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ABSTRACT

A contingent valuation survey was conducted to estimate the aggregate willingness to pay for reducing pollutants in a popular, highly visited creek in Indiana. The Little Sugar Creek Watershed is located in the southwestern portion of the state, runs through two state parks, and is frequently used for various recreational purposes including canoeing, fishing, hiking, and camping. As such, it has a direct value for recreational as well as non-recreational purposes that are directly related to the water quality of the creek. The survey was useful in gathering information to estimate a tobit regression model to determine the valuation of an improvement of water quality by 50 percent. Reduction of pollutants and sediment load in the creek would result in a benefit to the public in the form of improved water quality for many purposes. The results of this survey would be useful in formulating public policy in terms of a potential tax on local residents to help pay for creek cleanup.

KEY WORDS Environmental Economics; Contingent Valuation; Sugar Creek

Point and nonpoint sources of pollution are major contributors to water quality issues in the state of Indiana. The Clean Water Act passed in 1972 has been effective in addressing most point sources of pollution, such as from industries and municipalities, but now, the main contributor of water pollution in the state is from nonpoint sources. These can include land development for agricultural and commercial or residential purposes, animal farming operations, oil and gas production, and a host of other causes. Agriculture is one of the contributors to nonpoint source pollution, with soil erosion and associated sediment runoff, and the use of chemical fertilizers leading to phosphorus washing into waterways. According to the US EPA, in the state of Indiana, the most

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probable sources of watershed and water body contamination are nonpoint sources, including crop production, with the associated soil erosion and fertilizer runoff, livestock feeding and grazing operations, and contaminated sediments. A related issue is that paved impervious surfaces such as roads, parking lots, and sidewalks do not absorb precipitation, and snow melt and stormwater runoff wash over roads, paved lots, and compacted soil and into storm sewers and lakes and watersheds as untreated water.

Recognizing the importance of maintaining clean waterways, the state has established the Indiana Department of Environmental Management (IDEM), which oversees issues regarding land, water, soil, and wildlife resources. The IDEM was established in 1986 as a watchdog group to oversee environmental laws and regulations and to implement and manage various environmental programs to protect public health. IDEM's mission statement is to "[p]rotect human health and the environment while providing permission for safe industrial, agricultural, commercial, and governmental operation vital to a prosperous economy" (IDEM 2013a). It achieves these goals through a variety of mechanisms, including (but not limited to) environmental cleanups, pollution prevention partnerships, environmental stewardship programs, and educational initiatives.

The need for environmental protection and cleanup in Indiana is strongly recognized, as many of the state's bodies of water and waterways are frequently used for recreational purposes. The IDEM continues to identify the causes of water impairment in the state and to target impaired water bodies for cleanup projects via the use of grant funds. Reduction of water impairment is crucial for the supply of safe drinking water to residents, but also for recreational purposes. In 1990, the state's Water Pollution Control Board instituted strict water quality standards that set criteria for more than 90 chemicals; these standards greatly assisted in improving water quality, and since the IDEM was established, enforcement activity has increased. In addition to the above programs, several counties have adopted storm water quality measures, and a manual of guidelines designed to control soil erosion and to treat the nonpoint source pollution associated with sediment-laden runoff and the management and treatment of pollutants associated with post-construction land uses. The IDEM publishes a manual online that contains guidelines to help prevent soil erosion and specifies how to minimize excessive sediment runoff and control pollutants and sediments generated from construction, development, and other activities that result in adverse land disturbances. All these are with a specific aim in mind: to reduce the impact of human activity in development, construction, and agriculture and to minimize the damage of such activities on soil and water resources. As a result, there have been marked improvements in water quality in the state due to these above measures. The IDEM has assessed approximately 35 percent of Indiana's stream miles for recreational uses and has found that 32 percent (7,652 miles) of those are now fully supporting of full body contact recreational uses. Approximately 53 percent of Indiana's stream miles have been assessed for aquatic life use support, and 82 percent of these (13,641 miles) were found to be fully supporting of healthy aquatic communities (IDEM 2007).

This paper is an empirical study of the Little Sugar Creek Watershed (henceforth referred to as Sugar Creek) in the state of Indiana. The watershed flows through two state parks and is heavily used for recreational purposes. A contingent valuation survey was developed and administered to local residents and visitors to the creek and the state parks, and the collected data is used to estimate the determinants of the willingness to pay (WTP) for a cleaner creek.

