AgEcon SEARCH
RESEARCH IN AGRICULTURAL & APPLIED ECONOMICS

The World's Largest Open Access Agricultural & Applied Economics Digital Library

This document is discoverable and free to researchers across the globe due to the work of AgEcon Search.

Help ensure our sustainability.

Give to AgEcon Search

AgEcon Search
http://ageconsearch.umn.edu
aesearch@umn.edu

*Papers downloaded from **AgEcon Search** may be used for non-commercial purposes and personal study only. No other use, including posting to another Internet site, is permitted without permission from the copyright owner (not AgEcon Search), or as allowed under the provisions of Fair Use, U.S. Copyright Act, Title 17 U.S.C.*

A Latent Class Analysis of Public Attitudes toward Water Resources with Implications for Recreational Demand

By

Oren Ehrlich, Xiang Bi, Tatiana Borisova, and Sherry Larkin

Department of Food and Resource Economics
University Florida

The authors are graduate student, assistant professor, associate professor, and professor, respectively. Correspondence should be sent to: Xiang Bi, P.O.BOX 110240, University of Florida, Gainesville, FL 32611-0240, USA (email: xiangbi@ufl.edu).

Selected Paper prepared for presentation at the 2016 Agricultural & Applied Economics Association Annual Meeting, Boston, Massachusetts, July 31-August 2.

Copyright 2016 by Oren Ehrlich, Xiang Bi, Tatiana Borisova, and Sherry Larkin. All rights reserved. Readers may make verbatim copies of this document for non-commercial purposes by any means, provided that this copyright notice appears on all such copies.

A Latent Class Analysis of Public Attitudes toward Water Resources with Implications for Recreational Demand

Abstract

This study examines the extent to which heterogeneous environmental attitudes influence recreational demand in a river basin and the valuation of recreational benefits. We first employed a latent class analysis to reveal two distinct classes of respondents that differ in their environmental attitudes despite representing similar demographic characteristics. We then estimated a recreational demand model conditional on respondent's latent class membership after controlling for the probabilistic nature of the membership classification. We found that environmental attitudes directly influence consumer recreational demand and valuation. Ignoring preference heterogeneity leads to overestimation of the recreational benefits.

Key words: Latent Class Analysis (LCA), Recreational Demand, Travel Cost Method (TCM), Non-market Valuation.

JEL Code: Q51, Q57.

1. Introduction

The St. Johns River (SJR) is the longest river in the state of Florida, stretching 310 miles across 12 counties. Located in northeastern Florida, the river flows north along the Atlantic coast, starting in the marshes of Vero Beach and eventually emptying into the Atlantic Ocean near Jacksonville. The study area is the SJR basin, which includes the SJR, lakes, smaller streams, and thousands of square miles of wetlands that are hydrological connected to the SJR.

The SJR is one of the many recreational designations in Florida. Figure 1 depicts the major recreation sites in the SJR Basin (FDEP 2014b, McCarty 2008, SJRWMD 2014b). Also, the SJR has been recognized as an American Heritage River (American Rivers, 2008) because of the value of the cultural services it provides to the region. Most of the water resources in the SJR Basin (SJRB) are designated for recreation and for fish and wildlife habitats.

However, the most recent reports published by the Florida Department of Environmental Protection has classified the SJR and its tributaries as impaired because they do not meet the necessary water quality standards for these designated uses (FDEP 2014a, 2015). Nutrient impairment results in periodic algae blooms, many of which are associated with fish kills, and the presence of blue-green algae that are toxic to both aquatic life and humans.

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

Protecting water quality and water flow while providing additional nature-based recreational opportunities will help the local economy. Regional water quality and allocation policies are being developed to meet the water demand of 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 use, potential use, and value are critical for justifying investment expenditures at the state level.

The goal of this study is to determine the economic value of recreation along the freshwater portion of the SJR. Particularly, we estimate the extent to which heterogeneous environmental attitudes influence demand for freshwater recreational activities and the valuation of freshwater recreational benefits. We incorporate consumer preference heterogeneity in the estimates through conducting a Latent Class Analysis (LCA) on consumer’s stated preferences and perceptions on water resources and environmental protection. Then we use travel cost method (TCM) to estimate recreational demand with respect to travel cost and characteristics of the sites visited, conditional on the classification of the latent class membership. We show that incorporating preference heterogeneity improves the estimates of recreational benefits; and the consumer segments identified through LCA can be used for understanding the potential distributional impacts of conservation policy on the SJR.

2. Literature Review

Identifying consumer preference heterogeneity and examining its impact on willingness to pay have become the focus of nonmarket valuation studies over the past decade. The recent literature emphasizes the latent nature of preference heterogeneity and incorporates latent classes of stated attitudes in estimating recreational demand using discrete site-choice modeling (Boxall and Adamowicz 2002, Morey, Thacher, and Breffle 2006, Bujosa, Riera, and Hicks 2010). In this type of analysis, a population is split up into groups based on survey responses to questions regarding demographic characteristics or attitudes about the environmental goods using Latent Class Analysis (LCA). LCA is especially appealing since collected information on consumers' stated attitudes is often discrete or categorical (Aitkin, Murray, and Rubin 1985).

LCA can be estimated jointly with a discrete site-choice model of recreation, where LCA is estimated using attitudinal data and/or demographics variables and the discrete site choice model is estimated using only choice data. Discrete site-choice model can only be estimated with information, such as travel cost and site characteristics, from each one of the recreation sites. When such detailed information is not available or too costly to collect, another way to estimate recreational demand is through single-site travel cost method (TCM).

TCM can incorporate consumer demographic characteristics or stated attitudes to approximate the impact of preference heterogeneity on recreational demand. Although demographic characteristics may be correlated with the unobserved heterogeneous preferences, using demographic characteristics to approximate preference heterogeneity is less likely to reveal direct relationships between consumption frequencies and consumers' stated perceptions or attitudes. Instead, consumer preferences are more likely to be revealed through their stated perceptions and attitudes about the environmental goods under examination (Boxall and Adamowicz 2002, Morey, Thacher, and Breffle 2006).

This study proposes to use LCA to incorporate the stated attitudes and perceptions into the single-site TCM by using the distribution information provided by LCA. There are several advantages of using LCA as opposed to including stated attitudes and perceptions as indicator variables in the TCM. First, practitioners often need to choose one or more indicators from multiple indicators to preserve degrees of freedom. LCA offers the flexibility to combine multiple indicators into a latent variable for segmenting by categorizing segments of individuals based on their response patterns for multiple indicators (Onozaka, Hansen, and Sorvig 2014). Second, multiple discrete or categorical questions are used to elicit consumers' stated attitudes or perceptions. These indicators may have different scales. LCA allows researchers to incorporate multiple indicators with multiple scales.

