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Valuing environmental education as a cultural ecosystem service at Hudson River Park

Walter Hutcheson [a,*], Porter Hoagland [b], Di Jin [b]

[a] New York University, United States
[b] Woods Hole Oceanographic Institution, United States

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ABSTRACT

The Hudson River and its estuary is once again an ecologically, economically, and culturally functional component of New York City's natural environment. The estuary's cultural significance may derive largely from environmental education, including marine science programs for the public. These programs are understood as "cultural" ecosystem services but are rarely evaluated in economic terms. We estimated the economic value of the Hudson River Park's environmental education programs. We compiled data on visits by schools and summer camps from 32 New York City school districts to the Park during the years 2014 and 2015. A "travel cost" approach was adapted from the field of environmental economics to estimate the value of education in this context. A small—but conservative—estimate of the Park's annual education program benefits ranged between $7500 and 25,500, implying an average capitalized value on the order of $0.6 million. Importantly, organizations in districts with high proportions of minority students or English language learners were found to be more likely to participate in the Park's programs. The results provide an optimistic view of the benefits of environmental education focused on urban estuaries, through which a growing understanding of ecological systems could lead to future environmental improvements.

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1. Introduction

1.1. Environmental education as an ecosystem service

Education programs are essential for the development of the public's environmental literacy. A sanguine view is that, over time, environmental education can lead to a deeper understanding of the tradeoffs among protection and development, supporting collective decisions that help to conserve beneficial ecosystem services (Vaughan et al., 2003; Sodhi et al., 2010; Tisdell, 2013). Too, as a means for promoting environmental stewardship, science-based, outdoor education is recognized as central to sustainable development (Hungerford and Volk, 1990; Chen and Tsai, 2015). With intensifying existential threats to the biosphere, such as climate change, natural hazards, and nutrient deposition and runoff, interest in environmental education has been growing strongly (Sauvé, 1996; AGEDI, 2016).

Environmental education takes place both in formal academic programs, to complement traditional forms of learning, and in less-than-formal settings, such as through the interpretive services offered at public parks or as an aspect of ecotourism (Tisdell and Wilson, 2005; Cable et al., 1984; Miller et al., 2013). Such experiences have been shown to promote knowledge of the environment and pro-environmental attitudes, including comprehending the sensitivity of the environment to human impacts (Farmer et al., 2007; Goldman et al., 2007). Despite its often-informal nature, Hill (2013) found that students may benefit significantly from participation in environmental education activities.

Education in general may yield both productive and consumptive benefits, but most research on the economics of education has focused mainly on the former (Schultz, 1967; McMahon, 1987). On the production side, economic benefits are realized as the present value of future incomes resulting from practical learning that is put to use in an occupational or business setting. In contrast, on the consumption side, education may be valued as an enjoyable activity *per se*, much like a recreational experience. With respect to educational programs provided at public parks, zoos or aquaria, or through ecotourism, consumptive benefits may predominate.

Environmental education is understood as a "cultural" ecosystem service (Milcu et al., 2013; Martin et al., 2016; Mocior and Kruse, 2016). Most efforts undertaken to value education or other, recreational benefits of ecosystems have focused on relatively

* Corresponding author.
E-mail address: wwh235@nyu.edu (W. Hutcheson).

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undeveloped terrestrial environments, such as national or state parks (Lee et al., 2009; Haefele et al., 2016). In contrast, few studies have sought to estimate recreational ecosystem service values in urban settings (*cf*., Sherer, 2003; Cho et al., 2008; Koo et al., 2013; Wolf and Robbins, 2015; Forleo et al., 2015). Nonetheless, it has been suggested that environmental education activities may promote biological diversity, and the self-organization of social systems surrounding the environment may promote resilience within urban natural systems (Krasny and Tidball, 2009). Further, to our knowledge, published studies valuing the educational ecosystem services relating to estuarine environments in urban settings are almost nonexistent.

1.2. The travel cost method

Although environmental education is well-recognized as a one kind of ecosystem service, it is important to begin to characterize its scale in economic terms. Research on the value of environmental education can help planners and resource managers develop a more complete understanding of the multi-dimensional contributions of a natural area, such as a river or estuary, to human welfare. Further, assessing the economic values of all of the services that flow from a natural area can help support decisions about investments that might enhance those flows, leading to welfare gains in the future.

