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# 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 sivilculture, 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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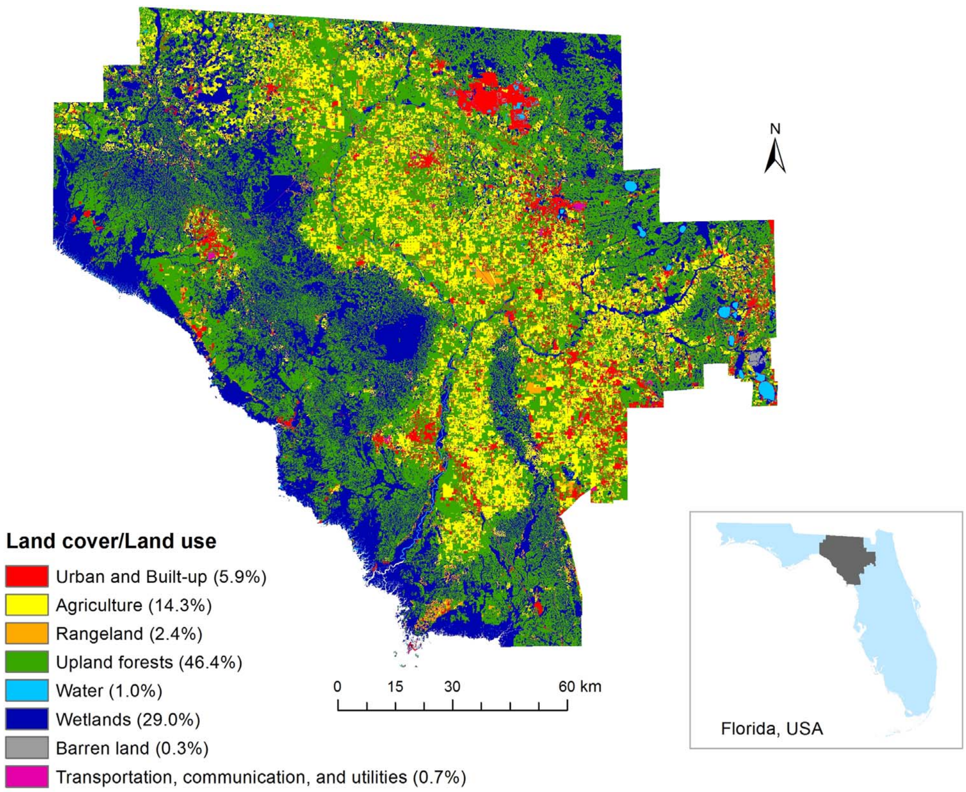


Florida Department of Environmental Protection (FDEP), Bureau of Watershed Restoration, 2009, 1:5,000.

**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 (Gloulder 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.

(2006) used CE to estimate farmers' valuation of agrobiodiversity in small-scale farms. Brouwer et al. (2010) assessed spatial preference heterogeneity related to water quality improvements that included hydro-geographical units and levels of water quality improvements in the experimental design.

## 2. Materials and methods

### 2.1. Study area

The study area for this project was the Suwannee River Basin of north-central Florida (FL-SRB), with an area measuring approximately 19,665 km$^2$ (Fig. 1). The climate of the area can be described as warm temperate and subtropical (Katz et al., 1998). The soil temperature regimes in the area are mixed, with 86% of the area being thermic and about 14% hyperthermic (Natural Resources Conservation Service (NRCS), 2006). Poorly or very poorly drained soils predominate in the FL-SRB and tend to have medium to high potential for nutrient and agrichemical leaching to groundwater. The land use/land cover (LU/LC) is comprised of upland forest (46.4%), wetland (29.0%), agriculture (14.3%), urban and built-up (5.9%), rangeland (2.4%), water (1.0%), transportation, communication, and utilities (0.7%), and barren land (0.3%) (Florida Department of Environmental Protection (FDEP), 2009). The study area had 122,424 households with a median household income of $37,613 and per capita income of $18,649 (U.S. Census Bureau, 2010). In 2012, about 54% of residents were males, 63% of residents were middle aged (45–64 years), and 17% were 65 years and over. Twenty-one percent of residents had less than a high school diploma or General Educational Development (GED) (U.S. Census Bureau, 2014).

### 2.2. Survey design

A mail survey was conducted to assess resident's preferences for ecosystem services protection. The survey consisted of three major parts. The first part was designed to gauge opinions and experiences of respondents related to ecosystem issues, and included general questions about the ecosystem services of climate regulation, soil carbon sequestration (storage), and nutrient cycling. Responses were obtained using three-point and five-point Likert-like rating scales, dichotomous choice, and nominal questions. The second part of the survey was the choice experiment. Details of the CE design are described in the next section. The third part focused on respondents' socio-economic information, including gender, age, education, income and Florida residency.

