synergies where the interests of children and other species converged. The work resulted in suggestions for the design and management of particular settings in the laboratory presented in the Results section.

5.4 Modification of settings

During the *fourth phase,* four settings, the hornbeam forest (10), the grove (12), the oak edge (14) and the half-open grassland (2) (Fig. 4), were recognised as having extensive potential for children's play, with implications for their further design and management. The focus of the interventions was to integrate the settings in pairs so that they formed two enriched play domains. The focus was to support children's movement across the two settings and to make their play more varied. The modifications were grounded in the results from fieldwork with children and the following dialogues with experts. The modifications carried out across settings 10 and 12 involved the children in a collaborative process with elements of cocreation (LH and JÅ) (Herngren and Ågren 2021), whereas the modifications across settings 2 and 14 were carried out by researchers (BW, AL, and FM). These interventions were followed by further observations of children's play and activity in the settings, and the field notes were analysed and used to further inform the process.

6 Ethical considerations

The schools expressed interest in taking part in the research and consented to the project after information meetings were held at the schools. Parents received a letter describing the study's aim, implications, data use, and who to contact if they had questions. 'Passive consent' from parents was deemed applicable, given that the children's own teachers led all the sessions (Morrow 2008). Procedures and information related to data collection followed established research practices (Swedish Research Council 2017) and were evaluated as part of an application to the Swedish Ethical Review Authority but were deemed out of scope for Swedish legislation. The schools were encouraged to hold their activities outdoors during the COVID-19 pandemic, which facilitated recruitment, but the situation required some physical distance between the participants and the researchers during fieldwork.

7 Results

This study provides an opportunity to test assumptions and ideas for how the physical environment in a natural setting influences children's play and activity and how an alteration of its design and management could benefit children, and possibly other species as well. The settings reported on are illustrating play biotopes potentially applicable also beyond the landscape of the laboratory investigated, and the overall approach applied and reported on, showing the way for more place-based ways of working with the design and management of green space. The first section presents an overview of the potential play-biotopes identified in the laboratory and the following sections present the result of research based developmental work for a selection of these settings.

7.1 Spotting nature-based play affordances and settings

The university students in *environmental psychology* paid attention to the variation in the height and density of the vegetation across the laboratory, as well as the presence of straight lines and formal patterns in the overall layout, when identifying features and settings that might be attractive to children in the landscape laboratory. They emphasised the value of organic forms in the design, which contributed to creating secluded places and natural enclosures. Spaces that varied in their layout and included some open areas were associated with activities such as running, hide-and-seek, and other vigorous games. Water and leaves were identified as treasures, offering distinct affordances by allowing children to grab, collect, build with and experience through their senses. The students noted how the wind created interesting sounds in stands of aspen. Running water was associated not only with gazing, jumping, throwing and transporting small objects but also with triggering children's imagination and more elaborate pretend play. They envisioned how winding paths, including some footbridges, encouraged balancing, running, jumping, and other playful ways of moving through the area while exploring it. The presence of wildlife,

for example, rabbits and snails, was deemed important in supporting children's affinity with nature. Taken together, these students identified 16 settings in the laboratory that are potentially attractive to children. See Fig. 4. The students in *vegetation design* further developed ways to account for ongoing natural processes and work with the overall structure of the vegetation in these settings and in the laboratory at large. They argued for more thoughtful management of spontaneous woody vegetation and suggested modifications to the overall structure through additional planting. They noted the role of vegetation in creating horizontal patterns through canopy stratification, as well as the spatial complexity of lower vegetation layers, including shrubs and small trees. They also emphasised the value of details, such as the textures of the bark and the cavities of the trees.

7.2 Developing nature-based play settings

Seven of the identified settings in the landscape laboratory became subject to fieldwork and dialogues on potential developments and interventions. Four of the settings were turned into two settings, along the way. It was the hut forest, stretching across settings 14 and 2 and the oak edge stretching across 10 and 12. For each of the *five* final settings presented, the results include (1) descriptions of the layout and content of the physical environment, (2) the lessons learned from observations of children's play and activity, and (3) the conclusions from dialogues with professionals on how one can develop this particular type of nature-based play setting.

7.2.1 A gathering place in grassland (setting 15)

One way to enter the laboratory on foot from the road is through a dense hedgerow structure, leading to a half-open, savannah-like landscape with a piece of furniture available for gatherings. The vegetation while passing through originates from planted edge mixtures: one is more species rich, whereas the other is dominated by oak (*Quercus robur*) and Swedish whitebeam (*Sorbus intermedia)*, developing into a hedgerow with low canopies. There is a marked contrast in the microclimate between the protected interior and the area near the road (setting 15 in Figs. 4, 5 and 6).

When the preschool children arrived at the laboratory, they jumped off a bus on the road running by the laboratory and then moved into the green fringe towards the gathering place with the piece of furniture. No long walk was required to get there, but they could still get a sense of being inside a forest. "This is our forest!" one child exclaimed. They were busy exploring the hedgerow and the many small stems along the way. When they arrived, they sat on the steps or climbed inside the structure, while the teachers presented the plans for the day. Some children picked up straws and sticks

Fig. 5 The gathering place with sitting furniture and a hedgerow with low canopies. Photo: Anna Litsmark

Fig. 6 The trees in the gathering place are placed inside and outside of areas with cut grass to make the transition more fluid. Photo: Anna Litsmark

while listening, whereas others continued jumping from the structure or kept running around it.

