USING THE TRAVEL COST METHOD TO ESTIMATE FRESH-WATER BASED RECREATION IN NORTH CENTRAL FLORIDA

By

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To my niece Sadie

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This thesis examines recreational benefits provided by four spring sites located in North Central Florida using the travel cost method (TCM). The first part of the study estimates the travel demand for springs using data collected from on-site intercept surveys from four springs in North and Central Florida. The second part derives the consumer surplus (CS) that represents the benefits from visiting the springs. A sensitivity analysis of the calculated travel cost was conducted to examine the robustness of the estimated CS. Lastly, an ordered logit model is estimated to examine whether the environmental quality measures can explain an individual's perception on water clarity in the springs.

The results of the TCM estimation are consistent with previously published CS estimates and they are on the high end of published recreational value estimates. The CS of the four parks is valued at $144,497,642 with an average trip valued at $177.49 per person per trip, with a 95% confidence interval (CI) of $141.78 to $234.04. The sensitivity analysis of TCM yields higher projected CS values of the springs versus the standard one-third wage rate. The ordered logit regression also showed a correlation between an individuals’ clarity rating and the environmental quality measures using the

ordered logit regression estimation output shows there is a link. The individual perception of water clarity is negatively correlated with the concentration of nitrogen reported during the month in which the survey was conducted. Thus, restoration efforts to reduce nitrogen concentration in the spring would improve individual's perception on water clarity of the springs, and increase recreational demand for the spring sites.

The results imply that the individuals' place a substantial value on the springs in North Central Florida. TCM is one of the several ways to estimate the value of the springs. The results of this study will help inform decision-makers regarding policies to protect springs from further degradation. While the study provides estimates of the visitors's value placed on the springs, decision-makers will need to use the information to implement new policies at the state and county levels to preserve the springs for future generations.

CHAPTER 1
INTRODUCTION

Outdoor recreation has been an important part of the American culture for decades. According to National Survey on Recreation and the Environment (NSRE), data showed an increase of 7.5% from 208 million participants to over 224 million participants per year in general outdoor recreation between 2000 and 2009. Nature-based recreation[1] increased by 7.1% from 2000 to 2009 from 196 million participants to over 210 million participants.

Nature-based recreation provided approximately $2.8 billion annually to the State of Florida for the fiscal year 2016 (Friends of Florida State Parks, 2016). The Florida springs located in North Central Florida are part of a unique system within the riverine ecosystems attracting thousands of visitors worldwide.

The springs are under significant threats from urban expansion and population growth. Post-World War II Florida experienced tremendous economic growth leading to significant urban development. Due to this growth, groundwater pumping has increased. Over-pumping of groundwater, and real estate development has resulted in the disappearance of springs in South Florida according to an article by Pittman (2012). The adverse weather patterns further exacerbate the condition, as rainfall has not recharged the water tables due to drought since the 2000s.

To conserve the unique and fragile system of springs, the State of Florida has invested approximately $15 million since the 2000s to restore, protect and educate the

[1] Nature based recreation is defined as travelling with the purpose of enjoying natural attractions and engaging in a variety of outdoor activities. Examples consist of fishing, hiking, bird watching and kayaking.

public about the importance of these springs. Given the high investment level there is a need to estimate the value of these sites to assist with future policy development and implications (Florida Department of Environmental Protection, 2011).

This study is to provide an economic valuation to assist policymakers a guide to create a plan on preserving or restoring the spring systems across the state of Florida. Once an ecosystem has deteriorated beyond its restoration capabilities, the use of restoration techniques may not be able to revive it. The economic valuation can provide policymakers with information to conduct a cost-benefit analysis for future projects to prevent degradation of the springs and to improve spring sites to provide value-added service (i.e. tourism).

The purpose of this study is to estimate a value of freshwater-based recreation on spring sites. This study uses a non-market valuation technique, the travel cost method, to estimate the value of freshwater recreation on four spring site in North Central Florida.

To achieve the objectives, data collected from an on-site survey of four spring parks in North Central Florida were used. Three of the four sites are state parks, with one site being privately owned. The surveys were collected from May 2016 to August 2016 during the peak season for visitation to the springs. Additionally, secondary data on observed water quality information was collected from the Suwanee River Water Management District (SRWMD).

The results of the estimation were found to be in line with previous TCM publications and the calculated CS to be above the range of other studies. The CS per person per trip is valued at $177.49. Higher valuation may be due to the uniqueness of the springs to the region with pristine conditions. Then, a sensitivity analysis of the travel cost was conducted; varying the assumed opportunity cost of travel time with implicit wage rates. The sensitivity analysis shows the CS has a range of $198.38 to $218.59 per person per trip when using the wage fraction ratio of one-half and two-thirds.

Finally, an ordered logit estimation was performed to estimate the correlation between perceived water quality and environmental water quality measures. Since the perceived clarity was rated using a Likert scale from below average to above average, an ordered logit model can examine the relationship between water quality measures and specific perceived clarity rating. The ordered logit estimation shows that individual perception on water clarity to be above average has a negative correlation with the nitrogen concentration in the spring.

CHAPTER 2
LITERATURE REVIEW

The TCM is one of the revealed preference approaches to calculate the economic value of nature-based recreation. Using the opportunity cost of travel time as an implicit price for the trip, demand functions are estimated relating trip costs and trip frequency (Whitehead, Haab, & Huang, 2000). The TCM can be used to assess the value of a recreation site, which is the consumer surplus, measured by the area under the demand function and above the implicit price (Freeman, 1993). This section will discuss the theoretical background of recreation demand modeling and the basis of TCM. The basis for TCM is: as travel cost increases, individuals will make fewer trips to a site compared to those who reside near the recreation site. The combinations of both travel cost and trips made can be used to create a site-specific demand function.

An individual's utility function will depend on the number of trips made to a recreation site represented as *R* and a bundle of other goods, represented by *b*. The price for good *R* will be referred to the travel cost represented as tc_i; and the price for the bundled goods *b* is represented as tc_j. The *i's* represents the round-trip distance from the respondent's home to the recreation site *j*. The individual's budget constraint can be represented by:

$$Rtc_i + btc_j \leq I \tag{2-1}$$

Where I represents the income level of the individual. The individual will want to maximize their utility function represented by:

$$Max\ U(R, b)\ subject\ to\ Rtc_i + btc_j \leq I \tag{2-2}$$

The individual will choose the optimal bundle representing the highest possible level of utility given the income constraint. This will lead to the point of tangency between the indifference curve and budget constraint if there is an interior solution.

An interior solution or corner solution forms the basis of the Marshallian demand function for recreational demand with the following:

$$R = f(tc_i, tc_j, I, z) \qquad (2\text{-}3)$$

R represents the number of trips undertaken by the individual, tc_i represents the total travel cost as a function of trips, income I represents the household income, and *z* represents the vector of demographic variables impacting the frequency of trips. The function also includes access to other sites leading to tc_a which represents substitute sites visitors may visit instead of the original intended site. This model is referred to as a single site model to value the site (Parsons, 2003). Including the income, demographic variables, alternative sites and trip cost can improve estimation of the actual trip frequency in the demand function.

In theory, the demand function (2-3) should show a negative relationship between the quantities of trips and price, thus representing the travel cost. This implies individuals residing closer to the site will visit the site more frequently. Individuals living further away will incur higher travel costs leading to fewer visits.

Figure 2-1 illustrates equation (2-3) graphically where an individual with a travel cost of tc_i^o will take trips represented as R^o. *Region A* represents the CS for trips taken to the site. *Region B* is the total trip cost - the difference between *Region A* and *Region B* is defined as the individuals' positive recreational value for the site. If the original intended site for recreation is closed, *Region A* cannot be included in the CS estimation.

Estimating trips to the alternative site is similar to the estimation of travel cost for the study sites. The choke price (tc_i^{choke}) represents a cost where an individual's trip to the site will be zero for the model. The CS is represented by the following equation:

$$\Delta w = \int_{tc_R^o}^{tc_R^{choke}} f(tc_i, tc_j, I, z) \tag{2-4}$$

The next discussion will cover TCM estimation with an environmental quality measure to study the quality changes of each site. To reflect the differentiated level of demand due to the quality of the recreation site, TCM often includes at least one site quality variable. The site quality characteristic (e.g., pollution levels) works as a shifter of the demand curve; this causes the CS area to widen or shrink. However, the benefits of quality improvement have been shown to be hard to measure with the traditional TCM because of problems in identifying the change in recreational demands from the quality change (Whitehead et al., 2000). The recommendation is to pool data from all the recreation sites with different quality levels and estimate the effect of the quality variation on the number of trips taken (Smith & Desvousges, 1985).

There are two limitations associated with this approach. First, there may be little variations in the quality rating of each recreational site and the difference observed may only be marginal. For example, if two sites being studied use the same environmental measures, the environmental measures may have similar variances and means, leading to no differences in the study site.

Second, the TCM approach using environmental quality measures assumes an individuals' decision are influenced by a scientific collection of environmental measures (total nitrogen, dissolved oxygen, phosphorus and other environmental measures). The use of environmental quality measures may introduce unintended bias to the individual deciding on the site to visit. Similar to the first limitation, the individual's view of the environmental measures generally will not vary at the same recreational site, leading to the difficulty in valuing the environmental quality. The concurrent agreement on the specific quality level cannot be explained. At each of the recreation site, pollution levels may meet or exceed federal guidelines. Some visitors may not be able to determine the level of degradation from personal experience.

Previous studies have used chemical and physical measures to represent the environmental quality measures studying water quality (Whitehead et al., 2000; Jeon et al., 2005; Smith & Desvousges, 1986; Dumas et al., 2005). The chemical measures can include examining the concentration of such pollutants within the water source as total nitrogen, phosphorus, and metals (Cordy, 2001). In turn, the second aspect of environmental measures includes physical measures can include using a Secchi disk (measures the depth of clarity within the water), pH levels (characterizing the acidity) and turbidity (which measures the cloudiness based on particles in the water) (Cordy, 2001).

One question that continues to puzzle many non-market valuation researchers is whether the decision to visit a recreation site is based on the environmental quality measures or the individual's perception from previous experiences (Jeon et al., 2005). Phaneuf, Herriges, and Kling (2000) hypothesized a Kuhn-Tucker model to analyze the behaviors of anglers visiting the Great Lakes. Kuhn-Tucker model can track catch rates of several popular fish species, and the average toxin level observed. The researchers found that some toxin levels do impact a users' decision to visit the Great Lakes. Specifically, external factors (pollution levels) can influence a visitors' decision on which site to visit, since pollution level affects catch rate and visitors will repeat visits to a site where they are satisfied with the catch rate.