For the CE design, a set of limited choices was provided in the form of programs where each program included four attributes. The first attribute was the type of ecosystem service, i.e., climate/carbon storage, nutrient control, or agricultural and forestry production. The second attribute represented the administrative agency to manage the ecosystem services program. Three agencies were identified as the Suwannee River Water Management District (SRWMD), county governments, and non-government organizations (NGO). The third attribute specified the size of the area to be managed for the program: 5 miles (8 km) or 20 miles (32 km) from the respondent's home, or anywhere within the FL-SRB. Lastly, a monetary attribute was used to represent the annual program cost that would be implemented through voluntary donations, annual taxes, or utility fees. Respondents were asked to choose $5, $25, or $50 as the per annum cost per household for the preferred program over a five-year period. These levels were chosen based on findings from Kreye et al. (2011), which compiled 17 studies examining WTP for water protection and applied a benefit transfer method to estimate an annual household WTP within four regions in Florida. The attributes and the levels of the attributes are presented in Table 1.

A fractional factorial design with four attributes and three levels was utilized to construct the optimal paired comparison choices as described by Street et al. (2005). An orthogonal main effects plan was used in the design to allow the uncorrelated estimation of all main effects. The paired comparison method offered two specific choice sets and one opt-out option, and respondents were asked to select the most preferred alternative or neither option. The choice sets were reduced to the minimum number to enable estimation of main effects and first-level interactions (Street et al., 2005). Thus, the minimum possible choice sets included nine questions, which were divided into two sets of surveys to avoid excessive time burden on respondents. Thus, each respondent received either five choice sets (1–5) or four choice sets (6–9), as shown in Table 2. Details for generating design codes are described in Appendix A.

The MWTP values were estimated using a nested logit model, with the coefficient for annual cost held constant in the model, which allowed the distribution of costs to be estimated directly from the distribution of non-monetary coefficients because two distributions took the same form in the model (Goett and Hudson, 2000).

**Table 1**
Attributes and attribute levels in choice experiments.

| Attribute | Attribute levels |
|---|---|
| Type of ecosystem services to be managed | Climate/carbon regulation |
| | Nutrient control |
| | Agricultural and forestry production |
| | Status quo |
| Program administration | Suwannee River Water Management District |
| | County government |
| | Non-government organization (NGO) |
| | Status quo |
| Location of area to be managed | Anywhere within the basin |
| | Within 20 miles from your home |
| | Within 5 miles from your home |
| | Status quo |
| Annual program cost (WTP) | $5 |
| | $25 |
| | $50 |
| | Status quo |

### 2.3. Survey sampling and implementation

All settlements within the fifteen-county study area were sorted based on census geographic and demographic data, and a total of 60 postal zip codes were identified using ArcGIS® software. According to the zip codes, the sampled area was slightly larger than the entire FL-SRB boundary due to edge conciliation. A random sample of 4000 household mailing addresses was created by a professional marketing firm (Marketing Systems Group, Inc.). A comparison of the survey sample to the population using data from the American Community Survey five-year estimates for 2007–2011 is shown in Table 3. Half of the households surveyed received one version of the survey with 5 choice sets and the other half received the survey with four choice sets. The recommended best practices for mail surveys were followed (Dillman et al., 2009). Each household was first contacted via an introductory postcard, then by a survey mailing with envelopes, and a thank-you/reminder postcard (Sep., 2012), followed two weeks later by a second mailing and reminder postcard (Oct., 2012). After the return of surveys, the response rate was compared to minimum sample size required for adequate power with formulas from Cochran (1963) and Yamane (1967) (Appendix B).

### 2.4. Econometric model

The econometric model used in this study was a random utility maximization or RUM model (Manski, 1977). The RUM is based on the assumption that an individual will select an option with a higher level of utility than other options. The random component is assumed to be a

**Table 2**
Choice experiment design for four three-level attributes of ecosystem services in the Suwannee River Basin.

| Choice set | Program A | | | | Program B | | | |
|---|---|---|---|---|---|---|---|---|
| | Ecosystem services | Program admini-stration | Location | Cost[a] | Ecosystem services | Program admini-stration | Location | Cost |
| 1 | Climate/carbon regulation | SRWMD[b] | Anywhere[d] | $5 | Nutrient control | NGO | Within 20 mi | $50 |
| 2 | Climate/carbon regulation | County | Within 20 mi | $50 | Nutrient control | SRWMD | Within 5 mi | $25 |
| 3 | Climate/carbon regulation | NGO[c] | Within 5 mi | $25 | Nutrient control | County | Anywhere | $5 |
| 4 | Nutrient control | SRWMD | Within 20 mi | $25 | Agricultural/forest production | NGO | Within 5 mi | $5 |
| 5 | Nutrient control | County | Within 5 mi | $5 | Agricultural/forest production | SRWMD | Anywhere | $50 |
| 6 | Nutrient control | NGO | Anywhere | $50 | Agricultural/forest production | County | Within 20 mi | $25 |
| 7 | Agricultural/forest production | SRWMD | Within 5 mi | $50 | Climate/carbon regulation | NGO | Anywhere | $25 |
| 8 | Agricultural/forest production | County | Anywhere | $25 | Climate/carbon regulation | SRWMD | Within 20 mi | $5 |
| 9 | Agricultural/forest production | NGO | Within 20 mi | $5 | Climate/carbon regulation | County | Within 5 mi | $50 |

[a] Annual program cost or WTP.
[b] Suwannee River Water Management District (SRWMD).
[c] Non-government organization (NGO).
[d] Anywhere within the Suwannee River Water Management District.

