Differences among Watershed Sub-Populations in Willingness to Pay for Water Quality Improvements: The Impact of TMDL Development

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Abstract

The Opequon watershed is located in northern Virginia (VA) and the eastern panhandle of West Virginia (WV). In both states, Opequon Creek is classified as impaired based on violations of bacteria, benthic and biologic standards. Both VA and WV are using Total Maximum Daily Load (TMDL) plans to improve water quality within Opequon Creek. However, these TMDL plans are at different stages with VA being completed and WV still in progress. As part of the TMDL process in VA, this research is based on a contingent valuation survey which was developed to measure the expected monetary benefits of TMDL implementation throughout the Opequon watershed. On the basis of log-likelihood tests of grouped tobit models to explain willingness-to-pay (WTP) for watershed clean-up, VA, WV, and VA riparian landowner respondents were found to consist of different populations. Riparian landowners had the highest median annual WTP at $64, VA respondents the next highest ($49), and WV the lowest ($32). These medians were found to be statistically different from each other. When valuing out-of-state clean-up, however, VA and WV respondents were found to be similar populations with a one-time median WTP of $28. Results show that the TMDL process did impact VA respondent WTP for in-state clean-up.

Introduction

The Opequon watershed is located at the state border of northern Virginia (VA) and the eastern panhandle of West Virginia (WV) (Figure 1). Opequon Creek starts in southern Frederick County, VA and flows east then north, before crossing over into Berkeley County, WV and then emptying into the Potomac River. The VA portion of the Opequon watershed is 97,000 acres in size and the WV portion is slightly larger at 124,000 acres. While the Opequon watershed contains mainly forest and agricultural land, rapid growth and development is being experienced in both states causing additional strains on the quality of water resources (LFSWCD 2006).

The Clean Water Act (CWA) of 1972 serves as the foundation of surface water quality protection in the U.S. (US EPA 2003). Its objective is to restore and maintain the chemical, physical, and biological integrity of the nation's waters (US EPA 2006b). As of 2000, however, 40% of assessed streams were not clean enough to support uses such as fishing and swimming (US EPA, Office of Water 2002).

Under Section 303(d) of the CWA, all states are required to develop a list of impaired waterways. Waterways are determined to be impaired if they do not meet state water quality standards and thus do not support its designated uses. In both VA and WV, Opequon Creek is listed as impaired based on bacteria contamination and degraded aquatic habitat. In both states, impaired waterways require creation of a Total Maximum Daily Load (TMDL) plan[1]. A TMDL is a written plan that specifies the maximum amount of pollution that a water body can receive and still meet water quality standards (US EPA 2005). In addition to a TMDL, some states, such as VA, also complete a TMDL Implementation Plan (IP) which describes actions [*e.g.* best management practices

(BMPs)] to implement the allocations contained in the TMDL study. The main objective of a TMDL IP is to restore water quality within the study area (Commonwealth of Virginia 2003).

Although the Opequon watershed is a continuous drainage area in which all of the land and water areas drain toward Opequon Creek, state standards require that the TMDL studies and IPs be developed independent of one another (US EPA 2006a). In VA, TMDL studies have been completed for creeks within Opequon watershed and a TMDL IP has recently been finalized (as of May 2006). In WV, a TMDL is still in the process of being developed for Opequon Creek and its tributaries. Because the Opequon watershed extends into two states, a multi-disciplinary, multi-state approach is perhaps the most appropriate method to address water quality. The Mid-Atlantic Regional Water Program assisted the use of this approach by facilitating a working relationship between state and local governmental agencies, area stakeholders and landowners, local citizens and watershed organizations and three universities [West Virginia University (WVU), Virginia Tech and the University of Virginia]. Across state lines, these entities had a broad, overarching goal of improving water quality within Opequon Creek watershed.

In order to provide monetary benefit estimates of improved water quality across both states and to facilitate enhanced public involvement in the TMDL process, a contingent valuation (CV) survey was conducted. The specific objectives of this study were to: (1) examine how different sub-samples within the Opequon watershed (the general public in VA as the upstream population versus riparian landowners in VA versus general public in WV as the downstream population) impact monetary values for watershed improvement; and (2) estimate the impact of the TMDL development process on the monetary value of in-state watershed improvement. It was expected that higher willingness-to-pay (WTP) would be found among riparian landowners for in-state improvements and among downstream respondents in WV for upstream (out-of-state) improvement compared to VA respondents. In addition, the TMDL process was expected to have a positive impact on respondent WTP for in-state water quality improvements. Our analysis supported a hypothesis that TMDL had a positive impact on WTP among VA respondents (both general public and riparian landowners). However, WV general public respondents had similar WTP for out-of-state improvements as VA general public respondents.

Methodology

Survey Development, Design, and Distribution

A CV survey instrument was designed and developed during the summer of 2005. The water quality improvements described in the CV questions were designed to approximate the expected outcomes from TMDL implementation. The survey instrument was designed using recommendations from Dillman (2000). To develop the survey instrument, meetings were held with the VA TMDL Steering Committee as well as with the WV Opequon Creek Project Team. In addition, CV surveys used in previous water quality studies were obtained. Focus group interviews were conducted with local citizens and watershed stakeholders. Lastly, three pre-tests were conducted to determine watershed residents' opinions of the survey instrument.