Egan et al. (2003) researched the demand of visitors recreating the 129 lakes in Iowa. They included 11 environmental quality measures (total nitrogen, phosphorus, chlorophyll *a*, dissolved oxygen, pH, Secchi disk, etc.), and included site characteristic (facilities, state parks, boating ramp, etc.). They showed that environmental quality measures do impact the decision which lake to recreate. However, Egan's study did not determine if there were any links between the environmental quality measures and individual perception. The perceptions were not investigated fully due to the prohibitive cost of conducting lengthy surveys (Egan et al. 2003).

Nevertheless, there is one study carried out by Adamowicz et al. (1997) that analyzed individuals' perceptions and physical attributes (objective measures). The study focused on moose hunting measures and used a discrete choice method. They showed that models using perception variables perform slightly better than models with physical attributes (access fees, environmental quality, etc.) related to the hunting sites. The study found models using the perception variable have lower CS estimates compared to the model using physical quality attributes. However, there are issues with the estimation when calculating the CS with using the perception variable. The weaknesses of the model are (1) determining the base level of users' experience visiting the site versus the base level set by a regulatory or management agency, and (2) measuring the recreation experience of users who are not in the sample of the study (Adamowicz et al., 1997). The individuals' perception level in estimating the CS will be different than when measuring the objective measures. With objective measures of improving a site quality, the difference between the current quality levels and improved levels will yield the change in CS. When estimating the perception gains of individuals', the same cannot be applied to individuals will have different base levels compared to the agency's set base level. Thus, the lack of difference in perceptions of the site quality makes it difficult to estimate the CS accurately.

Another study by Jeon et al. (2005) utilizes the recreation data for lakes in Iowa and the perception data from Egan et al. (2005). The study used a mixed logit model to determine if: (1) individuals care about the environmental measures and (2) if the perception regarding water quality at the lake influences individual household behavior. They showed that individuals could be influenced to visit a recreational site based on subjective view of the site. According to Jeon et al. (2005), "A high-quality (subjective) assessment does not necessarily imply that the lake is less contaminated." For example, four lakes in Iowa are listed as impaired by pollution, but received higher rating on their subjective assessments."

Another important issue in TCM is how to incorporate opportunity cost of lesiure time as a component of travel cost (Cesario & Knetsch, 1970). Some previous research has demonstrated the CS estimates of recreational demand models are affected by the cost of time (Bowker et al., 1996).

One assumption of the models for recreational demand is that individuals can freely adjust their hours worked. However, the work hours of the individuals are not flexible but fixed hours per week and this assumption are forced into the model estimation. The typical workweek of an individual consists of forty hours per week; thus, the fixed schedule is not likely to be optimal (Feather & Shaw, 1999). The total hours an individual will work per year is between 2000 to 2080 hours. Most travel cost estimation uses fixed work hours; however, literature does not provide for why this is so (Blaine et al., 2014; Egan et al., 2013; Parsons 2003). This unknown causes individuals to be modeled as under and over employed, leading to an inaccurate wage rate and estimation of the opportunity cost of time for recreation. However, the method introduced by Cesario (1976) uses the percentage of the wage rate for recreational demand, and the method is still being used to date because it has been proven to be consistent with many empirical publications. Additionally, the following articles recommend the use of the wage fraction rate to estimate the cost of time (Larson, 1993; McConnell, 1992; Parsons 2003), and conduct robustness checks using different levels of fractions.

This thesis contributes to the literature in the following ways. First, it examines the economic benefits provided by a unique freshwater system of springs in Florida. Secondly, the links between individuals' perception and environmental quality measures are examined to determine which variables are more likely to assess spring recreation accurately. Given the fact that many visitors have perceived the springs as a pristine natural system, it is essential to understand how perceived water quality is correlated with the environmental quality measures that can be monitored before and after conservation efforts. Lastly, a sensitivity analysis is conducted on the travel cost variable, which has not been previously conducted on spring recreation.

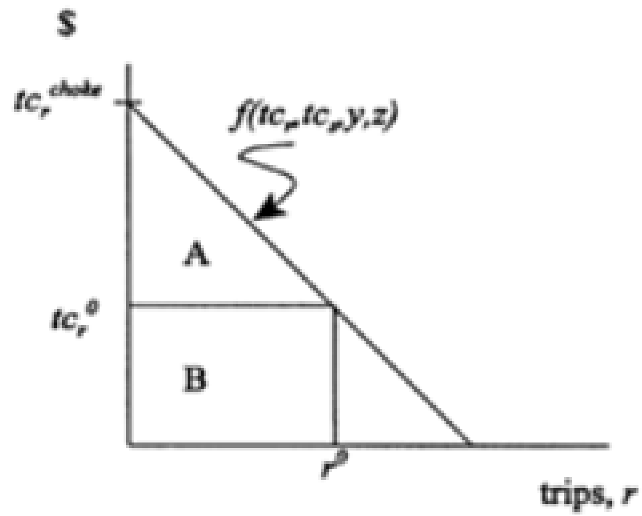

Figure 2-1. Illustration of a single-site model (Parsons, 2003)

CHAPTER 3
METHODS

TCM Estimation

The following illustrates the estimation of the TCM. Given the integer nature of the reported recreation frequency from data collection, the Poisson model can be applied to count data estimations, as the estimations are a discrete probability density function and non-negative. The Poisson function below will be used to estimate the count data (Parsons, 2003).

$$P(R) = \frac{\exp(-\lambda) \cdot \lambda^R}{R!} \quad , R = 0,1,2, \ldots , R \tag{3-1}$$

Where the parameter λ represents the value of the mean and variance of the random variable, *R* implies trip frequency, and all values must be positive for this function. When the mean and variance are not equal, there will be an error in the model; thus, correction steps are discussed below. λ will always be greater than zero leading to an exponential function:

$$\lambda = \exp(\rho_i \beta) \tag{3-2}$$

ρ_i represents the vector of variables influencing demand, and β represents the parameters used to estimate TCM.

The estimation of this single-site model results in the following equation:

$$R = \beta_{tc_r} tc_r + \beta_{tc_a} tc_a + \beta_y y + \beta_z z \tag{3-3}$$

The β coefficients are estimated for the single-site model where the number of trips is the dependent variable. The independent variables used to estimate the model are travel cost to the site, travel cost to an alternative site, income and some social demographic variable. This model uses similar variables discussed in the recreational demand function (1-3).

The parameters within this function can be estimated using maximum likelihood. The following equation is the likelihood function (Haab & McConnell, 2002):

$$L(\beta|\rho, R) = \prod_{i=1}^{T} \frac{\exp(-\exp(\rho_i\beta))\exp((\rho_i\beta)R_i)}{R_i!} \tag{3-4}$$

and the log-likelihood function is:

$$\ln\big(L(\beta|\rho, R)\big) = \sum_{i=1}^{T}\big[-e^{\rho_i\beta} + \rho_i\beta R_i - \ln(R_i!)\big] \tag{3-5}$$

These equations are concave using the listed parameters, where the maximum likelihood estimation (MLE) will converge. The conditional mean of the Poisson model is λ, using the following equation for expected trips:

$$E(R_i|\rho_i\beta) = \lambda = \exp(\rho_i\beta) \tag{3-6}$$

The following is the estimated model of the Poisson Model using the previously discussed parameters:

$$E(R_i|\rho_i) = \exp(\beta_{tc_r}tc_r + \beta_{tc_a}tc_a + \beta_y y + \beta_z z) \tag{3-7}$$

The beta coefficients $\beta_i's$ will be the coefficients estimated in the model.

The Poisson model does have limitations regarding (1) the dependent variable’s conditional mean and variance are equal because of restrictions in the estimation parameters, the variance does not deviate from the mean, and (2) when the variance is more significant than the mean, overdispersion is present in the data. Cameron and Trivedi (1998) suggest that the Poisson regression model is usually too restrictive for count data and the presence of overdispersion may be a result of the failure of an assumption of independence of events which is implicit in the Poisson process. This is due to an unobserved heterogeneity, generated by the process; the rate parameter is unavailable to be specified (random variable).

The remedial process for overdispersion count-data involves relaxing the conditional mean and variance constraint, using the negative binomial model (NB). An additional parameter is added to the model for controlling overdispersion. The reduction in overdispersion will also result in a narrower confidence interval versus the Poisson regression. The NB utilizes the same conditional mean from the Poisson model. There are several versions of NB, but for this study, the following will be adapted using the conditional mean of the Poisson model and the unobserved error:

$$\log(E(R_i)) = \rho_i\beta + \theta_i \tag{3-8}$$

θ_i, represents the unobserved heterogeneity. The equation from (3-8) will provide the random variation needed across all observation.

By substituting the equation from the right-hand side of the equation into the probability for the Poisson model, the number of trips based on the condition of θ_i is:

$$\Pr(R_i|\theta_i) = \frac{\exp(-\exp(\rho_i\beta+\theta_i))\exp(\rho_i\beta+\theta_i)}{R_i!} \tag{3-9}$$

When $exp(\theta_i) = v_i$ is the gamma normalized distribution, with $E(v_i) = 1$, the density for v_i is defined as $h(v) = \frac{\alpha^\alpha}{\Gamma(\alpha)}\exp(-\alpha v)v^{\alpha-1}$. This is the unconditional probability function for trips, R_i, by the process of integration of v gives the following:

$$\Pr(\mathrm{R_i}) = \frac{\Gamma(\mathrm{R_i}+\frac{1}{\alpha})}{\Gamma(\mathrm{R_i}+1)\Gamma(\frac{1}{\alpha})}\left(\frac{\frac{1}{\alpha}}{\frac{1}{\alpha}+\lambda}\right)^{\frac{1}{\alpha}}\left(\frac{\lambda}{\frac{1}{\alpha}+\lambda}\right)^{\mathrm{R_i}} \tag{3-10}$$

$\Gamma(.)$ denotes the gamma integral, the basis to a factorial for an integer argument. The parameter α represents overdispersion in the model. Special cases of the NB include the Poisson when $\alpha = 0$, which implies there are no occurrences of over dispersion, thus, reducing the equation to the Poisson model. When $\alpha > 0$, there is an indication of overdispersion and $\alpha < 0$ represents underdispersion.

