The natural environment as a playground for children
Landscape description and analyses of a natural playscape

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Abstract

Previous studies have explained children’s experience of place and their special preferences for the unbuilt and unstructured environment. However, the impact of a natural environment on children’s learning and development has been a topic of low priority within child research and the importance of natural playscapes for children has also been neglected in physical planning. The present study focuses on a natural environment, a small forest, as a playscape for children. The forest was used by a kindergarten as a supplement to their traditional outdoor playground and the impact such a landscape might have on children’s motor development was investigated through an experimental study on kindergarten children aged 5, 6 and 7 years of age. The landscape was described and analyzed by methods of landscape ecology and geomorphology implemented in a geographical information system (GIS). We found that the natural landscape had qualities to meet the children’s needs for a stimulating and varied play environment. Landscape ecology metrics showed high values for diversity, evenness and heterogeneity for the study area. The diversity of vegetation and topography corresponded to function-related structures that afforded versatile play. The study indicated a strong relation between landscape structure and play functions. The diversity of the vegetation was related to phytosociology and physiognomy, while the diversity of topography was related to slope and roughness. Diversity in landscape elements such as vegetation and topography might be considered a dimension of quality for a natural playscape. This playscape comprised the ground for training of motor fitness in children. Through all-round playing and exploring the natural playscape, the children’s motor fitness was improved. This proved the learning effects from a natural playscape on children’s motor abilities. This paper will focus mainly on the landscape descriptions and the affordance of versatile play.

Keywords: Environments for play and development; Natural playscapes; Landscape ecology

1. Introduction

"Climbing rocks is more fun than climbing trees — but climbing trees is more fun than the boring playground equipment." These words from a kindergarten
The boy may serve as an example of how children consider the traditional playground and how they find the natural playscape more attractive and exciting (Titman, 1994; Moore and Wong, 1997). Previous studies have explained children’s experience of place, their special preferences for the unbuilt and unstructured environment, and how children interpret place and space (Hart, 1979; Moore, 1986). Children need green playgrounds including fields to play on, trees for climbing and bushes for shelter and hiding (Titman, 1994). Prescott (1987) concluded that kindergarten environments were too simple in comparison with the natural environment. She mentioned three unique qualities about nature; the high diversity, the fact that nature is not made by man, and the impression of timelessness. Furthermore, several studies indicate that a diverse and adventurous playground stimulates creative play (Frost and Campbell, 1985; Frost and Strickland, 1985; Moore, G.T., 1985; Moore, R.C., 1986; Steel and Neuman, 1985; Winter, 1985; Frost and Wortham, 1988; Hart, 1993). Scandinavian studies report positive impact from playing in nature on the children’s social play, concentration and motor ability (Bang et al., 1989; Grahn, 1991; Fjørtoft, 1995a, 1998; Grahn et al., 1997). However, few studies systematically document the impact a natural environment might have on children’s motor development (Fjørtoft, 1998, 1999). For this presentation, we have concentrated on the description and analyses of the landscape as a playground for children, based on the affordance of the landscape for versatile play. It was hypothesized that variation and diversity in the landscape corresponded with diversity in play activities. The main objectives were (1) to describe and analyze a woodland area as a playground for children, and (2) to describe, analyze and visualize how children’s play was related to important landscape elements such as vegetation and topography. This involved exploring methods from landscape ecology and geomorphology for description, analysis and visualization of landscape characteristics as important elements in playscapes for children.

1.1. Aims and objectives

In Norway, nature is still a part of culture. The landscape has not only been an object of utilitarian value but also a scene for outdoor life and leisure activities (FRIFO, 1992; Kaltenborn and og Vorkinn, 1993). Nature is a part of people’s local environment and Norwegian children have usually grown up in places where the natural environment was the arena for free play and physical activities (Fjørtoft, 1995b). The present study aimed at describing a natural environment as a playscape for children in Norway. Furthermore, it was focused on the learning effects that all-round play in nature might have on children’s motor development (Fjørtoft, 1998, 1999). For this presentation, we have concentrated on the description and analyses of the landscape as a playground for children, based on the affordance of the landscape for versatile play. It was hypothesized that variation and diversity in the landscape corresponded with diversity in play activities. The main objectives were (1) to describe and analyze a woodland area as a playground for children, and (2) to describe, analyze and visualize how children’s play was related to important landscape elements such as vegetation and topography. This involved exploring methods from landscape ecology and geomorphology for description, analysis and visualization of landscape characteristics as important elements in playscapes for children.

1.2. Study area

The study area, the forest (Fig. 1), was a 7.7 ha woodland vegetation with varied topography, located close to a kindergarten in Bø, Telemark County in Norway. The forest was the outdoor playscape, outside the kindergarten fence. The closer parts of it were used spontaneously by the children on their own, while adults accompanied the children to the parts further away.

