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Revealed social preference for ecosystem services using the eco-price

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ABSTRACT

Ecosystem services have predominately been valued from the perspective of individual preference, where the willingness to pay of an individual is measured either directly or indirectly. However, when one observes where money is spent on increasing ecosystem services, preserving them, compensating for their loss, or replacing lost services it is almost always through collective action of governments, corporations, or non-governmental organizations. This work suggests that revealed social preference is the most appropriate economic perspective for institutions to use in analyzing the value of ecosystem services, particularly when the scale of inference is large, the decisions to be made are multiple, or the final use of the ecosystem service is uncertain. The eco-price collates instances where society has paid for an increase in ecosystem services, to avoid their loss or restore damages, in the form of $ paid per biophysical unit of ecosystem service. Eco-prices are categorized by type of biophysical work done (i.e. water, carbon, nutrients, soil, and biodiversity). Applying the categorical eco-prices to biophysical ecosystem services flows for average forest and freshwater wetland conditions in Maryland yields an estimate of the annual ecosystem service benefit of $5,767 per hectare of forest and $9,693 per hectare of freshwater wetlands.

1. Introduction

The value of a non-market ecosystem service (e.g. stormwater management, erosion prevention, protection of biodiversity) is typically estimated by asking what someone would be willing to pay for the service through contingent valuation surveys, or looking at the marginal changes in proximal markets for "revealed preferences" of individuals (e.g. hedonic pricing, travel cost analysis). All of these methods have well known flaws. For example, contingent valuation is subject to hypothetical bias, (Blumenschein et al., 1998; Ajzen et al., 2004; Yadav, 2007), hedonic pricing and travel cost analyses do not actually measure the ecosystem service (ES) and can easily conflate it with other values (Boyle et al., 1994; Loomis, 2011; Simpson, 2011; Hausman, 2012). These methods are typically biased towards measuring immediate economic well-being, discounting longer term values, such as intergenerational equity. The question of the viability of these methods has been placed in the context of whether or not ecosystem services should be valued at all (Gómez-Baggethun et al., 2010), or if the value of ecosystems should be framed as their inherent right to exist (Wilson, 1984; Sessions, 1995). However, the question of whether or not individual economic preferences for ecosystem services should be measured to quantify them is rarely asked. This paper questions both the appropriateness of using individual preferences to value ecosystem services, suggesting that considering the revealed preferences of society is preferable in most situations. A biophysical-based method for assessing social preferences for ecosystem services, the eco-price, is presented and applied to typical forests and wetlands in Maryland. The State of Maryland is part of the Chesapeake Bay watershed, and encompasses the northern portion of the Bay. The Chesapeake Bay is an important economic driver for the region, and the focus of a longstanding effort to improve the status of its waters. The eco-prices and ecosystem service assessments presented here are part of ongoing work within the Maryland Department of Natural Resources, an initiative entitled Accounting for Maryland's Ecosystem Services, seeking to assess and value ecosystem services across the state.

1.1. Biophysical and economic value

All ecosystem services defined here as ecological work, which benefits human well-being and which have been termed "final ecosystem services" by Boyd and Banzhaf (2007) have two dimensions — biophysical value and economic value. Biophysical value is the actual quantity of the ecological function that is yielding an economic benefit, e.g. grams of carbon being sequestered, cubic meters of water being recharged to the aquifer, etc. The biophysical value is equivalent to the Benefit Relevant Indicator in the

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suggested ecosystem service model for the US federal agencies (Olander et al., 2015). Economic value is the difference between the price paid for a good and what a consumer would be willing to pay – i.e. the consumer surplus. However, this information is not easily obtained for ecosystem services. Often one dimension may have been assessed, such as what a consumer would be willing to pay through contingent valuation or what a consumer has paid through a travel cost analysis; but it is very rare for a study to have assessed both dimensions, so that an economic value can be determined. This is why the monetary output of these assessments is expressed in terms of economic preference rather than economic value. In the approach presented in this article, both biophysical and economic quantifications are essential in performing an economic analysis of ecosystem services. A biophysical quantity without a connection to a consumer is not a service, and a person without access to a quantity of ecological work cannot consume it, these factors are considered along with the fact that the demand function of the consumer will change with the biophysical supply. For example, a wetland in the Canadian boreal forest is taking up nitrogen and phosphorus, but this is not an ecosystem service if there is not a population being impacted by eutrophication in downstream waterbodies. While it is difficult to imagine a situation where a consumer has no access to any ecosystem services, there are many situations where biophysical supply is constrained and demand increases, such as during drought conditions in the American southwest, where water supplies are limited.