Although Sugar Creek is a watershed that is semi-regularly assessed by the EPA,[1] no contingent valuation studies have been conducted so far to determine the public's willingness to pay for a cleaner watershed. The Sugar Creek watershed is an important element of two popular Indiana state parks, Shades State Park and Turkey Run State Park. Estimated visitation to Shades State Park and Turkey Run State Park were 80,522 and 734,618 respectively in the 2010–2011 fiscal year.[2] Tourism is one of the major generators of revenue, with significant multiplier impacts on other industries in the state (Thaiprasert, Hicks, and Fisher 2006). It therefore seems relevant to do an assessment of the public's willingness to pay for a cleaner creek, as water quality of the creek plays an important role in the recreational enjoyment component of tourism to the two above state parks.

LITERATURE REVIEW

The contingent valuation method (CVM) is a stated preference method: Given a hypothetical improvement in environmental quality, the participants are asked to state what they would be willing to pay for such an improvement. The CVM has been widely used to determine the economic valuation of environmental assets. The general acceptance of the validity of the CVM has a long history, and various US federal government agencies were among the first to adopt it to analyze issues in environmental resources. Agencies such as the US Army Corps of Engineers and the US Bureau of Reclamation have used the CVM since the late 1970s. The US Forest Service regularly trains employees on the method, and the US Department of the Interior adopted CVM as a standard methodology (Loomis 2000). One of the most famous uses of the CVM is the study by Carson and colleagues (2003) to determine the dollar valuation of the damages done by the Exxon Valdez oil spill in Prince William Sound, Alaska. Their study (and the subsequent assessment of it) was a major contribution toward establishing the CVM as a reliable method for determining the valuation of environmental goods.

Another noted study using the CVM was conducted by Loomis (1987) to determine the willingness to pay for the protection of birds and fish species in Mono Lake in California. The findings of this study led to a change in public policy in that non-use values of the ecosystem had to be included in the state's Environmental Impact Report when deciding water allocations for the area (Kramer 2005). Carson and Mitchell (1993) estimated the willingness to pay for national water quality improvements using CVM methodology. They were careful to note that although the CVM has been established as a reliable method for determining willingness to pay, its validity relies on the accurate and careful use of the method, as the results can be influenced by various factors. Survey respondents need to believe the plausibility of the scenario that is presented in the survey, and the administration of the survey instrument could also affect respondents' answers.

Numerous other CVM studies have been conducted to determine the valuation of other environmental goods and services. Earnhart and Smith (2003) conducted a study on the effects of atrazine on the recreational activity in Lake Clinton, Kansas. Atrazine is a pesticide, and on the one hand, its use inhibits the growth of algae in the lake and thus may promote recreational enjoyment. On the other hand, its presence in the water harms local fish populations and thus reduces recreational enjoyment. In a study that estimated the value of water quality in the Catawba River basin in North and South Carolina, Kramer and Eisen-Hecht (2002) conducted telephone interviews to collect stated preferences for the willingness to pay for a cleaner water basin. They found that the average willingness to pay was $139 per respondent; aggregated over the all counties in the affected basin, the authors estimated that improved water quality would amounted to $75 million in economic benefit.

In spite of its long use to determine the use and non-use value of environmental goods and services, the CVM is not without its critics. The validity of CVM estimates of willingness to pay has frequently been questioned. The difficulty in ascertaining the true willingness to pay comes from the fact that the environmental goods in question are usually public goods; thus, the free rider problem is unavoidable. Additionally, survey respondents are sensitive to the nature of the survey collection instrument and collection methodology. Realistic scenarios are necessary for survey respondents to accurately assess their true willingness to pay. Difficulty in determining true WTP stems from the fact that respondents are asked to pay a hypothetical amount of money, not an actual amount. This may lead to biased results, as respondents could overstate their valuation of an environmental good because they are never required to actually pay the amount they state (Hanemann 1995); however, Carson, Flores, and Meade (2001) found that a carefully designed study with appropriate implementation can address these issues.

This paper is an extension of Stumborg, Baerenklau, and Bishop (2001), but with an application toward the Sugar Creek watershed. In addition, the model was extended to include recreational activities as part of the assessment. Recreational activities such as canoeing and hiking are a vital part of visits to the creek, and the rationale behind including them is that participating in such activities will have a positive relationship with willingness to pay. It is hoped that with these estimates, there can be applications toward public policy in potentially developing an optimal tax to collect revenue that will be used for toward creek cleanup projects, pollution prevention, and educational initiatives.

DESCRIPTION OF THE LITTLE SUGAR CREEK WATERSHED AND SUGAR CREEK

The Little Sugar Creek watershed is located in west central Indiana and includes the counties of Boone, Clinton, Fountain, Hamilton, Montgomery, Parke, Tippecanoe, and Tipton. There are 36 waters included in the Little Sugar Creek watershed, and the focus of this paper is on Sugar Creek, which flows 90 miles west/southwest and is a tributary to the Wabash River. Sugar Creek flows through Montgomery County and through the city of Crawfordsville, which is the largest city built on its banks, and west toward Shades State Park and Turkey Run State Park. A map of the region is shown in Figure 1.

