Determining preferences for ecosystem benefits in Great Lakes Areas of Concern from photographs posted to social media

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A B S T R A C T

Relative valuation of potentially affected ecosystem benefits can increase the legitimacy and social acceptance of ecosystem restoration projects. As an alternative or supplement to traditional methods of deriving beneficiary preference, we downloaded from social media and classified ≈ 21,000 photographs taken in two Great Lakes Areas of Concern (AOC), the St. Louis River and the Milwaukee Estuary. Our motivating presumption was that the act of taking a photograph constitutes some measure of the photographer’s individual preference for, or choice of, the depicted subject matter among myriad possible subject matter. Overall, 17% of photos downloaded from the photo-sharing sites Flickr, Instagram, and Panoramio depicted an ecosystem benefit of the AOC. Percent of photographs depicting a benefit and the photographs’ subject matter varied between AOCs and among photo-sharing sites. Photos shared on Instagram were less user-gender biased than other photo-sharing sites and depicted active recreation (e.g., trail use) more frequently than passive recreation (e.g., landscape viewing). Local users shared more photos depicting a benefit than non-local users. The spatial distribution of photograph locations varied between photos depicting and not depicting a benefit, and identified areas within AOCs from which few photographs were shared. As a source of beneficiary preference information, we think Instagram has some advantages over the other photo-sharing sites. When combined with other information, spatially-explicit relative valuation derived from aggregate social preference can be translated into information and knowledge useful for Great Lakes restoration decision making.

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Introduction

The assessment of ecosystems services (key terms are defined in Table 1) and associated ecosystem benefits has been recognized as useful for prioritizing, designing, and comparing habitat conservation and restoration projects (reviewed by Boulton et al., 2016; Angradi et al., 2016). Angradi et al. (2016) showed how habitat restoration scenarios for Great Lakes Areas of Concern (AOCs) could be compared based on trade-offs resulting from marginal change in the area of habitats supporting different ecosystem services. They felt that the reliability, credibility, and social acceptance of these analyses would be increased if marginal changes in the area of habitats associated with restoration could be weighted using relative valuation elicited directly from beneficiaries, an idea with strong support in the literature (e.g., Daily et al., 2009; Lin et al., 2017; Rodrigues et al., 2017, and papers cited therein). The traditional method for obtaining stated preference information from beneficiaries is via surveys, interviews, and focus groups which are time consuming and expensive (Richards and Friess, 2015; Tenerelli et al., 2016). As a possible alternative or supplement to stated preference methods we explored using sets of geotagged (attributed with geospatial metadata) photos posted to social media.

Photographs may reflect the aesthetic values, interests, sentimental attachments, and emotional state of the photographer at a particular time and place (Garrod, 2007; Guerrero et al., 2016; Stedman et al., 2004). Although we cannot know the photographer’s exact motivation behind each photograph, we reasoned that the act of taking a photograph reflects the photographer’s individual preference for, or choice of, the depicted subject matter among all the other possible subject matter. In aggregate for a spatially explicit set of photographs, these preferences may serve as a relative rank or weight coefficient for ecosystem services and benefits associated with a habitat restoration (Satz et al., 2013).

This approach of using the content of photographs posted to social media to quantify or map ecosystem benefits or preferences is supported by some recent studies (Hausmann et al., 2017; Heikinheimo et al., 2017; Richards and Friess, 2015; Richards and Tunçer, 2017; Tenerelli et al., 2016; Wood et al., 2013; Yoshimura and Hiura, 2017).
but is not yet widespread (Andrew et al., 2015; Casalegno et al., 2013; Dickinson and Hobbs, 2017). Ecosystem or ecological benefit: the contribution to human well-being that results from the consumption, use, or appreciation of a final ecosystem good or service (after Harwell et al., 2017). Benefits are realized when labor and capital (often in the form of human effort) are added to final ecosystem goods and services (Landers and Nahlik, 2013).

Ecosystem services: broadly, biophysical outputs of ecosystem processes from which humans derive benefits (after Harwell et al., 2017).

Final ecosystem goods and services (FEGS): components of nature directly enjoyed, consumed, or used to yield human benefits. FEGS are biophysical outputs, qualities, or features of nature that need minimal translation for relevance to human well-being (Boyd and Banzhaf, 2007).

Final ecosystem goods and services classification system (FEGS-CS): a hierarchical framework for defining and classifying final ecosystem services and associated human beneficiaries (Landers and Nahlik, 2013).

Great Lakes Area of Concern: geographic areas designated by the Parties of the Great Lakes Water Quality Agreement (Annex 1 of the 2012 Protocol) where significant impairment of beneficial uses has occurred as a result of human activities at the local level.

Intermediate ecosystem goods and services: ecological processes, functions, structures characteristics, and interactions that are essential to the existence of FEGS, but are usually not directly enjoyed, used, or consumed by human beneficiaries (Landers and Nahlik, 2013).

Relative valuation (of benefits): non-monetary comparison among preferences for ecosystem benefits based on percentages, weights, ranks or other relative scale.

Human well-being: the condition of humans and society, defined in terms of the basic material needs for a good life, freedom, choice, health, wealth, social relations, and personal security (after MEA, 2005).

We downloaded all available public photographs and metadata as of August 2016 from within each AOC plus a 100 m AOC boundary buffer (Appendix A1). For the Milwaukee Estuary AOC there were >70,000 posted Flickr photographs. To reduce effort and make the sample size more equitable between AOCs, we randomly extracted 5000 Milwaukee Estuary Flickr photographs for classification. We included the boundary buffer to capture riparian and AOC-adjacent terrestrial habitats that may be relevant for restoration. We used geotags to identify photographs taken within the target area. Instagram photographs are tagged with the name of a location with generalized coordinates, rather than unique coordinates, such that there may be hundreds of photographs posted by different users at different times with the same place-name tag and coordinates. This introduces some location error into the data which is relevant when the named place is near or outside the boundary of the AOC. Of 22,059 original downloaded photographs, 3.8% were outside the target area, and 1.7% had bad hyperlinks. We viewed every photograph and video with a working hyperlink. We did not filter out or classify photographs using image tags or titles. This metadata was missing for many images and when present rarely provided sufficient detail to classify the depicted subject matter using our classification scheme (described below). For each usable photograph, we attempted to determine the user’s gender and origin (Flickr only for origin), the subject matter of the photograph, and if the photograph depicted an ecosystem service or benefit.

For each photograph we used a two-part characterization of the subject matter (i.e., level 1 subject + level 2 subject) to classify the photographs which we then linked to the Final Ecosystem Goods and Services Classification System (FEGS-CS; see Table 1). FEGS-CS has some advantages for our purpose: it provides clear rules for what is and is not an ecosystem service; it explicitly links human beneficiaries to FEGS, and it prevents double counting of benefits (Landers and Nahlik, 2013; Boulton et al., 2016). In some classified photographs, an ecosystem

**Table 1**

Explanation of key concepts used in this paper.

<table>
<thead>
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<th>Beneficiary</th>
<th>a member of a class comprised of individuals who benefit similarly from ecosystems via active or passive consumption, use, or appreciation (after Harwell et al., 2017).</th>
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<tr>
<td>Cultural ecosystem services</td>
<td>the non-material benefits people obtain from ecosystems through spiritual enrichment, cognitive development, reflection, recreation, or sensory experiences (after MEA, 2005; see also Chan et al., 2012; Dickinson and Hobbs, 2017).</td>
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