Measuring the Willingness to Pay for Fresh Water Cave Diving

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JEL Codes: Q26; Q51

JEL Keywords: Contingent Valuation Model; Willingness to Pay; Cave Diving; Scope Sensitivity

Abstract

Fresh water springs are unique natural resources that are contained within public lands across the United States. Natural resource management on public lands generates many interesting policy issues as the competing goals of conservation, recreational opportunity provision, and revenue generation often clash. As demand for recreational cave diving sites increases, the paper provides natural resource site managers with the first statistical estimate of divers' willingness to pay to dive fresh water cave and cavern systems. Using a contingent valuation model approach and correcting for hypothetical bias, we find that divers' median willingness to pay for cave diving opportunities at the site of interest is approximately $68 per dive. Model results also provide evidence of diver sensitivity with respect to scope as individuals are willing to pay more for dives that are higher in quality.

1. Introduction

A unique natural resource in the state of Florida is the number and size of fresh water springs. The Florida Geological Survey has inventoried more than 700 springs, of which 33 are considered first magnitude, having an average flow of 100 cubic feet per second (2.83 cubic meters per second) or more. The concentration of springs in Florida is not duplicated anywhere else on the earth. The Florida Department of Environmental Protection (DEP) has the management responsibility for Florida's public lands and the Division of Recreation and Parks manages a system of 160 State Parks that combine to put 700,000 acres scattered throughout the state under public management (Florida, DEP, 2009). Approximately 70% of Florida's Parks are related in some way to a natural spring. Natural resource management on public lands generates many interesting policy issues. The competing goals of conservation, recreational opportunity provision, and revenue generation often clash. In recent times, as public sector budgets have shrunk, natural resource managers have also been forced to search for revenue generation alternatives to supplement shrinking budgets. This situation is especially true in Florida.

For federal funding purposes states are required to publish recreation plans every 5 years. The most recent plan for Florida was produced by the Florida DEP in 2007. Chapter 5 of the plan addresses "outdoor demand and need" and it is stated that "Since outdoor recreation resources and facilities are generally felt to be 'free' goods and services, 'demand,' as an economic concept, does not lend itself to practical application," (DEP, 2009). What is provided below is a step towards providing a mechanism for practical application of demand measurement for a resource with public good elements. Because springs are an important natural resource in Florida and a key element in many state parks, a spring based state park was selected for the contingent valuation demand modeling that follows.

2. Site of Interest

The Edward Ball Wakulla Springs State Park is located just south of Tallahassee Florida in the Woodville Karst Plain (WKP). This area is well known for its karst, or landforms that have been modified by dissolution of soluble rock (eg. limestone), resulting in a terrain that is characterized by natural springs, sinkholes, sinking and rising streams, and caves. Wakulla Spring is the park's centerpiece feature and this particular spring is considered world class with regard to its flow and the cave system that channels its flow. In 2007, after years of exploratory effort, divers finally connected a number of other systems in the WKP to Wakulla. They entered at Turner Sink in the Leon Sinks Cave System and surfaced over 20 hours (a 6.5 hour dive with 14 hours of decompression due to 300 feet dive depth) later at Wakulla Spring after following almost 7 miles of cave passage. This established the Wakulla-Leon Sinks Cave System as the longest underwater cave in the U.S. (Kernagis et al. 2008). While Wakulla Spring is the most prominent feature in the park, it does contain other springs as well, including Sally Ward and Emerald Spring that also have associated cave systems.