The values of an NB must be non-negative similar with the Poisson model stated above for the equation to hold. The correction process will reduce, but do not eliminate issues relating to overdispersion. The estimation process of NB model is similar to the process of the Poisson model when using the equation from (3-7) and interpretations of the coefficients.

In addition to the issue of overdispersion, when conducting an on-site data collection, endogenous stratification can occur leading to frequent users of the site being oversampled, resulting in the bias of the β estimates (Shaw, 1988). The method for correcting this occurrence is by removing one trip count, *R-1* from the actual reported trips.

The estimated travel cost coefficient from the Poisson and NB models can be used to calculate the CS of recreational users traveling to the spring parks. The following equation is to calculate the CS for per household visit to the spring site:

$$\widehat{CS} = \frac{1}{-\hat{\beta}_{tc_i}} \tag{3-11}$$

$$\widehat{CS} = \frac{1}{-\widehat{\ln(\beta_{tc_i})}} * mean\ of\ travel\ cost \tag{3-12}$$

$\widehat{CS}$ represents the total CS for the site, and $\hat{\beta}_{tc_i}$ is the coefficient for travel cost. Equation (3-11) is used when travel cost variable is linear in the TCM and equation (3-12) should be used when travel cost variable is in natural log in the TCM. For this study, the estimated CS will be divided by the number of adults within the group during the visit. The second equation represents the calculation for CS when the variable is a natural log of the travel cost. The mean of the travel cost is multiplied by the coefficient. To calculate the total CS of the spring park, the following equation can be used:

$$TCS = \widehat{CS} \cdot CurrentTrips \tag{3-13}$$

TCS represents the total CS of the site and is calculated by multiplying the $\widehat{CS}$ estimates by the annually reported number of visitors' trips to each spring park. Figure 3-1 represents the demand function of an individual's demand with CS, travel cost of TCM, and average trips per season graphically. Lastly, when calculating the CS, the confidence intervals can be shown

$$TCS = \widehat{CS} \cdot CurrentTrips \tag{3-14}$$

Figure 3-2 represents the demand function of an individual's demand with CS, travel cost of TCM, and average trips per season graphically.

Lastly, the CI (confidence interval) of the travel cost estimated using a bootstrap simulated 5,000 times to obtain the bias-corrected CI (Cameron & Trivedi, 2010) will be provided next to estimated value of CS for each spring site.

One issue impacting the travel cost analysis is the use of different accounting approaches for the cost of operating a vehicle. Most papers suggest the use of the IRS's mileage rate for operating a vehicle (IRS, 2016); however, according to the American Automobile Association (AAA), there is a range of costs for operating a vehicle (AAA, 2016). For example, a small sedan has an average operating cost of 43.9 cents per mile based on 15,000 miles driven per year, and a sports utility vehicle (SUV) has a cost of 68.4 cents per mile using the same miles driven per year. Due to constraints of the on-site questionnaire, the actual costs were not captured to estimate the CS accurately. A skewed CS may result in an underestimation of the actual cost and benefit analysis.

Empirical Models

This portion of the thesis will discuss the empirical models that use the collected data to estimate the TCM while maintaining the integrity of the objectives discussed above.

R_i^{CT} represents the trip frequency of the on-site intercept including the previous twelve-month visit frequency, and is the dependent variable. The reported number of trips was also corrected for endogenous stratification using the mentioned (R-1) method.

$$R_i^{CT} = EXP(\beta_0 + \beta_1 \ln(Travelcost_i) + \beta_2 Income_i + \beta_3 Clarity_i + \beta_4 Facilities_i + \beta_5 Greenspace_i) \qquad (3\text{-}15)$$

Equation (3-15) are estimated with three variations of variables. The first model uses the original discrete rating of variables for perceived water clarity, condition of facility, and condition of greenspace; the second consist uses dummy variables of these perceived site characteristic in lieu of the discrete rating variables; and the third model adds the environmental quality measures in lieu of the perception dummy variable.

The first variable, *ln travel cost,* is the natural log of the travel cost variable. Due to the estimated cost being skewed above the mean travel cost, the use of natural log form of the travel cost to reduce the skewness. The travel cost is estimated by using the following equation:

$$Travelcost_i = cd_{ij} + \gamma\left(\frac{w_i}{2000}\right) \qquad (3\text{-}16)$$

c represents the average cost of operating a motor vehicle traveling to the recreation site. This cost variable was chosen from the American Automobile Association (AAA) cost of operating a vehicle at 58 cents per mile based on a yearly mileage rate of 15,000 miles (AAA, 2016). The variable, d_{ij}, is the round-trip distance from respondent *i's* home to the recreation site, *j*. The total distance is estimated by the respondent's home zip code to the recreation site using a Google Maps application program interface (API) in *R*. The wage fraction rate is represented by γ, with the standard rate of one-third of the annual income (Cesario, 1976; Englin & Shonkwiler, 1995; Parsons, 2003). The wage per year is represented by the response to household income from the on-site questionnaire. The denominator portion of the equation is divided by the total hours worked per year and varies between 2000 to 2080 per year (Blaine et al., 2014; Parsons, 2003; Bin et al., 2005). For this calculation, 2000 hours per year was used, factoring in two weeks of vacation time annually.

The variable *Income* is the household income reported by the respondent on the questionnaire. The household income reported consisted of seven categories, and was reduced to three: 1) lower income ($35,000 and below), 2) middle income ($35,000 to $89,999), and 3) high income ($90,000 or higher). The study expects that the effect of this variable on the number of trips to be non-linear and converted into a dummy variable. A low-income respondent may be able to visit the springs more often as the opportunity cost of time to work can be easily substituted. The opposite is observed, for a high-income respondent who can easily afford to visit the springs. As a result of the entrance fee being affordable, the reference group will be high-income respondents. For respondents who did not disclose their household income during the on-site survey, their income was determined by the median reported household income from their home zip code.

The characteristic site question asked respondents to rate the respective spring site's features. There were three categories: 1) clarity of the water, 2) on-site facilities, and 3) surrounding greenspace area. The rating scale consists of one (1) representing below average to five (5) being above average. The site characteristic variables were estimated with several approaches to determine the robust choice. The average ratings overall for the site characteristic was around 4.37 or higher. As a discrete variable, it was transformed into categorical to determine the effects of the rating. The three categories consist of: below average, average and above average. If the rating of the characteristic was three or less it was classified as below average, a rating of four received an average rating, and five received an above average.

A summary statistics of the site characteristic variable showed more than 50% of the rating clustering around average and above average rating. Site characteristics can be changed into a dummy variable due to the clustering near the upper range of the variable to conserve the degrees of freedom. The dummy variables of the perceived site characteristic are coded as one (1) if the rating of the site received a rating of four (4) or five (5), a rating of three and below is coded as zero (0). The numbers four (4) and five (5) were used as the dummy coding because one (1) is the average response rate for the site characteristics which had a range of 4.37 to 4.71. Also, the study estimated ratings in discrete form. Thus, the results do not statistically differ from using the dummy variables for the site characteristics. The results were not ideal and the original ratings from the survey was used.

The environmental quality measures in the model are *nitrogen monthly* measured during the seasons (May through August), and *Secchi disk* reading reported from each spring park. The SRWMD reports These measures. The nitrogen variables are measured in mg/L of water collected. The variable, *nitrogen monthly*, is the actual reading of total nitrogen during the survey intercept and collected remotely from each spring. The variable, *Secchi disk*, represents the amount of light penetrating the water body, with the higher recorded depth implying a significant amount of water clarity.

The next model will be used to conduct a sensitivity analysis of TCM by adjusting the fraction of the wage rate. The model is like Equation 3-15 with only the natural log of the travel cost variable adjusted to two levels of a fraction of the wage rate. The two-wage rates level being used are one-half and two-third examining the range of the recreational value of CS.

The last model will be used to examine the individuals' perception link with an environmental quality measure variable. The ordered logistic model is used to determine if there is a correlation between perception and environmental quality measure. The following regression model for estimation is:

$$\ln\left(\frac{P(clarity=average)}{P(clarity=above)}\right) = \beta_0 + \beta_1(Income) + \beta_2(Currenttrips) + \beta_3(Nitrogenm) + \beta_4(Water) + \beta_5(Firstvisit) + \beta_6(Alternativesites) \quad (3\text{-}17)$$

The dependent variable, *clarity,* represents the site perception portion of the questionnaire. As stated above, the variables are kept as discrete rating for regression purpose. The independent variables used for the model consist of an environmental quality measure of *nitrogen monthly*, *current trips*, *first visits* (first ever trip), *alternative* *sites*, *swimming* and the social demographic variable, *income*. The variable, *current trips,* represent the total visits made to the spring site in the past twelve months. The following variable, *first visit,* equals 1 if respondents made their first ever trip to the spring site, and *alternative sites* consist of nearby sites a respondent would visit in the case of closure or congestion. The variable, *first visit*, could have an impact on perception as users will have a different level of experience with nature-based recreation. The variable, *swimming,* represents activities participated at the spring site involving interaction within the water and are listed as dummy variables with one (1) implying the activity is present and zero (0) implying the activity is not. Swimming activities consist of interaction with the water like swimming and tubing.

There are two hypotheses for this thesis using the TCM valuation. The first null hypothesis assumes the TCM variable in the model will follow a similar pattern with previously estimated TCM applications (Blaine et al., 2014; Parsons, 2003; Bin et al., 2005). The independent variables, *ln travel cost,* should be statistically significant and have a negative coefficient. The second null hypothesis assumes there is a negative link between the perceived clarity rating and environmental quality measures. There is no literature to support this hypothesis as previous attempts have been difficult to prove. The intuition supporting the second null hypothesis is that as nitrogen levels decrease, the perceived clarity rating of each spring site should increase. The level of nitrogen measured can only fall to a certain threshold (not equal to zero) because there is a need for some level of nitrogen to sustain aquatic life in the spring ecosystem.

