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Research paper

The impact of field layer characteristics on forest preference in Southern Scandinavia

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ABSTRACT

Results from preference studies have been instrumental for including the general public's recreational preferences into forest policy, planning and management. Although recreational preferences have been studied intensively for approximately four decades, field layer characteristics have received very limited attention in Nordic countries and elsewhere. A representative experimental internet survey was conducted among adults (aged +18 years) in the nemoral and boreonemoral vegetation zone of the Scandinavian Peninsula, *i.e.* the coastal, most southern part of Norway, southern Sweden and all of Denmark. Survey participants (n = 4646) were asked to rank seven photographs that had been randomly selected from 30 digitally-edited photographs of oak and mixed hardwoods in three different stages of development and with five different field layer types. Young forests with the preferred field layer (anemone and litter) were ranked over mature and middle-aged forests with the disliked field layer (rough field layers or withered grass). In fact, anemone consistently increased the preference ranking of a stand compared to other stands, while rough field layer and withered grass reduced the preference. These findings challenge the general view among experts that field layer vegetation only makes a marginal contribution to the recreational value of forests compared to other structural attributes. The implications of this and questions for future research are discussed, as well as perspectives for forest management prompted by the results. The focus of this discussion is on urban and peri-urban forests, where recreational value is often the most highly valued ecosystem service.

1. Introduction

Forest is the most frequently visited type of nature for recreational purposes in Nordic countries (Gundersen, Frivold, Myking, & Øyen, 2006; Johannsen, Nord-Larsen, Riis-Nielsen, Suadicani, & Jørgensen, 2013; Rydberg & Falck, 2000). The results of 60 or so forest preference studies conducted in Nordic countries since the late 1960s have been instrumental for including the general public's recreational preferences into forest policy, planning and management (Edwards et al., 2012; Gundersen & Frivold, 2008; Jensen & Koch, 2004).

Recreational preference is defined here as the degree to which environmental characteristics meet people's preferences (Edwards et al., 2012; Manning et al., 2011), *i.e.* the attributes that pass through each person's perceptual and cognitive filters and become decisive for landscape decoding and judgement of liking/disliking (*e.g.* Parsons & Daniel, 2002). The literature relates preference to aesthetic appeal/scenic quality (*e.g.* Kaplan & Kaplan, 1989) and affordances provided by the environment, *i.e.* perceptible properties that have a functional significance for an individual (Heft, 2010). Furthermore, the literature suggests the role of familiarity. For example, Schraml and Volz (2009) reported regional differences in preferences across Europe for tree species and identified a correlation between preferred species and the regionally dominant forest species.

The aims and methods applied in previous forest preference studies in Nordic countries and North-America have mainly addressed conflicts with commercial forestry, *i.e.* the visual effects of logging, silvicultural treatments and road construction (Gundersen & Frivold, 2008; Ribe, 1989). Field layer characteristics – the focus of the present study – and other elements that are not directly of economic importance have not been studied to the same extent (for a review see Gundersen & Frivold, 2011). However, growing awareness of the contribution made by forests to human health and wellbeing calls for a change from relatively commercially-centred approaches to one that is more human-centred. This is especially relevant in an urban context where aesthetic, recreational and spiritual qualities are highlighted as ecosystem services to be optimised (Haines-Young & Potschin, 2010). It is therefore

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understandable and desirable that an increase in forest cover near cities has become a clear and consistent political priority in the EU, including at a national level in Denmark and Sweden's nemoral zone and in neighbouring forest-poor and highly urbanised north-western European countries (*e.g.* Nielsen & Jensen, 2007). Along with closer-to-nature management (*e.g.* Duinker, Lehvävirta, & Nielsen, 2017), the afforestation instrument has been important in supporting the inclusion of recreational value, biodiversity conservation and groundwater protection alongside timber production in forest services.

It is widely accepted that the greater preference for mature forests compared to young forests is influenced by a combination of structural attributes. For the purposes of a pan-European Delphi study among forest preference experts, Edwards et al. (2011) summarised 12 key structural attributes. Of these, an increase in "the size of trees within a stand" (as a measure of stand age) was assessed as making the most influential contribution to the recreational value of forests, while coverage of field layer (< 50 cm height) was the least influential attribute. However, participating panel experts acknowledged that the low importance given to field layer might be biased by the varying empirical knowledge base for key structural attributes, where the base for field layer in particular is rudimentary (Edwards et al., 2012). It therefore remains unclear whether attractive field layers in young forest stands can increase the recreational preference despite the small size and high density of trees.

