



## Does biological quality matter? Direct and reflected appraisal of biodiversity in temperate deciduous broad-leaf forest



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### ABSTRACT

Using a multilevel approach, this study investigates direct (perceptual, emotional, and physiological responses [qEEG]) and reflected (preference, attitude, and intention to accept conservation measures) appraisal of different levels of biodiversity in temperate deciduous broad-leaf forest biotopes. Thirty-five participants viewed three series of zoomed pictures from biotopes assessed according to biological criteria to be of High, Intermediate, and Low level of biodiversity. Participants' appraisal differed between the biotopes, and partly between the conceptualisation of appraisal, but overall there was a consistency across direct and reflected levels of appraisal. The most prominent result of the analysis of qEEG was a higher brain activity in the Theta frequency for the Low biotope. The Theta frequency has amongst others been associated with on-set of sleep and in the present context probably indicating that the Low biotope was less stimulating. The Low biotope was perceived to have the lowest degree of biodiversity followed by the Intermediate and the High biotopes. The Intermediate biotope elicited the most positive emotional response, and was rated highest in preference and in importance to conserve, whereas the intention to accept conservation measures did not differ between the biotopes. Thus biodiversity related criteria presently favoured in forest conservation management schemes are not necessarily prioritised by the public. Emotional components are likely to be at stake tending to favour the conservation of biotopes of an intermediate level of biodiversity.

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### Introduction

Today, forests in densely populated, primarily agricultural regions face high competition in terms of land use (Salafsky et al., 2008) and forest utilisation (Konijnendijk et al., 2005; Qviström, 2010). An understanding of public motivation to support biodiversity conservation would facilitate the dialogue on what biotopes, and what management measures should be prioritised (Council of Europe, 2000; Lindström et al., 2006; Johansson and Henningsson, 2011). This study focuses on temperate deciduous broad-leaf forests (hereafter called broad-leaf forests), in the densely populated and highly cultivated southern half of the county of Skåne, in the south of Sweden.

Public support of biodiversity conservation can be regarded as pro-environmental behaviour. To date, research into motivations of pro-environmental behaviour has largely neglected contextual factors such as specific characteristics of a certain product (Steg and Vlek, 2009). In the present context, this implies that we would

need more information about how people differ in their response to specific characteristics of broad-leaf forests. Edwards et al. (2011, 2012) partly addressed this gap by systematically identifying the relation between 12 structural forest attributes and visitors' preference for various European forest types. This study relied on forest experts' experiences of visitors' preference and do not provide in-depth understanding of lay-people's responses. The present research aims to a more nuanced understanding of the complexity and dynamics of human-environment relations, relevant in public support of biodiversity conservation, by employing a multi-level perspective, and by complementing self-report responses capturing different appraisal levels with a physiological measure (Winkel et al., 2009).

In studies conducted within research paradigms for restorative qualities of forest environments (e.g. Hartig et al., 2003; Annerstedt, 2011) or presence of fear inducing animal species (Flykt et al., 2013), characteristics of the natural environment have previously been shown to affect psycho-physiological correlates such as saliva cortisol, blood pressure, heart rate variability, and skin conductance. Quantitative electroencephalogram (qEEG) has been successfully used to complement self-reports of lay-people's response to rather neutral visual characteristics of the built environment (e.g. Küller

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et al., 2009), but has only to a limited extent been used to capture responses to such characteristics of the natural environment.

In this study appraisal theory and previous research on human response to biological variation in nature form the basis for a systematic multi-level investigation of appraisal of different quality of biodiversity in broad-leaf forest biotopes among *lay-people*. The quality of biodiversity is regarded as one characteristic of the forest of which appraisal might influence public support of conservation. The main question addressed is whether or not the public appraises broad-leaf forest biotopes of *different quality of biodiversity* in a similar way. Self-report measures are combined with a first to attempt explore qEEG in relation to visual stimuli of broad-leaf forests. The focus is on the biological variation between species.

Human appraisal of the environment can be expressed in several ways (Craig, 1970), including, for example, descriptions, preferences, emotional responses, and environmental concern (Gifford, 2007). These categories do not explicitly consider the underpinnings of the appraisal process. Following Leventhal and Scherer (1987) and Kappas (2006) we consider the individual's appraisal of an environmental stimulus to be made at different levels of processing; e.g. sensory-motor, schematic and/or conceptual. At the direct sensory-motor level, human appraisal is immediate and intuitive, and stimulated automatically without volitional control. At the other two levels, appraisal is more reflective i.e. the individual cognitively elaborates the stimuli. At the most basic of these two, the schematic level, appraisal is based on schemata, i.e. memories of previous responses to specific situations, and does not require abstract processing. At the second and more integrated level, the conceptual level, appraisal is made on several integrated schemas, includes abstract criteria, and may refer to experiences over a longer temporal context.