Bonn and Bell (2003) measured the economic impact from Wakulla Spring along with the impact from three other springs in Florida (Ichetucknee, Volusia, and Homasassa Springs). Although this set of four springs is not a representative sample of all Florida springs, Bonn and Bell (2003) concluded from their visitor surveys that for a "typical spring" annual aggregate visitor spending is marginally in excess of $17 million. They also noted that visitors to the springs average about $46 per day in spending, and while they did not distinguish between visitor recreational purposes, they did note that visitor spending varies significantly by spring. For Wakulla Spring they found an annual direct economic impact of $22.2 million on Wakulla County wherein the spring is located. They also indicated that some 180,793 visitors came to the spring in 2002 spending about $90 per day, 70% of whom were from outside the county.[1]

3. Background and the Contingent Valuation Model

We develop the first contingent valuation model (CVM) study measuring the economic benefit associated with cave diving. In the contingent valuation/travel cost literature, some attention has been directed at valuing recreational diving. One group of diving studies considered the economic benefits associated with diving Marine Protected Areas (MPAs). Quantifying the economic benefits from diving MPAs can provide local conservation and management groups with important policy-based feedback to determine whether access fees are an appropriate method to fund MPAs and help conserve and protect the natural ecosystems (Arin and Kramer, 2002; Hall et al., 2002; van Beukering et al., 2004; Barker and Roberts, 2004). Another group of studies focused

[1] The visitation estimate included individuals from Leon County. Leon County, which includes the Tallahassee metro area, borders Wakulla County. As Wakulla Spring is a 20 minute drive south of Tallahassee, including Leon County visitors as external might well be overestimating the annual visitation economic impact associated with the spring.

on diving natural and artificial reefs. Using both CVM and travel cost models (TCM), these studies found significant use values associated with diving reefs. For example, Ditton et al. (2001) and McGinnis et al. (2001) calculated divers' annual willingness to pay (WTP) for recreational reef diving off the coasts of Texas and California respectively, with estimates ranging from $205 to $646 per year depending on the disclosure mechanism used in the CVM framework. Also, Kragt et al. (2009) used panel data to measure the value of dive trips to the Great Barrier Reef off the Australian coast and calculated consumer surplus estimates of approximately $150 per trip. To further value the potential spillover benefits of diving artificial reefs, Leeworthy et al. (2006) considered whether deployment of artificial reefs could alleviate the diving pressure on adjacent natural reefs. They found a 13.7% decrease in use of surrounding natural reefs following the sinking of the USS Spiegel Grove as an artificial reef off Key Largo in the Florida Keys. Most recently, Morgan et al. (2009) used a TCM approach to value recreational diving on the USS Oriskany (the World's largest artificial reef). Results from different model specifications indicated per-person, per-trip use values between $480 and $750. In addition, they measured the value of "bundling" a second vessel alongside the Oriskany to create a multiple-ship reefing area between $220 and $1,160 per diver, per year. However, despite the contribution of research directed at valuing recreational diving, and the growing participation in the sport, no-one has considered the economic value associated with cave diving. In the U.S. alone, there are hundreds of cave diving sites and a cave diver population, based on association memberships and training records, consisting of thousands of divers. Based on the increase in demand for cave/cavern diving sites and the need for resource managers to offset budget constraints with new streams of revenue generation, our results will provide public managers with valuable statistical feedback on the use values and potential economic efficiency associated with fresh water cave diving within the state park system.

We also consider scope effects by measuring divers' WTP for diving cave and cavern systems that vary in diver experience requirement and dive quality. Essentially, WTP should be non-decreasing in scope. In a CVM framework, scope sensitivity exists if respondents' WTP for a public good of greater quantity or quality is significantly different. A priori, divers would be expected to exhibit a higher WTP for a more advanced cave dive that goes beyond the ambient light zone and penetrates the cave relative to a cavern dive that does not go beyond the cave entrance area. In the economic literature, findings on scope effects remain mixed. Some previous research found scope insensitivity effects, meaning that respondents are not willing to pay more for an increase in quantity or quality of the public good (Schkade and Payne, 1994; Whitehead and Finney, 2003; Whitehead, 2005). Others have found that WTP estimates are sensitive to the scope of the policy (Carson, 1997; Powe and Bateman, 2004; Morgan et al., 2009). Finally, some research has argued that a test for scope effects is a test of the validity of the CVM framework with scope insensitivity suggesting that the CVM method would not be valid for policy analysis (Diamond and Hausman, 1994).