2. Methods

To our knowledge, there is no established methodology to describe the natural environment as a playground for children. In environmental psychology, the focus is on how we mentally perceive the environment
A semantic environmental description is based on experienced dimensions of the landscape (Küller, 1972; Kaplan and Kaplan, 1989; Sorte, 1989; Lindgren, 1990). Application of these methods for describing natural environments as playgrounds for children have been explored (Fjørtoft, 1993; Berggren-Bärring and Grahn, 1995), but for this purpose, the semantic environmental description based on adults’ visual perceptions and qualitative appreciation of a landscape is insufficient. As adults, we perceive the landscape as forms, whereas children will interpret the landscape and the terrain as functions (Gibson, 1979; Heft, 1988). Therefore, methods focusing on structures and functions of the environment are more appropriate for describing natural landscapes as playscapes for children.

2.1. Landscape ecology

The theories of landscape ecology are based on composition, structure, function and change of physical landscapes (Forman and Godron, 1986). Quantitative metrics have been developed to describe the relations between the structure and the function in spatial patterns (Forman, 1997). A common way of describing landscapes from a species perspective is to study habitat variables that are likely to affect the species’ utilization of the habitat and landscape of interest, e.g. vegetation and topography (Ims, 1992; Forman, 1997). In the context of landscape ecology, we might therefore introduce the concept of human play habitats, i.e. the different landscape elements and structures that afford children’s play. The affordances of play are based on the features that the environment can provide (Gibson, 1979). We focused on vegetation and topography because these elements comprise the physical patterns of a landscape and can be expressed as composition, structure and function of an environment (Skånes, 1997). The landscape metrics were computed according to McGarigal and Marks (1998).

2.2. Vegetation

Vegetation mapping was done by field inventory and aerial photo-interpretation (Paine and Luba, 1980; Ihse, 1989, 1995). The vegetation was classified according to the Norwegian classification system (Fremstad, 1997). Identified patches in the field inventory were classified into main vegetation types, based on phytosociology and physiognomy (Heywood and Watson, 1995; Fremstad, 1997). Thematic maps of physiognomy were derived from the vegetation map by use of geographic information system (GIS) (Tomlin, 1990; Bernhardsen, 1995; Worboys, 1995).

2.3. Topography

Elevation data were contour lines extracted from the base-map transformed into digital representation as a digital elevation model (DEM). The DEM was the basis for calculating slope and roughness of the terrain.
Determined terrain measurements by use of geodetic methods were used for three reference profiles to determine the terrain configuration for a frequently used sliding slope, a steep cliff and a rough climbing track (Weibel and Heller, 1993; Wangen, 1998).

Methods for deriving and analyzing topography and vegetation data were implemented in the GIS-software ARC/INFO (Environmental Systems Research Institute (ESRI), 1997). For landscape ecology analysis, we used FRAGSTATS*ARC (innovative GIS solutions (IGIS) McGarigal and Marks, 1998).

2.4. Playscape

Global positioning systems (GPSs) were used to map specific play habitats. Calculation of this surveying was done as differential GPS (DGPS) (Simensen, 1998). The play activities were defined and classified into three categories (Frost, 1992). (1) Functional play comprised gross-motor activities and basic skills and were implemented in games like play tag, chase and catch, leapfrog, hide and seek, catch a tree, making angels in the snow, and other games involving basic movements. (2) Construction play was the type of play that was afforded by landscape structures and loose parts, e.g. building shelters, dens and other constructions like a pirate ship, building with cones and sticks and other moveable things. In the winter season, snow was an excellent building material. (3) Symbolic play included socio-dramatic play and was recorded as role play and fantasy play such as play house, pirates, play farm with cones and sticks etc. As a natural environment might challenge several movements and physical mastering, play in a natural environment was, therefore, assumed to have an impact on the children’s motor development. Consequently, an experimental study was carried out, describing how all-round play activities in a natural environment might have an impact on children’s motor development (Fjørtoft, 1999). The playscape was used by, in all, 46 children in the age group 5–7 years old for 2 h every day when they attended kindergarten. The study lasted for a period of 9 months, from September to June. The play activities and the localities for play were observed and reported by the kindergarten teachers (Robson, 1997). The spatial relations between the different landscape characteristics and the observed play activities were visualized by using spatial overlay analysis and correlation plots (Berry, 1997).

3. Results

3.1. Vegetation

The landscape spatial pattern formed by the vegetation of the forest, total area 7.7 ha, was a mosaic of 34 patches of different types of woodland interspersed with some open spaces consisting of rocks, fields and meadows (Fig. 2, Table 1).

