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Research Paper

Towards a comprehensive social and natural scientific forest-recreation monitoring instrument—A prototypical approach

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ABSTRACT

Forest policy planning and broad-scale management is often based on forest inventory data in many countries. However, the importance of social aspects such as aesthetic and recreational values is increasing, especially in urban areas, and need to be considered in forestry practice. We conducted a forest visitor survey at selected National Forest Inventory (NFI) sample plots in order to test whether this would be a way of integrating the social dimension of forest with national forest inventories toward a more comprehensive forest monitoring instrument, focusing on forest recreation and aesthetics. Visitors were asked to rate the visual attractiveness of the NFI plot and the surrounding forest. Multi-level modeling combining both plot-related inventory data and visitor-related questionnaire data showed that perceived forest attractiveness is determined by both social and physical factors. We conclude that it is worth further developing this method with the aim of implementing forest visitor surveys at a subset of NFI plots during routine field assessments, and, thus, significantly improving monitoring of forest recreation.

1. Introduction

Urban and peri-urban forests are often the main areas with natural qualities that are accessible to the public for outdoor recreation (Bell, Simpson, Tyrväinen, Sievänen, & Pröbstl, 2009). Forest management traditionally relies, besides other tools, on forest inventory data to address planning issues (Rudis, Gramann, Rudell, & Westphal, 1988). In order to meet the increasing recreational needs of urban populations, new multidisciplinary approaches to forestry are needed (Konijnendijk, 2003). Sheppard, Achiam, and D'Eon (2004) emphasize the relevance of integrating aesthetics and other social dimensions into forest certification. Rudis et al. (1988) point out the growing need to link public aesthetic perceptions with forest inventory parameters. What is needed is a planning and inventory tool bridging both aspects of forestry: the natural scientific, wood production and biodiversity related physical side, as well as the social dimensions.

One possible theoretical model describing this bridge between physical and social factors is proposed as the so-called "confluence model" in Hegetschweiler et al. (2017). According to the confluence model, physical factors such as characteristics and facilities of forests and other green spaces form the basis for the supply of cultural ecosystem services as defined by the Millenium Ecosystem Assessment (MEA, 2005). Social factors characterizing the population determine the demand for cultural ecosystem services offered. Use of services provided and subsequent benefits generated by the use of these services is a result of a spatial match between the physical and social factors (Hegetschweiler et al., 2017). The benefits that people draw from recreating in the forest are undisputed and several authors have reported positive effects of general health and well-being (Hartig, Mitchell, de Vries, & Frumkin, 2014; Martens, Gutscher, & Bauer, 2011; Russell et al., 2013). Management of natural areas, including forests, needs to better integrate social and biophysical components in order to maximize benefits to visitors while maintaining these areas as diverse, productive and sustainable ecosystems (Driver, 1996; Driver, Manning, & Peterson, 1996).

Assessment of forest characteristics, resource availability and

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evaluation of the state of forests has been traditionally carried out by National Forest Inventories (NFIs) (Tomppo, Gschwantner, Lawrence, & McRoberts, 2010) which also holds true for Switzerland. Modern NFIs use statistical sampling designs, mostly with plots on systematic grids covering whole countries (for a good overview of applied sampling designs see Lawrence, McRoberts, Tomppo, Gschwantner, and Gabler (2010)). Social aspects, including the increasing recreational function of forests, are often only marginally being considered by national forest inventories. Although the recreational function has been a topic of the Swiss NFI since the second survey (1993–95), only infrastructure for and damage by recreational use are investigated. The potential recreational demand and attractiveness of the forest are predicted using models based on physical data and forester surveys (Brändli & Ulmer, 2001). In the latter, questions about recreation, e.g., intensity, type and seasonality are asked (Brändli, 2010). Likewise, the Dutch Inventory interviewed policy makers for additional variables related to recreational use (Daamen & Dirkse, 2010). However, direct measures of people's attitudes, such as forest preferences or recreational satisfaction, and behavior, such as time spent in the forest, aesthetic perceptions or recreational activities, are completely lacking so far.

On the other hand, nationwide household surveys conducted in several countries on a regular basis provide valuable information about the relationship of the general public to the forest, usage patterns and motivations for forest recreation (Sievänen et al., 2008). Examples include the England Leisure Visits Survey ELVS (Ward, Grant, & Snowling, 2008); the Forest and Folk Project and Outdoor Life Project in Denmark (Jensen & Skov-Petersen, 2008); and the National Outdoor Recreation Demand and Supply Assessment LVVI in Finland (Sievänen & Pouta, 2008). In Switzerland, the socio-cultural forest monitoring WaMos (Waldmonitoring soziokulturell) has been conducted twice up to now − in 1997 (BUWAL, 1999) and in 2010 (Hunziker, von Lindern, Bauer, & Frick, 2012). While these assessments examine the social dimension of forest recreation, there is no spatial link to the physical forest.