4. **The Survey**

A CVM survey was developed to elicit divers' socio-demographic details and their WTP for two different cave dives and a cavern dive that are currently closed to anything but permit-based dives. A portion of the survey was pre-tested on 46 respondents at the 2008 Cave Diving Section of the National Speleological Society annual meeting in Marianna, FL. For the study the population of interest was individuals known to have dived cave systems similar to that which would be available at Wakulla State Park should it be opened for recreational diving. Diver registrations at a nearby cave system (Jackson Blue in Marianna Florida) were used so that divers with the requisite skill sets who had actually been in the area (by vehicle Jackson Blue and Wakulla Springs are about one hour apart) were surveyed. Surveys were sent to 525 individuals known to have dived in similar cave systems with a stamped addressed return envelope included to increase responses. Also to increase the response rate, we informed potential respondents that they would be entered into a random draw for one of three $100 vouchers at a local dive shop if they completed and returned a survey.

Insert Table 1 here

There were 146 responses received giving a response rate of 27.8%. The average age of respondents was 45.8 years, earning an annual income of $102,430, with a bachelor's degree. The majority of respondents were male (87%) and married (74%). The average diver in the sample had a full cave certification level and would incur $679 in travel costs to access the Wakulla site.[2]

Insert Table 2 here

5. Estimation Methodology

Consider a diver who receives utility, u, from a dive site quality measure, q, and a composite of all other goods, z. Each diver chooses to maximize utility, $u(q, z)$, subject to a budget constraint, $y=pz$, where y is diver income and the price of z is normalized to one. Solving for the indirect utility function gives $v(q, y)$. A diver's willingness to pay (WTP) to dive a site is given by the monetary payment that equates indirect utility, such that $v(q^0, y) = v(q^1, y - WTP)$, where q^0 is the current site quality, and q^1 is the new site quality. As such, WTP represents the amount of money that must be subtracted from respondent's income at the higher level of site quality to leave diver utility unchanged.

An issue that arises with asking respondents questions regarding their anticipated behavior based on a hypothetical scenario is the level of certainty in their responses. Critics of CVM and WTP values dispute whether respondents' stated WTP estimates approximate their true WTP. Diamond and Hausman (1994) argued that stated preference responses to hypothetic scenarios do not correspond to what the individual would pay in real life, and suggested that responses would be less if the respondent had to actually pay for the provision at that point in time.

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[2] Travel costs are calculated as round trip travel expenses, plus site fees, plus the opportunity cost of time estimates. Round trip distance was estimated using the PC*Miler software. Per-mile travel costs were assumed to be $0.48. The opportunity cost of time for the roundtrip travel was calculated as one-third the hourly wage foregone assuming the average diver sampled works 2,080 hours per year.

Kahneman and Knetsch (1992) further contended that, as individuals yield satisfaction from stating that they will contribute to a cause without actually having to pay, CVM valuations merely reflect individuals' WTP for moral satisfaction, and as such, are not good estimators of their true WTP.

To counter the criticisms of CVM methods, recommendations regarding survey design have been suggested to improve the validity of individual responses. One recent concept that has been introduced into the CVM literature is cheap talk. The notion of cheap talk was introduced as a means to mitigate hypothetical bias in an individual's response. Including responses from individuals that are uncertain about the likelihood of actually paying the fee in a real situation can result in an overestimation of true WTP (Whitehead and Cherry, 2007). However, findings from experimental research have indicated that controlling for cheap talk in a CVM model removes hypothetical bias and provides WTP estimates that more closely approximate an individuals' actual WTP (Cummings and Taylor, 1999).