Weibull probability distribution, which implies that the probability of choosing one option over other options can be described by the logistic distribution (McFadden, 1974; Greene, 1997). The logit model can be estimated using maximum likelihood methods with the log-likelihood function given by Hole (2006) as:

$$LogL=\sum_{i=1}^{N}\sum_{m=1}^{C} y_{im} ln\left[\frac{e^{V_{im}}}{e^{V_{in}}}\right] \tag{1}$$

where $y_{im}$ is an indicator variable that equals 1 if alternative $m$ is chosen by respondent $i$, and zero otherwise, $N$ is the number of respondents (with $i$ =1, 2,..., $N$), $C$ indicates the $m$ alternative in a choice set of the individual (with $m$ =1, 2,..., $C$), $V_{im}$ refers to an individual ($i$) that will choose choice $m$, and $V_{in}$ refers to an individual ($i$) that prefers not to choose other options ($n$). The utility function can be written in a following form:

$$V_{im}=\beta_0+\quad \beta_1X_1+\beta_2X_2+\ldots+\beta_yX_y \tag{2}$$

where $\beta_0$ is a constant that captures the effects of utility on any attribute excluded from the choice attributes, the vector of coefficients $\beta_1$ to $\beta_y$ is attached to a vector of attributes $X_1$ to $X_y$ and $\beta_y$ is the coefficient for the cost of an alternative $X_y$. The constant value is a meaningful interpretation only when all attributes $X$ can reasonably be zero.

Since a CE is embedded in the utility of maximization and demand theory (Bateman et al., 2003), the coefficients in CE provide parameter estimates of the utility of each attribute (Ginsburgh and Throsby, 2013). The cost/price coefficient can be interpreted as an estimate of the negative marginal utility of income (Hanemann, 1984; Parsons and Kealy, 1992; Hanley et al., 2001). In our study it is an estimate of marginal willingness to pay (MWTP).

$$MWTP=\quad -\frac{\beta_z}{\beta_y} \tag{3}$$

where, $\beta_z$ is the coefficient of any of the non-monetary attributes and $\beta_y$ is the coefficient for cost/price. The simplified formula of the ratio of coefficients is an 'implicit price' that represents the MWTP for a unit change in the quantity of an attribute (Ginsburgh and Throsby, 2013). Although the MWTP can be assumed to have positive or negative values, it is possible that individuals would maintain the status quo situation.

This study applied the conditional logit models which imposed the restriction that the alternatives are independent of one another. Violation of the independence of irrelevant alternatives (IIA) restriction leads to the cross-elasticities between all pairs of alternatives being identical (Wen and Koppelman, 2001). The most common technique to relax the IIA is the nested logit (Williams, 1977). The nested logit is often used when the decisions are branched. It allows the alternatives to be correlated and accommodates degrees of interdependence among pairs of alternatives in a choice set (Appendix C).

**Table 3**
Number of households sampled and number in population in the study area.

| County | HH[a] | % HH | HH sampled | % HH sampled | HH response | % HH response | % HH response by county |
|---|---|---|---|---|---|---|---|
| Alachua[b] | 97,542 | 40.32 | 1837 | 45.93 | 422 | 55.38 | 22.97 |
| Baker[b] | 8333 | 3.44 | 67 | 1.68 | 7 | 0.92 | 10.45 |
| Bradford[b] | 9188 | 3.80 | 163 | 4.08 | 18 | 2.36 | 11.04 |
| Columbia | 24,127 | 9.97 | 491 | 12.28 | 67 | 8.79 | 13.65 |
| Dixie | 5380 | 2.22 | 98 | 2.45 | 16 | 2.10 | 16.33 |
| Gilchrist | 6009 | 2.48 | 112 | 2.80 | 23 | 3.02 | 20.54 |
| Hamilton | 4441 | 1.84 | 90 | 2.25 | 11 | 1.44 | 12.22 |
| Jefferson[b] | 5313 | 2.20 | 106 | 2.65 | 17 | 2.23 | 16.03 |
| Lafayette | 2474 | 1.02 | 33 | 0.83 | 12 | 1.57 | 36.36 |
| Levy[b] | 6034 | 6.63 | 272 | 6.80 | 52 | 6.82 | 19.12 |
| Madison | 6939 | 2.87 | 132 | 3.30 | 15 | 1.97 | 11.36 |
| Putnam[b] | 29,061 | 12.01 | 44 | 1.10 | 13 | 1.71 | 29.55 |
| Suwannee | 15,810 | 6.53 | 321 | 8.03 | 59 | 7.74 | 18.38 |
| Taylor | 7632 | 3.15 | 148 | 3.70 | 25 | 3.28 | 16.89 |
| Union | 3665 | 1.51 | 86 | 2.15 | 5 | 0.66 | 5.81 |
| Total | 241,948 | 100.00 | 4000 | 100.00 | 762 | 100.00 | |

[a] HH denotes households.
[b] Only portions of Alachua, Baker, Bradford, Jefferson, Levy, and Putnam Counties were included in the study area; however, Table 3 shows the total number of households in each county.