1.2. Individual vs. social preference for ecosystem services

When we look at where non-market ecosystem services are actually paid, for the most part, it is not at the level of the individual, it is at the societal level through the actions of government, business, or non-governmental organizations (NGO's). In some cases, ecosystem services are marketed (e.g. the Pennsylvania Nutrient Trading Program, carbon trading in the Regional Greenhouse Gas Initiative), but these markets are formed to comply with government regulation, not to meet the "free market" demands of consumers. The position promulgated in this article is that assessing social preferences for ecosystem services can be revealed through prior investments made by government programs, actions of NGOs, or commercial payments that have resulted in a marginal increase in ecosystem services and that this approach is a more appropriate method of valuing ecosystem services than measuring individual preferences. This is particularly true when the benefits of ecosystem services must be broadly assessed and the alternative is to use benefit transfer. The benefit transfer method uses values from other studies, not necessarily performed with the same spatial or temporal boundary as the target region, to infer benefit values in the target region.

It is important to note that while the term "eco-price" may be misinterpreted as market price, it is in fact an effort to value the benefit that society gains from the work of the environment. I adopt the price terminology because I am looking at instances of the exchange of money for a biophysical quantity of an ecosystem service, assessing the "eco-price" paid in that exchange. In some cases this is an actual market price, but in most cases the exchange occurs due to a tax, regulation, or cost of replacement (see Table 1). The eco-price is different, although conceptually similar, to "ecological price" (Costanza and Neill, 1981, 1984; Patterson, 2002; Patterson et al., 2006). All these terms describe linking biophysical measures to economic flows, but the "ecological price" was previously applied as a weighting factor in input-output models, measuring the money exchanged for ecological energy flows in a given economy, whereas the eco-price assesses multiple modes of preference for the biophysical flow of an ecosystem service.

There is a limited literature on revealed social preferences (RSP), and the literature is even more limited on RSP for ecosystem services. This trend is beginning to shift, as researchers and practitioners realize the limitations of valuing ecosystem services using individual preferences (Ruckelshaus et al., 2015). Kenter et al. (2015) put forth a definition and typology for social values of ecosystem services, discriminating five dimensions of social value and seven categories of shared/social values. The study in this paper, considers the social value of ecosystem services, where society overall is benefiting from the work of the environment, at the scale of the state of Maryland. This method does not consider other aspects of shared/social value proposed by Kenter et al. (2015), such as transcendental value, communal value, or cultural value, but these values are seen as contributors (along with individual value) to "group values", in the Kenter et al. typology. An investment in ecosystem services is not necessarily an exchange where an individual directly benefits. It is possible he or she may benefit, or their neighbor may benefit, or the benefit may accrue to future generations. Decision making in a representative democracy can be seen as a form of group deliberation, as society has the opportunity to elect members that represent their desired actions. Of course, representative democracies have varying degrees of citizen engagement, and moving towards higher levels of citizen participation, "deliberative democracy", would increase the degree to which government action reflects social preference.

Deliberative monetary valuation (DMV) attempts to assess a social preference and describes a process where a group of people discuss and arrive upon a value for ecosystem services (Wilson and Howarth, 2002; Spash, 2007; Orchard-Webb et al., 2016). Similarly to contingent valuation, and in contrast to the method proposed here, DMV does not explicitly incorporate the biophysical supply portion of ecosystem services. This method does have the advantages of targeting a specific population and presenting information in a specific way, allowing the group to make decisions in a particular context through weighing costs and benefits to themselves as well as society as a whole, alleviating some of the problems associated with the contingent valuation method.

People largely believe that the responsibility of investing in ecosystem services falls on society as a whole rather than on the individual. This extends back to the Public Trust Doctrine, first established in Justinian compilation of Roman law c. 530 AD and carried through to medieval English courts (Slade, 1990), and to law in the United States (Ruhl and Salzman, 2006). The Public Trust Doctrine states that it is the Government's responsibility to protect natural resources in the interest of the people, the application in the United States statutory system was laid out by Sax (1970). Ruhl and Salzman (2006) examine how the public trust doctrine applies to ecosystem services, concluding that it would need to be expanded to apply to all ecosystem services, but services derived from public waters fall under this doctrine. Many surveys support the assertion that people see it as the responsibility of the state to protect and invest in ecosystem services (EcoAmerica and SRI Consulting, 2006; GFK, 2011; Logsdon et al., 2015; Gallup Polling, 2015). Unpublished survey data of randomly selected households in Montgomery, Co. Maryland (Campbell and Tilley) found that payments to a government entity were the most preferred option for ES investment, when compared to private or NGO investment.

There are several ongoing debates within the ecosystem service community (Farley, 2012; Schröter et al., 2014), some of which could be informed by a shift from considering ecosystem services from an individual value perspective to a social one. Ecological economists typically define a Pareto optimum from the perspective of societal well-being, rather than individual well-being as traditional economists do, but seek to find social well-being using measures of individual preference. The eco-price approach allows a direct estimate of a social optimum. Connecting ecosystem services with biophysical flows grounds the valuation, and allows pre-