Three similar survey instruments were designed for three separate sub-samples of households: (1) VA general public residents, and (2) VA riparian landowner, and (3) WV residents[2]. Because pollution problems and causes, as well as recreational uses of the main creeks are different in both states, separate surveys were developed for VA and WV residents. However, the general format for each state was the same. Each survey instrument included questions about respondent's use and knowledge of Opequon Creek, opinions about local environmental quality and improvements in the Opequon watershed, and socio-economic characteristics. Additional questions were asked to VA riparian landowners concerning their opinion of water quality problems as well as their willingness to implement BMPs with or without government cost share.

Two CV questions concerning Opequon watershed clean-up projects were included: one for in-state improvements and one for out-of-state improvements. In VA, water quality improvements were described in terms of an increased safety in swimming and wading (Figure 2). In WV, water quality improvements were described in terms of improved sport (game) fish populations as well as an increased safety in swimming and wading (Figure 2).

A combined approach was used to elicit monetary values. In the first CV question, respondents were asked in referendum format how they would vote (Support, Oppose, or Remain neutral/not participate) to clean-up the Opequon watershed within their own state. Supporters were presented with a modified payment card and asked to circle the maximum amount they were willing-to-pay using local taxes as a payment vehicle. If a respondent voted to *Oppose* or *Remain neutral/not participate*, they were asked to check which statement most accurately reflected the decision to provide an indicator for protesting. In the second CV question, respondents were asked how much they would be willing to donate in a one-time payment to a hypothetical Opequon Creek watershed restoration fund for out-of-state clean-up.

A total of 5,000 surveys were distributed by mail to a random sample of household mailing addresses within eight zip codes of the watershed. Of these, 2,500 surveys were mailed to general public households in WV, 2,300 to general public households in VA, and 200 to VA riparian landowners. Because of time and budget constraints, the recommended Dillman (2000) approach to survey distribution was not utilized. A single mailing of the survey instrument was conducted to a larger than normal sample with a follow-up reminder postcard. In addition, local newspapers within the watershed were contacted and agreed to publish articles about the survey.

Empirical Model

Numerous CV studies have examined water quality issues using a variety of survey techniques (Brox, Kumar and Stollery 2003, Collins, Rosenberger and Fletcher 2005, Eisen-Hecht and Kramer, 2002, Hurley, Otto, Holtkamp 1999, Loomis et al., 2000, Stumborg, Baerenklau and Bishop 2001, Whitehead 2000) (Table 1). Typically, these studies found an estimated respondent WTP for an improvement in water quality. The results of these studies are summarized in Table 1.

In this study, empirical WTP models were developed assuming that respondent WTP was a function of three groups of variables: individual use and knowledge of Opequon Creek (K_i); individual attitudes and opinions about local environmental quality including aquatic ecosystems (O_i); and socio-economic characteristics (S_i):

(1) $$WTP_{in} = WTP_i\,(K_i, O_i, S_i),$$

(2) $$WTP_{out} = WTP_i\,(K_i, O_i, S_i),$$

where WTP_{in} and WTP_{out} were respondent i's maximum WTP for improved water quality within and outside the state where the respondent lives. Awareness of the TMDL process was included as a variable within K_i vector and separate sub-samples were evaluated for VA general public, VA riparian landowners, and WV general public as to whether they were part of the same population and similar WTP. Table 2 shows the variables utilized to explain WTP_{in} and WTP_{out}.

The independent variables were selected based on previous CV research as well as economic theory. All variables except *DISTRUST* and *QUALITY* were expected to have a positive relationship with respondent WTP. Coefficient signs for *GENDER*, *LIFE* and *LAND* variables were uncertain given their relationships with WTP have shown mixed results in previous research. The in-state and out-of-state models were similar except for: equation (1) included additional variables reflecting local conditions (*DIRTSED*, *DISTRUST*, *LAND*, *QUALITY*, *TMDL*, and *USE*) while equation (2) contained a knowledge variable about the out-of-state portion of the watershed (*FAMIL*) and an indication of support for an in-state clean-up (*VOTE*).