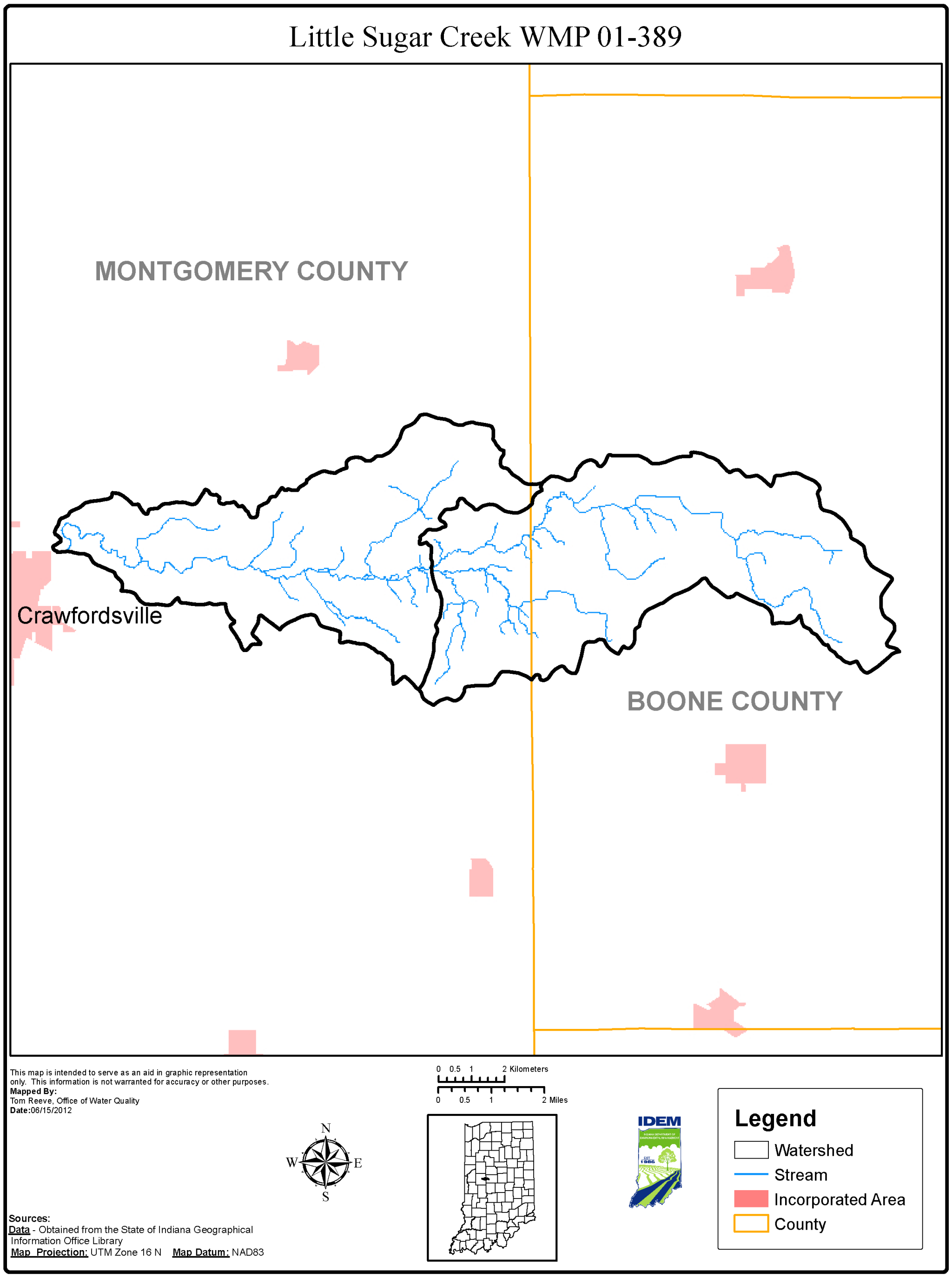
WATER QUALITY ISSUES FOR SUGAR CREEK

According to the US EPA, the following are the main water quality issues for Sugar Creek: impaired biotic communities, presence of E. coli in the water, and polychlorinated biphenyls (PCB) and mercury in the water and in fish tissues. In addition to the above contaminants, one study finds low dissolved oxygen levels in areas of the creek as a result of raw sewage discharge into the creek, as well as discharge from agricultural communities (Beckman 2000). Organic materials in raw sewage and wastewater from sewage treatment plants are decomposed by microorganisms that use up oxygen in the process; thus, raw sewage flows into the creek will eventually rob the waters of oxygen, resulting in fish hypoxia and fish kills. Several stretches of the creek (particularly downstream of the city of Crawfordsville) have fish advisory postings warning people not to consume any fish they catch from the creek because the levels of mercury and PCBs in fish tissue are too high for safe human consumption. The most probable sources of water contamination are nonpoint sources, including urban runoff from energy production, agricultural processes (crop production that relies on the use of chemical fertilizers), and permitted and non-permitted runoff from livestock feeding and grazing operations.

The main targets for creek cleanup would be nonpoint sources of pollution that lead to the presence of mercury, PCBs, and E. coli in the waters, as those are the leading contributors to impairment of the Sugar Creek watershed. The state of Indiana has an extensive system of managing nonpoint sources of pollution[3] and uses the EPA-recommended guidelines for target levels for those pollutants. Tracking the origins of nonpoint sources of pollution is difficult, as these sources are diffuse, but the main contributors of human-related nonpoint source pollution include "animal production operations and feedlots, agricultural activities, stream bank shoreline erosion, timber harvesting, and land development,"[4] as well as sewage and waste disposal areas, energy production, among others.

IDEM has implemented a variety of watershed-restoration programs that include the encouragement of best management practices for the management of landscape for agriculture, timber harvest, or construction. In addition, IDEM also has a total maximum daily loads (TMDL) program. The TMDL is defined as the "maximum amount of pollutant that a waterbody can receive and still meet water quality standards" (IDEM 2013c). These TMDL standards are used to assess impaired waterways and to subsequently determine the sources of the impairments.

Figure 1. Map of Little Sugar Creek



Source: IDEM (2012).

THE CONTINGENT VALUATION SURVEY

