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Analysis

Preferences for variation in forest characteristics: Does diversity between stands matter?

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ABSTRACT

The majority of existing studies of recreational preferences and forest characteristics focused on single stand attributes and demonstrated that people prefer stands with visual variation. However, it may be too simple since most people experience more than one stand when visiting a forest. This study aims at evaluating the effects of variation both within and between stands on recreational values. A choice experiment (CE) was applied to elicit people's preferences for forest types on their next recreational visit. Each alternative is presented with drawings of three forest stands which differ with respect to tree species, height (age) and distance to the site, the latter representing the cost factor – willingness-to-travel. Respondents also compose their ideal recreational forest by selecting three types of stands from the catalogue of drawings. We find that mixed tree species are preferred compared to monocultures. Stands with trees of varying height (uneven-aged stands) are preferred over stands consisting of trees of the same height (even-aged ones). Variation between stands is found to contribute positively to recreational value, and in some instances, this may outweigh contribution of variation within a stand. Comparing respondents' composition of their ideal forest with elicited preferences from the CE, confirm these findings.

1. Introduction

Recreation is one of the most important services forests provide to society (Daniel et al., 2012; Pearce, 2001; Slee, 2005). Forest management plays an important role in designing forests and thus affects the potential recreational attraction of the site. Hence, understanding visitor preferences for different forest characteristics or attributes and their recreational values becomes imperative in order to integrate recreational interests in policy as well as in practical decision-making.

A considerable body of literature in the field of preference research has provided insight into impacts of forest management on recreational values of forests (e.g. Schroeder and Daniel, 1981; Zube et al., 1982; Brown and Daniel, 1986; Jensen, 1999a; Bliss, 2000; Holgén et al., 2000; Silvennoinen et al., 2001; Heyman et al., 2011; Nielsen et al., 2012). Variation in forest and/or landscape characteristics may affect the recreational experience and thus the recreational value (Bell et al., 2005; Kaplan and Kaplan, 1989; Lee, 2001; Ode and Miller, 2011; Ribe, 1989). A number of studies have demonstrated preferences for visual diversity at a single stand level, e.g. that mixed stands in general are preferred over monocultures (see e.g. Willis et al., 2003; Nielsen et al., 2007; Gundersen and Frivold, 2008; Dhakal et al., 2012). However, a recreational experience in a forest most often involves visits to several stands and so far, it remains unanswered whether these findings can be extrapolated to forest level i.e. how the recreational experience is affected by diversity between multiple stands. Is it merely a simple sum of the recreational experiences and values of individual stand values or a more complex judgement? The need to examine the effect of variation between stands has been expressed numerously (e.g. Ribe, 1989; Mattsson and Li, 1994; Nielsen et al., 2007; Gundersen and Frivold, 2008). However, previous examples have mostly concentrated on preference comparisons without looking at the importance of this aspect relative to other preferences for structures (e.g. Axelsson-Lindgren and Sorte, 1987; Price, 2007; Edwards et al., 2012a).

The aim of this study is to evaluate the effect of variation within a stand and between stands on recreational preferences for forests in Denmark. Using a choice experiment (CE), respondents were asked to choose between sites for their next forest recreation visit from two alternatives – each made up by three drawings of forest stands that are characterized by tree species and height (as a function of age). Distance to the forest site was included as an attribute in order to estimate willingness to travel to the preferred forest. In addition, we asked respondents to create their ideal forest to visit by selecting drawings of three

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stands from a matrix of drawings, where each drawing could be chosen more than once. This was used as an internal consistency test for the CE findings. Finally, we calculated aggregated willingness to travel (AWTT) for a number of forests (composed of three stands) for a sample mean WTT and using individual posterior estimates.

The remainder of this paper is organized as follows. Section 2 summarizes relevant literature on forest recreation and provides hypotheses for this study. Section 3 outlines the CE setting and data collection. Section 4 presents main findings and Section 5 provides a discussion of their implications for forest management.

2. Literature Review and Hypotheses

A number of studies shows that visual diversity or variation within a stand of a forest is an important determinant of recreational value of forests (e.g. Ribe, 1989; Lee, 2001; Gustavsson et al., 2005; Nielsen et al., 2007; Dhakal et al., 2012). Variation has also been identified as a key cognitive factor that accounts for a considerable part of expressed preferences (Kaplan and Kaplan, 1989; Nielsen and Jensen, 2007; Bell, 2009; Ode and Miller, 2011). The present study defines forest and stand variation as presence of different levels of one or several forest characteristics (be it spatial, biological or structural) that results in a visually diverse recreational experience. In the landscape perception literature this is sometimes referred to as "complexity" (i.e. abundance of variety, where structure is not simple), "richness", "diversity", or "contrast" (e.g. Kaplan and Kaplan, 1989; Ode and Fry, 2002; Bell, 2009). Hence, the visual variation depends on several features, among others tree species, tree size, stand density, presence or extent of understorey etc. This study focuses on two of them – tree species and tree height (age).[1] The latter acting as a proxy for forest management system; i.e. stands consisting of trees of the same height (even-aged stands) often represent a clear-cut system, whereas stands comprised of trees of varying height (uneven-aged stands) indicate practice of single-tree selection systems. Variation may appear at different spatial scales; stand, forest, and landscape level. This study addresses it from both perspectives: within a stand and between stands.