The clearing represents a play biotope that can accommodate many visitors without losing its character. The children can find shelter and create their own spaces across the grass, whereas adults can oversee the area and easily supervise them. Additionally, the combination of shelter and connectivity to other social areas in the laboratory made the place attractive. Here, children could start the day sheltered from cold winds and away from social distractions.

The activity (gathering) is encouraged by the cleared shrubs, but some multilayered structures of hazel and other spontaneous vegetation add spatial and species diversity, creating a buffer around the clearing. Some trees were left to grow in an organic shape across the area. The grass, along

with the sticks, not only contributes to the environment but also facilitates children's encounters with butterflies and insects, all of which are potential attractions for them. These elements can serve as helpful distractions for some children when they are expected to wait and listen to adults, thereby facilitating their participation in group activities.

The lessons learned from observations and dialogues resulted in several suggestions for further developing this specific setting and potentially creating a play biotope for children. A further reduction in woody vegetation is needed to control the dominant species and maintain its sunny and semiopen character. In the open glade, which is surrounded by tall grass, children have the opportunity to squat and crawl around, observing insects at eye level. Enhancing the invitation to explore the worlds of flowers, butterflies, and insects would make it easier to sit down and move around. A network of smaller 'lawn glades' within the tall grass would improve opportunities for children to distribute themselves across the area, ensuring that everyone can find a play space and have things to explore. Additional edge plantings could support more flowering and fruit-bearing species within the interior, offering food for organisms. Creating extra areas with cut grass could support children who are unfamiliar with nature and may not yet be ready for close contact with nature.

7.2.2 Pathways with vistas

A path system of wooden chips, cut grass, and soil stretches across the laboratory. It forms a network of larger paths, consisting of stands of trees and more informal paths cutting across areas of open meadows. The paths follow straight lines in monoculture stands but curve in species-rich areas

Fig. 7 There is a mix of straight paths in more plain areas and more dwindling paths in more complex and species-rich areas. Photo: Björn Wiström

Fig. 8 There is a mix of straight paths in more plain areas and more dwindling paths in more complex and species-rich areas. Photo: Björn Wiström

(Figs. 7 and 8). The paths are modified over time, creating a complex system with sections of a more or less dwindling character. Along these paths, the management of vegetation has created 'windows', 'walls', and thin vegetation 'curtains'. Along one stretch of the path, one can look over agricultural land with the city at a distance, and along another stretch, one can obtain a glimpse of railway racks (Pink line in Fig. 4).

The walks through the laboratory were the most structured sessions during the visits and were also the most talked about among the children. One teacher would take the lead, another would stay among the children, and a third would walk behind the group. From the gathering place (setting 15 in Fig. 4), they would usually head towards the mosaic landscape (setting 4 in Fig. 4). When a teacher stopped talking along the way, some children would keep themselves busy by holding on to and shaking trunks of trees (Fig. 9). At other times, the children walked at their own pace; when something caught their attention, they paused and explored. Some children would negotiate with the teachers so that they could venture into a new part of the laboratory, thus dividing them into subgroups.

Some children recognised the way and would run ahead, pointing out what paths to take. Others walked more calmly. They would spot objects from far away or look around in search of things to examine, playfully touch, look at, smell, or interact with their surroundings. Fruits, berries, mushrooms, and small animals such as worms and snails captured their attention. Sometimes, they would show objects to each other, comparing and discussing them. Once, they found crab apples (*Malus sylvestris*) along the trail and started to sort them by colour, testing which ones were sour and which were sweet.

Fig. 9 A planting area where children would playfully toss slim stems back and forth. Photo: Anna Litsmark

There are several lessons learned about how the meandering paths through the laboratory serve children's mobility and exploration. In some sections, the vegetation became denser around the path, slowing their pace, whereas other more spacious and straight sections were used for swifter movement. Chopped trunks, fallen trees, and deadwood provided affordances for jumping and balancing, sometimes blocking the way and creating new routes (see Fig. 10). Some vistas along the paths encouraged children to stay near the edge of the laboratory, such as the solitary tree by the grove that they climbed (setting 12 in Fig. 4).

A larger variation along the paths, with more potential affordances for children, would facilitate more varied play and alternative modes of movement as they navigate through the laboratory. Diversifying the thinning of vegetation, taking into account the size of children's bodies, could create sections where children can move forwards by hanging, clinging, or crawling. To create more contrast and potentially add experiences of mystery to sections of the path, one could work at the stand level by including edge mixtures and adding woodland patches, resulting in more blooming and fruit-bearing shrubs and trees. One must also consider what

Fig. 10 Deadwood provides many affordances for play and creates new routes for movement through vegetation by blocking the way. Photo: Anna Litsmark

happens to children's sightlines as vegetation grows. Carving out sections in the vegetation can help children stay more attentive to their surroundings and be ready to explore. Creating alternative routes can help reduce any disturbance that children's presence might cause in specific habitats, such as for some bird species.

