Measuring The Willingness To Pay For Cave Diving

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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, this article provides natural resource site managers with the first statistical estimate of divers' willingness to pay (WTP) to dive cave and cavern systems. Using a contingent valuation model (CVM) and correcting for hypothetical bias, we find that divers' median WTP for cave diving opportunities at the site of interest is between $52 and $83 per dive. Model results also provide weak evidence of diver sensitivity with respect to scope, as individuals are willing to pay more for dives that are judged to be higher in quality.

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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, or those that have 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 (DRP) 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 Florida public sector budgets have shrunk, natural resource managers have begun to search for revenue generation alternatives. This situation is especially true in Florida, and recently the DRP increased entrance fees for state parks. For federal funding purposes, states are required to publish recreation plans every five 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" (Florida DEP 2009). This article takes a first 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. In doing so, we provide the first estimate of individuals' WTP for SCUBA diving at U.S. fresh water cavern and cave systems.1 Our findings suggest (after correcting for hypothetical bias) that individuals are willing to pay between $52 and $83 per cave dive and between $9 and $27 per cavern dive, generating an aggregate annual WTP at the study site of approximately $500,000.

Study Site

Because of the high concentration of fresh water springs, the focus of this study is on a spring system in Florida. Specifically, The Edward Ball Wakulla Springs State Park (hereafter termed Wakulla Springs) was selected as the study site, as it offers high-quality cave diving opportunities and also contains other cavern and cave systems that are currently closed to anything but scientific research-permitted diving but could be opened to the diving public with a park policy decision. This provides an interesting policy issue that can be examined in the context of a contingent valuation model (CVM).

Wakulla Springs is located in Wakulla County (figure 1), just south of Tallahassee, Florida in the Woodville Karst Plain (WKP). The 6,000 acre site has many recreational amenities, including boat tours, hiking, horse trails, swimming, a lodge and restaurant, and recreational diving opportunities.

Figure 1. Site Location–Wakulla County, Florida

The area surrounding Wakulla Springs is well known for its karst topography, or landforms that have been modified by dissolution of soluble rock (*e.g.*, limestone), resulting in a terrain that is characterized by natural springs, sinkholes, sinking and rising streams, and caves. Wakulla Spring itself is the park's centerpiece, and this particular spring is considered world class with regard to its flow and the size of the cave system that channels its flow. In 2007, after years of exploratory effort, divers connected a number of other systems in the WKP to Wakulla Spring. 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 depths) 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, McKinlay, and Kincaid 2008). While Wakulla Spring is the most prominent feature in the park, it contains 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 recreational trips to 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 averaged about $46 per day in spending, and while they did not distinguish between recreational activities, 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. 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.

Literature Review

While in the economic literature some attention has been directed at valuing other recreational diving activities, this study develops the first CVM to measure the economic benefit associated with U.S. cave diving. One group of related diving studies has considered the economic benefits associated with diving coral reef sites and Marine Protected Areas (MPAs). Typically, these studies used either CVM, travel cost models (TCM), or contingent behavior techniques to quantify the economic benefits from diving MPAs under current management conditions (Arin and Kramer 2002; Hall, Hall, and Murray 2002; van Beukering *et al*. 2004; Barker and Roberts 2004; Tongson and Dygico 2004). For example, Arin and Kramer (2002) estimated visitors' WTP for accessing three MPAs in the Philippines for two-tank, one-day boat trip dives. They used a payment card survey format with $0, $1, $3, $5, and $10 (U.S. dollars) options and found a mean daily WTP of $3.40 to $5.50.2 Kragt, Roebeling, and Ruijs (2009) used panel data and a contingent behavior approach 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. Other studies in this group also measured the economic benefit associated with an improvement in water quality conditions at MPAs, thereby providing 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. To date, the largest of these studies was conducted by Spash (2000). He interviewed 1,058 divers across two sites in the Caribbean to ask individuals if they would contribute to a trust fund for the existing MPA in Montego Bay, Jamaica. Respondents were told that the funding could raise the water quality from the status quo (75% of its potential) to 100%, compared to a 60% quality decline without the fund. The mean annual WTP for the improvement was estimated as $25.89. Bhat (2003) developed a joint revealed and stated preference travel cost model to examine diving trips to the Florida Keys Marine Reserve. Based on a modest sample of 89 respondents, a mean per-person, per-trip consumer surplus of $463 was estimated. Using stated preference elicitation techniques, he estimated that increasing fish abundance (by 200%), water quality (by 100%), and coral quality (by 100%) increased the expected number of trips by 80%, 61%, and 43%, respectively. The per-trip use value of the reserve then increased by $320 (69%) due to the proposed quality improvements relative to current conditions. Finally, Parsons and Thur (2008) developed a stated preference choice model to estimate the economic value of changes in the value of a coral reef ecosystem in the Caribbean to divers. A sample of 211 divers suggested that per-person annual welfare losses ranged from $45 for modest changes in quality to $192 for larger changes.