2.1. Preferences and Variation Within a Stand

Studies on recreational preferences show that the most important forest structure is related to tree age - older trees are preferred over younger ones (e.g. Ribe, 1989; Lindhagen and Hörnsten, 2000; Tahvanainen and Tyrväinen, 2001; Gundersen and Frivold, 2008; Edwards et al., 2012b). According to the Danish study by Koch and Jensen (1988), this effect is more prominent in broadleaved than coniferous forests. A relatively low recreational value of young stands may partially be explained by a high density of trees inside the stand, which offers low possibility for visual and physical penetration of the stand. In contrast, semi-open forests provide a better view and sense of safety than dense forests (Heyman, 2012; Kaplan and Kaplan, 1989) and may also be seen as more penetrable, for e.g. mushroom picking (Varela et al., 2016). However, there seems to be a large degree of heterogeneity in preferences. For instance, children and young people often favour more dense alternatives, and higher environmental knowledge often correlates with preference for more natural-looking sites (Gundersen and Frivold, 2008; Ribe, 1989; Tyrväinen et al., 2003).

Variation in tree size and tree spacing in the stand has been identified to have a positive relationship with recreational values across Europe (Edwards et al., 2012a; Willis et al., 2003). Trees of varying height are preferred over even-aged scenarios in Denmark (Nielsen et al., 2007) and a study performed in Germany demonstrated an even higher importance of structural variation under winter conditions (Elsasser et al., 2010).

Public preferences for tree species may partly be attributed to cultural and regional contextual issues. In the present paper, Denmark is used as a case where in general broadleaved and mixed forests are preferred to conifers (Jensen, 1999a; Nielsen et al., 2007; Termansen et al., 2013). It has been shown that monocultures appear to be less preferred due their limited variation (Abildtrup et al., 2013; Dhakal et al., 2012; Elsasser et al., 2010; Gundersen and Frivold, 2008; Ribe, 1989; Willis et al., 2003). However, the highest preference has been found for monocultures when they are of old age (Jensen, 1999b).

2.2. Preferences and Variation Between Stands

In most cases, a recreational experience in a forest would imply that people are moving around in the forest and thus passing multiple stands. While uneven-aged mixed forest is found to provide the highest variation at a stand level, the visitor may perceive less variation if all stands in the forest are similar. This suggests forests comprised of uneven-aged mixed stands may have a lower recreational value, than forests with more inter-stand variation (Lindgren, 1995). Findings of Mattsson and Li (1994) suggest that variation between stands of different ages (though each of them individually more or less uniform) is consistent with a higher non-market value. Moreover, openings in the forest provide space and visual access to more distant areas (Heyman, 2012; Kaplan and Kaplan, 1989).

Existing studies focusing on the effect of variation between stands are limited and mostly confined to pairwise comparisons. Axelsson-Lindgren and Sorte (1987) compare in a Swedish study two trails with different extent of variation and conclude that the trail including many visually different stands had higher attractiveness among participants than the trail with lower visual diversity. Price (2007) found a similar result and stipulates that such results could be due to poor representation of visual progression through the forest. In the 1970s a sample of residents in the Oslo area reported that they preferred taking a walk in "a mixture of old and young forest" compared to taking a walk in "old forest" (Haakenstad (1972) cf. Gundersen and Frivold (2008)). In a study by Koch and Jensen (1988) Danes showed preference for forest areas that contained both broadleaved and coniferous stands, especially if the majority of stands were broadleaved. Findings of a recent expert-elicitation study (Edwards et al., 2012a) on recreational values of forests demonstrate positive or a bell-shaped relationship between recreational value and "variation between stands along the path" (for Europe in general and Nordic countries respectively). Finally, results of a recent choice experiment study performed in Poland suggest that the average respondent prefers to visit forests that are comprised of stands that vary in tree species composition and age structures (Giergiczny et al., 2015). So while a few studies indicate importance of variation between stands, no studies have evaluated it relative to the variation within stands.

2.3. Hypotheses of This Study

The main hypothesis of the present study is that variation matters. Not only variation within stands but also variation between stands affects the recreational value of a forest. Specifically: (1) diversity in tree species composition across stands has a positive effect on recreational value; and (2) diversity in tree height across stands has a positive effect on recreational value. In addition, we expect preferences for tree species composition and height structures within the stand to follow same pattern, i.e. (3) mixed stands are preferred to coniferous and broadleaved stands and (4) stands with trees of varying height (uneven-aged stands) are preferred to stands with trees of same height (even-aged stands). The hypotheses are tested in two ways: by eliciting peoples' preference in a CE, and by asking respondents to create their ideal forest.

[1] This study is focusing on "tree height" as it is a direct visual component (as opposed to age). However, the literature mainly refers to "tree age". Thus, throughout this paper we use the terms height when referring to our study, but it may be interpreted as interchangeable with age.