Survey data for supporters of the clean-up plans were analyzed with a grouped tobit model. A grouped tobit model is based on a complete censoring of the dependent variable into categorical data. Formally, the grouped data tobit model is represented by Greene (2002) as:

(3) $$WTP^* = \beta' X + \varepsilon \text{ where } \varepsilon \sim N(0, \sigma^2),$$

where WTP^* is the true, unobserved willingness-to-pay and X represents the three groups of independent variables. Because each respondent's maximum reported WTP was elicited using a modified payment card approach, WTP^* is bounded between observed lower and upper limits:

(4) $$WTP = j \text{ if } A_{j-1} \leq WTP^* < A_j \text{ where } j = 1 \text{ to } J,\ A_0 = -\infty, \text{ and } A_J = +\infty.$$

Based upon payment card response categories utilized, equation (4) can be represented as:

$$\text{(5)} \qquad WTP = \begin{cases} 1 & \text{if } WTP^* < 5, \\ 2 & \text{if } 5 \leq WTP^* < 10, \\ 3 & \text{if } 10 \leq WTP^* < 15, \\ \vdots & \vdots \\ J & \text{if } WTP^* \geq 1{,}000. \end{cases}$$

Because the threshold values are known, an estimate of the scale parameter (σ) of WTP^* is also provided. Let L_i and U_i denote the lower and upper limits respectively, of the payment card interval in which the i[th] individual's willingness to pay (WTP_i) is observed. For example, when WTP_i is equal to 1, then L_i is $-\infty$ and U_i is A_1. The conditional mean function is the expected value of WTP^* in this range. The log likelihood function to maximize becomes:

$$\text{(6)} \qquad \log L = \sum_{i=1}^{n} \log [\ \Phi(Z_{Ui}) - \Phi(Z_{Li})],$$

where $\Phi(\cdot)$ is the cumulative standard normal density function, $Z_{ji} = (j - \beta' X)$, and j=lower (L) or upper (U) interval limits for each of n respondents. The software package *LIMDEP* was employed for the grouped tobit estimation (Greene 2002).

With payment card values expressed as lognormal, a lognormal conditional distribution for WTP was used so that the individual fitted conditional means and medians of WTP were easily reconstructed from the data (Cameron and Huppert 1989). The individual fitted median WTP_i for individual i was computed as $\exp(\beta X_i)$. The individual fitted mean WTP values are calculated by scaling the median by the estimated constant equal to $\exp(\sigma^2/2)$, or conditional mean $WTP_i = \exp(\beta X_i + \sigma^2/2)$. Thus, the conditional mean is sensitive to σ values, where median estimates do not take σ values into account. Individual mean and median annual WTP values were averaged over all respondents, including those respondents opposing or remaining neutral who were assigned a zero WTP. This was done to provide weighted estimates of the conditional average annual mean and conditional average annual median (Rosenberger, Collins and Svetlik 2005).

To determine if respondents from VA and WV could be pooled into one model, log likelihood ratio (LLR) test was used. The LLR test statistic used was $2*(LLR_U - LLR_R)$ using a χ^2 distribution with degrees of freedom equal to the number of restrictions imposed by the null hypothesis. LLR_U is the unrestricted model, which was computed from the sum of the individual LLRs from each sub-sample model. LLR_R is the restricted model based on combining the two sub-samples into one pooled sample. The null and alternative hypotheses for the estimated coefficients were:

$$H_o: \beta_{WV} = \beta_{VA} \text{ (restricted model)}$$

$$H_1: \beta_{WV} \neq \beta_{VA} \text{ (unrestricted model).}$$

Separate LLR tests were conducted to compare: VA and WV general public respondents' in-state and out-of-state WTP for watershed clean-ups; and VA general public and VA riparian landowner in-state WTP for water quality improvements.

Lastly, in CV surveys, there is often a proportion of the sample that reports a zero WTP yet has a non-zero *WTP**. These responses are known as protest zeros. Protest responses were identified as opposed and neutral respondents who thought that someone else should pay for water quality improvements, taxes were not the best way to pay for these improvements, or the improvements could not be accomplished. Protest respondents were excluded from the analysis. As described by Jorgensen and Syme (2000), this censoring of the survey sample will mostly likely bias the sample relative to the general population.

Results

Surveys were mailed out in August and September of 2005. Response rates were calculated based on a total of 625 returned survey questionnaires: 230 from VA general public, 332 from WV general public, and 63 from VA riparian landowner households. The overall response rate was 13%. Sample respondents were compared to watershed population statistics from the 2000 Census (Table 3). In both WV and VA, the average respondent was older and consisted of higher percentages of males, homeowners, college educated, and higher incomes compared to watershed populations. With the exception of percentage of males, VA riparian landowners had larger differences when compared to the watershed population.

Only a minority of survey respondents were not familiar with the Opequon Creek, while majorities of respondents had used the creek for recreation, were concerned about aquatic life, and thought there were environmental problems with Opequon Creek (Table 4). A minority of VA respondents (14%) were aware of the TMDL. As would be expected, VA riparian landowners were more aware of the problems with Opequon Creek and the TMDL than the general public (Table 4).

Most survey respondents supported water quality improvements in the Opequon watershed. In VA, 72% of general public respondents were in support of the in-state clean-up plan with 11% opposed and 17% remaining neutral. Over two-thirds of all riparian landowner respondents were in support of the in-state water quality improvement plan compared to one-third opposed or remained neutral. In WV, 69% of general public respondents were in support while the remaining 31% were not supportive (11% opposed and 20% remained neutral). Approximately 67% of VA and WV general public respondents had a positive monetary response for the out-of-state water quality improvement plan. Only 54% of VA riparian landowner respondents had a positive monetary response for the out-of-state plan.