This study addresses perceptual, emotional and psychophysiological responses proposed to be part of a rather direct appraisal of environmental stimuli (Berlyne, 1974; Küller, 1991). Environmental appraisal at a more reflected level is considered in terms of environmental preference, which would correspond to a schematic level. Attitude towards conservation, and intention to accept various conservation management measures, correspond to the conceptual level (Fig. 1). As described below these conceptualisations are inter-linked.

#### *The reflected level of appraisal: preference, attitude, and intention to accept*

Studies of landscape preference are numerous (e.g. Hartig et al., 2010; Kearny and Bradley, 2011). These studies report a general preference of natural environments, and thereby suggest that this preference might represent a schematic level of appraisal of nature. However, this literature says little about biological qualities of the nature elements investigated, e.g. in terms of biome and variation in number of ecological or botanical properties (Purcell and Lamb, 1998; Han, 2007; Hagerhall et al., 2008).

Studies that do classify environmental stimuli according to different biomes show that deciduous forests are highly preferred among people with experience of this environment (Balling and Falk, 1982; Lyons, 1983; Koch and Jensen, 1988; Falk and Balling, 2010; Hartmann and Apaolaza-Ibáñez, 2010), at least during the growing season (Han, 2007). The effect of biodiversity per se within a given biome on public preference is unclear, but it has been suggested that the psychological processes underpin preference for natural landscapes where understory species have been removed, i.e. landscapes less likely to hold a relatively large number and variety of species (Williams and Cary, 2002). Gobster (1993) reports a negative correlation between savannah landscapes of high diversity and preference among urban children, whereas van den Berg et al. (1998) found that people who assessed landscapes to have

a relatively high degree of biodiversity also rated it higher on perceived beauty. Other studies have looked into ecological parameters that are linked to biodiversity. In Williams and Cary's (2002) study, lay people's preference for vegetation types of different ecological quality, in terms of understory plants, leaf and wood litter on the floor of the habitat, and different age classes of trees, was not clearly associated with ecological quality per se. Neither did Purcell and Lamb (1998) find a significant main effect of vegetation density. On the other hand Misgav (2000) reported that presence of canopy of tall trees and a moderate plant density increased public preference.

People worldwide are concerned about the future state of the environment including biodiversity (Gifford et al., 2009), and people's preference of natural landscape is positively associated with this concern (Williams and Cary, 2002; Soliva and Hunziker, 2009). It is most likely, however, that there are many predictors of environmental concern. Theoretically environmental concern is sometimes treated as an attitude and sometimes as a behavioural intention, but in both cases it would represent a high degree of mental elaboration, i.e. conceptual appraisal (Stern, 2000; Fishbein and Ajzen, 2010). The public in Sweden is consistently concerned about the disappearance of plants, animals, and wildlife habitats (Wurzinger and Johansson, 2006; Lindström and Küller, 2008), and expresses a positive attitude towards biodiversity conservation (Lindström et al., 2006). People in Skåne consider that the deciduous broad-leaf forests are important to conserve (Lindström et al., 2006), but we do not know if the concern is related to the quality of the biodiversity. Environmental concern has been shown to empirically predict the individual's intention to support conservation of specific biotopes (Johansson and Henningsson, 2011). Intention to accept conservation measures would also represent a conceptual level of appraisal. Possible conservation measures aimed at temperate broad-leaf forests in Skåne include (i) silvicultural interventions for example various management techniques, such as retaining stands beyond the standard time of final felling, leaving some trees until they die from old age, mixing tree species etc., (ii) administrative strategies for example habitat protection, as expressed by the Ministry of the Environment (1979, 2000), nature conservation agreements such as subsidies, etc. as described by Almgren et al. (1984), Andersson and Löfgren (2000) and Brunet (2005) and, (iii) participatory and other voluntary activities, for example voluntarily taking forest areas out of production or aiming at sustainable forestry certified by the Forest Stewardship Council (2013) and the Programme for the Endorsement of Forest Certification Schemes (2013). Landowners are occasionally involved in conservation programmes initiated by authorities, such as voluntary forest restoration (Johansson et al., 2013). The public, however, seem to have a very vague idea of which activities are relevant to supporting conservation of local biodiversity (Johansson and Henningsson, 2011).

#### *The direct level of appraisal: visual perception and emotion*

Preference, attitude and intention to accept are partly based on the individual's mental elaboration of direct responses to the environmental stimuli, such as perception, emotion and psychophysiological response. Environmental perception is primarily visual, and the visual experience is based on a set of distinct heterogeneous processes operating in parallel (Latto, 1995). There are at least two separate channels for processing environmental information, dealing with colour and spatial resolution that dominates form perception (Livingston and Hubel, 1988; Seymour et al., 2010), relevant to the perception of biodiversity. Gyllin and Grahn (2005) developed a semantic method to capture lay people's visual experience of biodiversity in a natural environment (the Biodiversity Experience Index, BEI). The biological diversity experienced was mainly linked to the perception of form by words representing

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