Scarpa, Thinen, and Tempesta (2007) combined LCA with a single-site TCM model to examine consumer preference heterogeneity. However, they used demographic characteristics rather than stated attitudes and perceptions to determine latent class membership. Furthermore, they estimated LCA jointly with TCM (e.g., Poisson and Negative Binomial models). While joint estimation is more efficient, the formation of latent classes (i.e., the number of latent classes identified) and TCM estimates may hinge upon the choices of covariates in determining the latent class membership (Vermunt 2010).

As opposed to the joint estimation, one could use the results from a LCA model to allocate individuals deterministically to each class and estimate a recreational demand model for each class (Morey, Thacher, and Breffle 2006). In addition to being easier to estimate than a joint estimation, this two-step approach is especially appealing when consumers' attitudes and perceptions on a broader set of public goods are used for latent class segmentation. Conceptually, consumers' attitudes and perceptions about public goods should influence their consumption of a specific type of environmental good (such as freshwater recreation), but the consumption of one particular environmental good alone should not influence attitudes and perceptions of several public goods, upon which the consumers' latent segmentation is based. Thus, a joint estimation with latent class membership being determined by both consumption frequency and stated attitudes and perceptions is not ideal unless elicited attitudes only pertain to the particular environmental good under examination.

This study contributes to the literature in that we incorporate LCA with a single-site TCM by estimating TCM conditional on latent class formation. It provides insights through estimating consumers' conditional class membership probabilities, which can be used for examining the potential distributional impacts from a proposed policy change.

3. Study Design

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 watching (SJRWMD 2014c; Florida Division of Recreation and Parks 2014).

The SJR can be categorized into smaller sections, referred to as the Upper, Middle, and Lower SJR, with corresponding basins (SJRWMD 2014a). As the three sections of the SJR have distinct characteristics, the recreational opportunities offered by the three basins also differ. The Upper (southern) SJRB is characterized by marshes. While the Upper SJRB is not navigable by commercial boats, it provides plentiful opportunities for air boating, seasonal hunting, fishing, and kayaking (SJRWMD 2014c). Downstream (in the Middle SJRB), where clearly delineated bodies of water begin to take form, kayaking, swimming, hiking, and wildlife viewing are abundant recreation opportunities with suited sites such as Lake George and the Blue Springs State Park. The SJR widens significantly in the Lower (northern) SJRB and supports both commercial and recreation uses. For example, the Port of Jacksonville serves as the largest vehicle exporting port in the United States. In addition, the Lower SJRB is characterized by cultural heritage sites, such as the Timucuan Ecological and Historic Preserve.

Eleven sites that offered freshwater based recreation opportunities were identified along the SJR that were representative of the variety of nature-based activities, in order to cue survey respondents as to the landmark recreation sites along the SJR. The sites were decided upon based on their geography (a semi-uniform spatial distribution representing the spectrum of geographical features) and their visitation rates (sites with a higher number of visitors were given more consideration). A series of regional guidebooks provided information about the characteristics of the recreation sites, FDEP statistics ranked the most visited state parks in the study region, and personal interviews with SJRWMD officials and local business owners informed site selection when unclear (SJRWMD 2014c; Bellville 2000; McCarthy 2008).

The locations of the eleven sites are shown in Figure 1. On those sites, in addition to water-based recreation, visitors have land-based recreation and ecotourism options, such as hiking, horseback riding, bicycling, camping, and geo-caching on public and private park in the SJRB (Figure 2).

After identified the major recreational sites along the SJRB, we developed survey instrument to be implemented over the telephone. Our target group is the potential consumers of the SJR excluding those residents live by the SJR, therefore the survey focused on adults that had travelled for more than 10 miles for outdoor recreational activities in the past 12 months. These outdoor recreational activities include both land-based and water-based activities. If respondent participated in outdoor recreational activities in the past 12 months, we proceeded with a question on whether the recreational trip was to the SJRB.

If the respondent travelled to the SJRB, he or she was asked about the recreation habits and frequencies in the past 12 months; and the preferred activities and perceptions of water quality of the recreational site pertaining to the most recent trip to the SJRB. Following with questions on the most recent trip to the SJRB, the respondent was prompted with questions concerning his/her stated perceptions of the water quality and availability in their home counties; level of satisfaction with governing laws and regulations regarding Florida waterways; and perceptions regarding the amount of government spending toward education, the environment, economic development, and infrastructure. The last section of the survey gathered socio-demographic information.

The types of attitudinal questions were developed based on existing public attitudes studies in Florida (Odera and Lamm 2014). The attitudinal questions aimed at gauging respondent perceptions and satisfaction utilized Likert scale responses to assess a certain level of approval, disapproval, or neutrality. A Likert scale employs a numerical scale, most commonly on a five to seven point scale. The attitudinal questions and their Likert scale responses are presented in Table 1.

If the respondent did not travel to the SJRB, the respondent was asked the same sets questions on attitudes/perceptions and demographics.

4. Data Collection

A telephone survey was conducted using a random sample generated from random-digit dialing (RDD) to the landlines of households living in Florida, excluding the Panhandle and Miami metropolitan areas. The telephone survey was administered from September 20, 2014 to October 31, 2014 and we collected 500 completed responses (stratified equally by north, central and south). In total, our survey area included 49 of the 67 counties in Florida.

Table 2 summarized the demographic characteristics of the sample. Compared to Florida's general population, respondents in the sample were more likely to be Caucasians. The median age in the sample was 63 years old as compared to 40.4 years old for all Florida residents. The respondents had higher levels of education and home ownership than the average Floridian.

5. Empirical Framework

The Latent Class Model

Latent class analysis (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. 2007). This type of analysis is used to reveal underlying (or latent) classes based on multiple variables that are characterized by a pattern of conditional probabilities. In this study, attitudinal questions from the telephone survey were used as the explanatory variables to define the latent classes. Specifically, responses to questions regarding home-county water quality and quantity, the adequacy of Florida's laws and regulations protecting Florida's waterways, and the appropriateness of government spending on environmental protection and economic development were used.