A second group of dive-related studies focused on diving natural and artificial reefs. Using either CVM or TCM, these studies found significant use values associated with diving reefs (Bell, Bonn, and Leeworthy 1998; Ditton *et al*. 2001; McGinnis, Fernandez, and Pomeroy 2001; Leeworthy, Maher, and Stone 2006; and Morgan, Massey, and Huth 2009). The most comprehensive of these studies was conducted by Bell, Bonn, and Leeworthy (1998), who estimated the economic benefit of diving reefs off the Florida Panhandle, disaggregating their analysis by county. Using a CVM framework, they estimated an average daily WTP of $5.53, generating an aggregate annual recreational use value of $24.04 million across the five-county region of Northwest Florida. The most recent application is by Morgan, Massey, and Huth (2009), who used a TCM approach to value recreational diving on the *USS Oriskany* (an Essex Class Aircraft Carrier billed as 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 as approximately $423 per-person, per-trip.

Despite the contribution of research directed at valuing recreational diving, and the growing participation in the sport, no one has considered the WTP associated with cave and cavern diving. The only research that is close in nature to this article was a TCM application by Morgan and Huth (2010) that measured the improved access benefits and scope effects of extending the current cave system at another dive site in Florida.

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. Given an increase in demand for cave and cavern diving sites and the need for resource managers to offset budget constraints with new streams of revenue generation, our results will not only provide the first valuation of cave divers' WTP in the U.S., but also present public resource managers with valuable statistical feedback on the use values and potential economic efficiency associated with cave diving within the state park system.

The Contingent Valuation Method

While different potential stated preference techniques could be employed (*e.g*., choice experiments, TCM, and CVM) to estimate diver benefits, following a majority of other dive-related studies, a CVM procedure was selected here. CVM is a survey-based technique for eliciting values individuals place on goods, services, and amenities. In the environmental and natural resource economics literature, CVM studies have been used to estimate non-market values that include recreation days, environmental preservation, amenity values, and ecosystem service values. The first CVM study was performed by Davis (1963) to estimate the economic value of big game hunting in Maine.

Results from early applications were met with much skepticism, and CVM and WTP valuation critics disputed 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 payment responses would be lower if the respondent had to actually pay for the provision at that point in time. This criticism was supported by Little and Berrens (2004), Harrison (2006), and Harrison and Rutström (2008), who all suggested that CVM techniques tended to produce hypothetical bias by overestimating actual vales. Kahneman and Knetsch (1992) contended that, as individuals yield satisfaction from stating that they will contribute to a cause without actually having to pay, CVM valuations merely reflected individuals' WTP for moral satisfaction, and as such, were not good estimators of their true WTP.

