

Estimating the value of ecosystem services in a mixed-use watershed: A choice experiment approach



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ABSTRACT

The protection of water, land, and air resources has profound implications for the sustainability of ecosystem services provided to societies that are embedded within economies, global systems, and socio-cultural and political contexts. This study assessed preferences for provisioning, regulating, and supporting ecosystem services, specifically, climate regulation (carbon sequestration), nutrient control (water quality), and agricultural and forest productivity, and the willingness to pay for protection of these ecosystem services by residents in the Suwannee River Basin of Florida, as assessed through a household mail survey and choice experiment. A conditional logit model was used to evaluate preferences and marginal willingness to pay (MWTP) under different scenarios. Survey respondents identified nutrient control (water quality) as the most important service, while agricultural and forestry production was somewhat important, and climate regulation/carbon sequestration was the least important. Respondents expressed the highest level of trust in local government agencies to implement ecosystem service protection programs, and welcomed the implementation of such programs anywhere in the basin, but not close to their home. The average MWTP was extremely low (< \$2/household/year) when compared to other studies, and suggests that respondents have many competing interests for their discretionary spending in relation to environmental amenities.

1. Introduction

1.1. Rationale of study

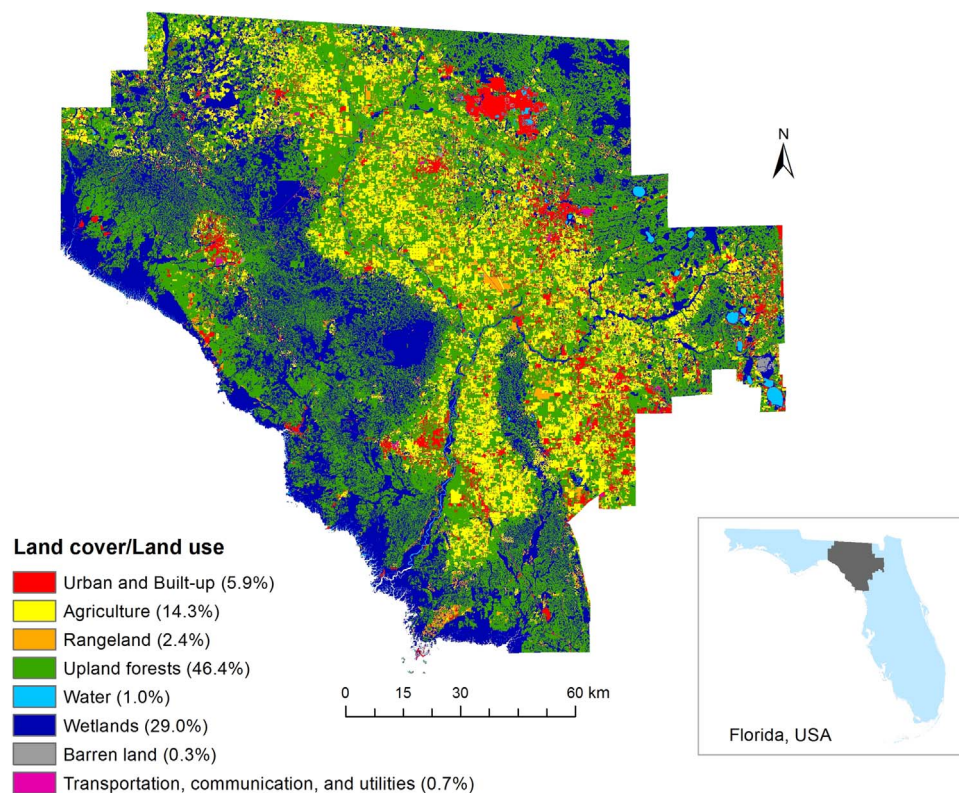
While most people realize the importance of ecosystem services, many case studies show how ecosystem services have become degraded when the values of natural services are overlooked or incompletely evaluated (Daily et al., 2000; Chee, 2004). Ecosystem services do not regularly fall within the sphere of markets; rather they tend to be ‘invisible’ in economic analyses (Costanza et al., 1997). As such, this leads to the idea of re-framing decisions and prompting improved management of natural capital by valuing ecosystem services as part of the decision-making process. Some argue that valuation of ecological systems is either impossible or unwise because intangibles such as human life, aesthetics, or long-term ecological benefits are difficult to assign a monetary value (Costanza et al., 1997). In the twenty-first century, the valuation of ecosystem services has become a significant research area, particularly with preference-based approaches (Turner et al., 2003). This is not just about placing dollar values on the environment, but also determining the effect of marginal changes in

ecosystem services (Hanley and Shogren, 2002; Randall, 2008). Stakeholder preferences and the valuation of non-market goods allow us to assess the trade-offs inherent in managing human societies within ecological systems (Farber et al., 2006) and provide information for decision makers to choose optimal policy options (Hicks, 2002).