In the CVM framework developed here, three separate questions were asked to elicit divers' WTP for new cave and cavern dives with varying quality levels. Each scenario represented a dive that is currently closed to anything but permit-based dives but could be opened to the diving public with a Park policy decision. Similar caves in size and depth are currently open on both state and private land throughout Florida. The first scenario involved is a dive at Sally Ward Spring. Specifically, respondents were told "Sally Ward Spring is located on the entrance road to Wakulla State Park just before the entrance station. Sally Ward is also known as "Numero Uno" because it is said to be the number one rated cave dive in Florida. Your guided dive would be a staged swim to the Balcony entrance into the Cube Room (a gymnasium sized room), and then a circuit around that room and exit."

Scenario 2 involved a dive at Wakulla Spring. Under this scenario, respondents were informed that "This dive is a cavern dive that does not go past the ambient light zone and remains in front of the cave entrance at 160 feet."

Scenario 3 also involves a dive at Wakulla Spring. Here though, divers were told that "This dive is a time and/or penetration limited Tunnel A cave dive that goes into Tunnel A and then to the "grand canyon," (approximately a 400 foot penetration and a max depth of 225 feet) and then on to and no further than the junction of Tunnel B (a 1,100 foot penetration and a max depth of 270 feet)."

Before each WTP question, respondents were told that studies have shown that when people are asked about whether they are willing to pay for goods, such as this one, they often say yes at the time they are surveyed, but later think that they should have said no. This can be for a good reason, as people later realize that this would take money away from other things that are important to them. Respondents were informed that when considering their willingness to pay for a permit to dive the system, they should think carefully about whether they really would prefer to pay for this permit, or would prefer to continue purchasing other things that are important to them.

After each scenario, the respondent was then asked:

> Consider for a moment that to gain access for this dive, you will be asked to pay for a dive permit. Suppose that the price of the permit is $A, would you purchase it and thus be able to dive the cave/cavern?

In each case, \$A is a randomly assigned permit price variable.[3] Respondents were presented with three possible answers: yes, no, don't know, where any don't know response were categorized as a no response. These responses were used to estimate the full version of the model (Model 1).

To account for potential hypothetical bias in individuals' responses, after each WTP question, the individual was asked a follow-on certainty statement. Here, each respondent was asked "on a scale of 1 to 10 where 1 is very uncertain and 10 is very certain, how certain are you that you would pay a \$A license fee." To control for hypothetical bias, a second set of models was run in which only responses from individuals that stated a certainty of 7 or more were included (Model 2).

For both models, a logistic model specification is estimated with the probability of saying yes *P(Yes)* as the dependent variable. This can be written as:

$$P(Yes) = 1/(1 + \exp(\beta_0 + \beta_1 ln\ (A) + \beta_2 Age + \beta_3 Male + \beta_4 Married + \beta_5 Income + \beta_6 Cert_{lev} + \beta_7 TC_{Site} + \beta_8 TC_{Sub})) \quad (1)$$

6. Results

Before discussing the main results, analyzing the yes responses indicates that the divers sampled behaved in line with economic theory as an increase in annual license fees reduces the likelihood of a yes response.

[3] Permit fees were randomly assigned as \$25, \$50, \$100, \$200, or \$300.

Insert Table 3 here

For each scenario, there is a clear trend in the decline in the percentage of yes responses as the permit fee rises.

Now considering the models, three different model specifications are run; one for each new cave/cavern dive scenario (Model 1). A second model that controls for hypothetical bias is also run under each specification (Model 2). Across all models, the log of the permit fee amount is negative and statistically significant at the 1% level, confirming that increased access fees reduce the likelihood of a respondent's WTP. For all scenarios, having adjusted for hypothetical bias, the income variable is positive and significantly different from zero, indicating that cave diving is a normal good.