### 2.5. Empirical data analyses

Demographic data were analyzed using descriptive statistics. The frequency, percentage, mean, and standard deviation for each question were reported. These responses provided 2690 observations, or 8070 cases. Respondents selected one of the specific program options (A or B) or the neither option. The nested logit model enabled the opt-out choice to be modeled in a different nest from the ecosystem protection program choices. The nested logit was implemented with the SAS® software Multinomial Discrete Choice (MDC) procedure.

Two models were used. Model 1 included the opt-out option (not interested in either program), while Model 2 excluded the opt-out option. The inclusion of the opt-out option in Model 1 captured the real behavior of individuals, which indicated the likelihood of choices for all respondents and estimated the overall marginal willingness to pay (MWTP) for the population. Model 2 set the opt-out option as a reference level, indicating the likelihood and MWTP only for respondents who chose program option A or B. Both models used effects coding for all variables except annual program cost that was coded quantitatively (Jaccard, 2001; Bech and Gyrd-Hansen, 2005).

## 3. Results

### 3.1. Demographics

A total of 764 usable surveys had been returned, representing an overall response rate of 19% (Table 3). The geographic distribution of returned surveys are shown in Fig. 2.

Source: The American Community Survey five-year county estimates for 2007–2011.

In general, respondents were more likely to be women (52%), late/middle-aged to elderly (40% ages 45–64 years old and 32% ages 65–84 years old) and highly educated (29% with graduate or professional degrees, 21% with some college, and 18% with a bachelor's degree). Within the sample, 66% percent lived in urban areas, 25% lived in small and isolated small rural town, and 9% lived in rural areas. The primary land use of land owned by respondents was housing (73.5%), followed by other (13.5%), agriculture (6%), recreation (4%), and timber production (3%). The length of residency in this area was evenly distributed between "less than 10 years" (29%) and "more than 30 years" (31%). Thirteen percent of respondents resided in the SRB area between 10 and 14 years, 9% resided between 15 and 19 years, 9% resided between 20 and 24 years, and 9% also resided between 25 and 30 years. Of the respondents who answered the question, their annual household income fell into the following categories: $25,000–$49,999 (19%), less than $24,999 (18%), $50,000–$74,999 (16%), $75,000–$99,999 (12%), $100,000–$149,999 (10%), more than $150,000 (5%) and preferred not to answer (20%). Because about 20% of the respondents preferred not to provide income information, the income variable was excluded from the explanatory variables in the multinomial logit models since the high number of non-responses affected the performance of the logistic model predictions.

### 3.2. Attitudes regarding ecosystem services

On a scale of 1–3, respondents were familiar with water quality protection, carbon storage, climate regulation, and nutrient cycling, with mean levels of 2.23, 2.00, 2.00, and 1.79, respectively. Respondents rated "good water quality" the highest (2.92), followed by "clean air" (2.88), "soil fertility" (2.58), "agricultural production" (2.49), "forest production" (2.46), and "nature recreation" (2.40). Respondents were most concerned with "water quality" (2.62), followed by "low agricultural productivity" (2.22), "poor soil fertility" (2.21), and "global climate change" (2.14).