To determine if VA and WV general public respondents were similar in what explains WTP for in-state clean-up, a grouped tobit model was developed and state sub-samples were compared on the basis of LLR tests (Table 5). The log likelihood results were -767.46 for the pooled (WV + VA) versus -323.43 for VA and for -432.40 WV. The LLR test statistic of 23.26 was slightly greater than a 5% significance level ($\chi^2_{0.05, 13}$ = 22.36) so that the null hypothesis cannot be accepted. Thus, the VA and WV sub-samples cannot be pooled for in-state WTP for watershed clean-up.

Separate VA and WV grouped tobit models were developed (Tables 6 and 7). The VA model included the variable *TMDLEDU* as a replacement for *DISTRUST*[3]. VA model results showed statistically significant, positive impacts on WTP for in-state clean-up from respondents who were: recreation users, very concerned about aquatic life; aware of the TMDL and had at least a college education, older, and had a higher income (Table 6). The *TMDL* variable had a negative coefficient which was not statistically significant. WTP was lower among VA respondents who believed the local environment had improved in recent years. The WV grouped tobit model showed that older, higher income, and recreational users had statistically positive impacts on WTP for water quality improvements within the WV portion of Opequon watershed (Table 7). Those WV respondents who lived within the watershed their entire life had a statistically significant, negative impact on WTP.

A LLR test was used to determine if VA riparian landowner respondents could be pooled with VA general public respondents (Table 8). A test statistic of 27.09 was calculated which is greater than the 5% significance level ($\chi^2_{0.05, 14}$= 23.69). The null hypothesis cannot be accepted and VA general public and VA riparian landowner respondents cannot be pooled. Thus, LLR tests showed that all three sub-samples are separate populations and should not be pooled when estimating in-state WTP. Grouped tobit model results for VA riparian landowners showed statistically significant, positive impacts on WTP from college educated and aware of the TMDL. Those landowners who had lived within Opequon watershed their entire life had a lower WTP for improved water quality within the Virginia portion of the Opequon watershed.

Examining the impact of TMDL across in-state WTP models, signs on the coefficients and statistical significance of *TMDL* and *TMDLEDU* were opposite for VA general public and VA riparian landowner respondents. For VA general public respondents, *TMDL* was not statistically significant but *TMDLEDU* was. For VA riparian landowner respondents, *TMDL* alone was found to be statistical significant while *TMDLEDU* was not. However, for both respondent sub-samples, only statistically significant variable had a positive coefficient. In addition, the coefficient on *TMDL* for VA riparian landowners was considerably larger than the coefficient on *TMDLEDU* for VA general public respondents. These findings confirm that TMDL awareness has a greater effect on WTP by VA riparian landowners compared to VA general public respondents.

To determine if VA and WV respondents were similar in what explains out-of-state WTP, a LLR test was conducted between these two sub-samples (Table 9). When comparing the VA and WV respondents, the LLR test statistic was 14.91 which is less than a 5% significance level ($\chi^2_{0.05,\ 10}$=18.31). Thus, the null hypothesis cannot be rejected and the two populations can be pooled. This LLR test showed that VA and WV respondents were from the same population when explaining out-of-state WTP for watershed clean-up. In the pooled grouped tobit model, statistically significant, positive impacts were found for respondents who were familiar with the other states' portion of the watershed, were very concerned about aquatic life, had supported in-state water quality improvements, were older, and had a higher income.

Before sample average WTP values could be estimated, protest responses were examined. Among VA general public respondents, 69 respondents opposed or remained neutral, of which 41% were determined to be protesters. Nine non-supporters among the VA riparian landowner respondents (43%) were found to be protesters, leaving a total of 12 landowner respondents with true zero WTP. For WV respondents, 117 opposed or remained neutral and 49 were determined to be protesters (42%). Excluding protesters, 41 respondents in VA and 68 respondents in WV were assigned a zero WTP for improved water quality in Opequon watershed.

Mean and median welfare estimates were calculated for the sample respondents by multiplication of supporter respondent data times the separate in-state model coefficients and including the non-protest zero WTP observations (Table 10). For the out-of-state model welfare estimates, coefficients from the pooled model were used to compute mean and median WTP for each supporter observation. All zero responses for out-of-state clean-up were included directly in the mean and median welfare estimates for the sample.

Respondents in VA were found to have higher annual WTP for in-state water quality improvements than those in WV (Table 10). Across both supporter and non-protest zero sample respondents, the average annual WTP for median and mean estimates in VA varied from $49 to $69 compared with $32 to $45 in WV. Based upon 95% confidence intervals, all averages were different from zero and VA WTP was higher than WV WTP. Mean calculations had higher averages than median calculations. Riparian landowner households had average annual WTP between $64 and $80, statistically greater than both VA and WV general public respondents. For out-of-state water quality improvements, VA and WV respondents had average WTP of $28 to $43 for a one-time donation. VA riparian landowner respondents had average out-of-state WTP ranging from $8 to $35. Due to differences in payment periods (five year versus one-time), WTP cannot be directly compared between in-state and out-of-state unless discounting is applied to the in-state WTP values.