To counter the CVM methods criticism and to elicit WTP values with confidence, recommendations regarding survey design have been suggested to improve the validity of individual responses. Following the National Oceanic and Atmospheric Administration's (NOAA) Panel recommendations, budget or substitute reminders were the first *ex ante* method introduced in CVM as a means to address hypothetical bias (Arrow *et al*. 1993). As subsequent evidence on hypothetical bias motivated research into mechanisms to remove this bias (Cummings, Harrison, and Rutström 1995; Carson *et al*. 1996; List and Gallet 2001; and Harrison 2006), Cummings and Taylor (1999) introduced an *ex ante* mitigation technique, termed cheap talk, that informs respondents that in hypothetical situations, individuals say yes more often than they would in real life situations, and asks the respondent to consider carefully what they would actually do. Results from their experimental research indicated that controlling for cheap talk in a CVM model mitigates hypothetical bias and provides WTP estimates that more closely approximate an individual's actual WTP. They also noted that their cheap talk script was long and may not be appropriate for all applications. Aadland and Caplan (2003) and Whitehead and Cherry (2007) both applied a short-script version of the cheap talk design and found that it also mitigated respondents' hypothetical bias.

The success of cheap talk in attenuating hypothetical bias has not been universal. List (2001) and Lusk (2003) found that a cheap talk script was not successful in mitigating hypothetical bias for individuals with more experience or familiarity of the good being valued. More recently, Landry and List (2007) conducted a field experiment at a sports memorabilia show to compare cheap talk and consequentialism (another *ex ante* technique that informs individuals that their responses have the potential to impact public policy in order to provide them with incentives to state their true preferences). They found that accurate WTP estimates are more likely from respondents that view their decisions as being sufficiently consequential, but also that cheap talk can be a useful alternative mechanism when in the field and individuals' perceptions of consequences are small.

An *ex post* correction mechanism can also be used to control for uncertainty regarding individuals' WTP responses. This technique typically asks respondents how certain they are that they would actually do what they have stated they would do. Responses to these follow-up questions are called certainty statements. Research has indicated that including responses from individuals that are uncertain about the likelihood of actually paying the fee in a real situation can result in overestimating true WTP (Whitehead and Cherry 2007). Only responses from individuals who are certain that they would do what they have stated should be included in the model (Whitehead and Cherry 2007). Blumenschein *et al*. (1998), Blumenschein *et al*. (2001), and Blumenschein *et al*. (2004) asked respondents if they are "probably sure" or "definitely sure" that their response reflects their true WTP, and then only included responses from individuals that were definitely sure as "yes" responses. Adjusting for respondent certainty, they found no statistical difference between hypothetical and real WTP. A second method (and the one used here) is to provide a follow-up question that asks how certain respondents are on a 10-point Likert scale, with 10 indicating very certain. Only responses from individuals suggesting a certainty level above a critical value are included (Champ *et al*.

1997). Poe *et al*. (2002) and Vossler *et al*. (2003) both found that respondents who indicated that they are certain of their WTP at a level of 7 or more out of 10 had similar hypothetical payment probabilities as a real WTP sample.

Finally, some research has employed both *ex ante* and *ex post* measures (for example, Aadland and Caplan 2003; and Blumenschein *et al*. 2004). Whitehead and Cherry (2007) found that WTP estimates were similar when either *ex ante* or *ex post* measures were used. Further, their findings suggested that the two approaches are complements (rather than substitutes); thus studies only employing one of the approaches in an attempt to mitigate hypothetical bias may overstate WTP. We employ both *ex ante* cheap talk and *ex post* certainty statement calibration techniques to mitigate hypothetical bias and control for respondent uncertainty in the WTP survey responses.

Because the purpose of the survey is to elicit respondents' WTP for diving different caves and caverns at the site that vary in diver experience requirements and dive quality, scope effects of divers' WTP are also examined. 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 further into 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 has 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, Massey, and Huth 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).