The woodlands consisted of six different vegetation types, and were dominated by rich deciduous woodlands in the south-western parts of the area (Fig. 2a). Two types of rich deciduous woodland were registered (Fig. 2a, Table 2). The wych elm small-leaved-lime woodland was the most widespread one with maple (Acer platanoides), alder (Alnus incana), hazel (Cor- ylus avellana), ash (Fraxinus excelsior) and elm (Ulmus glabra) as common tree species. In the north-eastern parts, the coniferous and mixed wood-

| Table 1 |
| Landscape metrics of the total area and the playscape |
| Landscape metrics | Ta | NP | LPI | MPS | PR | SIDI | SIEI |
| Total area | 7.71 | 34 | 21.2 | 0.23 | 10 | 0.82 | 0.92 |
| Playscape | 4.89 | 22 | 33.5 | 0.22 | 9 | 0.78 | 0.88 |

a Ta: total area (ha).
b NP: number of patches.
c LPI: largest patch index.
d MPS: mean patch size (ha).
e PR: patch richness.
f SIDI: Simpson’s diversity index.
g SIEI: Simpson’s evenness index.
Fig. 2. Vegetation map and derived thematic maps on edge contrasts between vegetation types and physiognomy of trees and shrubs. Playscape is indicated by border lines.
lands dominated the forest (Fig. 2a, Table 2). The coniferous woodland consisted of pine woodland with Scots pine (*Pinus sylvestris*), while the Norway spruce (*Picea abies*) dominated the bilberry woodland. The low-herb woodland was a mixture of pine, spruce and deciduous trees like birch (*Betula pubescens*) and aspen (*Populus tremula*) and a more scattered occurrence of sallow (*Salix caprea*) and mountain ash (*Sorbus aucuparia*). This woodland was dominated by scattered deciduous shrub vegetation (Fig. 2a, Table 2), and a mixture of trees and shrubs (Fig. 2c–e).

### 3.2. Landscape metrics

Based on the vegetation data, several landscape metrics were computed (Tables 1 and 2). Mean patch size (MPS) of 0.23 ha and the largest patch index (LPI) of 21.2 illustrated the fine-grained pattern in the landscape mosaic. The Simpson diversity index (SIDI) of 0.82 and the Simpson evenness index (SIEI) of 0.92 indicated variation and heterogeneity in the area.

At the class level, the wych elm-small-leaved woodland had an LPI of 14.9, and covered 23.8% of the total area (PLAND) with an MPS=0.5. It also had the highest class area (CA) of 1.8 and was distributed on four different patches (Table 2). The low-herb woodland was the second largest class of woodland in the area (CA=1.3) distributed on four patches, with the LPI=0.9 and the MPS=0.3. The coniferous woodland consisted of six patches of bilberry woodland (CA=0.8, PLAND=9.8) and three patches of pine woodland (CA=0.3, PLAND=4.4). The open space was dominated by meadows and fields with weed vegetation on road embankments and waste places.

#### Table 2

Class metrics of the total area (TA) and the playscape (PL)