The impact of the TMDL process on WTP for VA in-state watershed clean-up is shown in Tables 10 and 11. When examining only VA respondents, WTP was 100% larger for those respondents who were aware of the TMDL and had a college education compared to respondents who had not heard about the TMDL (Table 10). The TMDL process also made a major contribution to the difference between WTP across states. Among respondents with no awareness of the TMDL, VA WTP was 16% higher than

WV WTP. With TMDL awareness, however, the difference between VA and WV WTP for in-state clean-up increased to 94% (Table 11).

Conclusions

Contingent valuation (CV) surveys were sent to households within one watershed (Opequon Creek) in both Virginia (VA) and West Virginia (WV). On the basis of log-likelihood ratio tests of grouped tobit models to explain willingness-to-pay (WTP) for watershed clean-up plans, each of the three sub-samples (VA general public, VA riparian landowners, and WV general public) were found to be different populations when valuing in-state water quality improvements. VA riparian landowners in the sample were found to have a statistically greater WTP (median annual WTP of $64) than either general public sub-sample.   The median annual WTP of $49 for VA general public respondents was statistically larger than WV respondents (median annual WTP of $32). When valuing out-of-state clean-up, VA and WV respondents were found to be similar populations with a one-time WTP of $28. Thus, WV respondents had neither different explanatory influences nor a higher WTP for out-of-state (i.e. upstream) watershed clean-up than VA respondents. However, as expected, riparian landowners had the largest in-state WTP. This larger monetary value partially reflects the additional landowner benefits (recreation, property value, etc.) stemming from water quality improvements in the Opequon Creek.

A portion of the higher in-state WTP in VA can be attributed to the TMDL process. Although awareness of the TMDL was low among survey respondents in VA (only 14%), this variable had a statistically significant, positive impact on WTP for in-state watershed clean-up. However, this positive impact was limited to college educated respondents. One implication of this result is that the marketing and encouragement of public participation within the TMDL process needs to reach a broader audience than the highly educated.

The CV monetary values found in this study have validity from two perspectives: (1) relative to previous CV research on watershed improvements, WTP values for the Opequon watershed improvement were on the low side of the range; and (2) income had statistically significant, positive impacts in explaining WTP in group tobit models using general public respondents. Given the unreasonably high number of protestors in the data set (14% of all respondents), additional analysis of these respondents is warranted.

A major limitation of this study was that a low percentage response rate makes it difficult to extend survey results to the entire watershed population. However, this response rate does not necessarily invalidate within sample comparisons between VA and WV as respondents from any subsequent mailing probably would be similar to the initial mailing[4]. Another limitation is that it is difficult to determine what role the TMDL process played in stimulating respondent interest and valuation for water quality improvements. Did the TMDL process motivate respondents to have higher a WTP for water quality improvements or does TMDL awareness simply denote a pre-existing interest in water quality issues? This question is left for future research.

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Table 1. Summary of Previous Water Quality CV Studies

Study	Water body	Survey type	Response rate	Annual household WTP range [a] ($\approx$)
Brox, Kumar and Stollery (2003)	Grand River	Mail	70%	$60-$123
Collins, Rosenberger and Fletcher (2005)	Deckers Creek	Mail, Internet & personal interviews	53%	$154-$206
Eisen-Hecht and Kramer (2002)	Catawba River	Mail & telephone	47%	$156
Hurley, Otto and Holtkamp (1999)	Two small watersheds in Southern Iowa	Mail	33%	$60-$97
Loomis et al. (2000)	South Platte River	Mail & personal interviews	26%	$296
Stumborg, Baerenklau and Bishop (2001)	Lake Mendota	Mail	44%	$65-$99
Whitehead (2000)	Pamlico Sound	Telephone	71%	$155-406

[a] Estimates reported in 2006-year dollars. Original WTP estimates were adjusted using Consumer Price Index.

Table 2. Variables Used in WTP Models and Their Expected Sign

Category	Variable	Coding	Expected Sign
Use and Knowledge (*K*)	*DIRTSED*	1= Aware of dirt/sediment problems in creeks, 0 otherwise.	(+)
	FAMIL	1= Familiar with the out-of-state portion of Opequon watershed, 0 otherwise.	(+)
	FISH	1= Regularly fish in a lake, creek, or river, 0 otherwise.	(+)
	PUBACC	1= Would like public access for fishing and recreation as an improvement, 0 otherwise.	(+)
	TMDL[a]	1= Aware of TMDL, 0 otherwise.	(+)
	TMDLEDU[a]	Interaction variable, TMDL*EDU. 1= aware of TMDL and college or graduate school educated, 0 otherwise.	(+)
	USE	1= Use creeks for recreation, 0 otherwise.	(+)
Attitude and Opinions (*O*)	*CONCERN*	1= Very concerned about fish and other aquatic life, 0 otherwise.	(+)
	DISTRUST	1= Distrust local government to make decisions about the clean-up of Opequon watershed, 0 otherwise.	(-)
	QUALITY	1= Quality of environment in past few years has improved, 0 otherwise.	(-)
	VOTE	1= Had a positive WTP for in-state improvements, 0 otherwise.	(+)
Socio-Economic Characteristics (*S*)	*AGE*	A respondent's age (years).	(+)
	EDU	1= Education level is at least a college degree, 0 otherwise.	(+)
	GENDER	1= Female, 0 otherwise.	(?)
	INCOME	Mid-point of survey categories. Under $10K category= $10K, $200K+=$250K ($1,000's).	(+)
	LAND	1= Home or residential landowner, 0 otherwise.	(?)
	LIFE	1= Lived within Opequon watershed their entire life, 0 otherwise.	(?)