7.2.3 The climbing edge (settings 14 and 2)

The climbing edge is a popular destination among children. Upon arrival, one child exclaimed "This is the place to climb and to look at the train", and when the day was over, one child hugged and kissed a tree, saying "I want to thank the tree, bye tree!".

A row of oaks forms the climbable edge of a larger glade bordering agricultural land (setting 14 in Fig. 4 and Figs. 11 and 12). In this part of the laboratory, high grass has contributed to plant mortality among Swedish whitebeams (*Sorbus intermedia)* and rowan (*Sorbus aucuparia).* However, over time, groups of planted oaks (*Quercus robur*) and spontaneously established shrubs and trees have created a landscape of half-open grassland, which is maintained through thinning.

Up to five children climbed in the same tree. Some climbed without hesitation, reaching high heights into the crown, whereas others moved along the rows between the trees. The children spent long periods in the crown and are immersed in conversations. They experimented with various ways to climb, balance, and twirl. They tried different spots and eagerly helped each other in difficult situations, adjusting their boots and bodies. They swung up and down, standing on one branch and holding on to the one above.

Fig. 11 The climbing edge, formed by pruning and allowing the oaks access to sunlight, encouraging the branches to grow all the way to the ground. Photo: Anna Litsmark

Fig. 12 The climbing edge is located in a clearing with benches and a rope, facilitating climbing and bordering a half-open area with a narrow path leading to the small hill. Photo: Anna Litsmark

One child lay beneath the trees looking up at the crowns and the sky.

Now and then, a passing train would make an incredibly loud noise. The children would immediately jump off the trees to watch, covering their ears, screaming with excitement, and waving their arms. Some organised a competition, running back and forth along the strip by the train tracks. They argued about who would run first. An official 'judge' organised the groups and exclaimed, 'Ready, set, go!' After celebrating the winner, the procedure was repeated.

The youngest children, approximately three years of age, would look for opportunities other than climbing. They collected twigs, stones, and shells, dug in the dirt, and created combinations of sand, leaves, and pieces of acorn. One child walked around, carrying a large lump of wood. Sometimes, the activity turned into pretend play, involving a "baby,

Fig. 13 The small hill with herbaceous plants populated with rabbits creates a more varied terrain. Photo: Fredrika Mårtensson

mummy, and daddy" and an imaginary fireplace of stones, twigs, and leaves.

Some children would play hide and seek among hazel and rowans, but they never made it to the small hill (Fig. 13) across the grassland (Fig. 14). This hill, which houses rabbits, is approximately one metre high, with the vegetation kept trimmed. It is created from masses excavated from the stream in the laboratory where the seed bank within the material has resulted in coarse herbaceous vegetation mixed with pioneer species of *Salix*.

Staying in the crown of a tree was truly an adventure for the children. It offered opportunities to take on challenges, engage in vigorous play and have extended conversations with peers while socialising undisturbed. However, the affordances for climbing were limited, and some competition for space occasionally made the activity repetitive. The children appeared to cling to their spots to avoid losing them.

An overall challenge has been regulating access to light in this area, supporting the half-open character, where both climbing trees can thrive and vegetation at a child's scale can be established. The oak rows framing the area have developed very deep and wide crowns. A management style inspired by the traditional 'stubble' typical for the area, which combines coppicing with haymaking, could create a biodiverse meadow that is partly wooded. While oaks make up the core of the climbing structure, hornbeam (*Carpinus betulus*), willow (*Salix*), hazel (*Corylus avellana*), and linden (*Tilia cordata*) could be added to create a denser and more interesting understorey, thereby extending children's opportunities to climb in the area. Coppiced multistemmed willow can become climbable earlier than oak and is easily regenerated when protected from children and grazing during the first year. A more multilayered vegetation structure would provide hiding places not only for children but also for birds. Grass trimmed only in early summer, rather than cut repeatedly, would turn into a summer meadow housing species related to pastureland, such as butterflies dependent on nectar and pollen-rich flowers important for bumblebees.

Fig. 14 Low-growth flowering species such as the germander speedwell (Veronica chamaedrys), forget-me-nots (Myosotis) and wild strawberry (Fragaria vesca) thrived in the half-open grass area. Photo: Anna Litsmark

All in all, these are measures which could make the area more interesting to children.

In addition, the relative lack of enclosures and the straight forms in the layout, with fields along the rail tracks, contributed to children's activities becoming repetitive and sometimes competitive, as evidenced by the running game. A larger number of climbing options, together with a more organic layout, could contribute to making the overall play repertoire more diverse, encouraging more exploration, pretend play, and vigorous activity among children. Another way to influence the overall play dynamics in the setting would be to include the strip of half-open grassland (setting 2 in Fig. 4 and Fig. 14) between the climbing trees and the small hill (Fig. 13). An intervention was set up to target children's mobility across this area.

The lessons learned on the basis of looking at and listening to children's play in this setting laid the groundwork for ideas to make their activity more mobile, dynamic, and varied. The idea was to facilitate a more diverse matrix of play by triggering children to extend their play into areas beyond the tree row, into the half-open grassland, and potentially incorporate the small hill in their play. A trimmed network of hay paths already offers a network of narrow paths, both straight and undulating paths, connecting the climbing oaks with the small hill.