Numerous studies have measured people's perceptions and preferences of landscapes and forests (Carvalho-Ribeiro & Lovett, 2011; Daniel & Poster, 1976; Kaplan & Kaplan, 1989). These normally work with verbal stimuli, photographs, digitally edited photographs or computer-generated images (Gundersen & Frivold, 2008). Many studies have focused mainly on certain forest management activities like thinning regimes, harvesting practices or the occurrence of dead wood (Hauru, Koskinen, Kotze, & Lehvävirta, 2014; Petucco, Skovsgaard, & Jensen, 2013; Ribe, 2009; Shelby, Thompson, Brunson, & Johnson, 2003; Silvennoinen, Pukkala, & Tahvanainen, 2002; Tyrväinen, Silvennoinen, & Kolehmainen, 2003). Others focused their research on forest characteristics like forest structure, visibility within the forest, forest age, growing stock, ground vegetation or diameter distribution (Brown & Daniel, 1986; Buhyoff, Hull IV, Lien, & Cordell, 1986; Chen, Sun, Liao, Chen, & Luo, 2015; Gong, Zhang, & Xu, 2015; Ribe, 1990; Silvennoinen, Alho, Kolehmainen, & Pukkala, 2001). A good overview of Scandinavian studies on preferences for forest structure can be found in Gundersen and Frivold (2008).

Most of the published studies we found were conducted in North America or Scandinavia, in regions where coniferous forests dominate. A comparison to Swiss conditions should be possible but species composition and forest management is distinctively different in Switzerland. One such example is that clear cutting is forbidden by law and selective logging is usually applied. On the other hand, Ribe, Ford, and Williams (2013) showed that forest perceptions vary between regions making generalizations difficult. In addition, forest visitors' forest preferences and perceptions can change based on the provision of information (Gundersen & Frivold, 2011; van der Wal et al., 2014).

In the following, we present a study describing the first step to develop an instrument to measure visual attractiveness of forests that integrates social and physical aspects and is closely related to or potentially part of an NFI. Visual attractiveness serves as one possible measure for recreational value and corresponds to the aesthetic service of the forest in terms of cultural ecosystem services (MEA, 2005). In the above-mentioned confluence model, visual attractiveness is the dependent use and benefit variable determined by physical factors assessed by the NFI and social factors assessed by socio-cultural forest monitoring. As mentioned above, NFIs assess physical forest characteristics using statistical sampling designs. In contrast, socio-cultural forest monitorings are usually carried out by household surveys investigating the social dimension of forest recreation. Both aspects need to be considered in forest management and planning. If we succeed in developing a tool to bridge the gap and integrate these two monitoring instruments, it should be possible to model and derive and/or and explain parameters relevant to forest recreation, e.g., visual attractiveness and other measures of recreational value, from physical and social data. We are aware of two possible approaches. One is to take visualizations, e.g., in the form of photographs, of NFI sample plots with underlying forest data and use them in a survey. Then, forest data is fitted using regression models to predict the recreational value (or some other related score) of the forest (Edwards et al., 2011; Rudis et al., 1988; Vega-Garcia, Burriel, & Alcazar, 2011). The second approach is to take (parts of) the questionnaire from a household survey, e.g., the Swiss socio-cultural forest monitoring, use them in a forest visitor survey at NFI sample plots and relate recreational use and forest perceptions to on-site forest data. To our knowledge, this latter approach has never been tested and if valid could be applied to any sample based NFI. The advantage is that respondents can assess the changing experience of forest characteristics of real plots, instead of being restricted to what can be captured in photos. Research comparing field and photograph ratings in visual landscape assessments suggest caution in the use of photographic representations, even though this is common practice in landscape preference studies (Palmer & Hoffman, 2001). In addition, an on-site study providing same-point specific data concerning human-environment interactions there, may increase its applicability in urban planning (Kabisch, Qureshi, & Haase, 2015).

Our long-term goal − not yet the concrete objective in this pilot phase of method development here − is to predict the recreational value of forests using data from both social and physical monitoring instruments relevant to forest recreation. The social aspects include societal values, general psychological needs and specific forest preferences. The physical data include distance from home, forest characteristics and state of the forest. If the required data is available on a fine spatial scale, such a comprehensive model can provide indications of which forests are especially attractive for forest recreation. This can be a good basis for decisions in forest planning and management, e.g., to aid discussions in which areas to promote forest recreation and in which areas to potentially restrict recreation. Such measures might be necessary if human presence is not wanted due to a prioritization of wood production or nature conservation.

The actual objective of the herewith presented pilot study, however, was to develop a method for data collection and test whether it delivers interpretable and plausible results (even if not yet valid and reliable in terms of measurement), which could later lead to a wider sampling application in form of the above-mentioned monitoring tool to predict visual attractiveness as a partial measure for the recreational value of forests. Once this method is established, it could be used for numerous other measures of recreational value as well. To achieve this method-development objective, the following research questions had to be answered:

- How can a forest visitor survey be carried out so that data from the two monitoring instruments, NFI and the Swiss socio-cultural forest monitoring, can be combined in one statistical model?
- How might this data help enable prediction of visual attractiveness of forests combining physical forest characteristics with social data?