<table>
<thead>
<tr>
<th>Vegetation types</th>
<th>Area</th>
<th>CAa</th>
<th>NPb</th>
<th>PLANDc</th>
<th>LPId</th>
<th>MPSf</th>
<th>MSIf</th>
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<tbody>
<tr>
<td>Wych elm-small-leaved lime woodland</td>
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<td>1.8</td>
<td>4</td>
<td>23.8</td>
<td>14.9</td>
<td>0.5</td>
<td>1.8</td>
</tr>
<tr>
<td></td>
<td>PL</td>
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<td>1</td>
<td>7.7</td>
<td>7.7</td>
<td>0.4</td>
<td>1.7</td>
</tr>
<tr>
<td>Low-herb woodland</td>
<td>TA</td>
<td>1.3</td>
<td>4</td>
<td>17.2</td>
<td>9.9</td>
<td>0.3</td>
<td>1.6</td>
</tr>
<tr>
<td></td>
<td>PL</td>
<td>1.3</td>
<td>3</td>
<td>25.7</td>
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<td>0.4</td>
<td>1.7</td>
</tr>
<tr>
<td>Bilberry woodland</td>
<td>TA</td>
<td>0.8</td>
<td>6</td>
<td>9.8</td>
<td>6.7</td>
<td>0.1</td>
<td>1.4</td>
</tr>
<tr>
<td></td>
<td>PL</td>
<td>0.8</td>
<td>6</td>
<td>15.5</td>
<td>10.6</td>
<td>0.1</td>
<td>1.4</td>
</tr>
<tr>
<td>Pine woodland</td>
<td>TA</td>
<td>0.3</td>
<td>3</td>
<td>4.4</td>
<td>3.4</td>
<td>0.1</td>
<td>1.4</td>
</tr>
<tr>
<td></td>
<td>PL</td>
<td>0.3</td>
<td>3</td>
<td>6.9</td>
<td>5.4</td>
<td>0.1</td>
<td>1.4</td>
</tr>
<tr>
<td>Alder-ash woodland</td>
<td>TA</td>
<td>0.2</td>
<td>1</td>
<td>2.2</td>
<td>2.2</td>
<td>0.2</td>
<td>2.1</td>
</tr>
<tr>
<td></td>
<td>PL</td>
<td>0.2</td>
<td>1</td>
<td>3.4</td>
<td>3.4</td>
<td>0.2</td>
<td>2.1</td>
</tr>
<tr>
<td>Tall-fern woodland</td>
<td>TA</td>
<td>0.1</td>
<td>1</td>
<td>1.1</td>
<td>1.1</td>
<td>0.1</td>
<td>1.7</td>
</tr>
<tr>
<td></td>
<td>PL</td>
<td>0.1</td>
<td>1</td>
<td>1.7</td>
<td>1.7</td>
<td>0.1</td>
<td>1.7</td>
</tr>
<tr>
<td>Woodland border shrub</td>
<td>TA</td>
<td>0.5</td>
<td>2</td>
<td>6.4</td>
<td>4.3</td>
<td>0.2</td>
<td>1.9</td>
</tr>
<tr>
<td></td>
<td>PL</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Vegetation on road embankments and waste places</td>
<td>TA</td>
<td>2.0</td>
<td>2</td>
<td>26.1</td>
<td>21.2</td>
<td>1.0</td>
<td>1.5</td>
</tr>
<tr>
<td></td>
<td>PL</td>
<td>1.6</td>
<td>1</td>
<td>33.4</td>
<td>33.5</td>
<td>1.6</td>
<td>1.6</td>
</tr>
<tr>
<td>Weed vegetation in cultivated fields</td>
<td>TA</td>
<td>0.5</td>
<td>6</td>
<td>6.3</td>
<td>1.9</td>
<td>0.1</td>
<td>1.7</td>
</tr>
<tr>
<td></td>
<td>PL</td>
<td>0.1</td>
<td>3</td>
<td>2.4</td>
<td>1.0</td>
<td>0.0</td>
<td>1.8</td>
</tr>
<tr>
<td>Rocks</td>
<td>TA</td>
<td>0.2</td>
<td>5</td>
<td>2.7</td>
<td>1.1</td>
<td>0.0</td>
<td>1.5</td>
</tr>
<tr>
<td></td>
<td>PL</td>
<td>0.2</td>
<td>3</td>
<td>3.3</td>
<td>1.8</td>
<td>0.5</td>
<td>1.5</td>
</tr>
</tbody>
</table>

a CA: class area (ha).
b NP: number of patches.
c PLAND: percent of landscape (%).
d LPI: largest patch index.
e MPS: mean patch size (ha).
f MSI: mean shape index.
as the largest ground (CA=0.5, PLAND=26.1) (Table 2, Fig. 2a).

The edge parameters indicated varying contrasts in the study area (Fig. 2b, Table 3). The highest contrast appeared where open fields met dense woodland (edge contrast\(=1\)). The longer borders also had higher edge contrast when coupled with the weighted contrast for the vegetation types (weighted length\(=63.6–125.6\)). The contrast between the different woodlands was low, due to short borders and low weighted contrasts (Fig. 2b, Table 3). Even spaces with open rocks had a low edge contrast, i.e. tall-fern woodland/rocks\(=0.2\) (Table 3). This may also be explained by the very short perimeter (weighted length\(=0.4–25.5\), Fig. 2b).

### 3.3. Topography

The topography was undulating with terraces and slopes and a dominating steep slope traversing the area. Topography analysis results are presented as profiles, slope-map, roughness-map, and statistical figures (Fig. 3).

Directional derivatives of the surface provided information about slope and roughness as the most important descriptive variables of topography. Slope (the first derivative) was calculated in degrees and showed a range from min 0 to max 72 with a mean value 14.5 within the total area (Fig. 3a). Roughness (the second derivative) described the variation of slope (Fig. 3c). This variable can be calculated in different directions; we used the profile curvature that showed the change of steepest slope across the surface (SURFER User’s Guide, 1997). A value around 0 indicated a smooth terrain and higher values a more rough landscape. The statistical figures in Table 4 show that the mean value for roughness for different play habitats was approximately 0, which means nearly the same volume of convex and concave changes in the topographical curvature. The standard deviation illustrated the variation of topography within different play habitats, where a standard deviation of 1.5 indicated a smoother topography and 4.8 a more ‘dramatic’ landscape.