Based on the methodology of Carson et al. (2003), data were collected using a contingent valuation survey administered at various collection points in a number of the counties through which Sugar Creek flows. The survey was conducted during the summer months of 2009 (June, July, and August), which is peak time for recreational activity on the creek. Survey construction followed the structure of Stumborg et al. (2001) and Imperial, Jones, and Dumas (2003). Participation was purely voluntary, and a participant need not have visited the creek to complete the survey; in this way, it was hoped that existence value of the creek could be determined for those people who had never visited the creek. Surveys were also left at public libraries, county fairs, canoe liveries, and state parks, with student workers administering and collecting surveys on various days. A total of 196 complete surveys were collected. It is difficult to achieve a completely random sample, especially with survey data, as various collection methodologies can suffer from selection bias. A mailed survey elicited less than a 5 percent response rate, so we resorted to more direct means of survey collection via a physical presence at various locations. Although this collection method was not completely randomized, it is hoped that the surveys collected give a snapshot of participant attitudes toward the creek.

Background information on the creek, along with a summary description of the water quality issues and environmental challenges was given to each participant. The participants were given a series of questions to answer regarding their visits to the creek in the past year, including the number of visits to the creek, number of adults and children on a typical visit, recreational activities participated in during their visit, distance traveled to reach the creek, amount of money spent on various categories (food, restaurant meals, gas, other transportation costs, entrance fees, equipment purchase and rental, and parking fees, to name a few). Participants were also asked about their various demographic characteristics (age, race, sex, ethnicity), educational level, income category, home ownership or rental, and number of years lived in current residence. Then the question of payment mechanism was presented. Residents were asked how they would vote on a hypothetical proposal that would raise funds that would go for creek cleanup costs, the form of which could be seen as higher income or property taxes, changes in home construction regulations that may result in higher home costs, cost-share pollution reduction programs, or voluntary contributions to environmental organizations (Stumborg et al. 2001). Dollar values for willingness to pay were given to survey participants, with dollar values ranging from a minimum of $0 to a maximum of $300. For participants who were willing to pay more than $300, those respondents were asked to specify their maximum amount. Participants were reminded that every dollar amount they were willing to pay would be money that could not be spent on alternate uses, such as goods or other services they could potentially enjoy. It was hoped that by this question structure, participants would be fully cognizant of their valuation of a cleaner creek as compared to any alternative purchases. (The entire survey is available upon request.)