Assume the sample population is composed of a number of different preference groups denoted *C,* and an individual's preference group is latent, or unobserved. What is observed is the individual *i*'s responses to attitudinal questions (x_i) and the observed characteristics of the individual z_i as a set (x_i, z_i). Following Hagenaars and McCutheon (2003), Boxall and Adamowicz (2002) and Morey, Thacher, and Breffle (2006), a general LCA model includes the following four probabilities:

(1) $Pr(c{:}\, z_i),\ \ Pr(c{:}\, z_i|x_i),\ \ \pi_{qs|c},\ \ Pr(x_i{:}\, z_i)$

$Pr(c{:}\, z_i)$ is the unconditional probability that individual *i* belongs to group *c* based on the observable characteristics *z*. This probability is unconditional because it does not rely on the specific answer to the attitudinal questions. Respondents with the same observable characteristics *z* belong to group *c* because of the unconditional membership probabilities.

$Pr(c: z_i|x_i)$ is the conditional membership probability that individual *i* belongs to group *c* based on the observable characteristics z and is conditional on the individual's answers to attitudinal questions. This allows for a more accurate prediction of the respondent's group membership.

$\pi_{qs|c}$ is the probability that an individual in group *c* answers level *s* to attitudinal question q. This is a function of an individual's preferences.

$Pr(x_i: z_i)$ is the probability that an individual with characteristics z_i has the response pattern x_i. These are functions of the $\pi_{qs|c}$ response probability.

If x_{iqs} represents individual *i*'s answer to attitudinal question *q* at level *s*, then x_{iqs}=1, otherwise x_{iqs}=0. The unobservable characteristics of which the latent groups are formed is the basis of why individual response patterns from the same group are more correlated to each other as opposed to individuals from the other membership group, basically showing that those who share commonalities are more likely to answer the same questions similarly.

The latent class model assumes that once group membership is accounted for, the attitudinal responses are independent. Keeping this in mind, the probability that an individual with given characteristics has a specific response pattern is explained as follows:

(2) $\Pr(x_i: z_i) = \sum_{C=1}^{C} \Pr\,(\text{c}: z_i)\Pr(x_i|c) = \sum_{c=1}^{C} \Pr\,(\text{c}: z_i) \prod_{q=1}^{Q} \prod_{s=1}^{S} (\pi_{qs|c})^{x_{iqs}}$

Note that $\Pr(x_i|c) = \prod_{q=1}^{Q} \prod_{s=1}^{S} (\pi_{qs|c})^{x_{iqs}}$ is the probability that the individual response pattern x_i is conditional on belonging to group c, which ultimately results in the probability of observing an individual's response pattern.

The main goal of this type of estimation is to find the parameter values that can describe the response patterns most effectively. This is achieved by finding the probabilities that will maximize the log likelihood function using $Pr(c: z_i|x_i)$ and $\pi_{qs|c}$, which are both functions of the conditional probability $Pr(c: z_i|x_i)$:

(3) $\ln L = \sum_i^N \ln [\Pr(x_i: z_i)] = \sum_i^N \ln [\Pr(c: z_i) \prod_{q=1}^{Q} \prod_{s=1}^{S} (\pi_{qs|c})^{x_{iqs}}]$

subject to $\sum_{s=1}^{S} \pi_{qs|c} = 1$ and $\sum_{c=1}^{C} \Pr(c: z_i) = 1$.

The function $\pi_{qs|c}$ that maximizes the log likelihood function (3) is

(4) $\pi_{qs|c} = \frac{\sum_{i=1}^{N} \Pr(c:z_i|x_i) x_{iqs}}{\sum_{i=1}^{N} \Pr(c:z_i|x_i)}$

In equation (4), the numerator results in the number of times respondent *i* gives a particular answer *s* to question q, weighted by the conditional probability that the respondent is in group *c*. The denominator is the number of individuals in a group *c*. Thus, equation (4) is the proportion of the number of times respondent *i* in group *c* gives a particular answer *s* to question q.

Before looking at the unconditional probability that maximizes equation (3) it is worth discussing element z_i as it can either vary continuously or have a finite number of discrete values. Since z_i does in fact have elements that vary continuously, $\Pr(c: z_i)$ is specified as a function of some vector class-specific parameters β_c such that $0 \leq \Pr(c: z_i) \leq 1$ and $\sum_c \Pr(c: z_i)=1$.

Considering that z_i will have continuous values a logit specification is used:

(5) $\Pr(c: z_i) = \frac{e^{\beta_c z_i}}{\sum_{k=1}^{C} e^{\beta_k z_i}}, c = 1, \ldots, C,$

The elements of β are estimated, but since the closed-form solutions for β do not exist, a numerical optimization routine must be embedded in an expectation-maximization algorithm (Bartholomew and Knott 1999, Dempster, Laird, and Rubin 1977, Morey, Thacher, and Breffle 2005). Considering the parameters in equations (4) and (5) are unknown, it is not possible to obtain the maximum likelihood estimates of the functions $Pr(c: z_i|x_i)$ and $\pi_{qs|c}$. The remedy for this situation is to use the expectation-maximization (E-M) algorithm, which can be used to perform a maximum likelihood estimation when there is incomplete information. The E-M algorithm estimates the maximum likelihood in two steps: an expectation step and a maximization step. The expectation step determines the expected value of the latent information, then the maximization step estimates the maximum likelihood while treating the latent information's true value the same as the latent information's expected value. Upon reviewing the results, the expected value of the latent information is compared to the true value and this process is reiterated until the log-likelihood function converges. Convergence occurs when the percentage change in L_β approaches a small, pre-specified number. With a latent class model, the conditional membership probability is $Pr(c: z_i|x_i)$, which means that the E-M algorithm is determining the values of $Pr(c: z_i|x_i)$ and $\pi_{qs|c}$. What makes this an expected likelihood function is the treatment of the expected values of the conditional membership probability being the same as that of the true values.

In short, the model is initially estimated using a guessed number of values of $Pr(c: z_i|x_i)$. Equations (4) and (5) are then used to calculate $\Pr(c: z_i)$ and $\pi_{qs|c}$. The resulting equation is used to recalculate the new $Pr(c: z_i|x_i)$ and the estimation is repeated using the new probability. Each iteration uses equation (3) to calculate the log likelihood lnL.