Young forests usually develop a rough and species-poor field layer of invasive weeds. Due to most forest herbs' poor dispersal capacity combined with the legacy effect of past land use and the poor recruitment opportunities in highly fragmented landscapes – frequently found in urban areas – these conditions can persist for several decades (Elemans & Heil, 2007). Such field layers deviate markedly from what people usually associate with forest, and may be a contributing factor in young forest stands being perceived as unattractive, ignoring the fact that such development phases are needed in order for stands to reach maturity (Ryan & Simson, 2002). Mature forests are by far the most visited, with people more or less deselecting the many young forests resulting from afforestation or recently regenerated stands (Jensen, 2003). Owing to the increasing area of young forests and their predominance in urban areas in the southern Scandinavian peninsula – and in neighbouring north-western European countries where afforestation in and near urban areas is a political priority (*e.g.* Nielsen & Jensen, 2007) – such knowledge would be of direct relevance for forest management and future research initiatives.

For the purposes of visual preferences analysis, it is common to divide forest scenes into three main components: ground plane, trees and surrounding matrix (*e.g.* Gundersen & Frivold, 2008; Ribe, 1989). The tree component is characterised by the size, density, species composition, colour and texture of trunks, and the pattern of branches. The surrounding matrix is composed of foliage, sky extension and background. Finally, the ground plane is characterised by the forest floor's form, extension, vegetation types, colour and texture. The lower understorey or shrub layer's height, density, plant type, colour and texture are also descriptive of the ground plane. These characteristics correspond to the present category for field layer.

Table 1 summarises previous forest preference studies from Europe and North America that include "ground plane or field layer characteristics". In these studies, the beneficial characteristics of the herbaceous field layer are explained as enhancing visual diversity, vividness, ease of movement, the smoothness of ground texture and the visual penetration of the forest stand. The general pattern shows that herbaceous field layers are preferred over shrub and sapling understorey as well as bare or disturbed soil, with the greatest preference for low field layer, *e.g.* 'a green mat of mosses' is highly preferred in Norway. Preferably the field layer should also be flowering; *e.g.* 'encountering anemone flowers' is highly appreciated by Denmark's population (Aasetre, 1993; Jensen & Koch, 1997; Lind, Oraug, Rosenfeld, & Østensen, 1974).

In relation to the importance of the height of the field layer, an on-site study in Belgium, for example, found that field layers over 54 cm in height were perceived as a significant obstruction to free movement (Roovers, Dumont, Gulinck, & Hermy, 2006). This underlines the fact that field layer preferences not only reflects aesthetic judgements, but also the affordances provided by the environment (Heft, 2010). Similarly, preference studies addressing understorey vegetation have repeatedly found dense understorey and a related low degree of visual and physical accessibility to considerably decrease preference (*e.g.* Kellomäki & Savolainen, 1984; Palmer & Sena, 1992; Ribe, 1990; Tyrväinen, Silvennoinen, & Kolehmainen, 2003). Preference for low field layer and related high visual accessibility appears to be a basic human preference. For example in a study of streetscapes in Japan, Todorova, Asakawa, and Aikoh (2004) found that low and ordered compositions of flowers were the most preferred ground cover below street trees, while tall flowers were markedly less preferred. The findings of Todorova et al. (2004) also exemplify that the preference for flowers is pertinent across many types of environments, contributing to aesthetic quality as well as psychological wellbeing. Kaplan and Kaplan (1989) argue that the aesthetic appreciation of flowers across cultures basically has evolutionary roots in flowers being symbols of future resource potentials.

1.1. Aim and objectives of the study

The overall aim of this study was to assess the contribution of field layer to the general public' preference for forest environments. Contrary to the general belief that field layer makes a 'marginally small but beneficial' contribution (cited from Ribe, 1990) in particular compared to stand age and species composition, it was hypothesised that differences in field layer could change the preference ranking between stands of varying age and understorey density, *e.g.* that young stands with a highly preferred field layer would be preferred over middle-age stands and even mature stands with less desirable field layer types and *vice versa*.

The study was designed to allow for an analysis of preferences for forest stands and field layer types separately before testing preferences for their combinations. The rationale for this step-wise approach was that if preference ranking of the stands and field layer types were individually consistent and supported by previous forest preference research, then this would provide reliability of the preference ranking of their combinations.

2. Materials and methods

2.1. Study area

Whereas earlier forest preference research in Nordic countries has been limited to a national or even a regional/local scale (Gundersen & Frivold, 2008), the present study includes the entire nemoral and boreonemoral vegetation zone of the Scandinavian Peninsula (hereafter called Southern Scandinavia), *i.e.* the coastal, most southern part of Norway, southern Sweden – home to most of these two countries' populations – and all of Denmark.

2.2. Forest stand and field layer types

In Denmark, Norway and Sweden, southern hardwoods and oak are among the most preferred forest types (Edwards et al., 2012). As a result of forestry subsidies, afforestation policies and adaptation of forests to climate change, these species are favoured for afforestation in Southern Scandinavia and, due in part to their recreational merits they are also increasingly replacing conifers when long-established forests are being regenerated. This is especially true in publicly-owned forests close to cities (Gundersen et al., 2005). Accordingly, the study focused on oak stands without understorey and mixed hardwood with