### 3.4. Playscape

The play habitats were located next to the kindergarten area (Fig. 1b, Fig. 2a) and covered 63% (4.9 ha) of the total landscape. The playscape had a patch richness of 9 out of 10 possible vegetation types and included all the six woodland types, rocks, fields
Table 3
Edge contrasts: contrasts between vegetation types based on observations and a reasoned guess

<table>
<thead>
<tr>
<th>Vegetation types</th>
<th>Alder-ash woodland</th>
<th>Bilberry woodland</th>
<th>Low-herb woodland</th>
<th>Pine woodland</th>
<th>Rocks</th>
<th>Tall-fern woodland</th>
<th>Vegetation on road embankments and waste</th>
<th>Weed vegetation in cultivated fields</th>
<th>Woodland border scrub</th>
<th>Wych elm-small-leaved lime woodland</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alder-ash woodland</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Bilberry woodland</td>
<td>0.3</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
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<td>–</td>
</tr>
<tr>
<td>Low-herb woodland</td>
<td>0.3</td>
<td>0.3</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
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</tr>
<tr>
<td>Pine woodland</td>
<td>0.4</td>
<td>0.3</td>
<td>0.2</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Rocks</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Tall-fern woodland</td>
<td>0.8</td>
<td>0.8</td>
<td>0.8</td>
<td>0.8</td>
<td>0.2</td>
<td>–</td>
<td>–</td>
<td>–</td>
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<td>–</td>
</tr>
<tr>
<td>Vegetation on road embankments and waste</td>
<td>0.8</td>
<td>0.8</td>
<td>0.8</td>
<td>0.7</td>
<td>0.2</td>
<td>0.2</td>
<td>0.2</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Weed vegetation in cultivated fields</td>
<td>0.8</td>
<td>0.8</td>
<td>0.8</td>
<td>0.8</td>
<td>0.2</td>
<td>0.2</td>
<td>0.1</td>
<td>–</td>
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<td>–</td>
</tr>
<tr>
<td>Woodland border scrub</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
<td>0.4</td>
<td>0.3</td>
<td>0.3</td>
<td>0.3</td>
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<td>Wych elm-small-leaved lime woodland</td>
<td>0.1</td>
<td>0.3</td>
<td>0.3</td>
<td>0.4</td>
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<td>0.9</td>
<td>0.8</td>
<td>0.8</td>
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<td>–</td>
</tr>
</tbody>
</table>
and meadows (Fig. 2a). The low-herb woodland was the dominating woodland type, covering 26% of the playscape and representing an LPI of 15.5 (Tables 1 and 2). The diversity index for the play habitats was 0.78 and the evenness index 0.88, i.e. a little lower than for the total landscape (Table 1). The physiognomy of tree species was shaped by pine, spruce, deciduous trees and mixed (Fig. 2c). The physiognomy of the shrubs was mixed and deciduous and the density of shrubs was scattered only with some dense areas in the outskirts, bordering the neighboring field (Fig. 2d and e). The edge contrasts showed low to medium contrast values between the vegetation types in the play area (Fig. 2b). The shape index for vegetation types ranged from 1.4 to 2.1, indicating a relatively commensurable shape for the different vegetation types (Table 2). The 5-, 6- and 7-year old children in the kindergarten used the playscape for approximately 2 h every day (Fig. 4). The diversity in woodland types afforded all the three categories of play activities (Fig. 4, Table 4). Woodland types constituted climbing areas, with the pine as the most frequent climbing tree, while areas with scattered shrub cover were preferred for construction play, like building dens and shelters, and symbolic play like playing house and pirates. Shrubs like the Juniper bush turned into a nice home, the stump might represented a nice pilothouse for the pirate ship, while the meadows