In this study, we estimate a simpler version of equations (4) and (5) by using respondents' attitudes to identify unmeasured class membership without controlling for the observed characteristics z_i as covariates. We employ this approach for two reasons. First, introducing covariates into LCA is primarily used in studies with large samples (more than 500) because the logistic regression coefficients for covariates have relatively high biases when the sample size is relatively small (Wurpts and Geiser 2014). Our sample size is 500, which is considered relatively small and at risk for large biases if this alternative is followed. Second, including the observed demographic characteristics z_i as covariates may influence the class membership formation (Vermunt 2010).

Travel Cost Model

The travel cost method (TCM) is a commonly used revealed preference approach that can be used to estimate the total economic value a consumer derives from travelling to a site for recreation by accounting for the costs incurred in taking the trip. These costs include transportation, access fees, lodging, and the opportunity cost of time. Utilizing data regarding the number of trips taken by the sample and the costs that have been incurred, a function for the recreational demand of a consumer can be estimated. Once the demand function is estimated, it can be used to estimate consumer surplus, which is the difference between the total economic value derived and the total cost incurred from taking a recreational trip by the sample of respondents. Consumer surplus can be visualized on a demand curve by observing the area under the demand function and above the travel cost level (Hanley, Shogren, and White 2007).

We estimate a single-site TCM with a substitute site as follows (Haab and McConnell 2002):

(6) $v_{i1} = f(p_{i1}, p_{i2}, q_{i1}, y_i)$

The model describes the number of trips v_{i1} undertaken by respondent i to site 1 as a function of respondent $i's$ travel cost to site 1, p_{i1}; the travel cost to an alternate site, p_{i2}; the perceived water quality at site 1, q_{i1}; and the visitor demographics, y_i (such as household income), that are included in the model that might influence the number of trips a respondent would take.

Employing the travel cost method requires some initial calculations of the incurred travel costs to visited site p_{i1} and alternate site p_{i2} from the respondent's starting point. These costs are estimated using the monetary cost of travel and the opportunity cost of travel time. In this study, the costs are estimated from the mid-point of the provided zip code of each respondent to the visited site in the SJRB by using the following relationship:

(7) $p_{i1} = cpm * d_{i1} + \gamma * w_i * (\frac{d_{i1}}{mph})$

where cpm represents the cost per mile traveled, d_{i1} is the round trip distance from the respondent's mid-point of home zip code to a site in the SJRB, and mph is the travelling speed in miles per hour. The implicit wage rate is calculated using the respondent's household income from the survey as a fraction (0< γ<1) of the hourly wage rate w_i (Water Resources Council 1983, p. 78). The fraction γ of the wage rate is assumed to be 0.33 based on the previous literature (e.g., Anderson 2010; Parsons 2003).

The cost per mile cpm is \$0.575 based on the standard mileage rate determined by the Internal Revenue Service (IRS 2015).

Considering that the study area spans a large area of the state of Florida, and that the respondents resided in three regions (north, central, and south Florida), an alternative site for freshwater recreation was decided upon for each region. Since Florida has abundant opportunities for fresh water activities, we select these alternative sites based on popularity, proximity to a respondent's residence (based on respondent home zip codes), and the availability of comparable opportunities for recreational activities[1].

Given the nonnegative integer feature of the expected number of trips, a typical TCM is estimated assuming a Poisson distribution. However, this has the drawback of assuming that the conditional mean is equal to the variance (equi-dispersion); this is violated in our dataset. In the presence of over-dispersion, we estimate a negative binomial model (Parsons 2003).

The expected number of trips a household takes is represented by the λ_i parameter, otherwise known as latent demand. The demand function is represented in a log-linear form to ensure nonnegative probabilities and is written as

(8) $$\ln(\lambda_{i1}) = \beta_0 + \beta_1 p_{i1} + \beta_2 p_{i1} + \beta_3 q_{i1} + \beta_4 y_i$$

which can be transformed to

(9) $$\hat{\lambda}_{i1} = exp(\hat{\beta}_0 + \hat{\beta}_1 p_{i1} + \hat{\beta}_2 p_{i2} + \hat{\beta}_3 q_{i1} + \hat{\beta}_4 y_i)$$

The consumer surplus of a trip to site 1 can then be assessed using the results from the estimation using (Bockstael and Strand 1987, Adamowicz, Fletcher, and Graham-Tomasi 1989):

---

1 As a robustness check, we also used the closet site to respondent's residence along the SJR as the alternative site. Our results remain qualitatively unchanged.

(10) $$CS/household/trip = -\frac{1}{\widehat{\beta}_1}$$

Then the value consumer surplus can be found by multiplying (9) with (10):

(11) $$CS/household/year = -\frac{\widehat{\lambda}_{i1}}{\widehat{\beta}_1}$$

The consumer surplus each household receives per trip in a year (10) can then be multiplied with the predicted number of trips, as shown in (11) to estimate the annual benefit per household. To arrive at an aggregate annual estimate of the value of recreation generated by the SJRB, we multiply (11) with the number of households in Florida using data gathered from the most recent US Census (US Census Bureau 2015).

6. Results

LCA Results

Following previous studies, we use the Bayesian Information Criterion (BIC) likelihood-based criteria to determine the number of latent classes (Scarpa, Thiene, and Tempesta 2007; Nguyen et al. 2013; Onozaka, Hansen, and Sørvig 2014, Lanza et al. 2015). When assessing the best fit of the model, the lowest BIC will result in the best fit. As a result of using the BIC, two latent classes were identified.

Class 1 resulted in a total of 261 respondents and class 2 was comprised of 238 respondents out of 496 respondents with complete data on all variables of interest. Using a non-parametric Wilcoxon rank-sum test, not many demographics were statistically different among classes, with the exception of residency (Table 3).

The two classes were set apart by their major differences with regard to responses to attitudinal questions. The distribution of all attitudinal responses among classes resulting from LCA can be seen in Table 4. All differences between the two classes are statistically significant at the 5% or 10% significance levels. Here we focus on the perceptions and attitudes pertaining to environmental protection and environmental spending to highlight the key differences between the two classes.

When asked about water quality in their home county, 70% of class 1 respondents expressed concern as opposed to 50% of class 2 (Table 4). Similarly, 44% of class 1 felt that a water shortage in their home county was unlikely to occur compared to 35% of class 2. When asked about their perceptions regarding the reach of laws and regulations protecting Florida's freshwater quality, 77% of class 1 felt that existing laws have not gone far enough to protect Florida's freshwater, whereas 60% of class 2 felt that the laws have struck the right balance (Table 4). With regard to respondent satisfaction with Florida's government spending on the environment, 90% of class 1 felt that there is not enough money being allocated to this area, whereas 59% of respondents in class 2 believed that the amount of spending is at the proper level (Table 4).

