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Research article

Can digital reinvention of ecological monitoring remove barriers to its adoption by practitioners? A case study of deer management in Scotland

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ABSTRACT

Monitoring is one of the key tools employed to help understand the condition of the natural environment and inform the development of appropriate management actions. While international conventions encourage the use of standardised methods, the link between the information monitoring provides and local management needs is frequently overlooked. This problem is further exacerbated when monitoring is employed in areas where there are divergent interests among stakeholders in land use and management. Such problems are found in the management of wild deer across Scotland, where monitoring, in the form of habitat impact assessments, have been introduced as an innovation in sustainable deer management. However, the uptake of habitat impact assessments has been limited. We used deer management in Scotland as a case study to explore whether reinventing habitat impact assessments, and hosting the system on a familiar digital platform (a mobile phone) could help to remove perceived barriers to the implementation of assessments. Using the diffusion of innovations as a theoretical framework three sets of workshops were conducted with participants representing different stakeholder interests. While the proposed digital system did address perceived barriers to the conduct of habitat monitoring, in addition it revealed underlying concerns on the use and purpose of habitat monitoring as a tool in land management. Such concerns indicate friction between scientific and management perspectives, which need to be considered and addressed if monitoring is to become more widely acceptable as a tool to inform the management of natural resources.

1. Introduction

Since the 1980s, there has been an 'explosion of monitoring' in the management of resources across organisations and institutions (Power, 1997; Mol, 2008). Within the environmental arena, a number of international conventions promote the monitoring of ecological condition (e.g. Convention on Biological Diversity, Ramsar Convention, and Bonn Convention). Monitoring obligations under these international conventions are realised in national policies that promote the use of standardised methods, for example, the Joint Nature Conservation Committee's *Common Standards Monitoring* for designated sites in the UK (Williams, 2006). Yet, there is a growing body of evidence that points to problems with current environmental monitoring approaches, with criticism being made of unclear objectives (Legg and Nagy, 2006; Lovett et al., 2007; Holland et al., 2012), poor consideration of eventual analysis (Field et al., 2007) and methodological design being affected by resource constraints (Couvet et al., 2011; Reynolds et al., 2011).

To overcome some of these problems, more flexible and innovative approaches to monitoring natural resources focussed on local engagement have been proposed (Funder et al., 2013; Aceves-Bueno et al., 2015; Vugteveen et al., 2015). Adaptive monitoring encourages the evolution of methods as new information becomes available, or as management objectives change (Lindenmayer and

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Likens, 2009). However, adaptive monitoring has faced criticism that shifting protocols affect the ability to identify long-term data patterns (Hutto and Belote, 2013:186), make it difficult to address broader scientific questions (Haughland et al., 2010) and result in the documentation of trends without the capability to determine underlying causes (Holland et al., 2012: 95). In nature conservation such criticisms can exacerbate the problem of monitoring as an activity aimed at informing policy, but isolated from informing management decisions (Sutherland et al., 2004; Pullin et al., 2004; Westgate et al., 2013).

Yet, to inform policy habitat monitoring needs to occur at a landscape scale, beyond designated areas (Adams et al., 1994; Ostermann, 1998; Nagendra et al., 2013), where land is still composed of important habitats and species. This in turn requires the input of multiple stakeholders with differing management perspectives and objectives (Quinn et al., 2010; Hughes et al., 2011). Such an approach will require innovative approaches to habitat monitoring to address the associated complications that come with the involvement of multiple stakeholders, such as tension in the collation, use and sharing of data (Pocock et al., 2015; Young et al., 2016). However, the advent of digital tools to collect data in recent years has provided opportunities in some areas of environmental monitoring to open up the data collection process. Nature conservation in particular has seen a growth of digital innovation that promotes the collection of data from numerous individuals (e.g. citizen science, Arts et al., 2015; Newman et al., 2012). Such inclusive digital technologies present new opportunities for the involvement of multiple stakeholders in ecological monitoring and decision-making (Arts et al., 2015).