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 at the Wakulla Springs site that are currently closed to anything but scientific research-permitted diving. These "research permits" have not involved any payments to the park and have been based on developing an understanding of the region's hydrology and exploring the extent of the conduits. 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 the three systems at Wakulla Springs. Diver registrations at a nearby cave system (Jackson Blue in Marianna, FL) were used so that divers with the requisite skill sets who had actually been in the area were surveyed (by vehicle Jackson Blue and Wakulla Springs are about one hour apart). 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 the survey. Variable definitions and summary statistics are provided in table 1.

Table 1 Variable Definitions and Summary Statistics (Obs = 146)

Variable	Definition	Mean	Std. Dev.	Min.	Max.
Age	Age of respondent (years)	45.79	10.36	18.00	66.00
Male	Dummy variable denoting respondent gender (male = 1, 0 otherwise)	0.87	0.34	0.00	1.00
Married	Dummy variable denoting respondent marital status (married = 1, 0 otherwise)	0.74	0.44	0.00	1.00
Income	Income of respondent ($1,000s)	$102.43	42.79	$25.00	$155.00
Cert_lev	Cave certification level	3.72	0.80	1.00	4.00
TC Site	Per-person travel cost necessary for each respondent to dive at Jackson Blue	$679.03	611.33	$45.30	$3,406.20
TC Sub	Per-person travel cost necessary for each respondent to dive at a substitute site (Ginnie Springs, FL)	$704.31	626.57	$52.50	$3,587.20

There were 146 responses received, yielding 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 Wakulla Springs. Travel costs were 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 $0.48.6 The opportunity cost of time for the round-trip travel was calculated as one-third the hourly wage foregone assuming the average diver sampled works 2,080 hours per year. Travel costs were also calculated in the same manner to a substitute site (Ginnie Springs, FL). Ginnie Springs was chosen since it is a site that is well recognized among cave divers as providing diving opportunities of a similar quality to those of Wakulla Springs.

Estimation Methodology

Consider a diver who receives utility, u, from cave or cavern dive site use, x, a dive site quality measure, q, and a composite of all other goods, z. The expenditure function, $m(p,q,u)$ is found by solving the problem: min $(z+px)$ subject to $u = u(x,q,z)$ where p is the use price (or site access fee), and the price of pz = 1. The expenditure function measures the minimum amount of money a diver must spend to achieve the reference utility level and is increasing in p and u but decreasing in q. WTP is the maximum amount of money divers would give up in order to enjoy an improvement in dive quality. The WTP for a quality improvement is:

(1) $$WTP = m(p, q^0, u) - m(p, q^1, u),$$

where $q0$ is the current site quality, and $q1$ is the new (improved) site quality.

In the CVM framework developed here, three separate questions were asked to elicit divers' WTP for new cave and cavern dives at Wakulla Springs that had varying quality levels. Each scenario represented a dive that is currently closed to anything but scientific research-permitted diving 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 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. 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 asking the WTP questions, respondents were provided with a shortened cheap talk script. Again, this cheap talk script is designed to mitigate hypothetical bias in divers' responses and is provided in the Appendix.

After each dive 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. Respondents were presented with three possible answers: yes, no, and don't know, where a don't know response was categorized as a no response (Carson *et al*. 1998). These responses were used to estimate the full version of the model (Model 1). To control for respondent uncertainty, after each WTP question the individual was asked a follow-up certainty statement asking divers to indicate how sure they are that they would actually pay the amount. 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?" Following Champ *et al*. (1997), Poe *et al*. (2002), Groothuis and Whitehead (2009) and others, to control for uncertainty a second set of models were run in which only responses from individuals that stated "yes" to purchase the dive permit and stated a certainty of 7 or more were coded as a yes response (Model 2). Overall, both models attempt to control for hypothetical bias through use of an *ex ante* cheap talk script, while Model 2 also introduces an *ex post* control for uncertainty.