The two classes differed by their recreational and pro-environmental behaviors. For example, 52% of the respondents in Class 1 donated time and monies for environmental causes, while only 32% of the respondents in Class 2 had done so in the past five years (Table 5). They also differed by the percentage of respondents that traveled more than ten miles to participate in any inland outdoor activity (i.e., hiking; biking; wildlife viewing; horseback riding; or freshwater-related activities like swimming, boating, or swimming) in the past twelve months (Table 5). While 44% of class 1 reportedly traveled more than ten miles to recreate in the past 12 months, class 2 reported fewer visits (34%). Fifty-two percent of class 1 reported contributing time or money to environmental causes compared with 32% of class 2. Similarly, 20% of the class 1 traveled to the SJRB for outdoor recreation in contrast to 11% of the class 2.

Furthermore, 55% of class 1 who visited the SJR for recreation engaged in freshwater-related activities such as boating (non-motorized and motorized), swimming, and fishing. The rest of class 1 was engaged in recreational activities on the green space supported by the SJR such as hiking, picnicking, and wildlife viewing. In comparison, 70% of class 2 respondents visiting the SJRB did so for freshwater-related recreation.

In summary, despite having similar socio-demographic characteristics as class 2, class 1 was more concerned with the quality of the environment in their home counties. Their concern with environmental quality is apparent by the share of respondents that reported making environmental contributions as compared to class 2. The importance that class 1 places on the environment is further illustrated by nearly the entire group's desire to see more government spending toward the environment. For class 2, the results from LCA suggest that they are generally content with the level of protection of water resources, the quality of water in their home counties, and the amount of spending toward environmental protection. Class 1 visited the SJRB more often than class 2 and class 1 had more diverse uses of the SJRB than class 2. Our results resonate with some of the previous studies on recreational anglers in that the latent classes could share similar demographic characteristics yet present different environmental attitudes which led to different practices of catch-and-release (Nguyen et al. 2013).

TCM Results

One of the drawbacks of modeling consumption conditional on latent class membership is the class membership uncertainty due to the probabilistic nature of the latent class formation. However, this can be mitigated through adjustments in estimating the second-step recreational demand through probability weighting methods proposed by Vermunt (2010) and Clark and Muthén (2015). We calculated the variation of the class membership probabilities for each respondent under 20 sets of simulations, and used the inverse of the variations as weights in the TCM model. In other words, given a set of simulations, respondents with great variation in their probabilistic class membership should be given fewer weights than respondents with little variation in their class membership.

To compare with the results by class, we further estimate a joint TCM model reported in column 3. As expected, we find a negative inverse relationship between the travel cost and number of trips taken to have statistically significant coefficients at 10% significance in class 1 and 1% significance in class 2. Holding all other variables constant, an increase in the travel cost to an alternate site would result in increases of visitation to the SJRB, confirming that the alternate site is a substitute to the SJRB. Results in column 3 contain all of the observations pooled. We further use the log likelihood ratio test for the hypothesis that a pooled model should be estimated versus two separate models, and we reject the null hypothesis at the 5% significance level ($\chi^2_7 = 47.8$), which supports the estimation of two separate models.

Information from the TCM was used to estimate consumer surplus and the predicted number of future trips in order to estimate the economic benefits generated by the SJRB (Table 7). The main model predicted the number of trips per year for classes 1 and 2 to be 2.66 and 2.10 with standard deviations of 5.45 and 4.86, respectively. Using the coefficients from Table 5, this translated to a consumer surplus per household per trip of $83.33 for class 1 and $40.00 for class 2. The annual consumer surplus per household for classes 1 and 2 was $221.67 and $84.00, respectively. The total annual benefit for all Florida households estimated to belong to class 1 was $142.1 million and was $28.8 million for class 2. While both classes predicted a relatively similar number of trips, class 1 received a higher annual consumer surplus per household per trip resulting in a significantly higher level of total annual benefits received.

The results from LCA suggest that class 1 is more environmentally concerned and spends more time on recreation than class 2. This is consistent with the findings that the benefits that class 1 received from recreation are much higher than that of class 2.

The pooled model predicted the number of trips per year to be 2.27 with a standard deviation of 4.86. Using the coefficients from column 3 of Table 6, this resulted in a consumer surplus per household per trip of $76.92 and an annual consumer surplus per household of $174.62. The resulting total annual economic benefit received is $171.6 million.

Compared to the aggregate level of benefits from class 1 and class 2, the estimated total benefit from the joint model is $738,287 greater. This is because the pooled model assumes equal weights between class 1 and class 2. Though classes 1 and 2 have almost equal shares of the population (48% vs. 52%), their derived benefits from consume the SJR differed significantly. Thus, using the pooled model while ignoring the two latent classes resulted in the over estimation of the recreational benefits of the SJR.

7. Conclusions

The addition of consumer perceptions and attitudes regarding freshwater resources and government policies did in fact have a significant impact on the estimated demand for freshwater recreation. Conducting LCA to account for the individual preference heterogeneity of consumers resulted in a more efficient model of demand for freshwater recreation. The likelihood ratio test indicated that the two separate models by class provide a better fit than a pooled model. The results showed that the class 1 visitors (more frequent users) gain higher total annual benefits from SJRB recreation compared to class 2 (the less frequent users).

Estimating TCM by the results of LCA enhanced the model by accounting for consumer perceptions and their individual preference heterogeneity. Future studies can benefit from utilizing the methods presented in this study to account for differences in the underlying groups of consumers that might not be captured in standard valuations. Since forming latent groups based on the recreationists' perceptions and attitudes improved the overall model fit, future studies can benefit from the inclusion of more stated preference questions in their survey design in order to better capture individual preference heterogeneity and improve the overall model estimation.

Even more so, the straightforward manner in which this estimation was conducted is preferential for policy analysts since it allows for similar studies to be easily replicated. 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. A tangible example of current policy that could benefit from this type of analysis would be the Surface Water Improvement and Management (SWIM) plan and the Basin Management Action Plan (BMAP) developed to restore and manage water resources in the SJRB. The results from this study can be used in these plans and other water quality policy initiatives by accurately analyzing the distribution of benefits between (latent) groups of Florida residents.