The payment time horizon was over a period of three years, to spread out the costs of the hypothetical cleanup plan to survey participants. Previous research by Kunreuther et al. (1998) and Baron and Maxwell (1996) indicate that an individual's maximum willingness to pay for the benefits accrued from investing in a protective measure or public good such as an environmental good is not very affected by a longer time horizon of the benefits. These findings could indicate that individual willingness to pay per year is affected by not only the time horizon of the payments but also the time horizon of the benefits received. In our survey, a time horizon of three years seems appropriate to spread out the costs to households but also to bring to mind the time frame for cost versus benefits. A summary of the results is discussed below.

SURVEY DATA

Descriptive statistics for the 196 complete surveys collected are listed in Table 1. Of the surveys collected, 158 out of 196 (80.6 percent) respondents were from Montgomery County. The next highest county response was from Boone County, with 15 of the 196 respondents (7.65 percent) from that county. As this was not a truly random selection of survey participants, it is necessary to see if our sample is truly representative of the overall population. Because the majority of the respondents reside in Montgomery County, we focus on comparing our sample data with that county's data.

Table 1. Descriptive Statistics for Survey Data (selected variables)

Average number of visits per year	2
Average number of adults on a typical trip	4.5
Average spending per tripbelow)	$86.29
Median spending per trip	$40
Average age	46
Median age	44
Percent of male respondents	44%
Percent of white respondents	98.5%
Average education	15 years
Median education (in years)	14 years
Average annual income	$50,114
Median annual income	$42,500
Average years lived in current residence	24 years
Percent of respondents who own their	25%
Distance of home from the creek (miles)	11.6
Average WTP (for three years)	$214.53
Median WTP (for three years)	$117.37

Based on STATS Indiana data and data from the US Census for 2009, per capita income in Montgomery County was $38,637. The average household size was 2.5

persons, and the median age was 38.6 years. The percent of adults aged 25 or older with a high school degree was 87.4 percent. In comparison, in our collected data, the average income was $50,114, average household size was 3.03, median age of respondent was 44 years, and 98.5 percent of the respondents had a high school degree. We see that for our collected survey data, our respondents had, on average, higher income, larger household size, greater median age, and more education compared to the rest of Montgomery County. Our sample could suffer from selection bias, as it is possible that only respondents who are more interested in environmental issues and a cleaner creek participated in the survey. This could imply that the average WTP for a cleaner creek is overstated based on the demographic profile of our sample, compared to the overall population in Montgomery County. Even though our sample is not representative of Montgomery County as a whole, however, it can still provide useful information about the WTP for a cleaner Sugar Creek and could be extended to examine the WTP of other local watersheds with similar characteristics and recreational uses.

Of the 196 completed surveys, 14 of the respondents had never visited Sugar Creek. This constitutes approximately 7.14 percent of all respondents. Average WTP of all the 14 respondents was $65.71. Examined by county, 9 respondents were from Montgomery County, with an average WTP of $90; 3 were from Boone County, with an average WTP of $13.33. The remaining two were from Hamilton and Vanderburgh Counties and had an average WTP of $35. Although these respondents comprise a small percentage of survey participants, their responses give an interesting snapshot of the existence value of the creek.

Participants were also asked what recreational activity or activities in which they participated during a visit to the creek, including camping, picnicking, visiting a state park through which the creek runs, canoeing, swimming, fishing, hiking, reading/relaxing, or other. The most popular recreational activity was visiting a state park, with 98 responses, followed by canoeing with 88 responses, and hiking with 78. Other descriptive statistics are listed in Table 1, with number of visits, amount of money spent per trip on various categories (gasoline, groceries, restaurant meals, entrance fees, camping fees, equipment rental, cabin or campground rental, and other), demographic characteristics, and information on income. The respondents were asked how far they live from the creek, if they own or rent their home, and how long they've lived at their current address. These questions were included based on the theory that a resident who lives close to the creek and owns a home may have a higher WTP for a cleaner creek, as property value is positively affected by creek cleanliness. Similarly, the length of time a resident has lived in the home is assumed to be positively related to WTP. The total WTP is calculated by summing the present value discounted value of the respondent's stated willingness to pay each year over the three-year time span during which the hypothetical program would take place, then calculating the average of all respondents. Present value discounting is calculated based on a real interest rate of 1.25 percent.[5] The average total WTP for the three-year time span was $214.53, with a standard deviation of $338.71. Because a majority of the respondents resided in Montgomery County, we calculated an estimate of the 95 percent confidence interval using the data from those respondents.