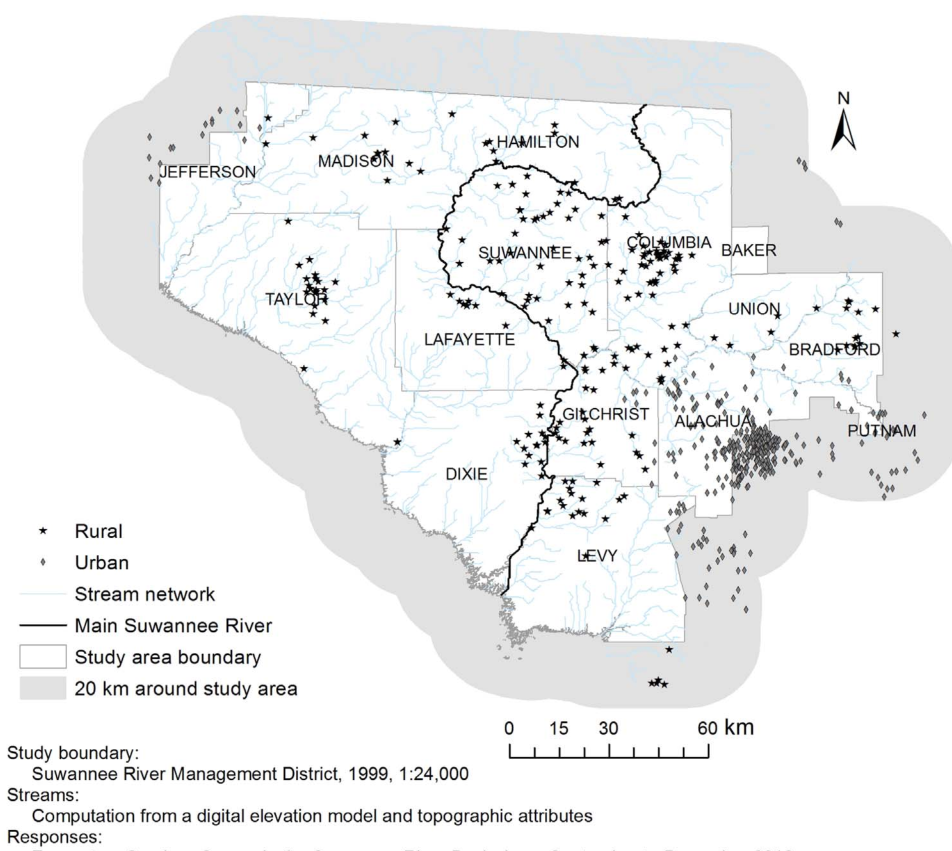


**Fig. 2.** Geographic distribution of survey respondents with the study area.

**Table 4**
Nested logit model results for choice experiments.

| Attribute | Model 1[a] | | Model 2[b] | | Odds ratio | Preferences |
|---|---|---|---|---|---|---|
| | Coefficient | MWTP ($)[c] | Coefficient | MWTP ($)[c] | | |
| Type of ecosystem services to be managed | | | | | | |
| Climate/carbon regulation | −0.004 | −0.24 | 0.015 | 0.88 | 1.01 | 3 |
| Nutrient control | 0.026 | 1.55 | 0.045 | 2.67 | 1.05 | 1 |
| Agricultural and forestry production | 0.005 | 0.32 | 0.024 | 1.43 | 1.02 | 2 |
| Status quo for ecosystem management | −0.019 | −1.11 | 0 | 0 | 1 | 4 |
| Program administration | | | | | | |
| Suwannee River Water Management district | 0.048 | 2.88 | 0.067 | 3.99 | 1.07 | 2 |
| County | 0.082 | 4.88 | 0.101 | 5.99 | 1.11 | 1 |
| Non-government organizations | −0.103 | −6.15 | −0.085 | −5.05 | 0.92 | 4 |
| Status quo for program administration | −0.019 | −1.12 | 0 | 0 | 1 | 3 |
| Location of area to be managed | | | | | | |
| Anywhere within the basin | 0.222* | 13.22 | 0.241 | 14.35 | 1.27 | 1 |
| Within 20 miles of your home | 0.076 | 4.55 | 0.095 | 5.67 | 1.10 | 2 |
| Within 5 miles of your home | −0.272 | −16.17 | −0.253 | −15.04 | 0.78 | 4 |
| Status quo for area to be managed | −0.019 | −1.12 | 0 | 0 | 1 | 3 |
| Annual program cost | −0.017* | 0.12 | −0.017* | 1.24 | | |
| Number of responses | | | | | | 2690 |
| Number of cases | | | | | | 8070 |
| Log likelihood | | | | | | −2832 |

* Significance at the 95% confidence level ($p < 0.05$).
[a] Logit model includes opt-out option.
[b] Logit model excludes opt-out option.
[c] Annual household MWTP over a period of five years.

### 3.3. Preferences for ecosystem services protection

The likelihood of preference for each ecosystem protection program was calculated relative to the alternatives within each stratum. The model indicated how the attributes of a program affect the likelihood that a respondent chose the program. The odds ratios and standard errors with a significant level were reported. The results were interpreted as a preference ranking from most preferred attribute level to least preferred attribute level. Table 4 shows the results from the nested logit model of the CE analysis.

Of all the attributes, only location and annual program cost were statistically significant predictors for MWTP. Annual household income also played a significant role in selection of ecosystem services protection. According to the multinomial logistic model, the difference between annual household income < $25,000 and income > $150,000 was found to be statistically different ($p < 0.001$) for choosing an annual payment of $5 relative to $0 in the model. The relative log odds of respondents willing to pay $5 versus zero would increase by 0.872 for respondents reporting an annual household income > $150,000 as compared to those with < $25,000. Similar results with respect to household income were found for choosing an annual cost of $25 relative to zero ($p < 0.05$), and for choosing an annual cost of $50 versus zero ($p < 0.001$). The relative log odds of choosing an annual cost of $50 versus zero decrease by 1.150 if changing status from > $150,000 to < $25,000.

### 3.4. Economic valuation in choice experiments

To calculate the marginal WTP (MWTP) of each non-monetary variable, a simple linear utility function provided the estimated coefficient of the non-monetary variable divided by the estimated coefficient of the monetary variable. (Krinsky and Robb, 1986). In the context of ecosystem services conservation and planning, the MWTP provides the bottom line evaluation for decision making. The average household MWTP per year was $0.12 for Model 1 and $1.24 for Model 2. The most highly preferred combination across attributes of Model 1 had an overall average MWTP of $6.55, while for Model 2 its was $7.67. The average household MWTP for both models was much lower than reported for the same area by Kreye et al. (2011): annual household WTP of $4.29 for water quality programs that use land acquisition and $70.72 for programs that do not use easement-type strategies.