The Suwannee River basin in Florida is an example of a subtropical mixed-used watershed that contributes significant ecosystem services to sustain human society. Agriculture and forest lands together account for the vast majority of developed land uses in the basin and provide provisioning services for silviculture, row crops, pasture, and timber (Florida Department of Environmental Protection (FDEP), 2009). Trends in the agriculture and forest industry are shifting toward more intensive production, and concerns about increased levels of nutrients in surface and ground water are being addressed by water management agencies (Hoos et al., 2008; Bruland et al., 2008). The ecosystem services in this area go beyond water supply and agriculture or forest products. Soil carbon sequestration, for example, involves the long-term storage of atmospheric carbon dioxide through biological, chemical, and physical processes, as well as improving soil fertility that supports growth of primary products. Therefore, climate regulation

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Florida Department of Environmental Protection (FDEP), Bureau of Watershed Restoration, 2009, 1:5,000.

Fig. 1. Land uses in the Suwannee River Basin in north-central Florida.

and carbon sequestration are interconnected services provided in the basin. The benefits humans obtained from these ecosystem services are agricultural/forest products, clean water supply from nutrient control, enhancement of air quality, and renewal of soil quality through climate/carbon regulation. The values of these ecosystem services, however, are not known.

People may value ecosystem services differently depending upon their scale-perception (Araña and León 2012), the immediate direct effect (Boissiere et al., 2013; Howe et al., 2013), governance management (Costanza and Liu, 2014), and/or demographic and socio-economic background (Peixer et al., 2011; Andersen et al., 2012). Many other confounding factors may lead to valuations of climate, carbon, and nutrient regulation that differ from their biophysical values. The goals of this study were to (i) investigate the preferences of households in a large mixed-use river basin in regard to three different ecosystem services (i.e., climate/carbon regulation, nutrient control, and agricultural/forestry production), and (ii) assess their willingness to pay to protect these ecosystem services. This study contributes to the literature by evaluating the tradeoffs and relative willingness to pay for different ecosystem services.

1.2. Choice Experiments (CE)

Stated preference methods are commonly used to estimate the welfare effects of non-market goods through hypothetical choice scenarios. The best-known stated preference methods are the contingent valuation method (CVM) and choice experiments (CE) (Haipeng and Xuxuan, 2012). The CE approach, developed by Louviere and Hensher (1982) and Louviere and Woodworth (1983), has gained popularity in a variety of research fields (Boxall et al., 1996; Taylor and Longo, 2009; Álvarez-Farizo et al., 2009; Hoehn et al., 2010; Broadbent, 2013; Vollmer et al., 2013; Hainmueller et al., 2014). Hanley et al. (1998) and Stevens et al. (2000) viewed CE methods as a

generalization of the closed-ended CVM involving two or more goods or services. The CE methods allow researchers to focus on valuing marginal changes as multi-dimensional attributes rather than discrete changes (Hanley et al., 2001). Choosing between alternatives encourages respondents to explore their preferences and trade-offs in more detail in relation to different management plans (Stevens et al., 2000; Nalle et al., 2004). When a choice set includes a price or cost factor as an attribute, economic values such as willingness-to-pay (WTP) can be estimated (Boxall et al., 1996). Since attribute levels of choices are designed in a systematic fashion, the measurement of marginal value of changes and multiple characteristics of environmental programs is expected to be meaningful (Boxall et al., 1996; Hanley et al., 2001).

The CE technique requires a careful choice design that helps reveal the factors influencing choices. Identification of the attribute space, such as levels and ranges must be relevant, realistic, and feasible for the environmental program questions being asked. One of these attributes is usually a monetary cost that allows estimation of WTP (Hanley et al., 1998, 2001). A bundle of interdependent services, such as climate regulation and carbon sequestration, can provide more meaningful values than summing the values of independent service levels when using CE (Glouder and Kennedy, 1997). In addition, a baseline status quo is typically included in the assignment of levels (Boxall et al., 1996).

Many studies relevant to a variety of ecosystem services have applied CE to evaluate individuals' perceptions and preferred choices of attributes. For example, Adamowicz et al. (1998) implemented both CE and CVM methods to measure passive use values of habitat enhancement. Bullock et al. (1998) used the CE approach to measure preferences of respondents for deer hunting and landscape change in the Scottish Highlands. In a study by Milon et al. (2000), individuals were asked to identify the importance of restoration plans for the Everglades ecosystem based on five multi-attribute choices. Birol et al.

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