Based on census data from STATS Indiana, the number of households in this county in 2009 was 14,750. Using this, we can estimate that the 95 percent confidence interval for county-wide WTP is \$3.16 million ± \$4.99 million. The above standard deviation (SD) is large relative to the mean, and consequently, the 95 percent confidence interval includes zero. This raises the issue of the statistical power of the exercise. To address this problem, the average and SD of the WTP was calculated without the outlier values for WTP. We omitted those values of WTP that were greater than or equal to \$300 per year. Eight respondents out of 196 gave a WTP greater than or equal to \$300, and omitting those respondents gave an average WTP of \$150.34 with an SD of \$151.45. This leads to a confidence interval of \$2.21 million ± \$2.23 million, which is an improvement compared to the interval calculated with the full data set.

The Indiana Department of Natural Resources (2011) estimates that the number of visitors to Turkey Run State Park, one of the state parks through which Sugar Creek flows, was 743,157 in the 2008–2009 fiscal year. Based on our collected survey data, the average number of people in a group was 6 (adults and children) per visit, and the average amount of spending per trip was \$86.29. Based on this, we can estimate that the total amount of revenue per group trip was \$10,687,836. From our survey data, we see that the average number of trips is 2 per year, which translates into a yearly potential revenue of \$21,375,673. Admittedly, this is most likely a high estimate, given that the number of visits was based on visits to Turkey Run State Park, not to the creek itself, but as the creek is a vital component to the park, for hiking and water recreational purposes, it cannot be denied that it is an important consideration for visits, and this calculation gives us a rough estimate of the valuation of the creek to the state's tourism revenues.

Given that the value of potential tourist revenues for the state is quite substantial, it is of particular interest that environmental quality be protected and preserved in Sugar Creek, as well as in other Indiana watersheds. To that end, the IDEM has worked in conjunction with local watershed protection groups to protect and improve local waterways. There have been several success stories for the improvement of water quality in other waterways in the state, including (but not limited to) Big Walnut Creek in Hendricks and Boone Counties, Clifty Creek in Bartholomew County, and Pigeon Creek in Posey, Warrick, Gibson, and Vanderburgh Counties. These three are example cases that had water quality problems similar to those of Sugar Creek, including impaired biotic communities, bacteria contamination from livestock lots, and other pollutants from the use of chemicals in agricultural processes. Although no estimation of the cost for cleanup has been made for Sugar Creek, we can use the three above success stories as a basis for estimation of the cost for Sugar Creek cleanup, as each of those situations is similar to (although not exactly the same as) that in Sugar Creek.

In the case of Big Walnut Creek, IDEM developed several watershed restoration projects, including targeted best management practices such as introducing structural or vegetative elements in farming to reduce runoff, no-till agriculture, and minimizing tree harvests in management zones. These practices were implemented from 1999 through 2007, after which IDEM assessed the water quality in Big Walnut Creek. Their findings indicated that E. coli levels dropped substantially, with a 96.6 percent reduction in East Fork of Big Walnut Creek and an 81.8 percent reduction in West Fork of Big Walnut Creek. As a result of this significant improvement, IDEM has proposed that all of Big Walnut Creek should be removed from the list of impaired waters for E. coli contamination. The spending for this program was approximately $163,000 for the Big Walnut Creek watershed. Local conservation partners used other funding from the Natural Resource Conservation Service (NRCS), but these were not officially reported. Regardless, the cost of the program was most likely substantially lower than the yearly potential revenue of tourist dollars to Turkey Run and serves to show the potential net benefit is positive for a cleaner waterway.

A similar problem with E. coli contamination existed in Clifty Creek, with best management practices implemented to reduce those levels, resulting in a drop in E. coli levels and IDEM's recommendation that Clifty Creek be removed from the list of impaired waters. Similar was Pigeon Creek, which had impairment issues with chlordane, an agricultural pesticide used to control insects. Chlordane was banned in the early 1980s, but the chemical forms strong bonds with soil, leading to persistent high levels in agricultural land. As a consequence, high levels of chlordane were found in Pigeon Creek long after the ban on its use, due to soil erosion from agricultural lands. The local group Citizens for Improvement of Pigeon Creek, in conjunction with the NRCS, developed conservation plans for best management practices to reduce the levels of chlordane in Pigeon Creek. These plans were implemented from 1997 through 2001, and a water quality assessment was made in 2005. Samples of fish tissue were taken from catfish caught from the lowest point of the Pigeon Creek watershed. Compared to samples taken in 1992, total chlordane residue levels were reduced by 81 percent, and Pigeon Creek is no longer considered impaired for chlordane. The cost for this program was approximately $563,000, still considerably below the potential yearly tourist revenues to Turkey Run State park above. These three examples illustrate fairly typical scenarios of water impairments for Indiana watersheds, with best management practices resulting in a significant reduction of water pollutants at a cost far below the estimated tourist revenue that may be generated from visits to state parks that include important waterways. Similar best management practices could be implemented for the Sugar Creek waterway, leading to reduced levels of mercury, PCBs, and E. coli. This would be valuable to the state for revenue generation via recreational visits.

