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Evaluating opportunities to enhance ecosystem services in public use areas

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ABSTRACT

Public use and conservation areas (PUAs) offer opportunities to protect and enhance the delivery of ecosystem services (ES), however ES are rarely evaluated on such lands. We developed a spatially-explicit method for estimating regulating and cultural service capacity and evaluating intent to conserve ES in PUAs. We use management priority information to infer conservation intent and demonstrate the application of a social capacity metric for assessing cultural service capacity. We present a decision framework to guide efforts to enhance the delivery of benefits to public land users and downstream residents. We test this approach by pairing analyses of two ecosystem services—water purification and recreational bird watching-in PUAs throughout the Albemarle–Pamlico basin (Virginia and North Carolina). Our results reveal that management of the majority of sites does not currently give priority to either service, despite a wide range of service capacities. The decision framework suggests that managers of PUAs with moderate to high service capacity could protect ES flow by increasing awareness and other social capacity factors within PUAs. In contrast, managers of PUAs with low service capacity but high potential to influence local and regional environmental condition might focus on enhancing the biophysical capacity to provide selected services.

1. Introduction

During recent decades, the concept of ecosystem services (ES) has gained traction in conversations about the value of nature (Daily, 1997; Millennium Ecosystem Assessment (MA), 2005) and sparked a wide range of assessments and model development aimed at quantifying and mapping services in order to enhance the representation of ecosystem-related values into decision-making (InVest—Tallis and Polasky, 2011 and ARieS—Bagstad et al., 2013; also see Chan et al., 2006, 2012; Fisher et al., 2009; de Groot et al., 2010). The ES lens has helped reframe the relationship between humans and (semi-)natural areas and draw public attention to the effects of human activities on ecological conditions and human well-being (MA, 2005), especially at landscape scales (de Groot et al., 2010). The ES movement has also increased public awareness of many ecological functions and benefits that are often overlooked in land use decisions and economic valuations of natural or public use areas (Ingraham and Foster, 2008; Wenny et al., 2011), including federal, state, and local government-owned lands as well as privately owned lands that are open to the public (hereafter, PUAs). Yet, despite the recent surge in ES-focused research (Fisher et al., 2009) and the incorporation of ES into global conservation initiatives (see World Wildlife Fund, 2012; The Nature Conservancy, 2012), ES remain largely underrepresented in most state and regional land-use and conservation planning (de Groot et al., 2010).

1.1. Economic and biophysical assessment of ecosystem services

The exclusion of ES from decisions is often attributable to the difficulty of assessing and valuing ES and the lack of appropriate and easily accessible data. While economic valuation has contributed greatly to ES inventories worldwide, benefit transfers (i.e., applying the value estimates from one site to another) assume that monetary values do not vary across space and time (Eigenbrod et al., 2010; Plummer, 2009). In this way, economic valuations based on willingness-to-pay, hedonic or replacement valuations are driven by demand for and the perceived availability of the service more than by the true supply of the service. Thus, economic valuations without biophysical assessments of supply as a foundation can introduce uncertainty and error, especially when assessments are applied to other sites. Moreover, not all

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services are suited for economic analysis. Non-material benefits derived from services are difficult to quantify because people differ in how they value services (Martín-López et al., 2012), especially when they represent transformative or moral values (Chan et al., 2012). Market-based valuation, focusing mostly on final service benefits, often fails to identify the intangible values commonly associated with regulating and cultural services (Chan et al., 2012).

Biophysical assessments of ES also involve significant challenges. In addition to understanding differences among types of services (MA, 2005; Villamagna et al., 2013), assessments of services for which production records are not readily available may be based solely on land-cover proxies (Eigenbrod et al., 2010) or simply avoided where data, money or time for analysis are limited. Since most regulating and supporting services (i.e., the direct and indirect ecological processes that ultimately provide services), are not represented in economic markets, they are often considered public goods (Wenny et al., 2011). Water typically is priced by volume, not by quality; hence the purification that occurs to maintain high-quality water is overlooked. Moreover, many regulating services may be seen as intermediate services, those ecological functions or processes that are necessary to produce the final services directly consumed by people (Boyd and Banzhaf, 2007). For example, water purification, including riparian filtration of sediment and nitrogen, may be identified as an intermediate service to the final service of drinking water provision. While the latter is much easier to quantify and value monetarily, the former is not without value (Boyd and Banzhaf, 2007) and is strongly affected by land management decisions.