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

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

As respondents were asked to consider each dive scenario option independently regardless of their response in the other two options, it is likely that errors across all three choices are correlated. To address this problem, we also pooled the data and adopted a random-effects probit model, presented as:

(3) $$R_{it=\beta X_{it} + u_i + \varepsilon_{it}},$$

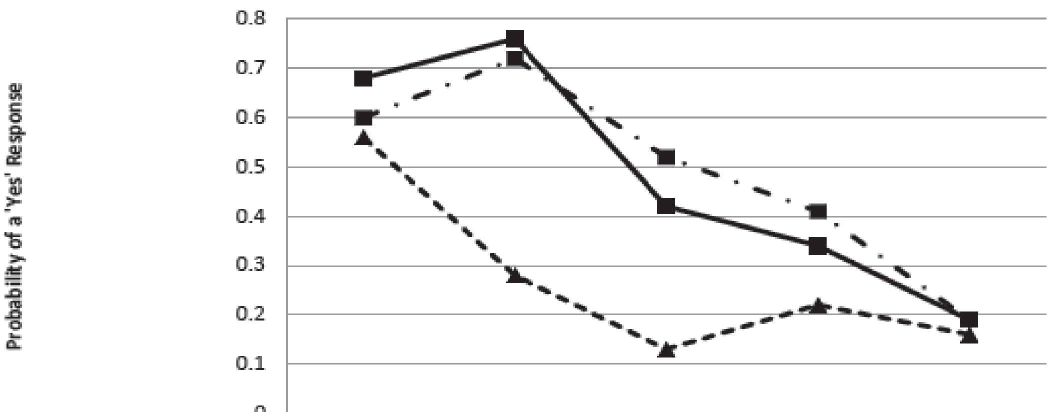
where *R* is a binary variable equal to one for a yes response; ***β*** and ***X*** are vectors of coefficients and explanatory variables, respectively; *i* indexes divers in the sample; *t* indexes the number of responses per sampled diver; *ui* is an unobservable characteristic specific to diver i. It is an individual-specific random disturbance that is constant across each diver’s responses to the cave/cavern diving scenarios and assumed to be uncorrelated with other regressors; *εit* is the transitory error term due to random response shocks across individuals.

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.

Examining the bid-acceptance curves in figure 2, for each scenario there is a clear downward trend in the probability of acceptance (moving down the vertical axis) as bids increase (moving left to right along the horizontal axis). Two other effects are noteworthy. First, the bid-acceptance curves for the two cave dives follow a similar trend. Second, for each bid, the probability of acceptance for the cavern dive is lower than either cave dive. This perhaps reveals scope sensitivity in diver responses with divers perceiving the cavern dive as a lower-quality dive. Using the WTP frequencies, Turnbull lower bound nonparametric WTP estimates can be found (Haab and McConnell 2002). This estimate is appealing in policy-based research because it presents a conservative estimate of WTP (see table 2). Based on WTP frequencies in the standard model (Model 1), WTP is $111 and $119 for the Sally Ward and Wakulla cave dives, respectively, but declines to $65 for the Wakulla Cavern dive. For Model 2, controlling for uncertainty by only including yes responses from respondents with a certainty of 7 or more, lower bound WTP estimates all decline, as expected; again, with greater WTP for the cave dives scenarios.

The socio-demographic and diver certification explanatory variables in the model were selected for inclusion based on their statistical importance in other recreational diving studies (Mathieu, Langford, and Kenyon 2003; Lindsey and Holmes 2002; Morgan, Massey, and Huth 2009; Morgan and Huth 2010). With regard to modeling, two different model specifications were run for each new cave and cavern dive scenario. Table 3 presents the WTP determinants for new dives from Model 1 (controlling for hypothetical bias), while table 4 provides WTP determinants from Model 2 (controlling for both hypothetical bias and uncertainty). For both Models 1 and 2, we run three individual probit models for each dive scenario and a pooled random-effects probit model.