Here we present an experimental approach to the digital reinvention of a monitoring tool: habitat impact assessments, which are used to assess the impact of wild deer populations on vegetation across Scotland. Increased data collection, through habitat impact assessments, has previously been promoted in wild deer management to increase collaborative natural resource management (Davies and White, 2012; Fiorini et al., 2011). The assessments are completed on paper forms and the methods derived from ecological approaches to monitoring impacts. The uptake of assessments has faced problems (Dandy et al., 2014) with criticism due to lack of understanding, practical constraints and concerns of trust in relation to data access (Maffey et al., 2013). In this study we presented three potential user groups, representing divergent stakeholder interests, with a proposed alternative digital system to conduct habitat impact assessments. We reinvented habitat impact assessments by using a familiar digital tool, a mobile phone, to host a data collection platform that reduced the time required to collect and collate habitat condition data. In addressing some of the practical constraints to habitat impact assessments (time required for collection and collation of data) we were able create the opportunity for broader critical reflection on environmental monitoring approaches. We subsequently ask: to what extent can digital reinvention of ecological monitoring remove barriers to adoption? We answer this research question by conducting workshops with three different stakeholder groups. The stakeholder groups were identified from previous studies on the use of habitat impact assessments in deer management, which indicated that it was the younger generation that would be those integrating such methods into standard management practices (Maffey et al., 2013), and a three step approach to the study was adopted:

i) *Triangulation*: critical reflection is used to consider the current purpose and function of habitat assessments, as well as potential barriers to its conduct - in line with previous research (Maffey et al., 2013);
ii) *Introduction*: a potential technical fix (reinvention) is introduced in the form of a digital data collection system; and,
iii) *Reflection*: participants compare the proposed digital system against their knowledge and/or experience of the current paper-based data collection system, providing additional reflection on barriers, reinvention and overall adoption.

2. Case study and theoretical frame

In the Highlands of Scotland, a diverse range of management interests exists among multiple private and public landowners (Austin et al., 2013; Glass et al., 2013), especially in relation to deer management. Deer present a particular problem as, on the one hand they are valued as an economic resource (MacMillan and Leitch, 2008; Phillip et al., 2009), whereas on the other high densities of deer can have a negative impact on habitats and species therein (Putman et al., 2011). As a result, attempts have been made to introduce (standardised) methods for habitat monitoring, in the form of habitat impact assessments, as an innovative tool to inform decision-making in deer management across Scotland. Habitat impact assessments require that landowners/managers establish assessment plots (quadrats) to record and monitor vegetation types and indicators of herbivory; the plots are revisited every two years. Currently methods for the conduct of assessments are outlined in the *Best Practice Guidance on the Management of Wild Deer in Scotland* (SNH, 2011), together with data collection forms. The assessments were derived from broader ecological monitoring methods for those working on large areas of privately owned land across Scotland. The methods are taught as part of college qualifications in gamekeeping and wildlife management to encourage increased uptake across the sector. The use of these methods is also promoted under the voluntary *Code of Practice on Deer Management* (SNH, 2012), which was developed in compliance with the Wildlife and Natural Environment (Scotland) Act 2011, and implies an expectation that regional deer management groups should regularly conduct habitat assessments. However, for those involved in deer management who have limited ecological training habitat assessments are an innovation that is policy, rather than management led and the subsequent uptake of habitat impact assessments among many land managers has been limited (Dandy et al., 2014). Several barriers to adoption have been identified (Maffey et al., 2013), including problems with the complexity of the data collection protocol, the time data collection takes, and the costs of conducting habitat impact assessments.

In our case study we used the 'diffusion of innovations' theoretical framework – a theory that was originally developed in the 1950s and considers the introduction of an innovation, whether an idea, theory or product, across a community (Rogers, 2003). We were interested in the process of innovation adoption by a community – categorised as the implementation stage of the diffusion of innovations framework. The framework refers to different elements that can influence the uptake of an innovation during the implementation stage; three elements were of particular interest – core elements, reinvention and familiarity. The role of the three elements in the context of the framework and deer management is explained below.

2.1. Core elements

Following early criticisms that the diffusion of innovations model failed "to view innovations as dynamic and reciprocal" (German et al., 2006: 356), the model was refined to incorporate reinvention (see Section 2.2). Yet, in order to understand how much potential there is for adaptation of an innovation, it is necessary to