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Ecological engagement determines ecosystem service valuation: A case study from Rouge National Urban Park in Toronto, Canada

Stuart W. Livingstone [a,b,*], Marc W. Cadotte [a,b,c], Marney E. Isaac [a,d,*]

[a] Department of Physical and Environmental Sciences, University of Toronto-Scarborough, 1265 Military Trail, Toronto, ON M1C 1A4, Canada
[b] Department of Biological Sciences, University of Toronto-Scarborough, 1265 Military Trail, Toronto, ON M1C 1A4, Canada
[c] Ecology and Evolutionary Biology, University of Toronto, 25 Wilcocks Street, Toronto, ON M5S 3B2, Canada
[d] Department of Geography, University of Toronto, 100 St. George Street, Toronto, ON M5S 3G3, Canada

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ABSTRACT

Understanding stakeholder valuation of ecosystem services (ESs), and perceptions of threats to their conservation, can improve planning for urban protected areas. Our study objectives were to examine ES valuations by Rouge National Urban Park (NUP) users as well as perceptions of the impact of the invasive vine *Vincetoxicum rossicum*. Further, we sought to determine how those valuations and perceptions are affected by "ecological engagement" (EE). We conducted a social survey of Rouge NUP users and found that valuation of most ESs was significantly greater for EE users. Interestingly, non-EE users tended to give recreation ('cultural' ES) the highest importance value. Conversely, EE users tended to assign pollination ('supporting' ES), the highest importance. Further, we were surprised to find that 15.2% of EE and 38.4% of non-EE users disagreed or were neutral to the notion that *V. rossicum* is negatively impacting the Park's supporting ESs. Similarly, 32% of EE and 54.1% of non-EE users disagreed or were neutral to the notion that *V. rossicum* is negatively impacting the Park's aesthetic ESs. We conclude that examination of EE can reveal differential ES valuations and perceptions of invasion impact. Furthermore, we believe such examination can inform conservation management plans and public engagement strategies.

1. Introduction

Contemporary human activities are drastically altering the earth's ecosystems (Kareiva et al., 2007). A troubling consequence of this alteration is the staggering decline in biodiversity around the globe (Ceballos et al., 2015; Dirzo et al., 2014). It is increasingly recognized that humans depend on biodiversity in a number of ways for our well-being (Daily, 1997; Haines-Young and Potschin, 2010; Liu and Opdam, 2014). This recognition has spurred the popularization of the concept of ecosystem services (ESs) as a means of quantifying, communicating and integrating that dependence into conservation policy and environmental governance (Cimon-Morin et al., 2013; Costanza et al., 1997; Daily, 1997; Martinez-Harms et al., 2015; Snäll et al., 2015). The Millennium Ecosystem Assessment broadly defined ESs as "the benefits that people obtain from ecosystems" (Millennium Ecosystem Assessment (Program), 2005) and introduced a four-category classification system to differentiate different kinds of ESs. These categories are; *provisioning services* (e.g. food, water, timber), *regulating services* (e.g. natural water filtration, climate regulation via evapotranspiration), *supporting services* (e.g. soil formation, nutrient cycling), and *cultural services* (e.g. recreation in nature, aesthetics of natural systems) (Millennium Ecosystem Assessment (Program), 2005). By conceptualizing the functioning of ecosystems as "services" upon which we depend, and communicating that these ESs are provided by nature at no cost to society, the ESs concept has become "a powerful discursive tool for conservation practitioners and policy-makers" (Muradian and Rival, 2012). Essentially, the ESs concept is a tool to internalize a positive environmental externality (Gómez-Baggethun et al., 2010) either in an economic sense (Bellver-Domingo et al., 2016) or as a heuristic for public appreciation of the value of nature (Potschin and Haines-Young, 2016).

In addition to communicating the value of preserved native ecosystems, the ESs concept is increasingly used in the context of urban biodiversity conservation (Ahern et al., 2014; Haase et al., 2014). Urban regions provide a diverse ecological, socio-economic and governance context to examine the importance of

* Corresponding authors at: Department of Physical and Environmental Sciences, University of Toronto-Scarborough, 1265 Military Trail, Toronto, ON M1C 1A4, Canada.
E-mail addresses: s.livingstone@mail.utoronto.ca (S.W. Livingstone), mwcadotte@utsc.utoronto.ca (M.W. Cadotte), marney.isaac@utoronto.ca (M.E. Isaac).

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different ESs (Ahern et al., 2014; Kroll et al., 2012), and threats to their conservation (Marvier et al., 2004; Mcdonald et al., 2009). "Natural ecosystems" and protected areas provide a rich array of ESs (Foley et al., 2005; Gamfeldt et al., 2013) but they are extremely scarce in most urbanized regions (Mcdonald et al., 2009; Scolozzi and Geneletti, 2012). Moreover, those located in urban regions are often relatively small and contain an abundance of non-indigenous invasive species (NIS) which threaten the continued provisioning of ESs (Pejchar and Mooney, 2009; Trentanovi et al., 2013; Potgieter et al., 2017). Because of these factors, valuation of ESs in urban regions is highly dependent on the priorities of local stakeholders that benefit from those ESs (Hein et al., 2006; Menzel and Teng, 2010) and their perception of threats to ESs, such as NIS (García-Llorente et al., 2008). Furthermore, given the high degree of anthropogenic land conversion, high human population density and relatively small size of protected areas in urban regions, it has been often noted that the cultural ESs provided by urban protected areas are likely of greater relative importance than supporting, regulating and provisioning ESs and can serve as a conduit for the recognition of other ESs (Andersson et al., 2015; Chan et al., 2012; Lin et al., 2014).