In mid-May, when the trees were budding and the ground was blooming, an intervention involving modifications to the content and layout of the area was initiated. Additional paths and rooms were created by thinning, clearing, and raking the grassland. A new sightline was established to connect the climbing edge with the small hill, and trees along this route were made climbable through pruning. The natural materials that were mowed and cut were collected, sorted and used to create various compositions. Sticks were collected in piles, birch (*Betula pendula*) saplings were chopped into round 'plates', and thorny pieces of blackberry rift (*Rubus* sect. Rubus) were used to decorate trees (Fig. 15).

Overall, children´s activity on the ground below the trees increased after the intervention. They engaged with the loose materials added to the site and became busy moving natural elements playfully around, carrying, dragging, and jumping over them. They used sticks to dig and construct things. However, the overall distribution and play flow of the children across and beyond the setting did not change with the modifications. The envisioned scenario of children venturing into the half-open grassland with its small trees, shrubbery, and flowers and including the small hill in their play did not materialise. The children remained along the climbing edge.

7.2.4 The hut forest (settings 10 and 12)

For many years, there have been two stands of trees in the laboratory housing huts and materials available for people to build more huts. One of the settings is the hornbeam hut forest (setting 10 in Fig. 4), which contains small groups of trees with woody material left in place from thinning. Hornbeam tends to grow in crooked and gnarly ways, especially when affected by drought and extensive rabbit grazing, as is the case here. The more odd-looking individuals are favoured during thinning. The other area with many dens is located in the grove setting (setting 12 in Figs. 4, 16 and 17), the most species-rich woodland planting area in the laboratory, containing approximately 14 different species, including hornbeam, linden, bird cherry (*Prunus padus*), and hazel. Thinning and the fact that elm (*Ulmus glabra*) and ash (*Fraxinus excelsior)* trees were struck by diseases have

Fig. 15 Chopping and sorting wood were carried out as part of the intervention at the climbing edge. Photo: Anna Litsmark

Fig. 16 The hut forest of hazel in the grove during autumn. Photo: Linnea Herngren/Josefin Ågren

Fig. 17 The hut forest of hazel in the grove during spring. Photo: Anna Litsmark

created an oak-dominated canopy with an understorey of hazel, contributing to a dense middle layer underneath. Early thinning efforts focussed on maintaining species diversity and producing high-quality timber, whereas later interventions aimed for larger variations in form and content, forming glades and other more or less open areas. Over time, the setting has lost some of its character as trees have grown, limiting the view of the sky.

The hut forest was one of the most popular types of settings among the children. Upon arrival, they would hang their jackets on a tree and begin exploring the different hut constructions and the loose materials available. They balanced on the timber lying around and carried pieces of lumber, sometimes helping each other. Another group collected twigs and logs and compared their sizes.

Now and then, the children engaged in more versatile and vigorous physical activities in the hut forest. They built a piece of equipment for 'acrobatics' by placing a log horizontally between two trees. They tried hanging on it but had to adjust to make it more stable. They flipped around the log in various ways. When they fell to the ground, the leaves beneath seemingly cushioned their fall, and they would immediately stand up and start laughing.

The children also built new dens, destroyed or modified existing dens, and created other types of constructions. They swept the ground and decorated the inside of the dens. In and around the dens, they engaged in pretend play, e.g. playing horses, pretending to be elves, cooking pretend food, playing cops and robbers, building houses for worms and manning a shop selling twigs. Inside one hut, they had long conversations.

The grove is the most species-rich woodland planting area in the laboratory, matching the maximum number of tree species that you can find in a Swedish forest. It is also spatially varied, with its open and closed areas creating habitats for wildlife. Both the hornbeam forest, which contains only one species, and the grove, dominated by hazel, invite children to play and explore, with many prebuilt huts serving as attractions. Hornbeam, with its gnarly growth and peculiar forks, differs from multistemmed hazel, but both support hut-building with their diverse structures in both stem and tree forms.

Leaving logs and other woodland residues increases the overall amount of deadwood, which is important for many species and provides opportunities for children to explore wildlife. The branches, logs and stumps left offer various affordances for children, including jumping, balancing, carrying and building. Decayed timber can be especially attractive to very young children, as its light weight can make it possible for them to handle and carry around larger sticks and stumps.

Forests and water bodies are generally attractive features for children, but in the grove, they did not make substantial use of the nearby pond. An intervention was introduced to better connect the forest with the pond (Fig. 18) in children's play and activities.

The lessons learned from observations in the forest area with the pond were the foundation for a cocreation workshop with a group of six-year-old children. The workshop aimed to increase their mobility across the area, encourage them to linger closer to the water and foster closer contact with this element. Selective thinning focuses on strategically using trees with distinctive characteristics. A log placed between stems of cherry trees (*Prunus avium)* was added to create a new entrance between the forest and the pond area, facilitating the venturing of children back and forth. In addition, some structures for seating were added to the waterfront (Fig. 18). One construction contained a large bundle of twigs and branches, which served as a fauna deposit and storage for building materials.