Implications for future management strategies may also be realized by potential improvements in marketing and management strategies resulting from a more accurate representation of the groups that recreate in the SJRB. While these groups share many similar demographic characteristics, it is their personal values, attitudes, and preferences that lead to a more accurate grouping and targeting of recreationists. Specifically, consumers in class 1 were engaged with more diverse uses of the SJR, while consumers in class 2 were primarily engaged with fishing. Marketing programs should consider focus on increasing public awareness on the abundant recreational opportunities of the SJRB; and management programs should consider improve facilities or guided tours for a diverse set of recreational activities, such as paddling, wild life viewing and bird watching.

Acknowledgement

This work is supported by the USDA National Institute of Food and Agriculture, Multistate Hatch project [CRIS:005439].

References

Adamowicz, W.L., J.J. Fletcher, and T. Graham-Tomasi. 1989. "Functional Form and the Statistical Properties of Welfare Measures." *American Journal of Agricultural Economics* 71(2): 414-421.

Anderson, D.M. 2010. "Estimating the Economic Value of Ice Climbing in Hyalite Canyon: An Application of Travel Cost Count Data Models That Account for Excess Zeros." *Journal of Environmental Management* 91(4): 1012-1020.

Aitkin, M., and D.B. Rubin. 1985. "Estimation and Hypothesis Testing in Finite Mixture Models." *Journal of the Royal Statistical Society* 47(1): 67-75.

American Rivers. 2008. *Most Endangered Rivers: 2008 Edition*. Available at http://americanrivers.org (accessed March 2016).

Bartholomew, D., and M. Knott. 1999. *Latent Class Models and Factor Analysis*. Oxford,UK: University Press, Inc.

Bockstael, N.E., and I.E. Strand. 1987. "The Effect of Common Sources of Regression Error on Benefit Estimates." *Land Economics* 63(1): 11-20.

Boxall, P.C., and W.I. Adamowicz. 2002. "Understanding Heterogeneous Preferences in Random Utility Models: A Latent Class Approach." *Environmental and Resource Economics* 23: 421-46.

Bujosa, A., A. Riera, and R.L. Hicks. 2010. "Combining Discrete and Continuous Representations of Preference Heterogeneity: A Latent Class Approach." *Environmental and Resource Economics* 47(4): 477-93.

Clark, S., and B. Muthén. 2015. "Relating Latent Class Analysis Results to Variables Not Included in the Analysis." *MPlus Discussions*. Available at http://www.statmodel.com/download/relatinglca.pdf (accessed March 2016).

Dempster, A., N. Laird, and D. Rubin. 1977. "Maximum Likelihood from Incomplete Observations." *Journal of the Royal Statistical Society* B39: 1- 38.

Florida Department of Environmental Protection (FDEP). 2015. *Watershed Assessment Lists: 303(d)*. Available at http://www.dep.state.fl.us/water/watersheds/assessment/a- lists.htm (accessed March 2016).

Florida Department of Environmental Protection (FDEP). 2014a. *Final TMDL Documents*. Available at http://www.dep.state.fl.us/water/tmdl/final_tmdl.htm (accessed March 2016).

Florida Department of Environmental Protection (FEDP). 2014b. *Florida State Parks*. Available at http://www.dep.state.fl.us/parks/ (accessed March 2016).

Haab, T.C., and K.E. McConnell. 2002. "Single Site Demand Estimation." In Haab and McConnell eds., *Valuing Environmental and Natural Resources: The Econometrics of Non-market Valuation*. Cheltenham, UK: Edward Elgar.

Hagenaars, J.A., and A.L. McCutcheon (eds.). 2003. *Applied Latent Class Analysis*. Cambridge, UK: Cambridge University Press.

Hanley, N., J.F. Shogren, and B. White. 2007. "Environmental Economics in Theory and Practice." New York: Oxford University Press.

Internal Revenue Service (IRS). (2015). *Standard Mileage Rate (2015)*.

Lanza, S.T., J.J. Dziak, L. Huang, A.T. Wagner, and L.M. Collins. 2015. Latent Class Analysis (LCA) Stata Plugin (Version 1.2) [Software]. Available at https://methodology.psu.edu/downloads/lcastata (accessed March 2016).

McCarthy, K.M. 2008. *St. Johns River Guidebook*. Sarasota, FL: Pineapple Press.

Morey, E., J. Thacher, and W. Breffle. 2006. "Using Angler Characteristics and Attitudinal Data to Identify Environmental Preference Classes: A Latent-Class Model." *Environmental and Resource Economics* 34(1): 91-115.

Nguyen, V.M., M.A. Rudd, S.G. Hinch, and S.J. Cooke. 2013. "Recreational Anglers' Attitudes, Beliefs, and Behaviors Related to Catch-and-Release Practices of Pacific Salmon in British Columbia." *Journal of Environmental Management* 128: 852-865.

Odera, E., and A. Lamm. 2014. *Public Opinions of Water Quality & Quantity*. Available at http://www.piecenter.com/water/ (accessed March 2016).

Onozaka, Y., H. Hansen, and A. Sørvig. 2014. "Consumer Product Perceptions and Salmon Consumption Frequency: The Role of Heterogeneity Based on Food Lifestyle Segments." *Marine Resource Economics* 29(4): 351-374.

Parsons, G.R. 2003. "The Travel Cost Model." In *A Primer on Nonmarket Valuation*. Amsterdam, Netherlands: Springer.

Patterson, S. 2009. April 13). "SJR Water Withdrawal Permit Approved." *Florida Times-Union*, April 13. Available at http://jacksonville.com/news/2009-04-13/story/st_johns_water_withdrawal_permit_approved (accessed March 2016).

St. Johns Water Management District (SJRWMD). 2014a. *Water Supply: Priority List and Schedule*. Available at http://floridaswater.com/minimumflowsandlevels/prioritylist.html (accessed March 2016).

St. Johns Water Management District (SJRWMD). 2014b. *SJRWMD Recreation Guide to District Lands*. Available at http://www.sjrwmd.com/recreation/ (accessed March 2016).

St. Johns Water Management District (SJRWMD). 2014c. *St. Johns River Water Management District GIS Data*. Available at http://floridaswater.com/toolsGISdata/ (accessed March 2016).

Scarpa, R., M. Thiene, and T. Tempesta. 2007. "Latent Class Count Models of Total Visitation Demand: Days out Hiking in the Eastern Alps." *Environmental and Resource Economics* 38(4): 447-60.

StataCorp. 2013. *Stata 13 Base Reference Manual*. College Station, TX: Stata Press.