## 4. Discussion

Among the investigated ecosystem services in this study, the most significant need of households is better water quality. This implies that residents in the FL-SRB are concerned about water quality impairment in the basin because it directly impacts their drinking water (e.g., wells). An increasing trend of nutrient loads (total nitrogen and total phosphorus) in the Santa Fe River and the Upper and Lower Suwannee River basins, and excessive nutrient concentration in four drainage areas are possibly associated with residents' perception of water quality in the FL-SRB (Chaikaew, 2014). Residents have received a great deal of information about water protection issues from agencies, such as the federal Environmental Protection Agency (EPA), SRWMD, the Suwannee River Partnership (SRP), and environmental groups through targeted water quality campaigns and educational programs. The Governor of Florida committed to spending $1.4 billion in 2014 for environmental protection, the funds will target water restoration (FDEP, 2014).

While climate change is prominently discussed in the news media it is experienced differently from water quality by many people. One of the reasons that climate regulation and carbon sequestration were ranked as less important may be due to the disparity between perceptions concerning long-term global climate change and local perceptions of ecological problems (Hulme, 2010). Because climate change and carbon sequestration occur over a long-time scale, they are not perceived as being of immediate local concern (Garvey, 2008). In addition, as GlobalScan (2009) pointed out, people in general have become more pessimistic about the environment, with climate change slipping from first to fourth among major issues that worry people the most. Moreover, uncertainties have lessened the creditability of the so called "polluted science-communication" (Kahan, 2012). As a result, the anthropogenic climate change controversy continues leaving many local residents in confusion, disillusioned, paralyzed or passive (Hillman, 2004). Cook et al. (2013) analyzed 11,944 climate abstracts and found that 66.4% of all the abstracts showed no position of anthropogenic global warming, 32.6% endorsed human-causing global warming, and 0.7% denied any anthropogenic global warming. Weber (2013) discussed the idea that personal experience and beliefs of individuals strongly affect their preferences.

Results show that agency for program administration is an important factor because the farther the governing/administrative agency is removed from the community, the less trust and engagement occurs in the community. The interaction between local (county) government agencies and stakeholders (residents) is crucial since local agencies act as mediators between stakeholders and state/federal governing agencies (Lubell, 2004). For example, the SRWMD is the state agency that regulates water issues in the FL-SRB, and is accountable to the state government, not the local government. Local agencies often allow more flexibility in customizing regulations to local situations. This explains why local 'county' government was the most preferred agent for representing the residents in the FL-SRB, rather than state (SRWMD) government agencies or federal (EPA) and non-governmental agencies. One of the reasons that NGOs were least favored may be due to the long time required to establish trust with these groups. For example, the Okeechobee Basin project took five years to build trust in the NGO involved (Dr. Mark Clark, personal communication, September 12, 2013). In the bigger picture, NGOs are not as financially independent as the government upon whom they are often financially dependent and they are usually not well established as long as the county and government agencies (Shah, 2005; Bebbington et al., 2005).

Spatial scale as it relates to location of ecosystem services protection program implementation is used to determine whether the effect of an ecosystem service improvement or disturbance takes place locally or at a distant location (Rodríguez et al., 2006). Most families have lived in the FL-SRB for several generations. They are conservative, religious, and community oriented, and do not want to be regulated and they believe that they know best how to manage the land. (Dr. Thomas Obreza, personal communication, September 12, 2013). This explains why implementing any programs within 5–20 miles from these households was not favored. People in the FL-SRB have a mindset that conservation programs are good but "not in my back yard" (NIMBY). In addition, adverse impacts may occur as a result of the mismatch between the intent of the watershed decision and the area of implementation (Bengtsson et al., 2003, van Jaarsveld et al.al., 2005). An attempt to maintain or increase one service may cause substantial declines in other services on a broader (basin) scale (Tilman et al., 2002; Vidal-Legaz et al., 2013). For example, nitrogen and phosphorus loads per unit area in the upper and lower Suwannee River Basins increased significantly between 2000 and 2010 (U.S. Geological Survey (USGS), 2014). Increases in nutrient loading coincided with increases in soil carbon sequestration rates and crop and livestock sales across these sub-basins (Chaikaew, 2014).

