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A latent class analysis of public attitudes toward water resources with implications for recreational demand

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ABSTRACT

This study examines the extent to which heterogeneous perceptions and opinions toward water resource policy influence recreational demand in a river basin, and the associated valuation of ecosystem services. We first employed a latent class analysis to reveal two distinct groups of respondents that differ in their perceptions and opinions despite similar demographic characteristics. We then estimated a recreational demand model that is conditional on latent class membership. We found that respondents' perceptions and opinions directly influence recreational demand and valuation. Incorporating preference heterogeneity using latent class analysis, in addition to or instead of demographic characteristics, could help improve estimates of the distributional impacts of a policy designed to enhance ecosystem services.

1. Introduction

Ecosystem services are defined as direct and indirect benefits of ecosystems to human well-being (de Groot et al., 2010), and the ecosystem service framework introduced in the Millennium Ecosystem Assessment (MEA, 2005) has been extensively used to examine the effect of changes in ecosystems and land use on human well-being in land planning decisions (Daw et al., 2011). Economic valuation of the changes in ecosystem service flows has been increasingly demanded by stakeholders to demonstrate the value of natural resource preservation (e.g., de Groot et al., 2010; Bateman et al., 2013). A crucial step in assessing the value of water resources and land preservation is identifying people who benefit from the services, as well as considering the opportunities to increase the benefits by enhancing the associated natural resource-based experiences.

The well-being of various stakeholder groups is expected to differ as a result of a change in the flow of ecosystem services. The existing literature has discussed the importance of exploring the distributional patterns between groups defined, for example, by socioeconomic or demographic factors such as ethnicity, gender, or livelihood (Daw et al., 2011). Meanwhile, the value of ecosystem services and the preferences for the level of their provision also can depend on the interests, values, perceptions, and norms that can vary significantly among stakeholders (Hauck et al., 2013; Jax et al., 2013). Groups of people that differ in the benefits of ecosystem services and/or the costs of providing ecosystem services can also be correlated with the attitudes and opinions that people hold. However, the economic literature has largely been silent on this topic (Daw et al., 2011; Iniesta-Arandia et al., 2014).

Examining the extent to which attitudes and opinions influence ecosystem services valuation may provide important policy implications for managing natural resources. For example, a policy protecting water quality and water flow while providing additional nature-based recreational opportunities will likely have heterogeneous impacts on stakeholders. Some stakeholders may be more concerned about degrading water quality and decreasing water flow, or may be dissatisfied with the current level of government spending on protecting water resources, while others may prioritize economic development over protecting water resources. This information (attitudes and opinions) is likely to influence participation in water-based recreation, land-use decisions, and policy planning to improve water quality. As a result, the well-being derived from improved water quality and flow would be greater for the former group than for the latter group due to the policy.

One approach to examine the heterogeneity of perceptions, attitudes, and opinions is through latent class analysis (LCA), in which a population is divided into groups based on responses to survey questions. More specifically, LCA is a "statistical method used to identify a set of discrete, mutually exclusive latent classes of individuals based on their responses to a set of observed categorical variables" (Hagenaars and McCutcheon, 2003; Lanza et al., 2015).

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It is especially appealing to analyze stated attitudes since collected information is often discrete or categorical (Aitkin and Rubin, 1985). In essence, LCA estimates the probability of an individual belonging to a latent group given the individual's response pattern to a series of attitudinal questions. In this study, respondents are divided into groups based on their attitudes and perceptions about environmental goods.

Given the absence of markets for many goods and services provided by nature (environmental goods), economists have used data from surrogate markets to value the non-market environmental goods. For example, using the travel cost to a recreational site as a conservative proxy of the price to recreate at the site, a demand function for the recreational site can be estimated from the number of trips taken at different travel costs (prices). This method, known more formally as the Travel Cost Method (TCM), is a revealed preference approach because it uses past behavior (e.g., trips to a given site) as opposed to hypothetical trips (stated preference); as such the TCM approach has been widely used to value nature-based recreation (Farber et al., 2002; Shrestha et al., 2002, 2007).

The empirical literature that addresses preference heterogeneity in estimating total recreational demand for a single site has been limited, with the exception of Scarpa et al. (2007). They combined LCA with a single-site TCM model by first using demographic characteristics (i.e., years of hiking experience and age of the respondent) to determine latent class membership and then they estimated LCA jointly with TCM (i.e., Poisson and negative binomial models). A respondent's site selection among multiple recreation sites can also be estimated jointly with a LCA model on a respondent's stated attitudes (Boxall and Adamowicz, 2002; Morey et al., 2006; Bujosa et al., 2010). Using this random utility model (RUM) approach to examine multiple sites, a respondent's travel costs to all available recreational sites and the attributes of each site are estimated assuming that preference parameters follow a finite mixing model (i.e., a latent class conditional logit model is estimated).