Vermunt, J.K. 2010. "Latent Class Modeling with Covariates: Two Improved Three-Step Approaches." *Political Analysis* 19: 450-469.

Water Resources Council. 1983. *Economic and Environmental Principles for Water and Related Land Resources Implementation Studies*. Available at http://www.usace.army.mil/CECW/Documents/pgr/pg_1983.pdf (accessed March 2016)

Wurpts, I.C., and C. Geiser. 2014. "Is Adding More Indicators to a Latent Class Analysis Beneficial or Detrimental? Results of a Monte-Carlo Study." *Frontiers in Psychology* Available at http://journal.frontiersin.org/article/10.3389/fpsyg.2014.00920/full (accessed March 2016).

United States Census Bureau. 2015. QuickFacts on the State of Florida. http://www.census.gov/quickfacts/table/PST045215/12 (accessed March 2016).

Table 1. Attitudinal Survey Questions Used in LCA Estimation

Survey Question	Likert Scale Response
In your home county, how much of a problem is the quality of water in the lakes, streams, rivers, and springs?	1 = No problem at all 2 = A small problem 3 = A moderate problem 4 = A very big problem 8 = Not sure 9 = Prefer not to answer
How likely do you think it is that your home county will experience severe shortages of fresh water in the next 10 years?	1 = Not at all likely 2 = Slightly likely 3 = Somewhat likely 4 = Moderately likely 5 = Very likely 8 = Not sure 9 = Prefer not to answer
At the present time, do you think laws and regulations protecting water quality in Florida's rivers, lakes, and springs have gone too far, struck the right balance, or have not gone far enough?	1 = Not enough 2 = Right balance 3 = Too far 8 = Not sure 9 = Prefer not to answer
Florida's budget includes a wide array of government expenses. Some areas will be presented, and for each one, please express whether you think we're spending too much money on it, about the right amount of money, or too little money.	
(a) The Environment (b) Economic Development (c) Education (d) Infrastructure	1 = Too little 2 = Right balance 3 = Too much 8 = Not sure 9 = Prefer not to answer

Note. All of these categorical variables are used in LCA. Responses of not sure or prefer not to answer are also included and are treated as distinct categories.

Table 2. Demographics Characteristics of the Samples

	Telephone survey	Florida
Female	61%	51%
Caucasians	80%	78%
Median age	63	40.4
Education (College, professional and graduate level)	50%	26.2%
Household income $50000 or more	41%	50%[a]
Florida fulltime residents	97.60%	–
Median/average household size	2	2.56
Home ownership	85%	68%
Number of observations	495	19,552,860

Note. The median household income in Florida was $47212 in 2014 dollars.
Source: US Census Bureau (2015).

Table 3. Socio-demographics of Respondents by Latent Class (proportion)

Characteristics	Class 1 (n = 261)	Class 2 (n = 238)
Male	0.36	0.42
Average age	63.77	62.42
Full-time Florida resident	0.96*	0.99
Property:		
Owner	0.84	0.87
Renter	0.15	0.12
Home Type:		
Apartment / Condo	0.14	0.13
House	0.78	0.77
Mobile Home	0.07	0.08
Household Income:		
Income <$50k	0.34	0.34
Income >$50k	0.38	0.43
Income undisclosed	0.28	0.22
Education:		
High School or less	0.21	0.20
Some College / Tech School	0.29	0.28
College or higher	0.49	0.51

* Statistically different from Class 2 at 10% significance using a nonparametric Wilcoxson-Mann-Whitney test (StataCorp 2013).

Table 4. Attitudinal Responses by Latent Class (proportion)

Variable	Class 1	Class 2
Home county water quality		
A big problem or a moderate problem	0.70**	0.51
A small problem or not a problem at all	0.25**	0.43
Home county water shortage likeliness		
Not at all likely or Slightly likely	0.44**	0.35
Somewhat likely or moderately likely	0.36*	0.34
Very likely	0.10	0.10
Satisfaction with current Florida freshwater protection laws		
Too Far	0.01**	0.10
Balanced	0.14**	0.60
Not Enough	0.77**	0.13
Not Sure	0.08**	0.17
Satisfaction with current level of educational spending		
Too Far	0.02**	0.13
Just Right	0.09**	0.27
Not Enough	0.87**	0.47
Not Sure	0.02**	0.13
Satisfied with current level of environmental spending		
Too Far	0.00**	0.16
Just Right	0.10**	0.59
Not Enough	0.90**	0.07
Not Sure	0.00**	0.18
Satisfied with current level of infrastructure spending		
Too Far	0.15**	0.08
Just Right	0.29**	0.48
Not Enough	0.54**	0.33
Not Sure	0.02**	0.12
Satisfied with current level of economic development spending		
Too Far	0.15**	0.07
Just Right	0.38**	0.41
Not Enough	0.41**	0.37
Not Sure	0.06**	0.15

*, **Statistically different from Class 2 at 10%, 5% significance level using a nonparameti Wilcoxson-Mann-Whitney test (StataCorp 2013). Responses of not sure or prefer not to answer are treated as distinct categories and are omitted for brevity.

Table 5. Recreational Habits and Environmental Contribution by Latent Class

Variable	Class 1	Class 2
Contributed time or money to environmental organizations in the past 5 years	0.52**	0.32
Recreated outdoor in past 12 months	0.44*	0.34
Recreated in the SJRB in past 12 months	0.20*	0.11
Fish/boat/swim in the SJRB in past 12 months	0.55*	0.70

*,** Statistically different from Class 2 at 10%, 5% significance level using a nonparametric Wilcoxson-Mann-Whitney test (StataCorp 2013).