Unfortunately, without an established market, assessing the economic value of many cultural ecosystem services can be problematic. One approach to valuation without a market, the travel cost method (TCM), has been used extensively to estimate demands for the recreational uses of natural areas (Bockstael 1995; Ward and Beal, 2000; Parsons, 2003). TCM takes observed variations in travel effort across recreational users, as characterized by the costs of traveling and the opportunity costs of time, as a basis for valuing the services provided by an area or program (*cf*., Cable et al., 1984 for an early application to an interpretive facility for a national forest in Canada). In an application of TCM concerning cultural services, Willis et al. (2012) used booking data from a community theater in the United Kingdom to estimate the demand for theatrical shows. Following the travel cost logic, Wolsink (2016) found that the number of field excursions organized by teachers in Amsterdam was positively associated with proximity to an urban green space, although the authors did not estimate the demand for environmental education.

1.3. New York City's waterways

New York City is surrounded by several historically and ecologically significant waterways. Because of its biological productivity, the Hudson River and its estuary was prominent in the historical development of the NY metropolitan area (Waldman, 2013). Prior to the City's colonization by European settlers, massive oyster reefs lined its shores, forming the foundation of a complex ecosystem and supporting a diverse range of marine life (Kurlansky, 2006). Over the course of several hundred years, however, resource exploitation and urbanization led to the rapid degradation of the Hudson River and its connected estuarine environments. The oyster populations collapsed, and the Hudson's other estuarine resources were depleted or became contaminated.

In recent years, increased attention has been paid to expanding the City's environmental education and other recreational uses of urban-natural spaces, placing special emphasis on waterways (NYC Education, 2016; NYC Parks, 2016). At the forefront of these efforts, interest in the potential rejuvenation of the Hudson's estuarine resources has increased. Oyster restoration, conservation measures, and education initiatives have been developed to improve the Hudson estuary and to increase access to its resources (Billion Oyster Project (BOP), 2016; USACE, 2016). These efforts are essential for both restoration of and human interactions with the estuary, as other activities, such as channel deepenings, sewage overflows, industrial effluents, hazardous material spills, and shoreline construction, continue to threaten the ecosystem (Bain et al., 2007).

These threats persist, in part, due to dated public perceptions of a heavily polluted waterfront (Bain et al., 2007). In urban planning contexts, valuation studies serve to raise awareness of ecosystem services and inform land-use decision-making (TEEB, 2011). Valuation of ecosystem services provided by NYC's waterways could be used to better understand the costs associated with harmful activities and, in turn, to promote continued efforts to restore the Hudson River and estuary.

1.4. Hudson River Park

In 1998, the NY Senate and Assembly enacted a bill to establish the Hudson River Park (the Park) in Manhattan, running between the Hudson River and the West Side Highway from Battery Park to 59th Street. The Act also established an estuarine sanctuary in the Hudson River adjacent to and extending the length of the Park. An environmental education mission for the Park was created through its enabling legislation and given guidance in an Estuarine Sanctuary Management Plan. The Park is funded independently by a Trust, established to "promote knowledge of the Hudson River's ecosystem, prehistory and history by expanding youth and adult educational programs" (HRP, 2016a).

Currently, the Park offers a range of programs for children and adults, many of which focus on the ecology of the Hudson River. Some programs are available to the public on a walk-in basis during the summer; others are organized for schools and camps visiting the park. Many of the Park's programs are marine science-related, designed to educate the public about the estuary and its ecology (HRP, 2016b).

This study sought to estimate a range of plausible cultural ecosystem service values arising from the Park's education programs for K-12 schools and camps that concern the science and ecology of the Hudson River and Estuary. Using visitor data compiled by the Park and additional data from the City's Department of Education and the US Census Bureau, a travel cost model was implemented to estimate the benefits of these services. These estimates should be considered to be conservative in the sense that they comprise neither all of the environmental education services (adults also participate in environmental education at the Park) nor the complete set of the estuary's provisioning, supporting, or regulating services. Nevertheless, we argue that TCM can be useful in developing estimates of cultural ecosystem services for natural areas.

2. Methods and data

2.1. The travel cost method

A basic TCM estimates the probability of the number of visits to a location over a specified interval of space or time (Parsons, 2003). The mean and variance of nonnegative, discrete data, such as visits, are estimated using a "count data" approach, such as a negative binomial probability model, which is a variant of a Poisson count data model that has been generalized to allow the mean and variance to differ (Greene, 2012). According to this model, the probability of observing y_i visits to the Park from schools or summer camps in school district i in a year is:

$$Prob(Y = y_i|\mathbf{x}_i, \tau_i) = \frac{e^{-\lambda_i \tau_i}(\lambda_i \tau_i)^{y_i}}{y_i!}, \quad y_i = 0, 1, 2, \ldots \tag{1}$$

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