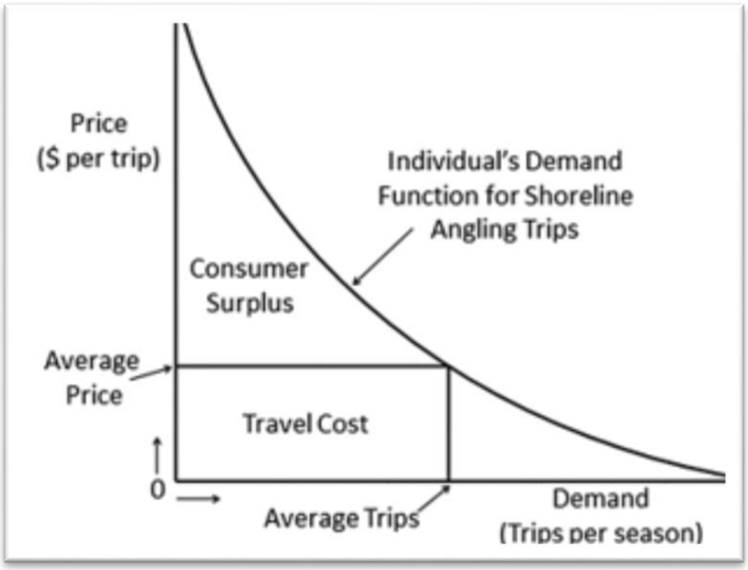

Figure 3-1. A graphical illustration of the recreational demand function showing consumer surplus and travel costs (Sohngen et al., 1999)

CHAPTER 4
RESULTS

Survey Results

A total of 494 surveys were collected from the four spring parks from May 2016 to August 2016. This period is considered peak recreation season. The survey team randomized data collection between weekdays and weekends (three weekdays and four weekend days). Table 4-1 shows each spring site and the total amount of surveys collected on-site. Blue Springs in Madison County had fewer responses as a result of the park’s closure during Hurricane Hermine. The data was cleaned by removing any discrepancies such as zip code errors, invalid responses and questions left blank. The final sample size was 468 respondents. Table 4-2 represents the total number of observation left after cleaning the data. Table 4-3 shows the summary statistics of some of the responses that are used in this study and table 4-4 are the variables defined.

Visitation Characteristics

Among the respondents from the on-site survey, 300 out of 468 respondents (64.1%) indicated the trip was a single-purpose day trip. The response rate collected on the weekend showed 333 out of 468 respondents (71.1%) versus 28.8% of visits on the weekday. Out of the 468 respondents, 82 respondents (17.5%) stayed overnight, with an average of 3.2 nights at the parks’ on-site camping area. A total of 419 out of 468 respondents (89.5%) chose the springs and its surrounding area as the primary reason for the trip. The average group size to the spring site was five (5), consisting of three (3) adults and two (2) children.

Expenditure

The mean expenditure reported when visiting the springs was $113.52 per group, and the mean expenditure per adult was $37.84. Note: each respondent's expenditure was divided by the number of adults reported for the group. The mean was taken from this calculation.

Spring Activities

At the four spring parks, when asked about the recreational activities, the top responses were swimming (63.8%), tubing (30.5%), and picnicking (26.7%). The other mentioned activities were nature viewing (9.6%), hiking (8.5%) and kayaking (4%). Table 4-5 summarizes the recreational activities during a typical spring site visit.

Trip Frequencies

Two hundred and ninety-four (294) out of 468 respondents (62.8%) stated they had visited the springs before the recorded day's visit. These respondents made an average of four trips to the spring parks in the past twelve months including the recorded date (day of questionnaire interception). When the respondents were asked on future expected visits to the springs, the responses averaged fourteen trips to the spring parks in the next twelve months.

Travel Distance

The travel distances reported by the respondents based on respondents' reported zip codes had an average of 123.29 miles, with a standard deviation of 293.83 miles. Table 4-6 shows the breakdown of each site's travel distance summary statistics. When calculating the travel distance, locals (defined by zip code) who visited the springs were assumed to live within five miles with a travel time of approximately ten minutes. Given the significant variation in distance traveled, approximately 227 out of 468 respondents (48.5%) drove more than fifty miles to the respective spring site.

When the respondents were asked if the original intended site became unavailable, would they visit a nearby similar site, 365 out of 468 respondents (78%) stated “yes.” Using the same home zip code provided, but calculated in relationship to the alternative site, the average distance calculation was 40.07 miles with a standard deviation of 59.33 miles.

Respondents’ Site Perception Ratings

Figure 4-1 summarizes the average rating respondents provided with regards to the perception of water quality, conditions of facilities and conditions of the green space around the springs. Ratings were based on a scale of one (1) to five (5), where one (1) is below average, and five (5) is above average. The average response rating was clustered between four and five for water clarity, facilities and green space.

Table 4-7 represents the summarized visitors’ level of agreement with the following statements, where (1) strongly disagrees, and (5) strongly agrees. The questions covered are: 1) If the water in the spring has become clearer; 2) wildlife in the water has increased; 3) wildlife in the surrounding green space has increased; 4) water flow in the spring has increased; and 5) water level in the spring has increased. Respondents only answered the next question if they had visited the springs before. Table 4-7 represents the summarized “visitors’’- the level of agreement to the following statements, where (1) strongly disagrees, and (5) strongly agrees. The responses for this category received an average response rating of neutral for the level of agreements.

Park Pass and Access Fee

Three hundred forty-three (343) out of 468 respondents (73.2%) reported to not have an annual park pass for the state of Florida. 63.4% of respondents stated fewer trips would be made to the spring site if access fees increased. About thirty-four percent (34%) respondents reported their trips to the spring parks would remain unchanged if the access fee increased.

Demographics

Table 4-8 summarizes the demographics of respondents versus the population of Florida based on census data. The respondents in the sample had a similar age and gender composition as the general population but were more likely to be college educated with higher household income levels then what was described by the census data. Figure 4-2 shows the distribution of the education level, and Figure 4-3 shows the employment status of respondents.

Estimation Results

The summary statistics from the on-site survey showed overdispersion is present in the independent variables. Due to overdispersion, the negative binomial model is used instead of the Poisson model. Furthermore, a simple ratio of the mean to variance is 552. Table 4-3 implies it would not correctly converge using the Poisson model. A concern with the count data model is an excessive number of zeros present in the data for current trips; however, this is not an issue due to the survey being on-site. The second concern is the on-site survey may result in endogenous stratification where frequent visitors may have been intercepted on the site, which has also corrected. Robust standard errors were used due to outliers skewing the data. Also, some observations were removed due to incorrect zip codes, respondents who came with large groups, those of 30 individuals or more, and one respondent lived outside the U.S.

The travel cost estimation using the Equation 3-19 resulted in a mean travel cost of $203.40 per household per trip. This estimation will be used in conjunction with the estimated beta coefficient from the regression output to estimate the CS for the spring site.

The empirical Equation 3-15 was estimated into three different equations. Model 1 uses the original Equation 3-15, which shows the variable *ln travel cost* and *clarity* as statistically significant. Model 2 use Equation 3-15 but with the dummy variable of the perceived site characteristics, which shows that *ln travel cost* and *clarity* as statistically significant. The dummy variable, *clarity,* is negative indicating springs with above average water quality received fewer visitations on average than springs with water quality rated less than average after controlling for travel costs and other factors influencing trip frequency. It is likely that respondents may be more familiar with springs with average water quality and visit them more often. The dummy variables for facilities and greenspace are not statistically significant and having above average facilities and greenspace do not statistically increase trip frequency.

Model 3 uses Equation 3-15 and adds the environmental quality measure variable *nitrogen monthly,* which is not statistically significant, but the variables, *ln travel cost* and *clarity* are still statistically significant. The environmental quality measures variables are not statistically significant for Model 3. The variable *nitrogen monthly,* (level of nitrogen present during the survey month), and *secchi disk* are not correlated with the number of trips. This is expected, since respondents do not observe physical water quality measures directly. Instead they form their own perception on water quality based on visual cues, and their perceived water quality is correlated with the trip frequency, as shown in Model 1 and 2.

Model 1 in Table 4-9 is chosen to calculate the CS due to lower Akaike information criterion (AIC). Additionally, multiple variations of the TCM model were estimated and are listed in Appendix B and they all have higher AIC than Model 1 thus are not used to calculate the CS. The following discussion will cover Model 1 which is used to estimate the model about the study.

Results of Model 1 indicate the beta coefficient for *ln travel cost* is negative and is statistically significant at $p < 0.01$, showing the quantities of trips demanded will decrease as travel cost increases. This results in a downward demand function slope. The results are consistent with the suggested literature showing downward demand and negative slope (Blaine et al., 2014; Parsons, 2003; Shrestha, Stein & Clark, 2006).

The beta coefficient for $Income_i$ in the model is not statistically significant. The variable may have an impact on visitor's trip to the site, but after controlling for travel costs and other factors influencing trip frequency, it is not statistically significant. Previous studies on the effect of income yield little results explaining the estimation of TCM (Loomis & Ng, 2010; Nicholson & Snyder, 2012), but a study by Phaneuf & Smith (2005) makes the case for including income in the model as an important requirement.

Results of Model 1 shows that the beta coefficients for $clarity_i$, $Facilities_i$, and $Greenspace_i$ represent the perceived rating of the site characteristics, while the only statistically significant variable is *clarity* at $p < 0.01$ level. Table 4-10 shows the estimated non-market value of nature-based visits to the springs in North Central

Florida using Model 1 in Table 4-9. Using the coefficient for ln travel cost from Table 4-9 and Equation 3-12 to calculate the CS estimate, the following results are derived. The values show a mean CS estimate of $177.49 per person per trip with a 95% confidence interval (CI) of $141.78 - $234.04 (the total CS per person per trip was divided by the number of adults per group).

According to Shrestha and Loomis (2003), who conducted a meta-analysis study of recreation sites across thirty years, the national average CS is estimated to be $47.10 (adjustment for inflation $62.81) per day trip visiting state parks. Comparing the estimated CS to other recreational activities in the state based on previous TCM application, the estimates are relatively high. For example, similar recreational activities in the Apalachicola River region have a value of $74.18 (adjustment for inflation $87.21) per trip (Shrestha et al., 2007) and Oklawaha River visit is $9.07 (adjustment for inflation $14.57) per trip (Stratis & Bendle, 1995). Environmental sites untouched by development will tend to be highly valued and considered pristine (Shrestha et al., 2007). The spring parks can be considered a natural location for recreation with no development nearby and (perceived) low pollution.

The mean CS estimates from the survey conducted at the spring parks can be used to estimate the total economic value of the resource. Each spring park has a reported annual attendance rate reported in Table 4-11 for 2016. The total economic value of outdoor recreation visiting the springs in North Central Florida is $144.49 million with a 95% CI of $115.61 to $190.83 million. The survey had an equal response from each site, but Ichetucknee Springs State Park and Fanning Springs State Park had higher visitation rates.