Table 6. Separate and Pooled TCM Estimations

Parameter	Variable	Class 1	Class 2	Pooled
β1	Travel Cost	–0.012	–0.025	–0.013
		(0.007)*	(0.008)***	(0.006) **
β2	Travel Cost to Alternate Site	0.090	0.098	0.088
		(0.007)***	(0.009)***	(0.006) ***
q1	Perceived Site Freshwater Quality	1.268	2.010	1.336
		(0.515)**	(0.664)***	(0.418) ***
yi	Household Income	0.305	–0.419	0.065
		(0.263)	(0.368)	(0.233)
	Environmental Contributions	0.920	2.443	1.232
		(0.368)**	(0.496)***	(0.298) ***
	Constant	–10.476	–6.105	–0.013
		(3.599)**	(3.948)	(0.006) **
α	Alpha (Overdispersion)	1.933	1.903	1.932
		(0.168)***	(0.249)***	(0.141) ***
	Log Pseudolikelihood	–224.1	–116.8	–364.9
	Observations	258	236	494
	Percentage of Class Membership	52	48	100

Robust standard errors are in parentheses. * p<0.1; ** p<0.05; *** p<0.01

Table 7. Consumer Surplus Estimations

Statistic	Class 1	Class 2	Pooled
(1) Consumer Surplus/ Household/ Trip	$83.33	$40.00	$76.92
(2) Predicted Number of Trips/ Year (Standard Deviation)	2.66 (5.45)	2.10 (4.86)	2.27 (4.86)
(3) Annual Consumer Surplus per Household	$221.67	$84.00	$174.62
(4) Total No. of Households in Florida	6,237,279	6,237,279	6,237,279
(5) Percentage of Class Membership	52%	48%	100%
(6) Probability of Visiting SJR	19.77%	11.44%	15.76%
Total Annual Benefits (3)*(4)*(5)*(6)	$142,130,800	$28,770,123	$171,639,210

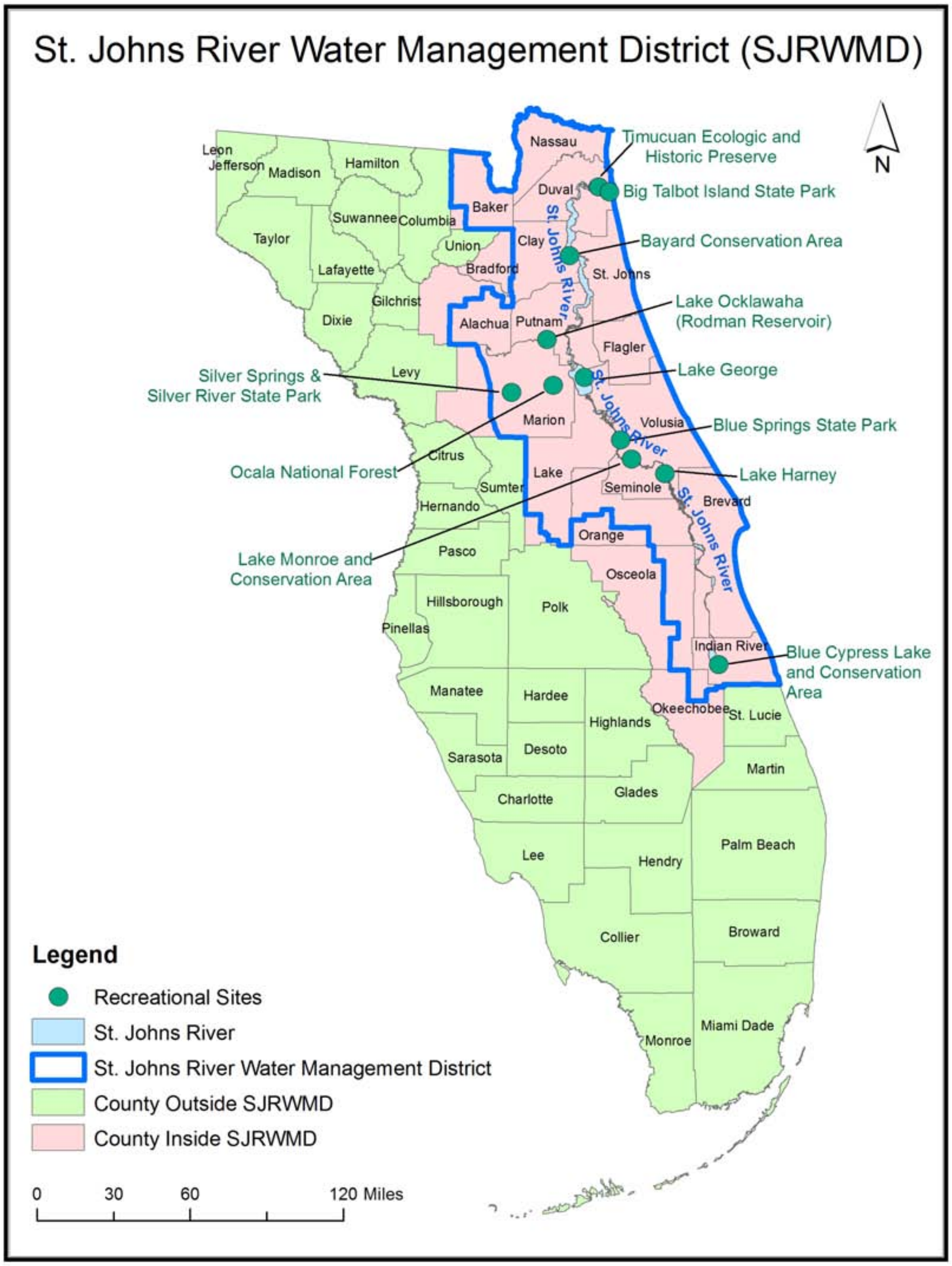

Figure 1. Locations of Major Recreation Sites in the SJRB
Source: St. Johns River Water Management District GIS data (SJWMD 2014c); Florida Division of Recreation and Parks (FDEP 2014b); St. Johns Rive Recreation Guide (McCarthy 2008).

	Fishing	Picnic	Diving / Swimming / Tubing	Kayak /canoeing	Motorized boating	Hunting	Camping	Wildlife /nature viewing	Hiking	Bicycling	Horseback riding	Geo tagging	Exhibition / tour
Lower SJR													
Timucuan Ecologic and Historic Preserve (including Ft. Caroline & Kingsley Plantation)				1				1					1
Big Talbot Island State Park	1	1		1	1			1		1			
Bayard Conservation Area	1					1	1	1		1	1		
Middle SJR													
Ocala National Forest	1	1			1	1	1	1	1	1	1		
Lake George	1				1	1	1	1	1				
Lake Ocklawaha (Rodman Reservoir)	1						1						
Silver Springs & Silver River	1	1	1	1			1	1	1	1	1	1	1
Blue Springs	1	1	1	1			1	1	1				1
Upper SJR													
Lake Monroe	1			1	1	1	1	1	1	1	1		
Lake Harney	1	1						1		1	1		
Blue Cypress Conservation Area	1			1	1	1	1	1	1	1			

Figure 2. Major recreation sites and opportunities identified by regional guidebooks
Sources: Florida Division of Recreation and Parks (FDEP 2014b; SJRWMD 2014b).