In the following workshop, the children set out to further improve the setting and share their ideas with each design, explaining them to one another. One group focussed on the entrances established by the researchers, expanding and enhancing these features. They received help from the researchers to saw the logs to suitable sizes and used sticks of various sizes to line the path, pruning branches that were obstructing their movement along the way. Another group of children set out to create a 'wooden playground', setting up a swing and incorporating logs for balancing and sliding in existing structures.

The introduction of distinct structures together with structures that allowed children to stay close to the waterfront while maintaining some distance from it seems to have increased the overall usefulness of the area. These structures provided opportunities to approach the pond more gradually and appeared to signal that the site was safe for them

Fig. 18 A seating structure of logs makes the waterfront more accessible to children. Photo: Linnea Herngren/Josefin Ågren

with an increased sense of place as result. Additionally, the arrangement of children's activities into specific areas made it easier for adults to monitor and predict their actions, which probably made them confident in allowing children to stay and play more independently in the area.

The overall idea of the intervention—to connect the hut forest with the pond area and make the pond area more engaging for the visiting children—seems to have succeeded. After spending some time by the pond, some children headed to the forest, exclaiming: 'We need to paint and decorate our hut!'.

7.2.5 The meandering valley (setting 8)

In the southernmost part of the laboratory, a stream meanders through a small valley with mild slopes (setting 8 in Fig. 4). This elongated open area features a series of wooden bridges crisscrossing the stream. The stream is partly hidden by the topography and self-sown pioneer trees and shrubs (Figs. 19 and 20). One can enter through a narrow path in the dense thicket. A mound provides an elevated point from which one can overlook the fields and view the city from afar.

The layout is the result of natural processes and management adaptations made over time. The stream was re-excavated from sediment two decades after its construction. A dense thicket of spontaneous trees and shrubs along the stream was then cleared away to provide room for the excavator, and these excavations were used to create the mound. The open room from the clearing has since been maintained through yearly trimming. A set of wooden bridges was added to guide visitors through the valley.

While walking through the valley, some children moved cautiously to avoid water, whereas others approached with excitement. They picked up feathers and twigs along the way. The sheltered conditions created a different microclimate than those in other parts of the laboratory, and many natural elements, including water, clay, aquatic plants (macrophytes) and animals, became attractive to the children.

The position of the valley—situated near open fields but with the view obstructed by height in the valley—appears to be intriguing to the children (Fig. 21). A large group of children ran swiftly up the hill. Upon seeing a tractor on the road from afar, they playfully expressed fear, turned around, and ran back down into the valley again. This sequence was repeated several times.

The children explored the water, weeds, dirt, and animals along the waterfront with their hands and utensils, stepping on the bridges and grass. They seemed excited when catching and touching the aquatic plants. They carefully watched the water dripping from the net down to the water surface. They lay on their stomachs, looking down into the water. One girl closely observed a bee drinking from the water and ran after it, watching as it flew away. Other children explored how various objects float. Occasionally, children would jump across the stream or throw stones and twigs into it, continuing until there is a large splash or until the teachers interrupt them. Several children eventually tumbled into the stream, soaking their feet. While one child sat drying his bare feet in the chilly sun, some other children fetched water from the stream to pour on his feet, over and over again. They all seemed exhilarated.

Water is one of the most fascinating elements for children and is also vital in the habitats of many species in nature.

Fig. 19 A meandering stream running in a green valley with a set of bridges. Photo: Anna Litsmark

Fig. 20 Aquatic plants in combination with water and mud were fascinating to the children. Photo: Anna Litsmark

This area has been transformed into a play space by working with the terrain and topography, making use of the undulating terrain with its high and low water levels. A landscape with microtopography and a gentle slope towards the water creates a gradient with rich edge zones and soil moisture, forming microhabitats for many plants and animals. Furthermore, spontaneous vegetation with many early-flowering willow species provides a resource for pollinators and shelters many animals in this open landscape.

Fig. 21 The horizon is a trigger point, and children would run up and down the hill to explore the landscape. Photo: Anna Litsmark

Water is a fascinating element, but when combined with a uniform design, such as placing one bridge after the other in a row, it seems to hinder children's overall mobility and play flow. Additionally, the distribution of rakes, nets, buckets and binoculars among the children introduced competition and repetitiveness to their activities, leading to comments such as "There isn't one for me" or "I want to play too". Only one group of children, playing horses, ventured into the shrubs surrounding the stream. It may be beneficial to open up corridors and enclosures in the thickets for exploration and pretend play on one side of the valley while allowing the other side to grow freely. This approach could help create more varied play opportunities for children and protect the habitats of birds and tadpoles, by creating a better distribution of children's activities across a 'meandering valley' play biotope.

8 Discussion

8.1 A strategy of learning from looking, listening, and modifying

This project aimed to explore a place-based collaborative approach to children's play settings that could contribute to sustainable green spaces, be compatible with local ecosystems and benefit both children and other species. It builds on earlier research that assessed health-promoting outdoor play behaviour in children (Mårtensson 2004; Sallnäs Pysander et al. 2023) and developed new regimes for green space management (Gustavsson et al. 2005, pp. 382–385) in a landscape laboratory (Wiström et al. 2023, pp. 219–226) and in public playgrounds (Beckman et al. 2023; Mårtensson et al. 2021, 2022). A common notion was that many simple adjustments and modifications of the physical environment substantially influencing children´s activity remain unnoticed in established ways of managing green space. The design phase also require more place-based field work off desk, in order to take into account the complexities of children´s transactions with place (Beckman et al. 2023).

