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Trade-offs between wind energy, recreational, and bark-beetle impacts on visual preferences of national park visitors

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ABSTRACT

Recreation pressure on natural resource settings, as well as the demand for new wind-energy production sites, is growing. In addition, extensive outbreaks of tree-killing insects are globally increasing. Protected-area managers are facing conflicts on proper land uses in and around their areas, and need information on visitor preferences for developing a land use policy for their area, accepted by the public. So far, little research has examined national park visitors' responses to windmills and recreational infrastructures, visual changes in forest recreation settings resulting from forest insect infestations, high use pressures, and how visitors weigh trade-offs between these technical, biophysical, and socio-environment factors. This study explored national park visitor preferences with a discrete choice experiment that photographically simulated spruce forest stands with varying levels of recreational and technical infrastructures including the presence of windmills, bark beetle outbreaks, forest management practices, and visitor use levels. On-site surveys were conducted with visitors to the Bavarian Forest National Park in Germany (N = 514). Results revealed that the condition of the forest surrounding, followed by the presence of windmills, was the most important variable influencing visitors' landscape preferences. Visitors preferred healthy mature forest stands and disliked forests with substantial dead wood, many windmills close to the viewpoint and high visitor numbers. Findings suggest that forest conditions and technical infrastructure are important concerns in addressing landscape preferences for forested protected areas and that trade-offs among these variables exist.

1. Introduction

Land use changes due to demands for technical infrastructures for wind energy and outbreaks of forest insects and concomitant forest management approaches can have visual impacts on natural-resource visitors (Arnberger et al., 2017a; Buhyoff et al., 1982; Devine-Wright, 2005; De Vries et al., 2012; Egert and Jedicke, 2001; Krohn and Damborg, 1999; Ryan, 2005). At the same time, visits to natural areas such as national parks are often increasing, and crowding and user conflicts can occur (Balmford et al., 2015; Burns et al., 2010; Manning, 2007). Protected-area managers have to provide recreational infrastructures such as trails and seating for their visitors. Therefore, area managers need to know how visitors respond to changes in the forest landscape associated with technical infrastructures and bark-beetle impacts with the relevant forest management approaches. They also need to know visitor preferences for recreational infrastructures and visitor uses, and realize the magnitude of the impact of technical and recreational infrastructures on visitor landscape preferences relative to other factors such as bark-beetle impacts and visitor numbers. Information on visitor preferences and their trade-offs is useful to natural-resource managers in identifying areas of visual concern in and around their parks, prioritizing and tailoring their management efforts, and developing a land use policy for their area that is accepted by the public.

To date, visitor trade-offs between technical and recreational infrastructures, biophysical characteristics, site management attributes and social factors have not been investigated in the context of bark beetle-impacted protected areas, despite the increasing manifold demands on these areas. The few preference studies that have existed so far combined biophysical, managerial and social aspects of recreation areas and found that recreationists simultaneously integrate many of these factors in their site choices but that these factors are differently

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weighed by them (Arnberger and Eder, 2011, 2015; Arnberger et al., 2017a, b; Bullock and Lawson, 2008; Manning, 2007; Van Riper et al., 2011).

This study employed an image-based discrete choice experiment (DCE) (Louviere et al., 2000), a stated choice approach, to simulate technical and recreational infrastructures, forest stands with varying levels of bark-beetle outbreaks, different forest management practices, and varying visitor uses to investigate visitors' visual preferences and trade-offs in a German national park. In addition, distance effects showing technical infrastructures and forest stands in different viewing distances were integrated. DCEs seem appropriate for the analysis of potential trade-offs among these park environment factors because visitors often have to balance a complex set of technical, infrastructural, biophysical and social factors in choosing their most, and least, preferred recreational park settings. In a DCE, two or more alternatives, defined as combinations of attributes and their levels, are merged into choice sets and respondents choose the most and/or least preferred alternative from each set. Random utility theory (McFadden, 1974) postulates that selection of one alternative over another implies that the utility of that alternative with its attributes is greater than the utility of any other alternative (Louviere et al., 2000).

The following research questions guided the study:

1 What are the visual preferences of national park visitors for technical and recreational infrastructures, bark-beetle impacted and non-impacted forest stands, and visitor numbers and composition?
2 Do visitor preferences vary by viewing distances of technical infrastructures and forest stands in the landscape?
3 What trade-offs do visitors make between technical, forest, infrastructural and social factors, and which factors influence visitors' preferences most?
4 Are there differences in visual landscape preferences between tourists and local residents?