Table 4

<table>
<thead>
<tr>
<th>Landscape characters</th>
<th>Vegetation Class</th>
<th>Climbing</th>
<th>Climbing trees</th>
<th>Running</th>
<th>Sliding</th>
<th>Skiing</th>
<th>Symbol play</th>
<th>Construction play</th>
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<tr>
<td></td>
<td>Deciduous</td>
<td>–</td>
<td>28%</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>35%</td>
<td>40%</td>
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<tr>
<td></td>
<td>Spruce</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>18%</td>
<td>–</td>
</tr>
<tr>
<td></td>
<td>Pine</td>
<td>–</td>
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<td>–</td>
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<td>–</td>
<td>20%</td>
<td>–</td>
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<td></td>
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<td>7%</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>6%</td>
<td>14%</td>
</tr>
<tr>
<td></td>
<td>Pine/spruce</td>
<td>–</td>
<td>20%</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>11%</td>
<td>38%</td>
</tr>
<tr>
<td></td>
<td>Deciduous</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>46%</td>
<td>48%</td>
</tr>
<tr>
<td></td>
<td>Mixed</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>48%</td>
<td>53%</td>
</tr>
<tr>
<td></td>
<td>Pine/spruce</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Density of shrubs</td>
<td>Open</td>
<td>13%</td>
<td>–</td>
<td>–</td>
<td>12%</td>
<td>98%</td>
<td>7%</td>
<td>–</td>
</tr>
<tr>
<td></td>
<td>Scattered</td>
<td>79%</td>
<td>–</td>
<td>100%</td>
<td>79%</td>
<td>–</td>
<td>86%</td>
<td>96%</td>
</tr>
<tr>
<td></td>
<td>Dense</td>
<td>9%</td>
<td>–</td>
<td>–</td>
<td>9%</td>
<td>–</td>
<td>8%</td>
<td>4%</td>
</tr>
<tr>
<td>Topography (slope)</td>
<td>Mean degree</td>
<td>22.5</td>
<td>–</td>
<td>11.6</td>
<td>22.3</td>
<td>7.0</td>
<td>17.2</td>
<td>10.3</td>
</tr>
<tr>
<td></td>
<td>(S.D.)</td>
<td>(7.8)</td>
<td>–</td>
<td>(4.1)</td>
<td>(7.7)</td>
<td>(8.3)</td>
<td>(7.7)</td>
<td>(3.4)</td>
</tr>
<tr>
<td>Topography (roughness)</td>
<td>Mean value</td>
<td>–0.8</td>
<td>–</td>
<td>–0.2</td>
<td>–0.8</td>
<td>0.2</td>
<td>0.2</td>
<td>–0.1</td>
</tr>
<tr>
<td></td>
<td>(S.D.)</td>
<td>(4.8)</td>
<td>–</td>
<td>(2.4)</td>
<td>(4.8)</td>
<td>(2.3)</td>
<td>(4.0)</td>
<td>(1.5)</td>
</tr>
</tbody>
</table>

\*a Physiognomy of vegetation reported in % playscape area, topography reported as mean values and (S.D.) of slope (degrees) and roughness (second derivative of height).
...and open spaces might be a battlefield. Symbolic play and construction play were more dependent on both topography and vegetation. Whereas the topography had a smooth character, the vegetation was more complex in tree species, shrubs and density of shrubs. Traditional games like hide and seek, catch and run were located to smooth topography with open space or scattered shrub density (Fig. 2c–e). The open, large meadow patch of vegetation on waste places and road embankments next to the kindergarten was solely used for skiing activities in the winter and was used daily in the period from January to April. Functional play activities were linked to activities such as climbing rocks, climbing trees, running, sliding and skiing (Table 4).

The traversing steep slope including rocks and cliffs dominated the topography of the playscape. Fig. 3b illustrates profiles at different sites of the slope. Profile 1 was a steep slope of 35° and Profile 2 was a rough slope, but less steep. These two profiles represented typical areas for climbing rocks. Profile 3 illustrated a long and smooth 21.5° slope which represented a long ‘bob-run’ used in the winter season. All three terrain measured profiles were located within the area mapped for sliding and climbing habitats and the statistical figures for roughness were the same for those areas (Table 4). The roughness values showed that the smoothest topography was found within areas for construction play (mean=−0.1, S.D.=1.5), while the most ‘dramatic’ topography was found within areas for climbing rocks and sliding (mean=−0.8, S.D.=4.8).

There were some core areas in the playscape that the children used more frequently. The children named those areas, and the names may illustrate their functional use. The activities taking place at those areas were closely linked to the structures and the functions they represented, e.g. ‘the Spaceship’ was a big ship-shaped rock randomly placed underneath the steep slope. ‘The Cone War’ was located in a patch of bilberry woodland of big spruces. ‘The Cliff’ was a steep end of the long traversing slope where daring sliding activities took place in wintertime. The activity map in Fig. 4 shows the location of the core areas.

Seasonal changes in the use of the play habitats were observed. The meadow next to the kindergarten (Figs. 2a and 4) was an arena for skiing activities. The snow and a suitable geomorphology afforded sliding (Figs. 3b and 4). Typical winter play activities like ‘angels in the snow’ and construction play with snow (figures, caves) took place in the forest. With a deep snow cover, the young deciduous trees became more accessible for climbing.

4. Effects on motor development

By all-round playing in a diverse and rough landscape, the children’s motor fitness was improved. Results from the experimental study showed considerable improvements in motor fitness in the experimental group (n=46) compared to the reference group (n=29). Significant difference (p<0.01) between the groups was found in balance and co-ordination skills. Those were considered important competencies regarding motor learning. The age and maturation related competencies such as strength and flexibility were improved in both groups, but were not related to training in the same way as other motor fitness skills (Fjørtoft (in preparation)).