[a] For VA residents only.

Table 3. Comparing VA and WV Respondents to Watershed Census Data

	Male	Median age (years)	Bachelor degree or higher	Owner occupied housing units	Income greater than $50,000
VA watershed population	49.2%	36.0	21.6%	61.8%	39.0%
VA general public respondents	60.0%	51.0	53.0%	79.0%	53.0%
VA riparian landowner respondents	56.0%	54.0	57.0%	84.0%	72.0%
WV watershed population	49.5%	36.0	15.0%	71.4%	35.3%
WV respondents	69.0%	52.0	40.0%	84.0%	51.0%

Table 4. Summary of Responses to Selected Survey Questions.

Content of Survey Question	VA (N=230)	VA Riparian Landowners (N=63)	WV (N=332)
Not familiar with Opequon Creek.	23%	6%	18%
Have used Opequon Creek for recreation.	53%	63%	64%
Very concerned about fish and other aquatic life in Opequon Creek.	46%	46%	57%
Thought there are environmental problems with Opequon Creek.	60%	77%	71%
Aware of the TMDL for Opequon watershed.	14%	30%	[a]

[a] This question was not asked in the WV survey because the TMDL development process had just started

Table 5. Summary of Grouped Tobit Model Results when comparing WTP for In-State Clean-up by VA and WV General Public Respondents

Variable	WV coefficient estimate	WV Standard Error	VA coefficient estimate	VA Standard Error	Pooled coefficient estimate	Pooled Standard Error
Constant	2.298***[a]	0.354	1.721***	0.412	2.162***	0.274
DIRTSED	0.107	0.14	-0.259	0.163	-0.027	0.109
FISH	-0.114	0.159	0.124	0.184	-0.039	0.121
PUBACC	-0.145	0.142	-0.077	0.159	-0.131	0.108
TMDL			0.138	0.215	0.232	0.206
USE	0.6***	0.166	0.476***	0.167	0.497***	0.12
CONCERN	0.159	0.137	0.279*	0.151	0.201*	0.104
DISTRUST	0.052	0.131	0.321**	0.151	0.162	0.1
QUALITY	-0.7	0.435	-1.046	0.707	-0.891**	0.374
AGE	0.013***	0.005	0.014**	0.006	0.121***	0.004
EDU	0.281	0.139	0.456***	0.157	0.199*	0.106
GENDER	0.197	0.151	0.014	0.156	0.097	0.11
INCOME	0.006***	0.002	0.009***	0.001	0.008***	0.001
LAND	-0.048	0.184	-0.014	0.216	-0.061	0.141
LIFE	-0.56***	0.163	0.26	0.2	-0.24*	0.129
Sigma	0.835***	0.047	0.825***	0.054	0.863***	0.037
Log-likelihood	-432.40		-323.43		-767.46	
Sample size	180		136		316	

[a] Note: *, **, *** denote statistical significance at P<0.10, P<0.05, P<0.01, respectively.

Table 6. Summary of Final Grouped Tobit Model Results by VA General Public Respondents for In-state Clean-up (N=136)

Variable	Coefficient Estimate	Standard Error	Variable	Coefficient Estimate	Standard Error
Constant	1.947***[a]	0.412	*AGE*	0.015***	0.006
DIRTSED	-0.225	0.164	*EDU*	0.348**	0.169
FISH	0.087	0.184	*GENDER*	-0.048	0.158
PUBACC	-0.052	0.16	*INCOME*	0.009***	0.001
TMDL	-0.311	0.322	*LAND*	-0.148	0.22
TMDLEDU	0.827*	0.431	*LIFE*	0.32	0.202
USE	0.528***	0.169			
CONCERN	0.347**	0.152	*Sigma*	0.831***	0.054
QUALITY	-1.24*	0.7	Log-likelihood	-323.833	

[a] Note: *, **, *** denote statistical significance at P<0.10, P<0.05, P<0.01, respectively.

Table 7. Summary of Final Grouped Tobit Model Results by WV Respondents for In-state Clean-up (N=180)

Variable	Coefficient Estimate	Standard Error	Variable	Coefficient Estimate	Standard Error
Constant	2.298***[a]	0.354	*AGE*	0.13***	0.005
DIRTSED	0.107	0.14	*EDU*	0.281	0.139
FISH	-0.114	0.159	*GENDER*	0.197	0.151
PUBACC	-0.145	0.142	*INCOME*	0.006***	0.002
USE	0.6***	0.166	*LAND*	-0.045	0.184
CONCERN	0.159	0.137	*LIFE*	-0.56***	0.163
DISTRUST	0.052	0.131	*Sigma*	0.835***	0.047
QUALITY	-0.701	0.435	Log-likelihood	-432.403	

[a] Note: *, **, *** denote statistical significance at P<0.10, P<0.05, P<0.01, respectively.