Insert Table 4 here

For the most part, results from the Sally Ward and Wakulla Cave dive models are similar. Intuitively, this makes sense as both dives represent more advanced cave dives that penetrate deeper into the cave systems, while the Wakulla cavern dive is a structurally different dive that does not venture beyond the ambient light zone or enter the cave itself. For the Sally Ward and Wakulla Cave dives, males are more likely to be willing to pay for a dive permit than females. Travel costs are important with results indicating that those living further from the site with greater travel costs are less likely to answer yes to the WTP question. Also, including travel costs to the closest substitute site indicates that those living further from the substitute site are more likely to answer yes. For the Sally Ward Cave dive, younger divers are more likely to answer yes while married divers are more likely to say yes for the Wakulla Cave dive. Finally, certification level does not appear to be important in any model.

Respondents' WTP and confidence intervals for each scenario are also estimated. There are a number of established methods to estimate WTP and confidence intervals in the CVM literature (such as the delta method and bootstrapping). Confidence intervals are estimated by simulation using the Krinsky-Robb procedure (Habb and McConnell, 2002). As the log of the permit fee amount (*lnA*) is also included in the model, the median WTP is estimated, with the mean WTP undefined (Haab and McConnell, 2002). As such, estimates of respondents' WTP are probably conservative as the median is lower than the mean (Groothuis et al., 2006).

Insert Table 5 Here

The median WTP estimates indicate that divers' value the more advanced cave dives more than the cavern dive. Specifically, for the Sally Ward Cave dive, respondents' median WTP is approximately $80, with a 95% confidence interval of from $56 up to $110. For the Wakulla Cave dive, respondents' median WTP is approximately $84, with a 95% confidence interval of $50 to $128. For the cavern dive, WTP estimates fall to $34 with a 95% confidence interval of $15 to $51. These results indicate that the sampled divers are sensitive to scope as they are willing to pay more for higher quality cave dives relative to the cavern dive. Based on a common criticism of CVM, this result also validates the policy-based analysis approach of this research (Diamond and Hausman, 1994).

When the estimates are corrected for hypothetical bias (Model 2), the WTP estimates decline. This was expected, as removing responses from divers that are not as certain of their answer provides a more conservative (and as has been argued, a more accurate) measure of individuals' WTP. For the two proposed cave dives, WTP estimates fall to between $68 and $69 (with 95% confidence intervals between $35 and $106), while for the cavern dive, WTP declines to approximately $23 (with a 95% confidence interval between $4 and $41).

7. Conclusion

We developed a contingent valuation model to provide the first estimate of individuals' WTP for fresh water cave diving. The results suggested that divers' median WTP for these cave diving opportunities at Wakulla Springs is in the region of $68 per dive when controlling for hypothetical bias in responses. For cavern dives requiring less experience, WTP estimates are $23 per dive. As natural resource managers face shrinking budgets, our results indicated that recreational cave diving within state parks could provide an important revenue stream. At the aggregate level, based on the number of individuals that dive comparable sites in the region, we estimate that if the cave/cavern system was open to the public, it would attract approximately 1,000 divers per year.[4] Our sample diver population makes, on average, nine dives per year at the Jackson Blue site, so we use this number as an estimate of the annual number of expected trips. Using the assumed visitation rates, aggregate willingness to pay is approximately $612,000. Based on a 30-year annuity with an assumed 5% yield, annual revenue generated would be $37,916. If the annual cost of managing the site with a new cave system open to the public is less than $37,916, then our results indicate that the site improvement represents an increase in economic efficiency.

4 This may be considered an upper bound estimate as visitation depends on the diving restrictions that the park may impose on the public. We also assume that the majority of divers are interested in cave dives.

The results also provided evidence of diver sensitivity with respect to scope. That is, individuals are willing to pay more for dives that are higher in quality. This finding of scope sensitivity, together with model estimation results that conform to economic theory, indicated that the WTP estimates provide useful information for policy-based analysis.