5. Discussion

5.1. The natural playscape

In this study, we found that a diverse natural landscape had the qualities to meet the children’s needs for a varied and stimulating play environment where the composition and structures of the landscape were conducive to different play functions. The landscape ecology analyses showed a heterogeneous environment rich in woodland types. The number and spatial pattern of patches constituted a varied landscape mosaic (Forman, 1997) and the diversity and the evenness indexes for the playscape were high compared to the total study area (Fig. 2, Tables 1 and 2). The shape and edge metrics also illustrated the variation and the heterogeneity of the landscape (Fig. 2b, Tables 2 and 3). The total amount of edge in a landscape is directly related to the degree of spatial heterogeneity, and the edge effects are influenced by the degree of contrasts between the patches (McGarigal and Marks, 1998). We found soft boundaries between woodland types in the playscape (Fig. 2b). Soft boundaries together with convoluted...
patch shapes increased interaction with the surroundings (Dramstad et al., 1996; Forman, 1997). Convoluted and low edge contrasts in our study made it easy for the children to move about and this might influence play behaviour.

5.2. Affordances and the impact on children

In the interpretation of the relevance of landscape ecology metrics and the topography for playscapes for children, we have focused on the affordances of the landscape for play. The structure of the landscape, such as the physiognomy of vegetation and the geomorphology, filled the functions for play. The children perceived the functions of the landscape and used them (Gibson, 1979). They selected the habitats that afforded play (Fig. 4 and Table 4). This was the observed behavioural response of the children to the environment, i.e. in ecological terms, their habitat selection (Begon et al., 1990). The play habitats were related to diversity in play activities and seasonal changes (Table 4). The characteristics of the habitats determined the use and the seasonal preferences (Begon et al., 1990; Ims, 1992; Skånes, 1997).

Nicholson (1971) argued that there is evidence that all children love to interact with physical environmental features, such as materials and shapes, gravity, smell, and other things, which they can discover, explore, and experiment with. The stimulation of inventiveness and creativity, and the possibility of discovery are directly related to the number and the kind of features in the environment. Table 4 illustrates the relationship between the play activities and the landscape characteristics. The physiognomy of trees played a significant role not only for climbing trees but also for symbolic play and construction play. The areas for climbing trees were dominated by pine trees (34%), deciduous trees (28%) and mixed pine and spruce (20%). For climbing trees, the other landscape characteristics were considered to be of no significance. Deciduous trees such as birch and sallow were popular climbing trees especially during wintertime when they became more accessible due to a high snow layer. In summer time, some ropes and rope ladders made the pines more accessible for climbing, hanging, dangling and swinging. The sites for symbol play were characterized by deciduous trees (38%), but with other tree species also present. The same was the case for construction play, where deciduous trees dominated. Materials from deciduous trees were more easily accessible for building huts and shelters and this corresponds well to Nicholson’s theory of playing with loose parts (1971). The physiognomy of shrubs seemed to have an influence on all the play activities except for climbing trees. At the sites for symbolic play and construction play, the deciduous shrubs and mixed shrub vegetation were dominating, while the density of shrubs was scattered, 87% of symbol play habitats and 96% of construction play habitats. The importance of shrub vegetation linked to those two play activities was obvious for the purpose of hiding, playing house, building shelters etc. The skiing and sliding areas were used in the winter only. The shrub cover in those areas was mainly open and scattered and did not hinder the activities. The topography of the playscape was linked to the activities by slope and roughness. The more challenging activities like climbing rocks and sliding took place in the steepest part of the playscape with a mean slope of 22.5° (S.D.=7.8), but ranged from 15° to above 30°. High values in roughness (mean=−0.8, S.D.=4.8) favoured climbing activities, but disfavoured sliding. The reason why Table 4 shows the same values of topographical data for both climbing rocks and sliding is because data have been captured from the same sites for both activities. The profiles in Fig. 3b illustrate topography for climbing and sliding. The other activities are obviously favoured by a less steep and a smoother topography (Table 4). These spatial and play activity relations proved to have an impact on children’s motor development (Fjørtoft, 1999 (in press)). Motor mastering is an important quality in children’s behaviour and a qualification to be included in different social activities. Grahn et al. (1997) also found the same effects in kindergarten children playing in an enriched natural environment compared to a traditional city kindergarten. He also found that an enriched environment improved the children’s concentration abilities. Health conditions in children in the nature kindergarten were also improved, as they reported less sickness absence compared to the urban kindergarten.