From a conservation management perspective, there are now multiple empirical studies that highlight the importance of analyzing stakeholder priorities with respect to ESs (Castro et al., 2011; Koschke et al., 2012; Lamarque et al., 2011; Martín-López et al., 2012; Orenstein and Groner, 2014; Palacios-Agundez et al., 2014) as well as perceptions of the impact of NIS on ESs (Bardsley and Edwards-Jones, 2006; García-Llorente et al., 2008; Humair et al., 2014; Lohr and Lepczyk, 2014). By highlighting synergies and conflicts with respect to prioritization of ESs and perceptions of NIS (Hicks et al., 2013), and shedding light on attributes that can influence those priorities and perceptions, stakeholder analysis can inform both management and communication actions by conservation practitioners (Bardsley and Edwards-Jones, 2006; Bryan et al., 2010; Hein et al., 2006; Sherrouse et al., 2014).

1.1. Analytical framework

We developed our stakeholder analysis framework following the key methodological steps formalized by Reed et al. (2009). These are (1) identifying the context and system boundaries; (2) applying stakeholder analysis methods to identify stakeholders and the stake; (3) differentiate between stakeholders; (4) examine relationships between stakeholders; and (5) utilize analysis to make recommendations for stakeholder engagement. Often, in studies employing stakeholder analysis, categorization of stakeholder groups is based on *a priori* knowledge of significant differences in interests and/or worldview between groups of people, sometimes referred to as a "top-down" process (Prell et al., 2009). Yet, the categorization of stakeholder groups and differentiating attributes can also arise as a "bottom-up" process through self-identification and emergent grouping based on survey responses (see Fig. 1) (Prell et al., 2009).

Using the contextual boundaries of participatory governance in Rouge National Urban Park (NUP), we identified the stakeholder group of Park Users, *a priori*, simply based on their presence in the Park. *Within-group* categorization of "ecological engagement" was stakeholder-defined (Prell et al., 2009) as knowledge of the NIS *Vincetoxicum rossicum*. To analyze *within-group* variability we examined stakeholder valuation and prioritization of ESs, and perception of NIS impact, with emphasis on cultural ESs - The "stake" here largely being access to, and protection of, ESs.

Broadly, with respect to the ESs provided by urban protected areas, stakeholders are individuals or groups whose well-being is affected by the presence and governance of those protected areas (Ostrom, 2009; Palomo et al., 2014), which, in essence includes all residents in and around these protected areas. Yet, this large stakeholder group can be subdivided to offer greater insight into ESs valuation and perceptions of local ecological threats. For example, all local residents that reside in close proximity to a protected area and benefit from its capacity to regulate the micro-climate or buffer storm surges (regulating ES) hold an inherent interest in the governance of that protected area. But there can be significant variability *within* a stakeholder group where individual attributes (eg. consumer behavior, age, level of education, etc.) might be correlated with certain opinions and perceptions about the relative importance of the issue at hand. This *within*-group variability is often assessed *a posteriori* following a "bottom up" process of consultation with stakeholders (Reed et al., 2009). Using the same protected area example, if we were interested in examining how "local residents" value the relative importance of different ESs provided by the protected area, we would likely be interested in whether or not these individuals visit the park. Here, *a posteriori* knowledge of their visitation rate could inform analysis *within* the stakeholder group.

In our case, we introduce the concept of "ecological engagement" as a dichotomous independent variable to examine variability *within* a stakeholder group (Fig. 1). "Ecological engagement" or the near-analogous designations "environmental engagement" (Vitali, 2014), "environmental attitude" (Castro et al., 2011; Opdam et al., 2015) or "nature orientation" (Gunnarsson et al., 2016; Lin et al., 2014) have been consistently shown to be an important attribute for the examination of social attitudes towards conservation issues and one that transcends typical stakeholder categorization (Imran et al., 2014; Ray and Bhattacharya, 2013). We define "ecological engagement" as an individual's awareness of local ecological issues, operationalized in our study as awareness of the highly invasive non-indigenous vine, *Vincetoxicum rossicum*, commonly known as "Dog-strangling vine".

The aim of our study was to: (1) assess the distribution, within a stakeholder group, of ESs valuations of an urban protected area; (2) assess the proportion of ecologically engaged individuals within that group; and (3) determine whether ecological engagement affects ESs valuation and perceptions of NIS impact. To do this, we surveyed park users in Rouge National Urban Park, Canada's newest National Park, and first National *Urban* Park, which is highly invaded by the non-indigenous invasive vine *V. rossicum.* To address our objectives we: (1) rank the importance placed by Park users on ESs provided by the Park; (2) examine the relative ability of Park user's ecological engagement and their Park visitation rate to predict ESs valuation, and (3) examine Park user perception of; (i) the potential of the park to provide cultural services, and (ii) the impact of *V. rossicum* on ESs provisioning.

1.2. Case study description: Rouge National Urban Park

Rouge National Urban Park (NUP) is located within the Greater Toronto Area in southern Ontario, Canada and is governed by Parks Canada. The Park is within one hour's drive for 20% of the Canadian population (Parks Canada Agency, 2015). When fully established the Park will be 79.1 km^2 and will consist of several land cover types (crop/grazing lands: 54.4%, forests/wetlands/plantations: 21.2%, developed areas: 20.4%, urban green space: 4%) (Parks Canada Agency, 2015). Parks Canada is currently in the process of developing an official management plan for the Park. In the interim, they have released a draft management plan that was developed following a round of community engagement activities (Parks Canada Agency, 2015). Though, the draft management plan does not use the concept of ecosystem services to articulate how the Park's ecological functioning benefits stakeholders. Given the clear challenges associated with policy development for a peri-urban protected area, we feel that an application of the ecosystem