



Internet-based monitoring of public perception of conservation



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ABSTRACT

Monitoring public perception of conservation is essential to ensure successful conservation outcomes. However, evaluating attitudes towards conservation projects presents daunting challenges because it is time consuming, expensive and open to social biases and small sample-size errors. Here, we present a recently developed approach to overcome these limitations – Internet-based methods – in particular offsite and onsite metrics. Offsite methods refer to Internet data mining tools that extract Internet search queries, such as Google Trends, while onsite methods refer to programmes that monitor traffic within websites, such as Google Analytics. We explore the potential of these methods rather than focus on the particular details of the case-studies provided to illustrate them. We used offsite methods to determine patterns in public interest in a reintroduced flagship species and in conservation awareness projects in the UK. We employed onsite metrics to assess the success in communicating a conservation outcome and to evaluate the success in online public engagement of a conservation NGO. Our results indicate that both offsite and onsite metrics are able to track changes in public interest across time and space. In particular, onsite metrics provide high levels of temporal and spatial resolution with a high degree of flexibility. These tools could add reliable information to traditional social surveys and represent an opportunity to improve our understanding of the drivers of interest in conservation.

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1. Introduction

Public engagement is a fundamental part of effective conservation (Bowen-Jones and Entwistle, 2002; Fischer et al., 2011). Firstly, public attitudes towards environmental programmes can be major policy drivers and can ultimately influence the outcomes for biodiversity (Martín-López et al., 2009). Secondly, the engagement of local communities in conservation projects is often a key factor leading to successful implementation (Bowen-Jones and Entwistle, 2002). However, evaluating public responses to environmental projects is challenging as most information is based upon public surveys, which are costly, time consuming and often suffer from small sample-sizes (Infield, 1988; Newmark et al., 1993; Schlegel and Ruf, 2010). Additionally, questionnaire responses can be difficult to interpret as a consequence of social context; for example because of non-response biases or social-desirability biases (Fisher, 1993; Groves, 2006).

The global extent of Internet use means that an increasing number of data sources are available to scientists to explore stakeholder opinion in ways that remove many of the biases associated with conventional

approaches. Internet policies protect users' identity to an extent, and this feeling of anonymity may increase honesty (Blank and Gavin, 2009; Razafimanahaka et al., 2012; Solomon et al., 2007). Moreover, the ubiquity of the Internet provides a wide range of Internet user profiles that encompass, to some degree, all possible demographic and social-economic groups, and allow coverage of extremely large geographic ranges. It is important to note, however, that Internet use might be lower in developing countries and among elderly people. Internet also provides wide temporal ranges; in Google Trends up to 12 years of data can be obtained, which is useful for assessing contemporary trends in ecological thinking (Lineman et al., 2015; McCallum and Bury, 2013; Nghiem et al., 2016). Additionally, it produces massive sample sizes that are not available with traditional social surveys. The two main methods to exploit this data are offsite and onsite metrics. The first, offsite metrics, refers to programmes designed to data mine the Internet and obtain information automatically about particular queries submitted to search engines, such as Google Trends, Naver Data Lab, Bing Trends or Baidu Trends; each one retrieves information from the respective search engine. The second, onsite metrics, refers to tools that monitor traffic within websites, such as Google Analytics, Twitter Analytics or Wikipedia Analytics. While Google Analytics can be implemented in any website, Twitter and Wikipedia Analytics are embedded in their respective websites.

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In some fields of study, offsite metrics measuring Internet search behaviour have been widely applied to assess population interest. For example, in economics this technique has been used to forecast consumer habits or to obtain indicators of the level of economic activity with shorter time lags than traditional methods (Choi and Varian, 2012; Vosen and Schmidt, 2011). Moreover, information from search engines has been used in medicine to monitor health issues such as disease outbreaks and suicide risk (Carneiro and Mylonakis, 2009; McCarthy, 2010; Pelat et al., 2009). Despite the clear potential of offsite metrics (reviewed in Ladle et al., 2016), it has only been applied in a small number of conservation studies to estimate temporal trends in interest in general environmental concerns (Lineman et al., 2015; McCallum and Bury, 2013; Nghiem et al., 2016), to assess change in interest in wetlands after their protection (Do et al., 2015), to determine trends for general fishing related terms (Martin et al., 2012; Wilde and Pope, 2013), to track biological processes and invasive species (Proulx et al., 2014; Szymkowiak and Kuczynski, 2015) or to assess species popularity in relation to their characteristics (Correia et al., 2016).

Onsite metrics, while being used to evaluate the usability of e-commerce sites or the potential of online health interventions (Crutzen et al., 2012; Hasan et al., 2009), have been overlooked as tools to assess public engagement in conservation. Such onsite web analytical services provide fine-grained information about online users' behaviour within a website, such as where they arrived from, which pages they visited and for how long, and the route taken through a website. To extract conclusions about differential preferences this information can be combined with social and demographic information. For example, comparison of traffic intensity among projects would indicate which are more engaging. In addition, onsite metrics could be used to validate whether projects targeting certain sections of the population are succeeding. More interestingly, if this is followed by actions designed to increase interest in certain projects, web traffic becomes an advantageous tool to determine the efficacy of those actions.