The goal was "learning together with others" (Gönner et al. 2023, pp. 11) through engaging with children, students, and colleagues across disciplines and planning practices. We set out to explore how to integrate children's needs and aspirations into green space design and management and learned lessons about nature-based play settings, so-called play biotopes, along the way. This resulted in a kind of microscale management informed by microethnographic fieldwork (Low et al. 2022), an approach well suited to the highly situated nature of children's outdoor play, with its dependence on nature and weather, making movement and a state of flux commonplace (Mårtensson 2004).

However, as a research study aimed at revealing the interaction between children and the environment, it has its limitations. A large number of investigators (five) carried out fieldwork in slightly different ways, with different groups of children at different points in time, over a period of nearly two years. This demanded a lot of coordination, with the

most reliable data being the field notes, which could be validated through multiple readings by the team. It is also well documented that the novelty of new attractions in a physical environment triggers interest and increased activity among children (Verstraete et al. 2006). For more general conclusions about the designs one would need to study how play behaviour evolved over longer periods of time.

Furthermore, the combination of systematic analysis based on observations in the laboratory implemented according to established research practices and learning from dialogues with professionals can make it difficult to know where the analytic work ended and the more synthesising aspects of the study began. In this case, historical records of the different stands and their management in the laboratory (Nielsen 2011) also informed the process. In a project without such records, resources need to be allocated to document the environment (e.g. Davies et al. 2009; Farinha-Marques et al. 2016). Additionally, the value of more elaborate cocreation with children should not be underestimated. In other parts of this project, not reported here, the children were more actively involved (Guimarães Gabriel 2021; Herngren and Ågren 2021). In this context, it is important to acknowledge how Scandinavian preschool practices of outdoor play have a tradition of allowing a large amount of free play also under ordinary conditions, with a positive attitude towards vigorous activity, children's own explorations and their creative additions to the outdoor space (Manni et al. 2024).

We developed a place-based iterative strategy for learning by looking and listening through observations, mapping, and dialogues in a multidisciplinary team, with minor modifications to test our assumption. These iterative loops, informed by research on landscapes, could serve as the first stepping-stone towards integrating a child perspective in the regular design and management of green play settings. The results reported do not aim to propose the best solutions for those particular children visiting the laboratory (Sommer et al. 2009) or for the particular settings documented in the laboratory. Instead, they represent efforts to envision play biotopes and to develop design and management practices supportive of the development of nature-based outdoor play settings.

8.2 More complexity with fewer lawns and paths

Lawns and paths are basic features of most urban green spaces supportive to recreation, wayfinding, and sports but if too dominating, they can deter children's play, offering them too little to explore (Ignatieva et al. 2017). In the laboratory the mosaic landscape is dominated by large areas of mowed grass. We think that the teachers might have favoured this place, as it was often sunny and gave them an overview of the children. We observed how children tend to sit and talk with their teachers in this area. Others would move into the green fringe of the area in search for other opportunities. It is questionable whether the extensive use of lawns in public spaces is adequate from the perspective of children in the younger age groups investigated in this study.

Large lawns are among the least diverse types of surfaces and contribute to greenhouse gas effects (Tidåker et al. 2016). For children, it is important that any environment has some elements that match their own size (Byström et al. 2019, p. 6). A modified management regime can turn lawns into more varied meadows or seminatural, unfertilised grasslands colonised by wild species. Such 'messy' seminatural grasslands combined with 'cues to care' (Li and Nassauer 2020) tend to be appreciated (Jansson et al. 2014). In contrast to lawns, this type of grassland is among the most biodiversity-rich ecosystems in Europe (Veen et al. 2009).

The presence of paths encourage children to move around (Raustorp et al. 2012). We documented how the shape and surroundings of paths contributed to the children's choice of routes and pace through different sections of the laboratory. While some hierarchy in the path structure is required for basic wayfinding, the possibility of getting "a little lost" can also be attractive (Johansson et al. 2021, p. 225). A greater complexity in the overall layout could have made children's transport across the area more adventurous. Children accustomed to spending time in nature do not rely on formal paths being constructed making it possible to work with attributes as sightlines and hay paths through more simple measures. Our material includes some examples of how mobility can be enhanced in the results related to the pathways and the gathering place. There are also some examples in the laboratory of how we attempt to influence the overall play dynamics of a landscape by working with existing vegetation; one involves the thinning of canopy trees to make the structure more multilayered (Richnau et al. 2012, pp. 152–155), and the other involves the development of a denser and more interesting understorey (Wiström et al. 2024) to facilitate climbing. These strategies were suggested for the climbing edge and the gathering place in the grassland.

8.3 Fine-tuning interventions

Many children at the climbing edge stayed in the tree crown for their entire visit. An intervention aimed at increasing the range of children in the area and adding variety to their play, did not change this. While they benefitted from the supply of loose parts as play props (Hayward 1971), which we provided through foraging, they did not engage with their surroundings, despite the additional paths and vistas implemented to support such movement. This confirms the immense attraction of climbing trees for children. Some preschools have trees in their yards for children to climb, but the children visiting the laboratory did not have this option, and in our experience, it is not very common.