5.3. Implications for physical planning

An important aspect, which needs to be further explored, is how and to what extent diversity indices
should be related to playscapes for children. In our study, landscape diversity was related to different structures in the topography and the vegetation, which were important for children’s spontaneous play and activities. Diversity is also synonymous with an enriched environment, which again stimulates and promotes play and learning (Frost, 1992; Titman, 1994; Rivkin, 1995; Moore and Wong, 1997). Learning effects due to diversity in the landscape have been documented in this paper (Grahn et al., 1997; Fjørtoft, 1998 (in preparation)). It is obvious that other learning effects from a diverse natural landscape such as nature studies may occur through children’s play and activities. Learning science from nature has not been the focus of this paper, but learning from nature when playing in nature may be characterized as the hidden curriculum (Titman, 1994).

A natural environment as playscape for children may represent a challenge demanding new attitudes in policy and planning. In existing planning directives, there tend to be three main criteria for playground planning: distance from residential areas, kindergartens, schools etc., area size, and safe access to the sites. The physical planning of playgrounds has not addressed children’s needs for a diverse and stimulating playscape. In schools and kindergartens, the outdoor grounds have not been corresponding with children’s needs for affordances and challenges for play, nor has it reflected the policy of the prevailing curriculum (Adams, 1990). It is, therefore, reasonable to suggest some new criteria to be included in planning directives to insure playscapes with landscape qualities representing affordances and challenges for children (Fjørtoft and Sageie, in preparation). In such a perspective, it is also necessary to discuss an acceptable level of risks. Playscapes with the highest level of security tend also to represent areas with the lowest affordances and challenges. Consequently, diversity in landscape elements, affordances for play, challenges and safety, accessibility and wear resistance may be important criteria in the planning and management of future playscapes for children.

In this study, methods from landscape ecology, and geomorphology implemented in GIS for description and analysis of the natural environment’s suitability as a playground for children were applied. For this purpose, we successfully used some of the methods, but more remains to be explored. Applied as a tool for planning and management for natural playscapes, some implications of the methods should be addressed. Necessary spatial resolution in data depends on the purpose of the study. The geometric accuracy range of the mapping methods was 10–15 m for the less accurate data. For our purpose, descriptions of the topography and the vegetation types are at a typical scale for botanical studies, i.e. some m², tentatively estimated to be sufficient. Consequently, for practical planning use, the vegetation map may be useful but not a must for describing and selecting suitable playscapes. But for more scientific description and analyses of play habitats, a vegetation map adds information. For detailed analyses of the landscape, ecology detailed vegetation data are most appropriate.

For the slope and roughness analyses, we have not explored all the possibilities available in GIS. The divergence in roughness value (Table 4), and evaluation results of the reference profiles (Fig. 3b) showed that a more distinct classification of play habitats is necessary. The children’s use of the landscape over time might influence its ecology. In this study, the time perspective was too short to register any ecological change due to the children’s use of the landscape. However, this might be a topic of serious concern in planning and selecting natural playscapes for children.

For the calculation of edge contrasts, the patches were weighted subjectively, i.e. a reasoned guess based on observed contrasts between the patches (McGarigal and Marks, 1998). This of course influenced the reliability of these data.

In theory, the appropriate scale of study is the smallest scale which an organism perceives and responds to (e.g. Forman, 1997; McGarigal and Marks, 1998). In our case, the user was the child, and the child perceives functions rather than forms (Gibson, 1979). Perhaps, the scale should be more function-related and linked to points and special features in the playscape, for example, a special feature, a climbing tree or a sliding slope.

6. Conclusion

The focus on the natural environment as a playground and learning arena is a way of rediscovering
nature's way of teaching, or 'learning from nature'. Hart (1982), Naylor (1985), Moore (1986), Heft (1988), Matthew (1992), Titman (1994), Rivkin (1995) and Moore and Wong (1997) have discussed the importance of the natural environment as a part of children's growth and development. The key concepts from previous studies and the present one are the importance of 'green structures and loose parts' and multivariable possibilities for versatile play. Our study showed a strong relation between landscape structures and play functions. Different landscape elements afforded different and specific possibilities for play. There was a positive relation between play activities and the diversity in vegetation types and physiognomy of trees and shrubs, i.e. building dens was linked to scattered shrub vegetation, climbing trees was linked to pines in the summer time and to young deciduous trees in winter. The diversity of topography expressed as slope and roughness also provided diversity in play activities. Steep slopes were linked to sliding and steep and rough cliffs were challenging for climbing. More even landscape structures were used for running activities, role-play and games. This corresponded with Gibson's theory of affordances (1979) which explained the composition of the environment as functions for use. The children interpreted these affordances and adapted them into functions for play. These functions have proved an impact on motor development in children as well as preventive health effects. The overall conclusion from the present study may be that natural landscapes represent potential grounds for playing and learning and this has to be taken into serious consideration for future policy and planning of outdoor grounds for children.

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