Onsite and offsite metrics can act as complementary tools since they measure different aspects of Internet use. In general onsite metrics produce a wider range of information and more detailed outputs (see onsite metrics section for detailed explanation). Moreover, since they are embedded in the website they can glean information at much lower traffic volumes than would be possible using offsite metrics, which only provide the data if the search volume exceeds a threshold (Table 1). The main drawback of onsite metrics is that they require a certain programming knowledge to be implemented and a website has to be developed (Table 1).

Here we aim to introduce and illustrate the opportunities provided by Internet-based datasets to assess public interest in conservation. Specifically, we examine the potential for conservation NGOs, managers and academics to quantify the interest in particular projects and the aspect of those projects that engage the public most. Our goal is to explain the potential of these tools and provide a framework for their use rather than focus on the detail of the case-studies chosen to illustrate them. First, we highlight the opportunities offered by offsite metrics through two examples. We assess patterns in public interest in a bird of prey, the red kite *Milvus milvus*, in the United Kingdom (UK); we selected this species because, after near extirpation, several geographically discrete reintroductions have been conducted, during which public engagement was a major priority. We then investigate temporal patterns of public interest in the Royal Society for the Protection of Birds (RSPB, <http://www.rspb.org.uk/>), one of the biggest conservation NGOs in the UK. Second, we demonstrate the use of onsite metrics by analysing the effect of a single conservation outcome from a different reintroduction project, *The Great Crane Project* (GCP, <http://www.thegreatcraneproject.org.uk/>), that successfully returned Eurasian cranes *Grus grus* to SW England 400 years after their local extirpation. We also analyse the importance of the Internet in communicating conservation actions using data from the *Wildfowl & Wetlands Trust* (WWT, <http://www.wwt.org.uk/>), an NGO focussed on the conservation of wetlands.

Table 1
Comparison between offsite and onsite metrics characteristics.

	Offsite metrics	Onsite metrics
Data accessibility	Data is public and available through several data mining tools, such as Google Trends	Data is private and the programme (e.g. Google Analytics) needs to be implemented in the website
Data type	Relative search volumes, i.e. search volume relative to the highest point in the term's popularity	Absolute number of visits to the website
Data availability	Only searches that reach a certain volume threshold can be retrieved	All data can be retrieved
Repeatability	Data is generated through non-public algorithms that might be modified, thus the same search can yield different results if the algorithms change	The results from onsite metrics are not generated by any algorithm, thus the data is more reliable
Time span	Depends on the data mining tool; Google Trends data are available from 2004 onwards	Data can be retrieved only after implementing the programme in the website
Temporal resolution	Weekly	Hourly
Geographic resolution	From country to town, aggregated in specific period for search terms with high volume	From country to town, easily aggregated in specified periods
Representability	Capture all the traffic going through a particular search engine	Capture all the traffic going through a particular website
Demographic information	None	Estimate ages and gender of visitors through third party cookies

2. Offsite metrics

We chose a Google tool for our study as it is the most used search engine, with over 40,000 search queries per second (<http://www.Internetlivestats.com/>). Google Trends reports relative rather than absolute search volumes on a 0–100 scale, i.e. for any given time-period, it yields the search volume relative to the highest point in popularity (= 100) of that term over the whole time-period under consideration. If we add a second term to the search, its popularity as a search term is measured on the same scale as the first term, thus allowing comparison of the popularity of the two terms. A decreasing trend in the index does not necessarily imply a decrease in the absolute number of searches (although this could be the case), but it does mean a decrease in the search term's popularity compared to other searches. This is one of the main weaknesses of the tool and has been raised as an issue in studies that assess whether interest in the natural environment is decreasing (Ficetola, 2013; McCallum and Bury, 2014; McCallum and Bury, 2013). Nevertheless, there is ample evidence that Google Trends outputs are generally good indicators of public interest in areas like epidemiology and general public opinion (Ginsberg et al., 2009; McCallum and Bury, 2014; Ripberger, 2011; Scharkow and Vogelgesang, 2011). An additional limitation is that, in cases where the volume of searches only breaks the threshold during certain time periods, any trend can be difficult to interpret. This means that Google Trends is best suited to assess high impact conservation projects (e.g. red kite reintroduction) or the activities of larger conservation organisations such as the RSPB.

2.1. Assessing patterns of public interest in a species: the red kite

Being able to target the periods and areas where people are more interested in certain species and conservation projects is crucial in the development of successful awareness campaigns. In this case, we present the seasonal pattern of interest in the red kite, a species which has been reintroduced in the UK (Fig. 1A). We selected this species because

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