The second part of the assessment is to conduct a sensitivity analysis of the different levels of the wage fraction rate. The standard wage rate used in the travel cost estimate is one-third based on literature (Cesario, 1976; Englin & Shonkwiler, 1995; Parsons, 2003). According to Feather and Shaw (1999), "The decision to participate in recreational activities is likely to be as heavily influenced by time constraints as by money constraints." An employed individual may have fixed work hours of 40 hours a week or 2000 hours per year, or some flexibility in hours. An issue with the actual one-third wage rate may be the rate does not apply to respondents from the on-site questionnaire. More than sixty percent of the respondent stated they were employed full-time implying a job with fixed work hours. Also, most of the trips were completed on the weekend when those fully employed individuals may not be giving up opportunity cost of time for work in place of leisure time.

A sensitivity analysis of the different levels of the wage fraction rate using Equation 3-15 will be analyzed further. There are three versions of this equation. The first version has already been estimated using the standard one-third wage fraction level. The second and third version uses one-half and two-thirds of the wage fraction level. The estimated CS of recreational value of various wage fraction levels can be seen in Table 4-12. The estimated total recreational value of the spring parks using one-half and two-thirds of the wage fraction rate are \$161,758,906 and \$178,242,175. The wage rates used are all statistically significant at $p < 0.01$. The coefficients estimated are only slightly different from the standard one-third wage fraction rate. However, the calculated recreational value of the springs is much higher than the original one-third wage rate.

The last part of the assessment is to determine what factors determine the respondent's perceived water clarity with environmental quality measures using the ordered logistic regression model. Following Equation 3-20, Model 1 is used to estimate with the dependent variable of *Clarity* and its corresponding independent variables.

The estimated coefficients of the independent variables are summarized Table 4-13. The variable, *first visit,* is significant at $p \leq 0.10$, with a log coefficient of .520 indicating *first visit* is positively correlated with the respondent's perceived rating of clarity for the spring. The second variable, *Swimming*, which implies respondents who have participated in water-related activities only, is also positively correlated with the perception of water quality. This variable is significant at $p \leq 0.10$ with a positive log coefficient of .419. The environmental quality measure of *nitrogen monthly* is significant at $p \leq 0.01$ with a negative log coefficient of -0.206 which implies that as the level of nitrogen in the water decreases, the perceived clarity rating should increase. Since perceived water quality is positively correlated with the trip frequency, as shown in table 4-9, reducing nitrogen level in the water would be likely to increase the perceived clarity rating, which can translate into an increased demand for visits to the spring site.

None of the marginal effects evaluated at the sample mean are statistically significant at $p \leq 0.05$, with one exception (Table4 4-13, Column 2). The marginal effect of nitrogen monthly is statistically significant at $p \leq 0.05$ showing that a one-unit change in nitrogen level is associated with a 0.31 % increase in the perceived clarity rating. These marginal effects are estimated at the sample mean across all categories of clarity ratings thus are less informative.

Table 4-14 further separates the marginal effects by clarity rating. *Nitrogen monthly* has a positive marginal effect on the perceived clarity rating of below average to above average. The marginal effect becomes negative for predicting the probability of above average water clarity, indicating as nitrogen level increases, the probability of the perceived water clarity being above average will reduce. A one-unit increase in the nitrogen level will result in a decrease in the probability by 3.54% of clarity rating of above average and is highly statistically significant at $p<0.01$. The marginal effect for the variable *swimming* is negative when the perceived water clarity is less than above average. It also indicates the activity does have an impact on increasing the probability of the perceived water clarity being rated above average by 7.22% and statistically significant at $p<0.10$. This also implies swimmers tend to rate water clarity higher. The similar effect is seen for the variable *first visit* and the probability of an above average perceived water clarity increases by 8.94% and statistically significant at $p<0.10$. The statistical significance of the variable *swimming* and *first visit* show the impact on the perceived clarity rating is marginal compared to *Nitrogen monthly.*

Table 4-15 shows the estimated output of *nitrogen monthly* as it increases by an increment of one mg/L; the probability of an above average perceived water clarity rating is shown. As the level increase from 2 mg/L of *nitrogen monthly* measured to 8 mg/L, the predicted probabilities show a decrease in the probability of an above average perceived clarity ranging from 79.2% to 52.6%. For example, using the average level of *nitrogen monthly* across the four springs (2.25 mg/L) the probability of the springs receiving an above average rating is 78.3%. If the level of *nitrogen monthly* were to increase by 1 mg/L from the average level, the probability would decrease to 74.7%.

The prediction probabilities are statistically significant at $p \leq 0.01$. Figure 4-4 shows the graphical illustration of the predicted probabilities of above average perceived clarity rating based on the incremental increase level of *nitrogen monthly* in mg/L.

In sum, the null hypotheses statements cannot be rejected based on the estimation results. The travel cost estimation is statistically significant with a negative coefficient. Additionally, there is a negative correlation between the perceived clarity rating and environmental water quality measures.

Table 4-1. Showing the total number of observations collected

Spring Site	N	Weekday	Weekend
Blue Springs	131	42	89
Fanning Springs State Park	127	40	87
Ichetucknee Springs State Park	126	38	88
Madison Blue Springs	110	19	91
Total	494	139	355

Table 4-2. After cleaning the data, the total number of observations remaining

Spring Site	N	Weekday	Weekend
Blue Springs	119	34	85
Fanning Springs State Park	124	42	82
Ichetucknee Springs State Park	125	38	87
Madison Blue Springs	100	21	79
Total	468	135	333

Table 4-3. Summary statistics of variables from the survey

VARIABLES	N	mean	sd	min	max
Cost (1/3 wage rate)	468	203.4	335.7	6.300	3,248
Cost (1/2 wage rate)	468	227.2	373.2	6.550	3,564
Cost (2/3 wage rate)	468	250.9	410.9	6.800	3,880
Ln Cost (1/3 wage rate)	468	4.662	1.15	1.840	8.085
Ln Cost (1/2 wage rate)	468	4.772	1.15	1.879	8.178
Ln Cost (2/3 wage rate)	468	4.871	1.15	1.916	8.263
Adults	459	3.510	2.503	1	17
Children	456	2.140	2.428	0	15
Expenditure	468	113.5	245.8	0	4,000
Swimming	468	0.709	0.455	0	1
Tubing	468	0.306	0.461	0	1
First visit	468	0.372	0.484	0	1
Current trips	468	4.002	9.915	1	100
Age	468	40.92	14.51	18	86
Household	467	2.176	0.888	1	8
Alternative visit	468	0.780	0.415	0	1
Secchi Disk	468	3.250	1.302	2.440	5.736
Nitrogen Monthly	468	2.247	1.633	0.645	4.863
Currents trips (corrected)	468	3.748	5.220	0	21
Clarity	468	4.680	0.692	1	5
Facilities	468	4.373	0.922	1	5
Greenspace	468	4.710	0.630	1	5
Household income	468	2.072	0.879	1	3
Male	468	0.449	0.498	0	1
College Educated	468	0.549	0.498	0	1

Table 4-4. List of variables defined

Variable	Definition
Cost	Travel cost using different wage fraction levels (1/3,1/2,2/3 of wage rate) in dollars
Ln travel cost	Log of travel cost using different wage fraction levels (1/3, 1/2, 2/3)
Adults	Number of adults visiting the spring parks over the age of 18
Children	Number of children
Expenditure	Reported trip expense from respondents
Swimming	Activity performed at the springs
Tubing	Activity performed at the springs
First Visit	1 = yes 0 = no
Current Trips	Dependent variable; number of visits in the past twelve months including today
Alternative visits	If sites are unavailable, a nearby site will be used 1= yes 0=no
Secchi disk	A device used to measure water clarity assessing the amount of light to water depth (ft.)
Nitrogen Monthly	The amount of total monthly nitrogen in water (mg/L)
Current trips1 (corrected)	Correction for endogenous stratification due to on-site questionnaire
Clarity	Rating of water clarity on a scale of 1 to 5; 1 is below average to 5 for above average
Facilities	Ratings of facilities offered on-site on a scale of 1 to 5; 1 is below average to 5 for above average
Greenspace	Ratings of the surrounding green space on a scale of 1 to 5; 1 is below average to 5 for above average
Male	1 =male 0=female
Household Income	Household income level (in thousand US dollars)
College Educated	1= college educated or higher 0 = less than college

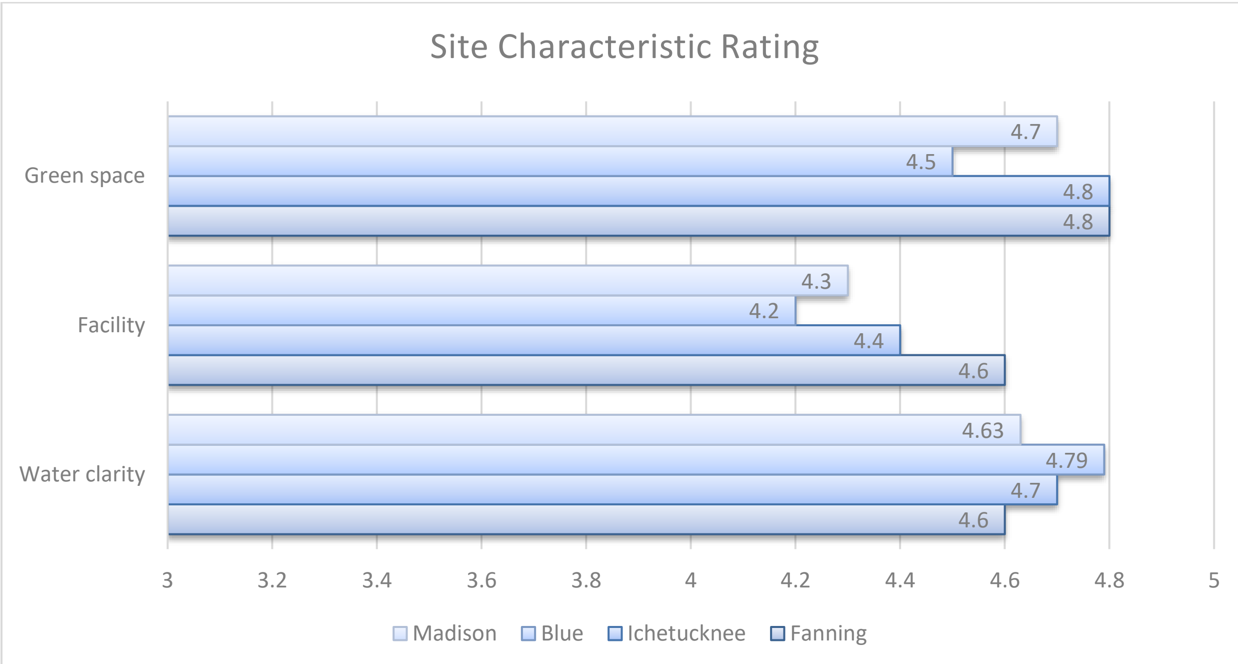

Figure 4-1. The rating of site characteristics with one for below average to five with above average