Our results indicate low values in particular when compared to the total value of ecosystem services in the Lake Okeechobee watershed, Florida provided by Shrestha and Alavalapati (2004). In their study, the public willingness to pay for improvements in water quality, carbon sequestration, and wildlife habitat through silvopasture practice was \$30.24–\$71.17 per household per year over five years derived by a random parameter logit model. A carbon sequestration improvement program alone was \$58.05 per household per year at the moderate environmental improvement level. In the Everglades region of Florida, willingness to pay for a full restoration plan was approximately \$60–\$70 per household per year over a ten-year period (Milon et al., 1999). Hulme (2010) argued that there are risks associated with monetary estimations for climate change. He cautioned that when long-term environmental problems are converted into a single monetary metric, it provides biased interpretation, particularly at a global scale. Ecosystem services are considered externalities and are associated with the 'local/global commons', for which the WTP is low because there is no direct ownership. The payment for the watershed ecosystem services program, for example, reported low WTP to improve downstream water resources (~1% of annual income), which is also considered local commons (Neef and Thomas, 2009). However, it was argued that when the data are collected systematically at a coarser scale and converted to a universal common set of units (\$/unit area/year), the monetary expressions of ecosystem services are meaningful (de Groot et al., 2012). GlobalScan (2009) reported that sustainability experts in 76 countries broadly viewed economic instruments as the most effective means to combat the climate change issue.

While economic incentives are not the panacea to solve environmental issues, valuation methods can be used as an additional tool to other integrative instruments. Input from natural and social scientists are recommended to improve the CE method. Above all, the most important point of the ecosystem service valuation of this study is not about expressing values in monetary units, but giving guidance in understanding public preferences and the relative current values. These preferences and values aim to prioritize managing or allocating resources between competing demands and sustainable uses.

## 5. Conclusions

The beliefs and perspectives of local residents of the basin identified nutrient control (water quality) as the most important ecosystem service, agricultural and forestry production as somewhat important, and climate regulation/carbon sequestration as least important. This stands in sharp contrast to scientific-based perspectives derived from empirical observations, monitoring of water quality, climatic trends, and watershed modeling that attest that the global climate change phenomena is real and water quality was not very degraded in terms of nitrogen and phosphorus contamination. Threshold levels of water pollutants that exceed health standards are hardly found in the basin. The sequestration of carbon in soils and biomass in the basin is substantial and offers opportunities to adapt to climate change impacts. These findings suggest that subjective individual perspectives and objective science-based ecosystem knowledge is profoundly divergent. Politics and decisions in regard to land and water management and air quality are at the interface between individual's needs for well-being and system-based perspectives. The latter viewing the natural capital of ecosystems as resources to sustain regional communities and societies at larger scale (i.e., across the whole FL-SRB) that are in competition with economic, and other interests. This scale sensitivity coupled with low value attribution to key ecosystem services and environmental consciousness by residents has numerous implications. In this case, tension is likely to arise that mutes the willingness for voluntary action, mandatory (e.g. regulation), or monetary actions to maintain and/or enhance ecosystem services. In addition, stakeholder engagement and embracing of political instruments to optimize ecosystem services is substantially hampered. For example, stringent greenhouse gas emission regulations, conservation programs targeting soil carbon sequestration, a carbon tax, carbon trust funds or emission trading banks to enhance the climate and carbon regulation ecosystem services are less likely to be embraced by local residents if they do not value these services, as indicated in this study. Some limitations in understanding the complexity of climate, carbon, and water cycles that impact ecosystem services as indicated by resident's relatively low household income (about 40% of households earn less than \$50,000/yr), educational level, and low participation in environmental groups ($<13\%$) may have contributed to the low valuation of the climate and carbon regulation services and very low MWTP, and higher benefits associated with agricultural and forestry production, and nutrient control services. The dissociation between local needs of residents (e.g., drinking water from the regional Floridan aquifer) and global phenomena and issues that are abstract and more difficult to experience directly (e.g., rising mean global temperatures) may explain the overall low valuation of climate and carbon regulation services.

Respondents welcomed the implementation of ecosystem services anywhere in the basin, but not close to their home (within 5 miles). They trust more county and regional agencies (SRWMD) than NGOs (e.g., Suwannee River Partnership) in efforts to enhance services provided by ecosystems. Ecosystem services focus on the benefits that people derive from ecosystems, which are composed of soil, water, air, and vegetation. All of them are part of the Global Commons, that are essential for the survival and livelihood of people (e.g., clean drinking water resources, food production, etc.), but are too often taken for granted, and thus are devalued in comparison to economic growth or materialistic-individualistic goals. Over 65% of the residents in the FL-SRB live in urban centers that may be mentally dissociated from natural resources in rural settings.

The willingness of residents to pay for ecosystem services was extremely low and much less than a meal at a fast food restaurant. These findings suggest that residents in the FL-SRB have other preferences than services provided by the very basin they live in. Interestingly, this is somewhat confounded by the fact that the level of outdoor activities (e.g., hiking, tubing in rivers, fishing) and appreciation of beautiful natural areas (e.g., State Parks) in the FL-SRB is quite high. This study provided evidence that the perception and valuation of ecosystem services is based on the beliefs, needs, and preferences that people associate with ecosystems. The spectrum of diverse responses to the survey was vast and provides an important foundation for politics and decision making. We believe that the coupling of socio-cultural valuation, economic assessment, and political instruments is saliently important to sustain and enhance ecosystem services.