An alternative to joint estimation of LCA and TCM is to use the results from a LCA model to allocate respondents deterministically to each class and then estimate a recreational demand for each class (Morey et al., 2006). This approach allows practitioners to obtain opinions and perceptions on environmental goods in general, and use that information to test for different correlations in the TCM for each recreational site. This approach is especially appealing for large-scale open-access ecosystems that have different types of current and potential users that could be affected differently by a proposed policy change. By recognizing different types of consumer groups based on their individual preference heterogeneity, policy makers can better consider the tradeoffs of implementing certain policies by accounting for which groups may benefit more and which groups have more to lose.

This study contributes to the literature by incorporating LCA and single-site TCM information by estimating TCMs conditional on latent class formation. We use the St. Johns River, the longest river in Florida, as an example to illustrate the effects of incorporating heterogeneous perceptions and opinions on the corresponding estimates of economic value for an environmental good (i.e., nature-based recreation). The method can be applied to estimate the demand for other types of ecosystem services and their associated economic values.

2. Study area

Florida recently became the third most populous state in the nation, with a population growth rate of 1.84 percent, twice as high as the national average (United States Census Bureau, 2015). Increasing water demand in support of an increasing population requires state agencies to search for alternative water supplies. In Florida, such proposals include harvesting water from previously untapped rivers, streams, and reservoirs, and transporting water supplies to growing municipalities. Population growth in general also results in rapid land use changes that can cause heated stakeholder discussions regarding the benefits and losses associated with land development and preservation decisions. Overall, Florida is at the forefront of developing processes to balance the provision of various ecosystem services from its limited water and land resources in the face of the continued rate of population growth.

Challenges associated with water resource and land use management in the St. Johns River Basin (SJRB) provide a good example for this study. This is because the SJRB includes numerous lakes, smaller streams, and thousands of square miles of wetlands that are hydrological connected to the river. Unlike most rivers in North America, the St. Johns River (SJR) flows slowly from south to north, making it difficult to flush pollutants. In addition, the SJRB includes two of the largest and fastest growing cities in Florida – Jacksonville and Orlando.

The SJR is recognized as an American Heritage River (American Rivers, 2008) because of the value of the cultural services it provides to the region. While most of the water resources in the SJRB are designated for recreation and for fish and wildlife habitats, the Florida Department of Environmental Protection has classified the SJR and its tributaries as "impaired" because they do not meet the water quality standards for these designated uses (FDEP, 2014a, 2015). Nutrient impairment in particular contributes to periodic algae blooms that can kill fish, discolor the water, and negatively affect human health.

Increasing pressure from population growth and urbanization is expected to further exacerbate the declining water quality and quantity in the SJRB. The increase in water use in the SJRB has resulted in reductions and irregularities in the flow of several springs located in the SJRB that provide recreational benefits. The local population is projected to increase from 4.7 million to 6.5 million by 2035 (St Johns River Water Management District [SJRWMD] 2014a). As a result, the SJRWMD and several counties and utilities within the SJRWMD are considering the potential of using the SJR as a water supply source to supplement their groundwater withdrawals to meet the increasing water demand in the public water supply sector (Patterson, 2009).

Regional water quality and allocation policies are being developed to meet the water demands of both the agricultural industry and the growing state population while protecting in-stream water use. Such policies should be based on understanding the flow of ecosystem services provided by the SJR and the associated economic values of all the services that benefit society. As such, having accurate estimates of potential use and value for non-market environmental goods are critical for justifying investment expenditures at the state level.

3. Survey Instrument and implementation

The SJRB includes a variety of ecosystems (wetlands, springs, lakes, tributaries, and the main stem of the river, which is influenced by tidal waters) that offer many recreational opportunities such as boating, fishing, and wildlife viewing (FDEP, 2014b; SJRWMD, 2014c). Fig. 1 depicts the major recreation sites in the SJR Basin (FDEP, 2014b; McCarthy, 2008; SJRWMD, 2014b). The SJR can be categorized into the Upper, Middle, and Lower SJR, with corresponding basins (SJRWMD, 2014a). Because the three sections of the SJR have separate distinct characteristics, the recreational opportunities offered by the three basins also differ. The Upper