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Table 1.
Variable Definitions

Variable	Definition
Age	Age of respondent in years
Male	Dummy variable denoting respondent gender (male = 1, 0 otherwise)
Married	Dummy variable denoting respondent marital status (married = 1, 0 otherwise)
Income	Income of respondent ($1,000s)
Educ	Respondent level of education
Cert_lev	Cave certification level
TC Site	Per person travel cost necessary for each respondent to dive at Jackson Blue
TC Sub	Per person travel cost necessary for each respondent to dive at a substitute site (Ginnie Springs, FL)

Table 2.
Summary Statistics (Obs = 146)

Variable	Mean	Standard Dev.	Min	Max
Age	45.79	10.36	18.00	66.00
Male	0.87	0.34	0.00	1.00
Married	0.74	0.44	0.00	1.00
Income	$102.43	42.79	$25.00	$155.00
Educ	4.64	3.33	0.00	6.00
Cert_lev	3.72	0.80	0.00	4.00
TC Site	$679.03	611.33	$45.30	$3,406.20
TC Sub	$704.31	626.57	$52.50	$3,587.20

Table 3.
Yes Responses by Payment Scenario

	Response	$25	$50	$100	$200	$300
Sally Ward	Yes	17	19	13	11	6
	Total	25	25	31	32	31
	Percent	68%	76%	42%	34%	19%
Wakulla Cavern Dive	Yes	14	7	4	7	5
	Total	25	25	31	32	31
	Percent	56%	28%	13%	22%	16%
Wakulla Cave Dive	Yes	15	18	16	13	6
	Total	25	25	31	32	31
	Percent	60%	72%	52%	41%	19%

Table 4.
Determinants of WTP for New Dives[a]

	Sally Ward		Wakulla Cavern Dive		Wakulla Cave Dive	
Variable	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2
Intercept	4.56***	3.77***	3.10***	0.85	1.83	1.48
	(1.71)	(1.81)	(1.83)	(2.02)	(1.62)	(1.71)
Log Price	-1.34***	-1.39***	-1.22***	-1.04***	-0.94***	-0.92***
	(0.28)	(0.29)	(0.29)	(0.31)	(0.24)	(0.25)
Age	-0.03***	-0.03	-0.00	0.01	-0.02	-0.02
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
Male	1.51**	1.63***	1.27	1.38	1.22*	1.26*
	(0.72)	(0.79)	(0.83)	(0.92)	(0.66)	(0.72)
Married	0.59	0.52	-0.08	-0.10	0.76*	0.81*
	(0.50)	(0.52)	(0.60)	(0.65)	(0.46)	(0.49)
Income	0.00	0.00***	0.02***	0.02**	0.00	0.00***
	(0.00)	(0.00)	(0.01)	(0.01)	(0.00)	(0.00)
Cert. Level	0.16	0.31	-0.21	-0.05	0.27	0.30
	(0.24)	(0.28)	(0.25)	(0.30)	(0.24)	(0.26)
Travel	-0.01***	-0.01	-0.01**	-0.00	-0.01**	-0.01**
Cost Site	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Travel	0.01***	0.01	0.00	0.00	0.01**	0.01**
Cost Sub	(0.00)	(0.00)	(0.00)	(0.00)	0.00	(0.00)
Model $\chi2$	47.68***	45.42***	34.73***	22.20***	33.19***	31.50***

[a] The top number in each cell is the estimated coefficient and the bottom number in parenthesis is the estimated standard error estimate.
*** Significant at the p = 0.10 level
** Significant at the p = 0.05 level
* Significant at the p = 0.01 level

Table 5.
Median Willingness to Pay by Dive Scenario

Dive Scenario		Model 1	Model 2
Sally Ward	Median WTP	$79.99	$67.57
	95% CI	($55.86 - $109.80)	($44.77 - $92.37)
Wakulla Cavern	Median WTP	$33.97	$22.54
Dive	95% CI	($14.48 - $51.07)	($3.89 – $40.63)
Wakulla Cave Dive	Median WTP	$84.38	$69.06
	95% CI	($50.37 - $127.99)	($34.86 – $106.15)