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## Appendix A. A procedure used to generate the choice experiments structure is as follows:

1. Determined ecosystem services survey design codes for four attributes with three levels.

| Attribute | 0 | 1 | 2 |
|---|---|---|---|
| Ecosystem services | climate/carbon reg | nutrient control | agri/forest production |
| Program administration | SRWMD taxes | County taxes | NGO contributions |
| Location | Anywhere | Within 20 mi | Within 5 mi |
| Willingness to pay | $5 | $25 | $50 |

2. Applied optimal pairs for estimating main effects for four ternary attributes.

| | Program A | | | | Program B | | | |
|---|---|---|---|---|---|---|---|---|
| Choice Set | Att1 | Att2 | Att3 | Att4 | Att1 | Att2 | Att3 | Att4 |
| 1 | 0 | 0 | 0 | 0 | 1 | 2 | 1 | 2 |
| 2 | 0 | 1 | 1 | 2 | 1 | 0 | 2 | 1 |
| 3 | 0 | 2 | 2 | 1 | 1 | 1 | 0 | 0 |
| 4 | 1 | 0 | 1 | 1 | 2 | 2 | 2 | 0 |
| 5 | 1 | 1 | 2 | 0 | 2 | 0 | 0 | 2 |
| 6 | 1 | 2 | 0 | 2 | 2 | 1 | 1 | 1 |
| 7 | 2 | 0 | 2 | 2 | 0 | 2 | 0 | 1 |
| 8 | 2 | 1 | 0 | 1 | 0 | 0 | 1 | 0 |
| 9 | 2 | 2 | 1 | 0 | 0 | 1 | 2 | 2 |

3. Generated codes with four attributes and three levels, then divided them into two survey sets.

| Ecosystem Services | Program Administration | Location | Willingness to pay | Choice set |
|---|---|---|---|---|
| Program A | | | | |
| climate/carbon reg | SRWMD taxes | Anywhere | $5 | X1 |
| climate/carbon reg | County taxes | Within 20 mi | $50 | Y1 |
| climate/carbon reg | NGO contributions | Within 5 mi | $25 | X2 |
| nutrient control | SRWMD taxes | Within 20 mi | $25 | Y2 |
| nutrient control | County taxes | Within 5 mi | $5 | X3 |
| nutrient control | NGO contributions | Anywhere | $50 | Y3 |

| | | | | |
|---|---|---|---|---|
| agri/forest production | SRWMD taxes | Within 5 mi | $50 | X4 |
| agri/forest production | County taxes | Anywhere | $25 | Y4 |
| agri/forest production | NGO contributions | Within 20 mi | $5 | X5 |
| Program B | | | | |
| nutrient control | NGO contributions | Within 20 mi | $50 | X1 |
| nutrient control | SRWMD taxes | Within 5 mi | $25 | Y1 |
| nutrient control | County taxes | Anywhere | $5 | X2 |
| agri/forest production | NGO contributions | Within 5 mi | $5 | Y2 |
| agri/forest production | SRWMD taxes | Anywhere | $50 | X3 |
| agri/forest production | County taxes | Within 20 mi | $25 | Y3 |
| climate/carbon reg | NGO contributions | Anywhere | $25 | X4 |
| climate/carbon reg | SRWMD taxes | Within 20 mi | $5 | Y4 |
| climate/carbon reg | County taxes | Within 5 mi | $50 | X5 |

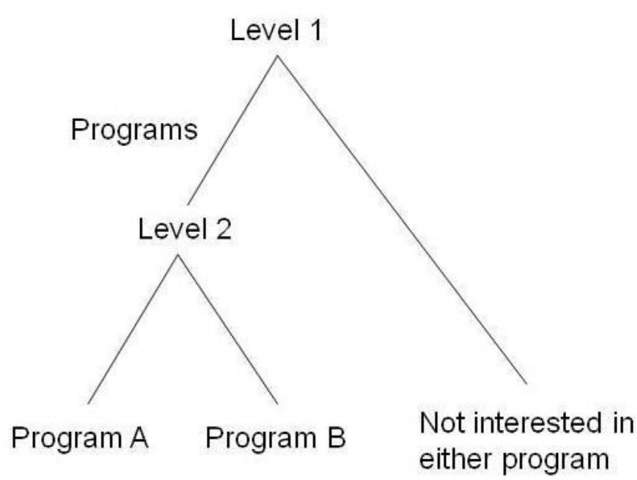
## Appendix B

Cochran's formula $\rightarrow n_0 = \frac{z^2pq}{e^2} = \frac{1.96^2(0.5)(0.5)}{(0.05)^2}$ =385 samples.

Yamane's formula $\rightarrow n_0 = \frac{N}{1+N(e)^2} = \frac{241,948}{1+241948(0.05)^2}$ =400 samples.

where $n_0$ is the sample size, $z^2$ is the cutoff area $\propto$ at the tails, $e$ is the desired confidence level of precision (5%), p is the estimated proportion of an attribute that is present in the population, q is 1-$p$, and N is the population size.

## Appendix C

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Decision tree structure of the nested logit model with two levels. Level 1 is the decision whether or not to choose any programs and Level 2 presents the program choices.

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