Table 4-5. Distribution of recreational activities of respondents visiting the spring parks in North-Central Florida State Parks (N=468)

Activity	Observation	Standard Deviation
Swimming	332	0.45
Tubing	143	0.46
Picnicking	125	0.44
Nature viewing	45	0.29
Hiking	40	0.28
Kayaking	30	0.24
Other	16	0.18
Camping	12	0.16
Scuba/Cave diving	7	0.12
Motorized boating	4	0.09

Table 4-6. Calculated driving distances to four North-Central Florida spring parks

Springs	Number of observations	Mean	Std. Dev.	Min.	Max.
Fanning Springs	119	113.39	269.52	5	2434.91
Ichetucknee Springs	120	104.77	243.21	5	2419.76
Blue Springs (High Springs)	118	148.23	290.33	5	1853.16
Blue Springs (Madison County)	109	127.48	366.96	5	3711.82
Total	466	123.29	293.83	5	3711.82

Table 4-7. Average level of rating on statements about the four spring parks on a scale of one to five.

	Fanning	Ichetucknee	Blue (Gilchrist)	Blue (Madison)
The water in the spring has become clearer	3.3	3.6	3.7	3.5
Wildlife in the water has increased	3.1	3.5	3.0	3.0
Wildlife in the surrounding green space has increased	3.3	3.5	3.0	3.1
Water flow in the spring has increased	3.1	3.7	3.2	3.2
Water level in the spring has increased	2.8	3.5	2.7	3.1

Table 4-8. Demographics of questionnaire respondents versus Florida population

Demographics	Survey Respondents	Florida Census
Gender		
Female	55%	51.5%
Male	45%	48.5%
Household income (median)	$60,000	$47,212
Education		
High school graduate or higher degree	95%	86.5%
Bachelor's degree or higher	54%	26.8%
Household size	2.2	2.62
Percent in labor force (full-time)	59%	59.2%
Age (mean)	41	40

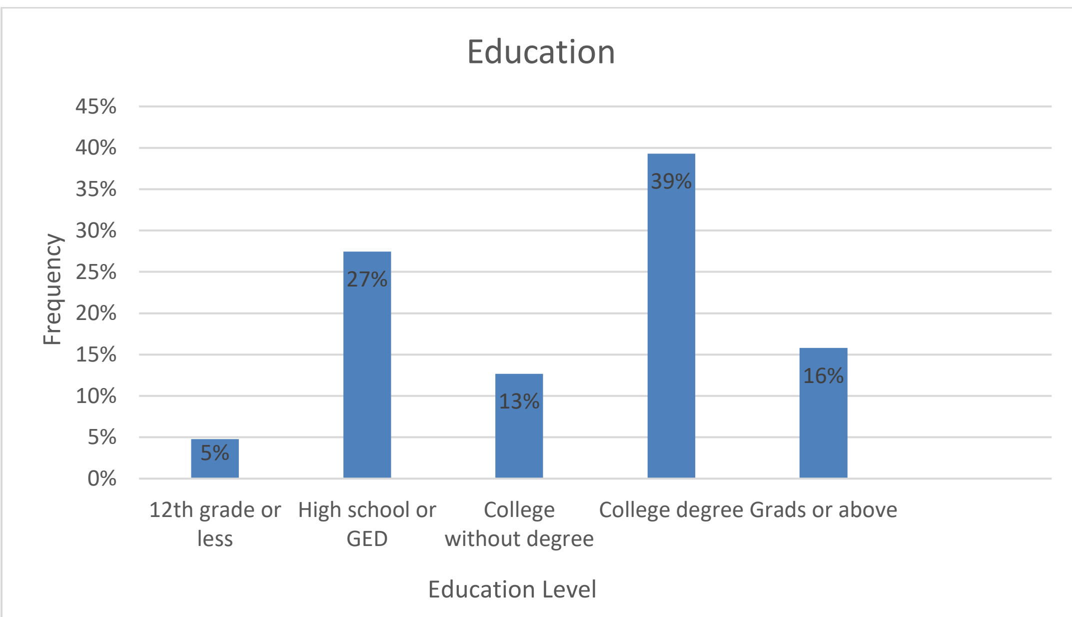

Figure 4-2. Education attainment reported by respondents

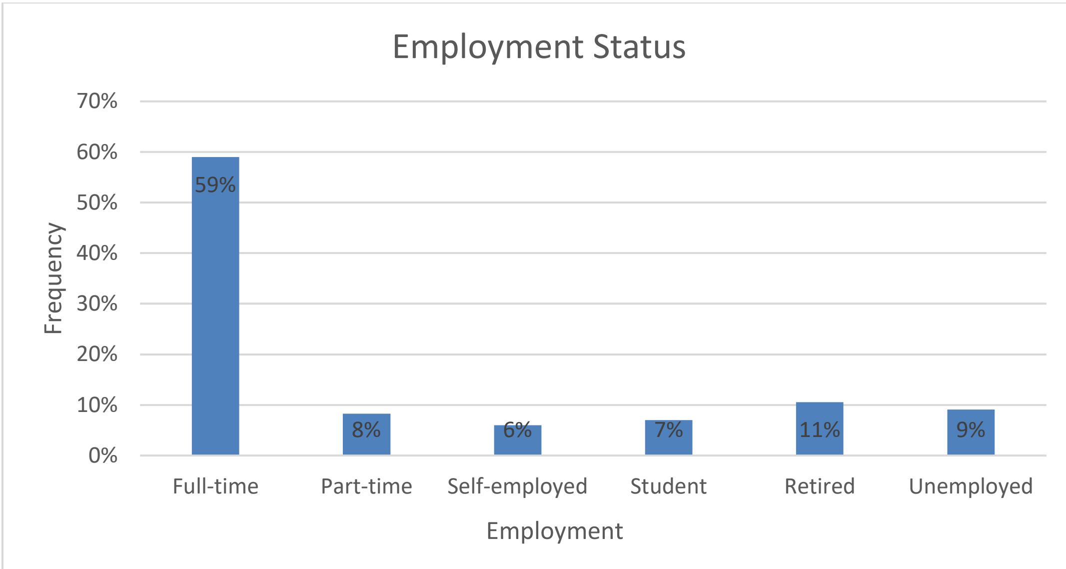

Figure 4-3. Employment status reported by respondents

Table 4-9. Travel Cost Model output for current visits using the negative binomial model

VARIABLES	Model1	Model2	Model3
Ln travel cost	-0.381***	-0.382***	-0.377***
	(0.046)	(0.045)	(0.046)
Income Below	0.204	0.213	0.188
	(0.167)	(0.169)	(0.171)
Income Average	0.026	0.043	0.047
	(0.133)	(0.135)	(0.136)
Clarity	0.203*		0.203*
	(0.112)		(0.112)
Facilities	-0.084		-0.084
	(0.095)		(0.095)
Greenspace	0.057		0.057
	(0.112)		(0.112)
Clarity dummy		-0.271*	
		(0.147)	
Facilities dummy		-0.014	
		(0.137)	
Greenspace dummy		0.078	
		(0.171)	
Secchi Disk			0.018
			(0.051)
Nitrogen monthly			0.033
			(0.039)
Constant	2.728***	3.085***	2.834***
	(0.310)	(0.287)	(0.284)
Ln alpha	-0.200***	-0.196***	-0.186***
	(0.067)	(0.068)	(0.066)
Observations	468	468	468
AIC	2218	2220	2222
BIC	2252	2253	2247

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 4-10. Annual visitation for 2016 and total consumer surplus of Springs; Florida Department of Environmental Protection provided annual visits

Recreation Site	Annual Visits (FDEP,2016)	Recreation value	95% Lower bound CI	95% Upper bound CI
Blue Springs	41,000	$7,288,411	$5,879,442	$9,592,133
Fanning Springs State Park	218,963	$38,924,204	$31,399,516	$51,227,369
Ichetucknee Springs State Park	507,238	$90,169,734	$72,738,444	$118,670,588
Madison Blue Springs	48,209	$8,569,927	$6,913,220	$9,592,133
Total	815,410	$144,952,276	$116,930,622	$190,768,799

Table 4-11. Sensitivity analysis of wage fraction rate using negative binomial model

VARIABLES	Model1	Model2	Model3
Ln Travel cost (1/3 wage rate)	-0.3814***		
	(0.0457)		
Income Below	0.2044	0.1724	0.1464
	(0.1674)	(0.1691)	(0.1705)
Income Average	0.0262	0.0073	-0.0076
	(0.1328)	(0.1334)	(0.1339)
Clarity	0.2030*	0.2034*	0.2037*
	(0.1125)	(0.1127)	(0.1129)
Facilities	-0.0839	-0.0847	-0.0854
	(0.0947)	(0.0946)	(0.0945)
Greenspace	0.0572	0.0568	0.0565
	(0.1120)	(0.1120)	(0.1121)
Ln Travel cost (1/2 wage rate)		-0.3822***	
		(0.0460)	
Ln Travel cost (2/3 wage rate)			-0.3826***
			(0.0462)
Constant	2.7279***	2.7905***	2.8438***
	(0.3099)	(0.3168)	(0.3227)
Ln alpha	-0.1998***	-0.1991***	-0.1985***
	(0.0668)	(0.0667)	(0.0667)
Observations	468	468	468
AIC	2218	2219	2219
BIC	2252	2252	2252

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 4-12. The adjust total consumer surplus with 1/3, 1/2, and 2/3 fraction of wage