	$25	$50	$100	$200	$300
Sally Ward	0.68	0.76	0.42	0.34	0.19
Wakulla Cavern Dive	0.56	0.28	0.13	0.22	0.16
Wakulla Cave Dive	0.6	0.72	0.52	0.41	0.19

Figure 2. Bid-Acceptance Probability Curves

Table 2 Turnbull Lower Bound Estimate for Willingness to Pay

	Model 1		
	Sally Ward	Wakulla Cavern	Wakulla Cave
Willingness to pay	$110.70	$65.46	$118.79
Standard error	12.27	10.88	12.53
Lower bound, upper bound	$86.65, $134.75	$44.14, $86.77	$94.22, $143.55
	Model 2		
	Sally Ward	Wakulla Cavern	Wakulla Cave
Willingness to pay	$97.71	$69.01	$112.95
Standard error	11.79	10.97	12.53
Lower bound, upper bound	$74.61, $120.81	$47.50, $90.51	$88.40, $137.50

Table 3 Determinants of WTP for New Dives (Model 1)

	Sally Ward		Wakulla Cavern Dive		Wakulla Cave Dive		Pooled	
Variable	Coefficient	Std. Error	Coefficient	Std. Error	Coefficient	Std. Error	Coefficient	Std. Error
Constant	2.541**	1.08	1.950888	1.06	0.883	0.99	2.505**	0.79
ln(Price)	–0.917**	0.00	–0.626**	0.15	–0.6398*	0.00	–0.822**	0.14
Cavern							–1.591*	0.90
Cave							–0.641	0.89
ln(Price*Cavern)							0.209	0.20
ln(Price*Cave)							0.148	0.19
Age	–0.018	0.01	0.001	0.01	–0.009	0.01	–0.008	0.01
Male	0.979*	0.43	0.436	0.42	0.774*	0.39	0.706**	0.23
Married	–0.066	0.34	–0.021	0.34	0.162	0.31	0.053	0.19
Income	0.014**	0.00	0.010**	0.00	0.009**	0.00	0.010**	0.00
Cert. level	0.052	0.16	–0.206	0.16	0.152	0.15	–0.016	0.09
Travel cost site	–0.006**	0.00	–0.003**	0.00	–0.004**	0.00	–0.004**	0.00
Travel cost sub	0.006**	0.00	0.003**	0.00	0.004**	0.00	0.004**	0.00
Model χ^2	59.53**		29.74**		40.13**		119.09**	

** Significant at the p = 0.01 level.
* Significant at the p = 0.05 level.

Table 4 Determinants of WTP for New Dives (Model 2)

	Sally Ward		Wakulla Cavern Dive		Wakulla Cave Dive		Pooled	
Variable	Coefficient	Std. Error	Coefficient	Std. Error	Coefficient	Std. Error	Coefficient	Std. Error
Constant	1.868	1.07	0.170	1.04	0.144	1.01	1.731*	0.78
Price	–0.907**	0.175	–0.368**	0.14	–0.514***	0.15	–0.756**	0.14
Cavern							–2.174**	0.90
Cave							–0.955	0.87
Price*Cavern							0.349	0.20
Price*Cave							0.224	0.19
Age	–0.017	0.01	0.008	0.01	–0.011	0.01	–0.007	0.01
Male	0.956*	0.46	0.294	0.42	0.646	0.40	0.599**	0.24
Married	–0.069	0.35	–0.020	0.35	0.130	0.31	0.043	0.19
Income	0.015**	0.00	0.006	0.00	0.008**	0.00	0.009**	0.00
Cert. level	0.108	0.16	0.087	0.16	0.208	0.15	0.064	0.09
Travel cost site	–0.006**	0.00	–0.001	0.00	–0.004**	0.00	–0.004**	0.00
Travel cost sub	0.006**	0.00	0.001	0.00	0.004**	0.00	0.00**	0.00
Model χ^2	55.04**		10.74		34.14**		100.43**	