Table 8. Summary of Grouped Tobit Model Results when comparing WTP for In-State Clean-up by VA General Public (VAGP) and VA Riparian Landowner Respondents (VARL)

Variable	VAGP Coefficient Estimate	Standard Error	VARL Coefficient Estimate	Standard Error	Pooled Coefficient Estimate	Pooled Standard Error
Constant	1.892***[a]	0.399	2.81***	0.959	1.964***	0.38
DIRTSED	-0.223	0.164	0.343	0.28	-0.121	0.146
FISH	0.081	0.177	0.272	0.401	0.221	0.164
TMDL	-0.161	0.332	1.339**	0.589	0.073	0.293
TMDLEDU	0.669	0.438	-0.589	0.677	0.396	0.381
USE	0.518***	0.169	-0.395	0.294	0.354**	0.154
CONCERN	0.359**	0.152	0.213	0.282	0.347**	0.141
QUALITY	-1.241*	0.698	0.551	0.824	-0.369	0.532
AGE	0.015***	0.006	0.014	0.011	0.015***	0.005
EDU	0.357**	0.169	0.863**	0.384	0.405**	0.16
GENDER	-0.051	0.158	-0.512	0.343	-0.072	0.147
INCOME	0.008***	0.001	0.001	0.004	0.008***	0.001
LAND	-0.109	0.22	-0.084	0.426	-0.176	0.198
LIFE	0.363*	0.202	-1.356***	0.421	0.158	0.187
Sigma	0.828***	0.054	0.678***	0.084	0.857***	0.05
Log-likelihood	-318.54		-78.91		-410.58	
Sample size	N=134		N=37		N=171	

[a] Note: *, **, *** denote statistical significance at P<0.10, P<0.05, P<0.01, respectively.

Table 9. Summary of Grouped Tobit Model Results when comparing WTP for Out-of-State Clean-up by VA and WV General Public Respondents

Variable	WV Coefficient Estimate	WV Standard Error	VA Coefficient Estimate	VA Standard Error	Pooled Coefficient Estimate	Pooled Standard Error
Constant	2.071***[a]	0.368	1.924***	0.435	2.051***	0.286
FAMIL	0.183	0.208	0.612**	0.282	0.349**	0.17
FISH	0.32**	0.156	-0.023	0.199	0.202	0.124
PUBACC	-0.361**	0.157	0.135	0.183	-0.149	0.121
CONCERN	0.234	0.151	0.244	0.175	0.237**	0.116
VOTE	0.532***	0.183	0.241	0.24	0.448***	0.147
AGE	0.013**	0.005	0.017***	0.006	0.013***	0.004
EDU	0.039	0.159	0.0002	0.181	0.03	0.118
INCOME	0.007***	0.002	0.005***	0.002	0.006***	0.001
GENDER	0.12	0.17	-0.646	0.18	-0.202	0.123
LIFE	-0.402**	0.173	0.237	0.243	-0.211	0.141
Sigma	0.896***	0.052	0.887***	0.063	0.916***	0.041
Log-likelihood	-414.506		-292.236		-714.196	
Sample size	N=169		N=120		N=289	

[a] Note: *, **, *** denote statistical significance at P<0.10, P<0.05, P<0.01, respectively.

Table 10. Summary of Mean and Median WTP by VA, VA Riparian Landowners (VARL) and WV Respondents, 95% confidence interval in parenthesis

	In-state WTP			
	Mean WTP>0 VAGP (N=136) VARL (N=37) WV (N=180)	Mean WTP ≥ 0 VAGP (N=177) VARL (N=49) WV (N=248)	Median WTP>0 VAGP (N=136) VARL (N=37) WV (N=180)	Median WTP ≥ 0 VAGP (N=199) VARL (N=49) WV (N=221)
VA	$89.32 (75.61,103.03)	$68.63 (56.61,80.65)	$63.24 (53.53,72.95)	$48.59 (40.16,57.02)
VARL	$105.43 (82.40,128.46)	$79.61 (58.05,101.17)	$84.10 (65.73,102.47)	$63.50 (46.30,80.70)
WV	$61.70 (56.42,66.98)	$44.78 (39.64,49.92)	$43.55 (39.82,47.28)	$31.61 (27.98,35.24)

	Out-of-state WTP			
	Mean WTP>0 Pooled (N=289) VARL (N=30)	Mean WTP ≥ 0 Pooled (N=454) VARL (N=54)	Median WTP>0 Pooled (N=289) VARL (N=30)	Median WTP ≥ 0 Pooled (N=454) VARL (N=54)
Pooled	$63.96 (60.11,67.81)	$42.85 (39.11,46.59)	$42.03 (39.50,44.56)	$28.16 (25.70,30.62)
VARL[a]	$62.23	$34.57	$50.00	$7.50

[a] There was no grouped tobit model for out-of-state WTP due to insufficient observations of riparian landowners and a lack of variation in the variables. Instead, WTP was calculated from survey response data.