1.1. Visual preferences for technical and recreational infrastructures in natural areas

Wind energy is the most expanding renewable energy resource and many wind parks have been developed in rural regions, often close to – or even in – protected areas (Deshaies and Herrero-Luque et al., 2015; Pasqualetti, 2011; Wolsink, 2010). Although wind energy appears to be rather accepted by the public (Cicia et al., 2012; Krohn and Damborg, 1999), the visibility of windmills at a close distance or near settlements is often disliked (De Vries et al., 2012; Molnarova et al., 2012; Nohl, 2001). Windmills are often less accepted by the local population (Krohn and Damborg, 1999; Meyerhoff et al., 2010). An explanation for the lack of acceptance by local residents is the NIMBY (Not in my backyard) syndrome. However, several authors argue that a close distance to windmills may have only a marginal, or no, influence on acceptance or preferences (Devine-Wright, 2005; Egert and Jedicke, 2001; Krohn and Damborg, 1999; Lothian, 2008; Meyerhoff et al., 2010; Nadaï and van den Horst, 2010) or even found that people living at a greater distance from existing windmills have a stronger refusal than the people living nearby (Molnarova et al., 2012; Van der Horst, 2007). Research has found that acceptance depends further on the landscape context. Windmills in very attractive areas are more disliked than in areas with lower landscape qualities (De Vries et al., 2012; Egert and Jedicke, 2001; Lothian, 2008; Molnarova et al., 2012). Research has also found that, among other factors, the acceptance of windmills depends on their visibility in terms of number, height, and density, and that wind farms are less liked than single windmills (De Vries et al., 2012; Egert and Jedicke, 2001; Graham et al., 2009; Meyerhoff et al., 2010; Nohl, 2001; Rogers et al., 2008; Torres-Sibille et al., 2009; Van der Horst, 2007). While an extensive body of research has analysed the visual impact they make, the question of how important the presence of windmills or other technical infrastructures, such as transmission masts, compared to bark-beetle impacts, is on visual preferences still needs to be asked.

Providing and maintaining recreation infrastructure is one of the main tasks of natural-resource managers (Hendee et al., 1990; Moore and Driver, 2005). Area management has to make decisions on the type of recreational infrastructure is appropriate to the protected-area category and policy, the intensity of recreation use, and which kind of recreation opportunities should be provided (Moore and Driver, 2005). So far, little research has been made into preferences for trail qualities in terms of surface and width, the kind of seating provided and signage along hiking trails in national parks. While many studies analysed trail preferences of forest visitors in rural and urban areas (Arnberger and Eder, 2015; Bullock and Lawson, 2008; Janowsky and Becker, 2003; Van Riper et al., 2011), little information exists about natural-resource visitors' preferences for seating and other recreational infrastructures, as well as the trade-offs between recreational and technical infrastructures, forest appearance and social factors.

1.2. Visual preferences for bark-beetle impacted forests

In Europe, the spruce bark beetle (*Ips typographus*) heavily affects forests (Raffa et al., 2008; Müller et al., 2008). Studies on insect-impacted coniferous forests show that the presence of dead or dying trees negatively affects public preferences, and that impacts are more disliked when beetle damage is observed at near-view distances as compared to midground or background distance zones (Arnberger et al., 2018; Buhyoff and Leuschner, 1978; Buhyoff et al., 1982, 1986; Edwards et al., 2012; Ribe, 1989; Sheppard and Picard, 2006).

Forest management responses to bark-beetle infestation depend on the respective land use policy. In core zones of national parks, a non-intervention policy is often followed to support natural processes and natural rejuvenation (Müller et al., 2008). In several national parks, bark beetles are only managed in a 500-meter buffer zone from the park boundary in order to avoid them spreading to neighbouring private forests (Müller et al., 2008; Nationalpark Harz, 2014; Nationalparkverwaltung Bayerischer Wald, 2010). Outside protected areas, interventions based on forestry policies and forest legislation include clear cuts of infected and dead trees, followed by artificial reforestation. Previous research has found resistance among the local residents to the non-intervention policy while national park tourists were less concerned about the visual impacts of bark beetles (Müller and Job, 2009).

1.3. Visual preferences for visitor numbers and composition

Visitor management is a core topic in protected-areas policies. Social factors such as visitor numbers and activities are addressed in visitor management frameworks such as LAC (Limits of Acceptable Change) and VERP (Visitor Experience and Resource Protection), which are often applied in protected areas (Manning, 2007). Many studies have found that natural resource visitors prefer low numbers of trail users (Mann, 2006; Manning, 2007; Shelby and Heberlein, 1986; Vaske et al., 1996). If use levels exceed preferred levels of encounters with others in the park, visitors feel crowded and may employ coping mechanisms. They may use other trails or come to the area at other times of the day thereby often increasing the impact on wildlife, or may even totally avoid the area with possible economic consequences for regional tourism (Arnberger and Brandenburg, 2007; Manning, 2007; Schneider, 2007).

User conflicts occur when the presence or behaviour of other users interferes with the visitor's goal (Jacob and Schreyer, 1980; Kainzinger et al., 2015; Mann, 2006; Schneider and Hammitt, 1995). Common use conflicts in recreational mountain forests are between hiking and mountain biking (Cessford, 2003; Watson et al., 1991), and between dog walking – particularly when the dogs were not leashed – and other recreational uses (Arnberger and Haider, 2007; Arnberger and Eder, 2015). Visitor management interventions can reduce hikers' conflict