** Significant at the p = 0.01 level.
* Significant at the p = 0.05 level.

Across all models, the log of the permit fee amount is negative and statistically significant at the 1% level, supporting the notion that respondents are behaving rationally to changes in site access fees. 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 in which the diver does not venture beyond the ambient light zone or enter the cave itself. For both cave dive scenarios, the income variable is positive and significantly different from zero, indicating that cave diving is a normal good. Also for the 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 farther 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 farther from the substitute site are more likely to answer yes. Age, marital status, and certification level do not appear to be important in any model. For the Wakulla cavern dive, in Model 1, higher income levels positively impact divers' WTP, so cavern diving is also a normal good. However, the age, gender, and marital status of the respondent are not statistically correlated with divers' WTP.

In the pooled random effects probit models, we also include two dummy variables (cavern and cave) equal to one for the second and third WTP diving scenario, respectively, zero otherwise. We also include two interactive terms with both WTP scenario dummies interacted with the individual-specific bid price. The intercept shifter (Cavern) is negative and statistically significant, indicating that the probability of a yes response is lower for the cavern scenario. Across both models, neither of the slope shifters (Price*Cavern and Price*Cave) are statistically significant.

Using results from the pooled models, respondents' WTP and confidence intervals for each scenario are also estimated. WTP is estimated at the mean of the independent variables. The Delta Method is used to analytically construct the WTP standard errors (Greene 2008) As we use the log of the permit fee amount (lnA) in the model, the median WTP is estimated, with the mean WTP undefined (Haab and McConnell 2002).

Table 5 presents the median WTP estimates. Results indicate that divers value the advanced cave dives more than the cavern dive. In Model 1, respondents' median WTP is approximately $82 for both cave dive scenarios with 95% confidence intervals from $55 up to $111. For the cavern dive, WTP estimates fall to $27 with a 95% confidence interval of $10 to $45. As we provide a 'within' design test for scope effects such that each respondent answers a WTP question under each scenario (and so endeavors to seek internal consistency in their responses across scenarios), the resulting answers provide weak evidence 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 provides some validation for the policy-based analysis approach of this research (Diamond and Hausman 1994).

Table 5 Willingness to Pay Estimates

Dive Scenario		Model 1	Model 2
Sally Ward	WTP	$81.71	$56.81
	95% CI	($58.54–$104.87)	($36.94–$76.68)
Wakulla Cavern dive	Median WTP	$27.40	$8.67
	95% CI	($9.45–$45.35)	(–$6.19–$23.53)
Wakulla Cave dive	Median WTP	$82.96	$51.72
	95% CI	($54.91–$111.01)	($25.36–$78.08)

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.

At the aggregate level, based on the number of individuals that dive comparable sites in the region, we expect that if the cave/cavern system was open to the public, it would attract approximately 1,000 divers per year.9 This figure assumes that most trips taken to substitute sites provide a reasonable estimate of trips to Wakulla Springs if opened to the public. We base this assumption on our knowledge that caves within an hour or so are complements and not substitutes, so expected visitation rates to Wakulla Springs can be approximated from known visitation to Jackson Blue, Indian Springs, and Emerald Springs (as all are sites within an hour of Wakulla Springs).

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 and the WTP corrected for uncertainty, aggregate annual WTP is approximately $500,000.

Conclusion

We developed a CVM to provide natural resource site managers with the first statistical estimate of divers' WTP to dive U.S. cavern and cave systems. The results suggested that divers' median WTP for these cave diving opportunities at Wakulla Springs is in the range $52 to $57 per dive when controlling for hypothetical bias in responses. For cavern dives requiring less experience, WTP estimates are $9 per dive. Based on the expected number of visitors to the site if the systems are opened for public use, the estimates translate into an aggregate annual WTP in the region of $500,000. With the number of recreational cave divers in the U.S. increasing and natural resource managers forced to search for viable revenue generation options, our results indicate that recreational cave diving within state parks could provide an important revenue stream.

The results also provide 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, indicate that the WTP estimates provide useful information for a policy-based analysis of this nature.

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