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Spatial variation in the impact of dragonflies and debris on recreational ecosystem services in a floodplain wetland

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ABSTRACT

Recreation is an important ecosystem service. The interaction between people and habitat components is rarely considered in the analyses of recreational experiences, making it difficult to predict what people will experience. In this study we develop a modelling framework that describes three stages of interaction between people and habitats. This framework considers: (1) the distribution of habitat components in the environment, (2) the proportion of the available components that visitors notice, and (3) the net impact of multiple components on the quality of the recreational experience. The model was applied to a case study river floodplain, and was used to estimate visitor exposure to a combination of positive habitat components (dragonflies) and negative components (debris). The model provided an index of net impacts on experience quality that showed spatial variation across the floodplain, and this analysis highlighted areas that would deliver more positive experiences to visitors. The results of a sensitivity analysis indicated that neglecting the noticeability (observation rate) of habitat components resulted in different predictions. It is therefore important that the noticeability of habitat components is considered during analyses of recreational experiences, and recreational ecosystem service valuations.

1. Introduction

Habitats, with their abiotic and biotic components, provide key recreational ecosystem services (Hernández-Morcillo et al., 2013; Plieninger et al., 2013). It is therefore important to understand how recreational experiences may be affected by changes in habitat management (Arnberger and Haider, 2007; Christie et al., 2007; McCool, 2009; van Riper et al., 2011). Previous studies of recreational ecosystem services have focused on quantifying demand for components of habitats, for example by identifying the organisms and physical features that people want to experience (Westerberg et al., 2010). This understanding of people's preferences can be used to suggest habitat components that could be enhanced to improve recreation (Bullock et al., 1998; Christie et al., 2007; Smyth et al., 2009), but knowing what people prefer is only the start; to manage habitats for recreation we also need to understand how likely it is that desirable habitat components will be supplied to visitors. In this study we quantify aspects of supply (abundance, spatial distribution, and noticeability) and recreational demand (public preference) in relation to two components of a floodplain habitat; debris items and odonates (dragonflies and damselflies). We integrate supply and demand information to provide an index of the net impact that these two habitat components have on a visitor's recreational experience, in different locations within a restored floodplain habitat.

An individual's recreational experience is affected by a range of factors including the physical environment, any activities that they undertake, their social interactions and individual psychology (Kaltenborn, 1997; Ballantyne et al., 2011). In this study we focus on the impacts of the physical and biological environment, by quantifying the presence and noticeability of habitat components that people experience (i.e. observe), and public preferences for these components. These data allowed us to create an index of the net impact of habitat components on the recreational experience, assuming that all other aspects of the recreational experience are held constant. While simplistic, this index of recreational impact may be useful in evaluating the potential outcomes of changes in habitat management, which commonly involve managing particular habitat components.

We outline a three-stage process that describes the impact that habitat components can have on visitor experience (referred to henceforth as the impact process). First, the potential impact is determined by the presence, abundance, and distribution of components in a habitat (Haines-Young and Potschin, 2007;

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Bastian et al., 2012). Second, a visitor will only observe a proportion of the potential habitat components, depending on the area that they visit, the timing and duration of their visit, their awareness of the habitat and the components that might be present in it, and the relative crypsis of the components that are present (Hull and Stewart, 1995; Hughes et al., 2005; Naidoo and Adamowicz, 2005). Third, particular habitat components will impact visitor experiences differently, depending on people's preferences for them. Some habitat components will generally be positive (i.e. will enhance the quality of the experience), and some will be negative (i.e. will reduce it), and the net balance of all components that are noticed by the visitor will determine the impact on the overall quality of the recreational experience (Chenoweth and Gobster, 1990; Bullock et al., 1998; Dorwart et al., 2009).

Typically, previous research has not considered all three stages in our recreational impact framework and, in particular, has neglected the relationship between what is present in the environment and what people notice. Research has focused on characterising visitor preferences for habitat components (Hanley et al., 1998; Hoehn et al., 2003; Birol and Cox, 2007; Westerberg et al., 2010; Kenter et al., 2013), and has commonly used choice experiments to measure these preferences (Adamowicz et al., 1994; Hanley et al., 1998). Some studies have combined preference information with records of what people experience in the environment, through the use of on-site surveys, visitor employed photography (Dorwart et al., 2009; Nielsen et al., 2012) or stakeholder mapping exercises (Fagerholm et al., 2012; Plieninger et al., 2013), or by integrating preference studies with field data recorded from the perspective of a visitor (Naidoo, 2004; Naidoo and Adamowicz, 2005). Such combined methods can tell decision makers which habitat components people notice, and which are most desirable. However, these methods do not necessarily allow the desirable aspects of recreational experiences to be related to the state of the ecosystem. For example, in a study of forest recreational experiences (Nielsen et al., 2012) it is not clear whether participants took more photographs of "negative" dead wood items than "positive" dead wood because there were more examples present, because the examples were more noticeable, or because the items provoked a stronger participant response. To inform the management of recreational ecosystem services we need to be able to distinguish between the relative impacts of ecology (e.g. total species richness, abundance of key species) and aspects of human behaviour (e.g. trail routes, the presence of tour guides, hide infrastructure) in affecting visitor experiences (Naidoo and Adamowicz, 2005).