MODEL AND ESTIMATION

Of the 196 participants, 22 respondents (11.2 percent) listed $0 as their maximum annual WTP. This necessitates the use of a censored dependent variable (tobit) regression model. The model is

$$\begin{aligned} y_i &= x'_i\beta + \varepsilon_i, \quad \text{if } x'_i\beta + \varepsilon_i > 0 \\ y_i &= 0, \qquad\qquad \text{otherwise} \end{aligned}$$

where $\varepsilon_i \sim N(0, \sigma_i^2)$, normally distributed with mean zero but nonconstant variance. The dependent variable is the annual maximum WTP, summed over the three-year period, with present value discounting calculated using the real interest rate of 1.25 percent. The variable x_i is a vector of control variables, including those listed Table 2. These control variables are included to account for various factors such as participation in recreational activities, demographic characteristics, income, education, place of residence, etc., that may determine the maximum WTP for a cleaner creek.

Table 2. Explanatory Variables in Tobit Regression Model

Variable	Description
Visits	Number of visits to the creek in the past year
Totalspend	Average amount spent per trip
Male	Dummy variable = 1 if male, 0 otherwise
White	Dummy variable = 1 if white, 0 otherwise
Age	Age in years
Education	Education in years
LogIncome	Natural log of annual income of the household
Years	Number of years lived in residence
Ownhome	Dummy variable = 1 if own home, 0 otherwise
Miles	Distance of residence from the creek in miles
Adults	Number of adults in household
Camp	Dummy variable = 1 if camping during visit
Picnic	Dummy variable = 1 if picnicking during visit
Statepark	Dummy variable = 1 if visiting state park during
Canoe	Dummy variable = 1 if canoeing during visit
Swim	Dummy variable = 1 if swimming during visit
Fishing	Dummy variable = 1 if fishing during visit
Hiking	Dummy variable = 1 if hiking during visit

The presence of heteroskedasticity in the data was evident from the results of the likelihood ratio test.[6] This necessitated the use of robust standard errors for an accurate calculation of test statistics and p-values. The results of the estimate of various specifications of the model are shown in Table 3. The relationship between *Visits* and *WTP* was positive, as expected, and in all the specifications in Table 3, the coefficient on *Visits* was statistically significant at the 5 percent level. This is consistent with the theory that a greater number of visits is positively related to a higher willingness to pay. Additionally, the coefficient on *LogIncome* was statistically significant at the 5 percent level for models 2 and 4 and showed a positive relationship with willingness to pay for a cleaner creek.

Table 3. Estimation of Regression Models*

Variable	Model 1	Model 2	Model 3	Model 4	Model 5
Visits	50.744** (0.042)	48.384** (0.047)	43.485** (0.052)	45.693** (0.043)	44.047** (0.049)
Age			0.203 (0.923)		0.301 (0.885)
Agesquared				0.121 (0.557)	
Education			17.422 (0.238)		17.511 (0.234)
LogIncome		80.350** (0.048)	66.324 (0.090)	76.862** (0.048)	68.458 (0.080)
Adults					5.08** (0.006)

Notes: *p-values in parentheses.
**Significant at the 5 percent level (two tailed test).

There are additional estimation outputs from a variety of specifications (Table 4). Once again, the coefficient on *Visits* was positive across all specifications and statistically significant for models 6–8. The coefficient on *LogIncome* was also positive across all specifications and statistically significant for models 7 and 8. From the results of the model estimation, it seems that the variable *Visits* is one of the strongest predictors for a higher willingness to pay for a cleaner creek, and *LogIncome* also contributed positively in a variety of specifications. The coefficients on other variables such as *Age*, *Education*, *Adults*, and *TotalSpend* had the expected positive signs, although none were significant at the 5 percent level.

Table 4 shows the regression results from the model that includes the dummy variables for recreational activity variables *Camp, Picnic, Statepark, Canoe, Swim, Fishing,* and *Hiking*. In this specification, only the coefficient on the *Adults* variable was statistically significant at the 5 percent level. None of the coefficients on the recreational variables were significant, and with the exception of *Picnic*, they were are all positive. At the very least, it makes intuitive sense that these variables are positively related to WTP, as these activities may bring participants nearby a creekside setting; however, it seems that recreational activity plays little to no role in the willingness to pay for a cleaner creek. This may be due to an issue with model misspecification or selection bias, or it could be the case that the variables representing recreational activity have, at best, a weak relationship with WTP. Although this seems counterintuitive, as these activities are directly related to water quality, it could be explained; various local nonprofit environmental organizations make a concerted effort to bring education and awareness of the creek's water quality issues to the public, with publications, events, and signage