To effectively inform conservation planning, assessments of regulating, supporting, and cultural services (i.e., non-material benefits derived from ecosystems) require greater development of theory and application (Chan et al., 2006, 2012; de Groot et al., 2010). New methods for evaluating the condition of regulating and cultural services will help enhance the role of ES in PUA management decisions. We suggest these methods need to (a) be conceptually sound and spatially explicit; (b) incorporate reliable data that are widely available; (c) use existing and vetted equations and models (where possible); and (d) recognize current conservation intent or effort. Further, assessments of cultural services, which are largely experiential, must include measures of both biophysical and social capacity (Villamagna et al., 2013).

1.2. Trade-offs and synergies

While it is necessary to develop a strong conceptual understanding of the production and delivery of ES, it is equally important to consider how ES interact and collectively respond to a stimulus (e.g., land management). The strong connection among ES suggests that land-use and conservation decisions often comprise trade-offs and synergies (Bennett et al., 2009); however, little attention has been given to the relationships among services. Ecosystem services linked in space and time can be considered ES bundles (Raudsepp-Hearne et al., 2010). For example, water purification (e.g., riparian filtration) and bird-watching, among other services, can be positively affected by PUA management to increase or enhance riparian vegetation, decrease impermeable surface coverage, and regulate site use (Fig. 1). More specifically, wildlife communities, including bird populations, can be supported by the maintenance of adequate vegetated riparian corridors (Smith et al., 2008). By examining multiple ES at once, we can more accurately evaluate the synergies and trade-offs associated with different management scenarios and increase awareness of non-target ES that may be affected by decisions (Ingraham and Foster, 2008). Finally, enhanced understanding of ES bundles can increase awareness of and funding for conservation and management, the flow of ecological benefits to people, the number of beneficiaries, and the social value assigned to conservation lands.

1.3. Management priorities as representation of conservation intent

Improvements in ES assessment methods, including the bundle approach, will lead to greater inclusion of underrepresented services in land-use decisions, which could enhance production and delivery of a broader portfolio of ES. However, information on

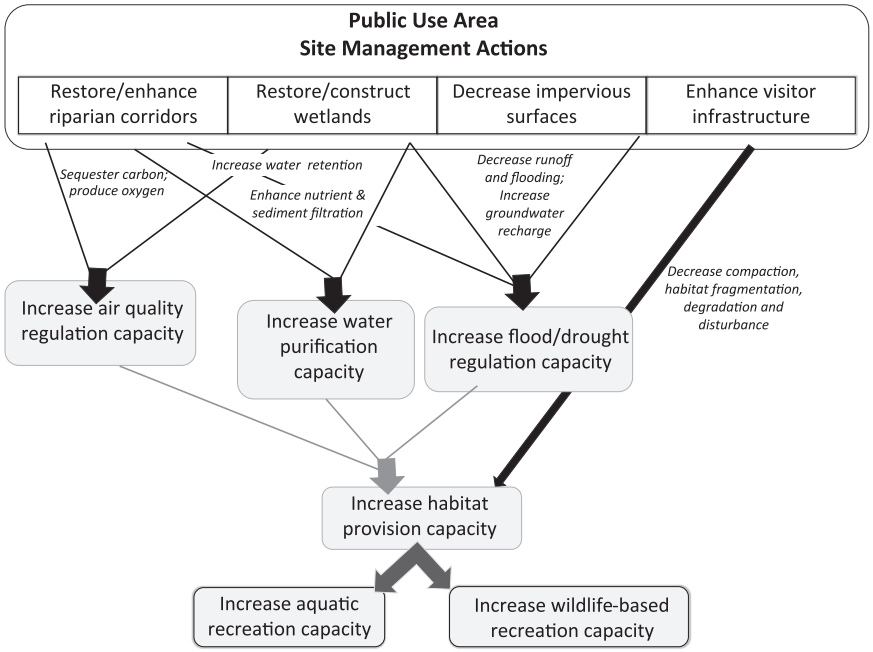

Fig. 1. Conceptual model illustrating the effects of site management actions on interconnected ecosystem services, including focal services such as wildlife-based recreation (e.g., bird watching) and water purification. The actions are shown (top) as rectangles; black arrows represent direct effects on a subset of services; descriptions of key biophysical changes are noted in italics beside the arrows. Services that are secondarily affected are shown in light gray, rounded rectangles; secondary effects are shown as light gray arrows; capacities of wildlife-based and aquatic recreation, influenced by the services and actions above them in the schematic, are shown in dark gray, rounded rectangles.