In this study we use the three-stage impact framework outlined above to model the relative impact of debris items and odonates on recreational experiences. The first stage in this framework is to model the spatial distribution of the habitat components that are of interest, in response to physical and ecological characteristics of the habitat. The second is to incorporate the noticeability of these habitat components to visitors. The third stage is to account for the relative preferences that people have for the habitat components. Combining these three stages allows us to estimate an index of impact on recreational experiences, and we apply this framework to model spatial variation in experience quality in a floodplain wetland case study.

Floodplain wetlands are an important recreational resource (Gren et al., 1995), and are commonly managed to enhance their recreational potential. Among the habitat components that can impact the visitor experience in wetlands, we analysed one positive and one negative component. Odonates (dragonflies and damselflies) and debris items (including both natural and man-made debris) were chosen as examples of positive and negative habitat components respectively, because they were expected to have contrasting impacts on visitor experiences and were known to be consistently present at the study site. Adult odonates are distinctive wetland organisms (Brooks and Lewington, 1997), and are attractive and popular, both with wildlife enthusiasts and in wider culture (Simaika and Samways, 2008; Lemelin, 2007, 2009). Debris accumulation is common in lowland river floodplains because buoyant items are carried in rivers and can be deposited during flooding (Williams and Simmons, 1999). Both natural (e.g. wood or vegetation) and man-made (e.g. food or drink containers) debris items are known to negatively impact the visitor experience in coastal (Tudor and Williams, 2003) and riverine (Williams and Simmons, 1999) habitats. These two habitat components, while not the only important aspects of visitor experience, provide relevant, contrasting, examples of components that people are likely to observe in floodplain wetland.

In this study we modelled spatial variation in the net impact of odonates and debris on recreational experience quality, to inform the management of visitors to the study floodplain. The net impact of odonates and debris on people's experiences may be manipulated through the construction of footpaths or wildlife viewing sites, or improved signage to encourage people to visit particular areas. We applied the three-stage modelling framework described above to compare spatial variation in experience impact, and conducted a sensitivity analysis to assess the relative importance of each of the three stages of the framework in estimating the impact index.

2. Methods

2.1. Study site and chosen habitat components

The study site is located at Fishlake, near Doncaster in the United Kingdom (Fig. 1a; Latitude: 53.611239, Longitude: −1.002889). The curvilinear site is owned by the UK Environment Agency, and is bounded by the River Don to the south and a combined footpath and flood defence bank to the north (Fig. 1b). The floodplain receives inundation from the river through an engineered bank breach. The habitat in the study area is a mosaic of open water, marsh, and wet grassland. The standing water provides habitats for aquatic organisms, including dragonflies (Odonata: Anisoptera) and damselflies (Odonata: Zygoptera), while the periodical flood events bring debris items from the river and deposit them across the floodplain. Fishlake village has a population of less than 700, and visitors from further afield are rare (Richards, 2014). During more than 80 site visits between 2011 and 2013, it was common to encounter less than two people daily, with a high proportion of repeat visitors (Richards, 2014). Current visitors to the site are mainly dog walkers or people walking for personal exercise or relaxation. Despite the currently low number of visitors to the floodplain, recreation is a priority of the Environment Agency, and improvement works including car park construction have been carried out to attract visitors (Richards, 2014). Visitors can experience an open landscape with a wide field of view, and walking along the raised flood defence bank gives good views over surrounding agricultural land. Extensive mining waste heaps and several power station cooling towers are visible from the site, and a raised motorway runs within 500 m of the southern bank of the River Don (Richards, 2014). The floodplain provides habitat for common waterbird species and the site is grazed between April and November by a herd of cattle and ponies (Richards, 2014).

There is anecdotal local evidence to support the choice of odonates and debris as habitat components that impact recreation. Informal discussions with local visitors indicated that debris items were generally perceived negatively, and the Environment Agency routinely carry out debris collection to improve it for visitors