Recreation Site	Annual Visits (FDEP,2016)	Recreational value (1/3)	Recreational value (1/2)	Recreational value (2/3)
Blue Springs	41,000	$7,288,411	$8,133,473	$8,962,276
Fanning Springs State Park	218,963	$38,924,204	$43,437,308	$47,863,580
Ichetucknee Springs State Park	507,238	$90,169,734	$100,624,550	$110,878,214
Madison Blue Springs	48,209	$8,569,927	$9,563,576	$10,538,106
Total	815,410	$144,952,276	$161,758,906	$178,242,175

Table 4-13. Perception versus physical environmental quality measures using ordered logistic regression model

VARIABLES	Model 1	Marginal Effects
Current Trips	-0.019	0.000284
	(0.022)	(0.000341)
Income Below	0.139	-0.00205
	(0.306)	(0.00454)
Income	0.059	-0.000909
Average	(0.256)	(0.00394)
First Visit	0.520*	-0.00775
	(0.270)	(0.00495)
Alternative visit	-0.337	0.00502
	(0.312)	(0.00501)
Swimming	0.419*	-0.00625
	(0.254)	(0.00447)
Nitrogen	-0.206***	0.00307**
monthly	(0.067)	(0.00151)
Constant cut1	-4.604***	
	(0.529)	
Constant cut2	-4.468***	
	(0.512)	
Constant cut3	-3.372***	
	(0.424)	
Constant cut4	-1.544***	
	(0.377)	
Observations	460	
AIC	652.5	
BIC	698	

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 4-14. Marginal effects of the independent variables on the probability of the respondent reporting each level of Perception of Clarity

VARIABLES	(1) Below Average	(2)	(3)	(4)	(5) Above Average
Current trips	0.000284	3.93e-05	0.000565	0.00239	-0.00327
	(0.000341)	(5.97e-05)	(0.000661)	(0.00272)	(0.00373)
Income Below	-0.00205	-0.000284	-0.00408	-0.0173	0.0237
	(0.00454)	(0.000682)	(0.00897)	(0.0379)	(0.0519)
Income Average	-0.000909	-0.000126	-0.00180	-0.00748	0.0103
	(0.00394)	(0.000558)	(0.00779)	(0.0323)	(0.0445)
First Visit	-0.00775	-0.00107	-0.0154*	-0.0652*	0.0894*
	(0.00495)	(0.00121)	(0.00883)	(0.0335)	(0.0460)
Alternative visit	0.00502	0.000697	0.0100	0.0422	-0.0580
	(0.00501)	(0.000948)	(0.00957)	(0.0390)	(0.0535)
Swimming	-0.00625	-0.000867	-0.0125	-0.0526*	0.0722*
	(0.00447)	(0.00101)	(0.00814)	(0.0315)	(0.0434)
Nitrogen monthly	0.00307**	0.000425	0.00611**	0.0258***	-0.0354***
	(0.00151)	(0.000446)	(0.00246)	(0.00813)	(0.0111)
Observations	460	460	460	460	460

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 4-15. Predicted Probabilities of Above Average Water Clarity Perception with Nitrogen Monthly increasing in mg/L

Nitrogen Monthly	Predicted Probabilities
2 mg/L	0.792***
	(0.0206)
3 mg/L	0.756***
	(0.0214)
4 mg/L	0.717***
	(0.0288)
5 mg/L	0.673***
	(0.0416)
6 mg/L	0.626***
	(0.0574)
7 mg/L	0.577***
	(0.0747)
8 mg/L	0.526***
	(0.0919)
Observations	460

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
NOTE: All predictors at their mean value

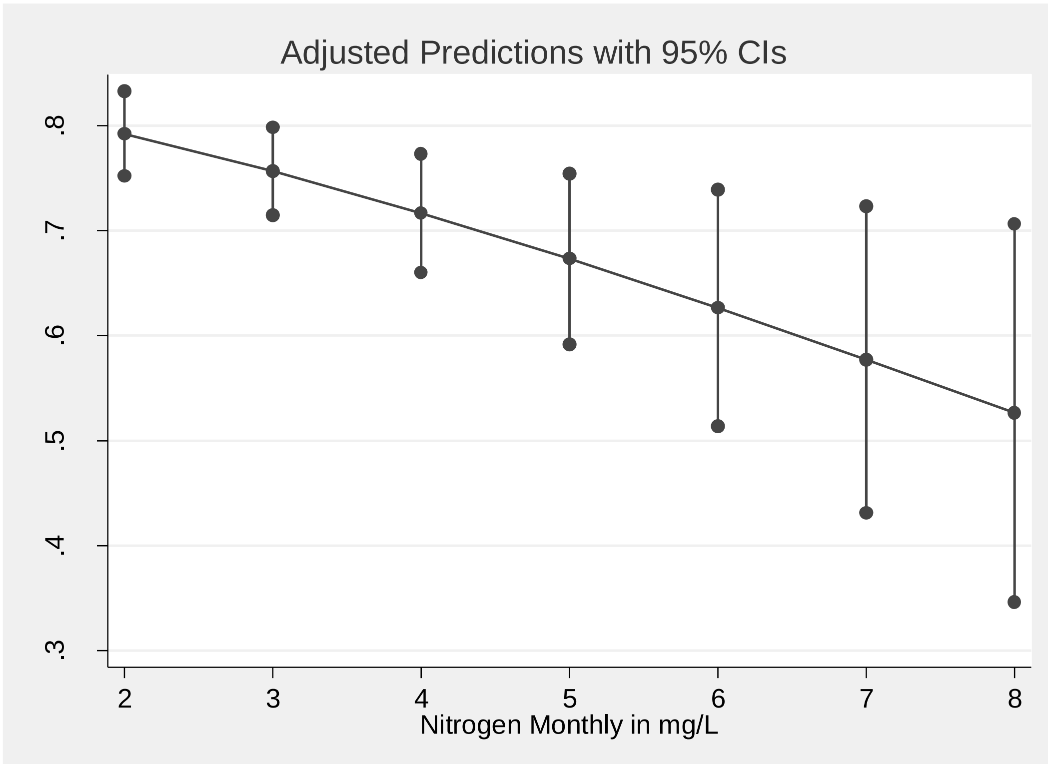

Figure 4-4. Graphical illustration of predicted probabilities along the confidence interval

CHAPTER 5
CONCLUSION

The TCM survey reveals approximately 68% of spring visitors having experienced the springs before being interviewed. The results show visitors make an average of four trips per year and willing to drive long distances from urban areas to the springs. The results of the survey are encouraging for local and state officials to ensure access to the springs by protecting and restoring the spring park, and increase the public awareness of the importance of having healthy spring systems.

The purpose of this study was to identify the environmental quality measures in conjunction with the TCM, conduct a wage analysis of the different wage ratios in TCM estimating the CS, and determine if the individuals' perceived the environmental quality measures can explain water clarity. The results of the NB estimation showed the recreational value of the four spring parks to be worth 144.49 million dollars. Using the ratios of the wage fraction level, the recreational value of the spring park has a value of 161.76 to 178.24 million dollars. The results of the recreational value are a conservative lower bounded estimation of the total CS. There is a need for detailed cost analysis of the entire trip expenditure, and the actual wage rate to estimate the exact travel cost estimation.

The results from the ordered logit model indicate that individuals' perceived water clarity rating is correlated with the environmental quality measure of nitrogen during the questioning period. The effect of nitrogen level is nonlinear where there are positive coefficients for poor and average quality, but vice versa for above average clarity rating. As the amount of nitrogen decreases, the perceived rating of water clarity will increase. Swimmers were also found to prefer a higher perceived water clarity rating, but could not differentiate water clarity up to a certain level of nitrogen in the water. The environmental quality measure variable is statistically significant explaining the perceived water quality, but there is a lack of variation in the perceived water clarity among visitors and nitrogen levels collected at the four springs.

Thus, future research should focus more on investigating a link between perceived clarity rating with the environmental quality measures over more extended periods of time. Additionally, future research should investigate how perceived water quality rating differ by the type of recreational experience using a larger sample over a longer period of time. A small but important group of visitors to the springs are drivers. However, our sample includes summer visitors and divers typically visit the springs in the fall and winter. Morever, as springs quality improve, a potential issue would be congestion. Additional data can be collected to investigate how congestion can affect values derived from recreation.

Some limitations to the study consist of the quality of data collected and the methods used to estimate the model. The data contained some errors such as invalid zip codes resulting in a small number of observations not having an estimated travel cost. The second issue was the trip count skewed above the mean visit patterns. The third issue was the environmental quality measure data where some sites had high levels of recorded pollution compared to the other spring parks. Also, the use of an on-site survey may have introduced unintended bias from the surveyor reading the questions to the respondent. One overlooked aspect of the survey data collected is the assumption of the respondent’s truthfulness.

TCM provides a convenient approach showing dollar values of recreation that can be compared to the potential restoration cost of the springs. The results can be used for a cost-benefit analysis to determine if allowing for an increase in human interactions such as camping or building a boat ramp is justifiable. Local and state agencies can use this data provided to create policies to protect the spring parks in the future. Also, this information can be used to raise public awareness regarding the importance of the springs for the communities, as well as the importance of the government programs aimed at springs protection.

Currently, the entrance fees charged to visit the springs are relatively low. Based on the survey results, respondents' will continue to visit the springs even if there is a marginal price increase. The revenue from the fee increase can be used to offset future protection initiatives to protect the delicate spring system. Furthermore, if the environmental quality of the spring site is improved by reducing nitrogen levels; perceived water clarity rating could increase which may result in an increase number of visitors to the spring sites. The increase in visitors could generate additional revenue for the state and improve the local economic condition near the spring sites.

APPENDIX A
SURVEY

Today's Visit

First, we have a few questions about your visit to the springs today.