The results of this intervention also highlight the importance of considering the context of any intervention and how other features available to children in the setting influence the overall play dynamics. As stated earlier, play gear can easily overshadow natural play affordances, making children's activities more competitive and less playful (Sallnäs Pysander et al. 2023). Similarly, natural features such as climbable trees at the climbing edge and running water in the meandering valley can take over in ways that disrupt the overall play flow and potentially trigger conflict in a group of children. However, the intervention by the waterfront close to the hut forest seemed to balance the two attractions, the huts and the pond. In this case, the modifications to make the two settings more accessible to the children seemed to support the overall play flow.

Another interesting observation related to the additions made to the pond was how this created a space supportive of children's independence while addressing safety and concerns related to adult supervision. This minor modification helped organise children's activities in a way that facilitated supervision, making the water more accessible to them without discouraging its playful use. No barriers, fences or other intrusions to the play space were necessary for safety.

8.4 Play biotope as a guiding idea

We suggest that the concept of 'play biotopes', as outlined by Fjørtoft (2012), can be useful as a pedagogical tool when striving to disentangle and communicate around more intricate relationships between children and nature in green space management (Wiström et al. 2024). It should help to conceptualise how a particular landscape, along with its flora and fauna, can help children thrive through intimate interactions with nature as part of their ongoing play and activity. In the planning and design of new playgrounds a catalogue of play biotopes (Beckman et al. 2022) can be helpful in opening up for new ideas and strategies (Beckman et al. 2022). The adaptation of play biotopes to the local socioecological context is vital. We do not want nature to be turned into an amusement park with similar solutions across the globe (Beckman et al. 2023, p. 38). Instead, the concept should help highlight how particular characteristics of particular types of natural environments can afford particular activities in children's play repertoire. The potential affordance are not the same as the actualised affordances of a particular place and its people (Kyttä 2004).

The documented positive correlation between habitat heterogeneity and animal species diversity (Tews et al. 2004) becomes especially interesting in light of research showing how settings featuring a blend of different types of land are associated with health-promoting play and everyday habits among children (Mårtensson et al. 2009; Puhakka 2019; Raustorp 2012). In this project, we experimented with low-key features resulting from minor modifications to create play habitats that support specific activities, contributing to an array of different play biotopes. We investigated how to open up and form enclosures within meadows, how hay and sticks can create paths, and how a hut forest can become self-sustaining with wood left after thinning, among other strategies. The lessons learned from this should inspire further exploration of how to work with different scales and features, such as forests, meadows, and water, as well as individual elements, such as trees and stones. This approach can enhance children's play while also meeting the requirements of other species (Wiström et al. 2024).

Another simple measure we suggest is to promote wider crowns on young oaks, as we did at the climbing edge. Given the historical records that oaks face pollarding, burning, and all kinds of hardcutting regimes, a treatment to promote a more elaborate branch structure supportive of children's climbing should not be very intrusive. One can also increase biodiversity by intentionally making trees older through veteranisation techniques, such as making scratches with a chain saw to mimic a woodpecker's work or damage from a thunderstorm (Bengtsson and Wheater 2021). However, to reach a climbable size, the oaks might need some thorny species around the stems for protection to minimise children's use for some time.

The considerations between children's needs and aspirations and the vitality of other species should be at the core of the development and management of nature-based play settings, not avoided but thoughtfully addressed. From a natural succession perspective, the vegetation in the investigated landscape laboratory is still young, and it will take considerable time for it to develop high biodiversity. The current vegetation contains young woodland plantings, shelter plantings, and leftover indigenous vegetation that can be unlocked resources for play (Konijnendijk and Schipperijn 2004, p. 31). In many urban and peri-urban areas, these types of settings are lost to densification (Nielsen et al. 2017, pp. 388–389). In other more biodiverse natural environments, reconciling play affordances with nature conservation can be much more challenging, and the applicability of the measures suggested here can be contested and in need of adaptions.

8.5 Deadwood and water injections for biodiversity

Wood in the form of logs, branches, and twigs of different sizes and stages of decay provides important material for children, as well as for other species. Children often bring pieces of wood and branches home as trophies. With better insight into how wood residues serve hut building and other play, the selection criteria for trees in favour of thinning could be adapted. In a natural forest, large free-standing trees are highly important for biodiversity (Ranius and Jansson

2000), and dead trees provide a range of habitats, including stumps and branches that vary in size and stage of decay. Additionally, branches of deadwood from young stands, such as those in the laboratory, are efficient at increasing fungal species (Heilmann-Clausen et al. 2004).

Water bodies are also highly important for biodiversity. For example, stormwater-retention ponds are habitats for many dragonfly species (Johansson et al. 2019). Water in all forms fascinates children and stimulates exploration (Bozkurt and Woolley 2020). In the meandering valley, children showed an interest in the flora and fauna in and by the stream and seemed to experience some of their most intense and joyful play episodes. Despite instructions not to run or get close to the water, children repeatedly ventured into the stream, expressing thrill and excitement as they ran to fetch water to pour over their feet and swept seaweed through the muddy water. Organised activities near water bodies can help children connect with nature (Barthel et al. 2018), but in this instance, the supply of binoculars and cameras seemed to distract the children from their more spontaneous ways of engaging with the water and other playful activities in the surrounding landscape. It is possible that children's spontaneous choices distributing their activity across a setting can be used to avoid excessive use of the most vulnerable terrain and habitats if one is attentive to how "landscapes play with the children" (Mårtensson 2004).