Table 4. Estimation of Additional Models*

Variable	Model 6	Model 7	Model 8	Model 9	Model 10
Visits	38.825** (0.048)	44.445** (0.039)	48.169** (0.031)	38.060 (0.058)	24.002 (0.287)
Totalspend	0.312 (0.288)	0.340 (0.246)		0.360 (0.220)	0.327 (0.270)
Male	67.922 (0.185)	72.838 (0.156)	63.567 (0.215)	81.687 (0.118)	57.087 (0.254)
White	208.568 (0.307)	231.243 (0.213)	185.009 (0.269)	203.866 (0.275)	230.942 (0.222)
Age	–12.234 (0.190)				–11.215 (0.230)
Agesquared	0.130 (0.146)			0.0216 (0.287)	0.126 (0.160)
Education	21.307 (0.136)			18.721 (0.189)	23.086 (0.125)
LogIncome	69.470 (0.083)	82.480** (0.054)	85.105** (0.046)	70.994 (0.092)	81.407 (0.063)
Years	–1.584 (0.538)		–1.136 (0.654)	–2.034 (0.416)	–1.300 (0.606)
Ownhome			–25.408 (0.719)	–34.540 (0.637)	–25.359 (0.720)
Miles			–0.745 (0.580)	–1.383 (0.356)	–1.905 (0.188)
Adults			3.433 (0.062)	3.715** (0.041)	3.548** (0.028)
Camp					87.192 (0.176)
Picnic					–45.563 (0.507)
Statepark					35.066 (0.469)
Canoe					4.375 (0.931)
Swim					30.229 (0.632)
Fishing					8.308 (0.901)
Hiking					83.292 (0.187)

Notes: *p-values in parentheses.
**Significant at the 5 percent level (two-tailed test).

posted along the creek, warning against swimming or consuming fish caught along portions of the creek. It could be that because of public awareness from these programs, fewer people are swimming and fishing in creek waters. Indeed, survey data showed only 45 responses for swimming (23 percent) and 39 for fishing (20 percent) as recreational activities people participated in while visiting the creek. For canoeing, however, 88 respondents (45 percent) indicated that they participated in this activity while on a visit to the creek. It would seem that water quality would be an important factor for canoeing, and therefore for WTP for a cleaner creek; however, it could be the case that impairment of water that is not visible to the casual observer has no bearing on a decision to participate in canoeing, as this does not affect enjoyment of this recreational activity. Of course, the possibility of model misspecification, selection bias, or other issues has a significant bearing on estimation of model parameters as well.

CONCLUSION

Determining the dollar valuation of better water quality in Sugar Creek has potential value for public policy for the State of Indiana, as the creek is widely used for a variety of recreational purposes. The revenue generated from visitors to state parks, campgrounds, picnic areas, and hiking trails is significant, with visitors spending, on average, $80 per visit in various categories including food, transportation, equipment rental, and other fees. The contingent valuation method was used to collect survey data and estimate willingness to pay for a cleaner creek and to estimate what factors were most important in influencing WTP. Overall, the results show that the number of visits played the largest role in influencing willingness to pay; a secondary factor was income. The contingent valuation method cannot fully capture all the determinants of WTP; however, it is useful in providing some empirical results that are consistent with economic theory. More research is needed, with future work to be done in specifying different functional forms in the hopes of more precisely capturing the determinants of WTP for cleaner creek waters. A possible application of this research could be a formulation of an optimal tax policy. An optimal tax that is reflective of the external cost associated with pollutants in this waterway would be helpful in internalizing the above externalities and improve social welfare.

ENDNOTES

1. The Sugar Watershed was last assessed by the EPA in 2010. Of the 27 streams and tributaries assessed in the watershed, 14 were classified as Impaired, 6 as Good, and 7 were not assessed (EPA 2013b).
2. For a full list of visitation statistics, see Indiana Department of Natural Resources (2011).
3. Refer to IDEM's website (2013b) for Indiana's Nonpoint Source Management Plan.
4. The full report of the Indiana Nonpoint Source Management Plan is online at IDEM's website (2013b).

5. This was calculated using the Federal Prime Rate of 3.25 percent and the expected inflation rates for the next three years, calculated using the Consumer Price Index from the Bureau of Labor Statistics.
6. The associated test statistic was 128.76 at 5 degrees of freedom. Various multiplicative error structures were examined, and only the variables *Totalspend, Male, Income, Adults,* and *Years* had a significant effect on the error structure.

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