1. Are you at the spring today on a "day trip" with plans to return home today, or are you spending one or more nights away from home?					
O1	Day trip (**Skip to Question 3**)	O2	Staying overnight (**Go to Q2**)	O8	Not sure/Refused

2. How many total nights on this trip will you spend in the area?			
Number of nights:		O88	Not sure/Refused

3. Is outdoor recreation at the spring and surrounding areas the primary reason for your trip to the area today?					
O1	Yes (**Skip to Question 5**)	O0	No (**Go to Question 4**)	O8	Not sure/Refused

4. What are the other purposes of this trip to the area? [Check all that apply. Do NOT read.](1 or 0)			
O x0	Visiting family, friends, or relatives	O x1	Attending a business-related activity or event
O x2	Visiting other cities/sites in Florida	O x3	Other (describe): in Excel
O x4	Not sure	O x5	Prefer not to answer

5. How many adults (age 18 or older), including yourself, and how many children (under age 18) are in your party on this trip?			
Number of adults:		O 88	Not sure/Refused
Number of children:		O 88	Not sure/Refused

6. For your group, how much did you spend or do you plan to spend in total, on your visit to the spring today, including gas, rental equipment, food & beverages, park tickets, and so on?			
Total $ amount		O8888	Not sure/Refused

7. What outdoor recreational activities did your group participate in at the spring and surrounding green space during this trip? [Check all that apply. Do NOT read.] 1 or 0			
Ox0	Swimming / snorkeling	Ox1	Scuba diving / Cave diving
Ox2	Tubing	Ox3	Camping
Ox4	Non-motorized boating (kayaking, canoeing)	Ox5	Hiking
Ox6	Nature viewing (bird, manatee watching, etc.)	Ox7	Picnicking, barbequing
Ox8	Motorized boating (including waterskiing & jet skiing)	Ox9	Not sure/Refused

Ox10	Other (describe): in Excel

8. Using a scale from 1 to 5, where 1 is 'below average' and 5 is 'above average,' please tell me how you would rate the following characteristics of the spring and surrounding area.						
	1	2	3	4	5	8DK/R
A. Clarity (cleanliness) of the water in the spring	O	O	O	O	O	O
B. Conditions of facilities at the spring	O	O	O	O	O	O
C. Conditions of the green space surrounding the spring	O	O	O	O	O	O

9. Is this your first trip to this spring?					
O1	Yes (**Skip to Question 12**)	O0	No (**Go to Question 10**)	O8	Not sure/Refused

10. Including today, how many times have you visited this spring in the last 12 months?			
# Visits		O88	Not sure/Refused

11. I'll read you a list of statements about how this spring may have changed over the past year. Using a scale from 1 to 5, where 1 is 'strongly disagree' and 5 is 'strongly agree,' please tell me how much you agree or disagree with each statement.						
	1	2	3	4	5	8DK/R
A. The water in the spring has become clearer	O	O	O	O	O	O
B. Wildlife in the water has increased	O	O	O	O	O	O
C. Wildlife in the surrounding green space has increased	O	O	O	O	O	O
D. Water flow in the spring has increased	O	O	O	O	O	O
E. Water level in the spring has increased	O	O	O	O	O	O

12. How many times do you plan to visit this spring in the next 12 months?			
# Visits		O 88	Not sure/Refused

Next, I'll read you some hypothetical descriptions about future trips you might take to visit this spring, or other similar springs. Please tell me what you think would be most likely, if the hypothetical situation were true.

13. Suppose this spring became unavailable for recreational use for some reason, would you visit a different location for similar types of outdoor recreation, or would you skip these activities?					
O1	Yes	***What other place would you visit?*** (name) in Excel			
O0	No (Would skip activities)	O8	Not sure	O9	Prefer not to answer

14. Do you have an annual pass to visit Florida's state parks this year?					
O1	Yes (**GO TO Q14A**)	O0	No (**GO TO Q16**)	O9	Prefer not to answer
	14A. Is that an individual pass or family pass?				
O1	Individual	O2	Family	O9	Prefer not to answer

15. Suppose the access fee to the spring were increased next year to improve conservation and restoration of the spring. If the access fee were increased by $20 per pass**, would that make you:**			
O1	Visit the spring fewer times?		
O2	Not change the number of times you visit the spring?		
O3	Visit the spring more times?		
O8	Not sure	O9	Prefer not to answer
Skip to Question 17 (Demographics)			

16. Suppose the access fee to the spring were increased next year to improve conservation and restoration of the spring. If the access fee were increased to $10 per person**, would that make you:**			
O1	Visit the spring fewer times?		
O2	Not change the number of times you visit the spring?		
O3	Visit the spring more times?		
O8	Not sure	O9	Prefer not to answer

Demographics

Finally, we just have a few demographic questions to be sure we've talked to all kinds of people who visit this area.

17. What is your <u>home</u> zip code?		**O**	**Foreign resident 00000**	**O**	**Refused 99999**

18. What is the highest level of education you completed? [Check one.]			
O1	12th grade or less (no HS degree)	O4	College degree (associate's or bachelor's)
O2	High school diploma or GED	O5	Graduate / Professional degree
O3	Some college, no degree	O9	Prefer not to answer

19. In what year were you born?		**O 9999**	**Prefer not to answer**

20. How many adults live in your household?		**O99**	**Prefer not to answer**

21. What is your employment status? [Check one.]			
O1	Employed full-time	O5	Student
O2	Employed part-time	O6	Retired
O3	Self-employed	O7	Other
O4	Unemployed	O9	Prefer not to answer

22. What was your total household income before taxes in 2015?					
O1	Below $35,000	O4	$70,000 to $89,999		
O2	$35,000 to $49,999	O5	$90,000 or more		
O3	$50,000 to $69,999	O8	Not sure	O9	Prefer not to answer

23. Have you donated time or money to any environmental causes in the past 5 years?					
O1	Yes	O0	No	O9	Prefer not to answer

24. Respondent gender [Interviewer: record, do not ask.**]**	**O1**	**Male**	**O2**	**Female**

That completes our survey. Thank you very much for your time and participation.

APPENDIX B
TABLE OF ESTIMATION RESULTS

VARIABLES	Model1	Model2	Model3	Model4	Model5
Ln travel cost	-0.362***	-0.364***	-0.355***	-0.356***	-0.376***
	(0.048)	(0.048)	(0.048)	(0.048)	(0.046)
Income Below	0.212	0.185	0.220	0.193	0.169
	(0.168)	(0.170)	(0.169)	(0.172)	(0.170)
Income Average	0.053	-0.036	0.049	-0.044	0.044
	(0.131)	(0.135)	(0.131)	(0.135)	(0.133)
Clarity	0.208*	0.202*			0.184
	(0.113)	(0.116)			(0.113)
Facilities	-0.107	-0.064			-0.105
	(0.095)	(0.098)			(0.092)
Greenspace	0.087	0.081			0.097
	(0.114)	(0.111)			(0.114)
swimming	0.363**		0.349**		0.590***
	(0.173)		(0.171)		(0.199)
Nitrogen monthly	-0.011	-0.077	-0.005	-0.068	
	(0.061)	(0.057)	(0.059)	(0.056)	
Swimming Nitrogen	0.010		0.013		
	(0.065)		(0.063)		
Non-Swimming		0.042		0.018	
		(0.129)		(0.127)	
Nonswimmingnitrogen		0.118**		0.117**	
		(0.054)		(0.053)	
Clarity_dummy			-0.324	-0.321	
			(0.266)	(0.266)	
Facilities_dummy			0.349*	0.303	
			(0.196)	(0.201)	
Greenspace_dummy			-0.499**	-0.511**	
			(0.248)	(0.244)	
Dissolved_oxygen					0.057
					(0.082)
Swimming_Dissolved					-0.102
					(0.079)
Constant	2.351***	2.518***	2.989***	3.253***	2.355***
	(0.376)	(0.380)	(0.465)	(0.460)	(0.364)
Ln Alpha	-0.227***	-0.227***	-0.234***	-0.238***	-0.228***
	(0.068)	(0.070)	(0.067)	(0.069)	(0.067)
Observations	467	447	467	447	467
AIC	2210	2113	2206	2109	2208
BIC	2256	2159	2251	2154	2253

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

VARIABLES	Model 6	Model 7	Model 8	Model 9
Ln travel cost	-0.378***	-0.362***	-0.357***	-0.363***
	(0.049)	(0.047)	(0.047)	(0.047)
Income Below	0.187	0.204	0.227	0.207
	(0.172)	(0.169)	(0.167)	(0.169)
Income Average	0.030	0.066	0.051	0.039
	(0.133)	(0.131)	(0.131)	(0.131)
Clarity	0.190*	0.188		0.216*
	(0.114)	(0.223)		(0.113)
Facilities	-0.079	-0.101		-0.102
	(0.096)	(0.094)		(0.096)
Greenspace	0.057	0.091		0.070
	(0.111)	(0.110)		(0.113)
Secchi	0.018			
	(0.051)			
Nitrogen monthly	0.023			
	(0.041)			
Swimming		0.462	0.431	
		(1.116)	(0.597)	
Swimmerclarity		-0.014		
		(0.236)		
Clarity_dummy			-0.288	
			(0.527)	
Facilities_dummy			0.356*	
			(0.195)	
Greenspace_dummy			-0.502**	
			(0.243)	
Swimmerclarity_dummy			-0.062	
			(0.615)	
Ln nitrogen monthly				0.001
				(0.101)
Swimming				0.280*
				(0.161)
Constant	2.607***	2.334***	2.958***	2.405***
	(0.381)	(0.404)	(0.650)	(0.369)
Ln alpha	-0.201***	-0.222***	-0.235***	-0.210***
	(0.067)	(0.068)	(0.067)	(0.068)
Observations	468	460	468	467
AIC	2222	2182	2207	2214
BIC	2263	2223	2249	2255

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

VARIABLES	Model 10	Model 11
Ln travel cost	-0.326***	-0.326***
	(0.049)	(0.049)
Income Below	0.256	0.232
	(0.172)	(0.174)
Income Average	0.054	0.044
	(0.138)	(0.139)
Clarity	0.734***	
	(0.171)	
Facilities	0.135*	0.131
	(0.079)	(0.081)
Greenspace	-0.098	-0.085
	(0.111)	(0.114)
Swimming	1.339***	1.525**
	(0.348)	(0.717)
swimmerclaritydummy	-1.004***	
	(0.378)	
Non Swimmerclarity		-0.242
		(0.155)
Constant	1.546***	1.742**
	(0.580)	(0.761)
Ln alpha	-0.228***	-0.227***
	(0.067)	(0.069)
Observations	421	416
AIC	1997	1977
BIC	2037	2018

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

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BIOGRAPHICAL SKETCH

Bryan Nguyen is a Florida native looking to learn about global cultures and the paradigms they must offer. Bryan graduated with a Bachelor of Science in food and resource economics at the University of Florida and had continued with the same department in his graduate school endeavors. With the many experiences his education has deemed him with and a passion for learning, Bryan will be moving to New York City to work with an NGO. He will have the opportunity to continue visiting new countries across the globe while focusing on issues in developing countries.