8.6 Beyond kit-fence-carpet solutions

Children's lack of contact with nature in everyday outdoor settings can adversely affect their well-being, making it harder for them to find ways to resolve challenges in life and to rest and recover from stress (Mårtensson et al. 2009; Mygind et al. 2019; Wales et al. 2022). Many playgrounds, particularly those of the kit--fence-carpet model, are too cramped and simplistic, failing to stimulate children's global and emotional way of approaching their surroundings. Many green play settings also tend to be quite plain with low levels of biodiversity (Sallnäs Pysander et al. 2023, p. 2). It becomes a particular challenge to create playgrounds compatible with children's use (Jansson et al. 2015, p. 167) when the spaces available are small. Professionals ask for lists of species well suited for children's play settings (Beckman et al. 2023, p. 22).

Reconciling the needs and aspirations of children with the preferences of other users is also a challenge in park design and management. Adults often prefer only moderately biodiverse settings (Johansson et al. 2014), which influences how parks and playgrounds are designed. Many times, the more complex understorey of vegetation is left out to make people feel more secure, which becomes a problem since children have many of their play props there (Jansson et al. 2018). In the management literature discussing children's "wear and tear," children's "constructive" use of natural elements (for example, building dens) contrasts with their "destructive" use (Gunnarsson and Gustavsson 1989). However, activities such as collecting leaves or breaking branches can be part of many playful activities, which need to be evaluated on a case-by-case basis to determine their impact on wildlife and if and how they can be part of a sustainable use.

Children associated with problematic wear and tear in green space management mirror an urban condition where the green play settings available to them are scarce and are confined to schoolyards and other playgrounds for outdoor stay and play (Raustorp et al. 2012). A first step in making nature-based play spaces available to children is to look beyond the notion of children's presence in nature as a risk factor to the flora and fauna of local ecosystems. Luckily, our transactions with the physical environment and with nature at large are dynamic and renegotiated over time. While children's play behaviours share many common elements across the globe, they also reflect the unique human conditions of particular places, which Schwartzman (1976) vividly demonstrated in her anthropological study of children's play.

Studies from less urbanised conditions illustrate how there are many benefits (as well as risks) of having animals and natural surroundings more integrated into the everyday lives of children and their families (Shapiro et al. 2017; Silva and Minor 2017; Tipper 2011). Nature takes on intangible meanings (Blicharska and Mikusinski 2015), and for children, it also triggers their physical activity and imagination in ways that make play more fun and beneficial to them (Sallnäs Pysander et al. 2023). We know that children who encounter fascinating elements in nature, such as animals, water bodies and flowers, are also more likely to show care and take responsibility for a place (Jansson et al. 2018), even capable of developing ways of protecting animals amidst school ground play (Ito et al. 2016).

The results highlight possibilities for an integrated way of working with design and management where the activity in a particular setting informs practice. It emphasises the role of looking and listening carefully to children as part of their ongoing events in everyday outdoor life. Making minor modifications and evaluating these can add knowledge by clarifying particular interdependencies between children and places. The forest hut area in the laboratory started as a workshop for university students, with *Cities of the Future* as a theme (Gunnarsson et al. 2023, pp. 328–331). Currently, the activity in this area has expanded so that families and children visiting the laboratory continue the project, modifying and remodelling huts, tearing others down and building new ones. The management of the laboratory saves material from regular thinning, which is left in two stands to be used by the public (Fors et al. 2023, p. 34; Gunnarsson et al. 2023, pp. 328–331). This illustrates the stepwise, iterative

procedure of green space design and management which this case study was set up to illustrate, but also how it had its forerunners in the established management practice of the landscape laboratory.

9 Conclusions

Facilitating children's adventurous outdoor play to support their health, well-being, learning, and overall development is a giant challenge for societies and we now know that environments with low biodiversity do not meet children's needs. Indeed, there are many opportunities and potential conflicts between nature conservation and children´s access to nature that need to be defined and better understood (Redpat et al. 2013). There is a substantial literature on how to incorporate children's perspectives into the planning and design of urban settings but children´s access to natural environments and applications for green space management, are less common. We outlined an iterative approach, including minor interventions, where the core is learning from looking and listening carefully to children's play and activity in place-based developments. A toolbox of strategies from landscape research was applied to uncover how natural features as forest, water, hedgerows and paths, contribute to dynamic nature-based play settings. The result presents suggestion for the design and management of a number of nature-based play settings, potential 'play biotopes', useful in any effort to create green play settings where both children and other species can thrive.

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Data availability Data is made available on request.

Declarations

Conflict of interest On behalf of all the authors, the corresponding author states that there are no conflicts of interest.

Ethical approval The Swedish Ethical Review Authority has confirmed in writing that no ethical approval is required.

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