Table 11. Effect of Awareness of TMDL on Median WTP by VA Respondents[a]

	Not aware of the TMDL and less than a college education, TMDL=0 & TMDLEDU=0.	Aware of the TMDL and at least a college education, TMDL=1 & TMDLEDU=1.
VA	$40.05	$80.48

[a] WTP values were calculated using VA in-state grouped tobit model coefficients and VA sample means of the other independent X variables.

Table 12. Comparing Median WTP for WV and VA Respondents[a]

	Not aware of the TMDL, TMDL=0 & TMDLEDU=0	Aware of the TMDL and at least a college education, TMDL=1 & TMDLEDU=1
VA	$46.99	$78.71
WV	$40.55	

[a] WTP values were calculated using pooled means (from VA and WV) of the other independent variables and coefficient estimates from each separate grouped tobit model.

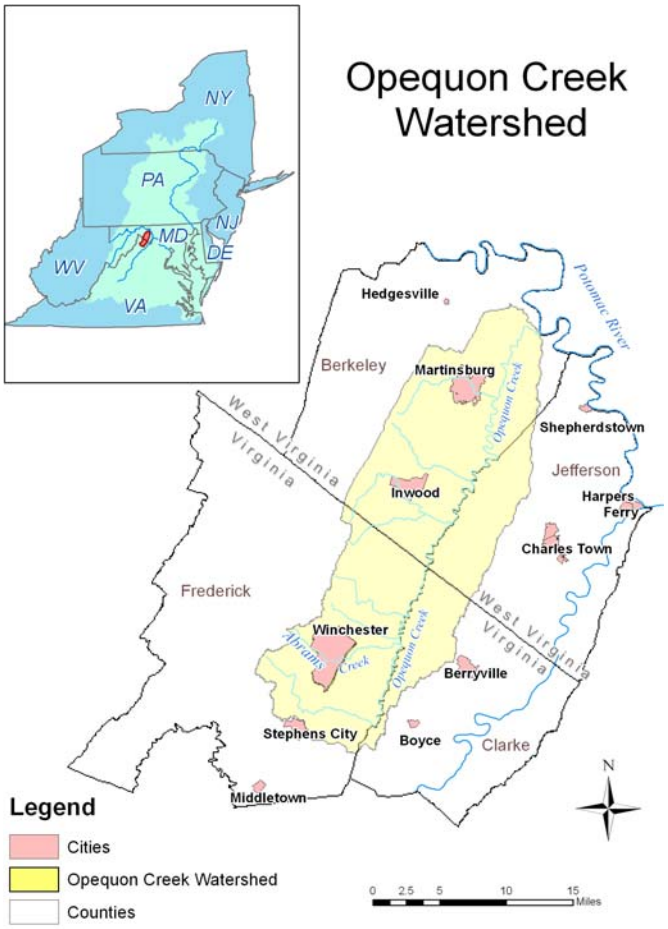

Figure 1. Map of Opequon Watershed

VA In-State

Opequon and Abrams Creeks are currently polluted with dirt and sediment along with sewage and bacteria. Because of these pollutants, no swimming or wading is recommended in the Virginia portion of these Creeks. Assume that you are asked to vote on a project that would provide the funding required to clean up Opequon and Abrams Creeks. In approximately five years, this clean up would make Opequon and Abrams Creeks safe for swimming and wading in the Virginia portion. This project would raise local taxes over a five-year period in order to pay for the clean up project. Would you support, oppose, or remain neutral about this project?

WV In-State

Opequon Creek is currently polluted with excessive nutrients and bacteria from sources such as agriculture, urban runoff, and sewage occurring in West Virginia. Because of these pollutants, no swimming or wading is recommended in Opequon Creek. While this creek is stocked annually with trout, not all portions of the creek can support year-round sport fish populations (bass, bluegill, trout, etc.). Assume that you are asked to vote on a project that would provide the funding required to clean up Opequon Creek. In about five years, this clean up would make Opequon Creek safe for swimming and wading. It would also provide habitat for year-round fish populations. This project would raise county taxes over a five-year period in order to pay for the clean up project. Would you support, oppose, or remain neutral about this project?

Figure 2. CV Questions

Endnotes

[1] In VA, the American Littoral Society and the American Canoe Association successfully sued the EPA on the basis that the state of VA was failing to clean up its impaired waters. In WV, TMDL development started in 1997 under a consent decree from lawsuit filed by Ohio Valley Environmental Coalition. This decree mandated that TMDL reports must be developed for impaired water bodies.

[2] WV riparian landowners were not surveyed because of lack of information on their names and addresses.

[3] In this model, the *DISTRUST* coefficient had an unexpected positive sign. Upon further investigation using contingency tables, this *DISTRUST* was found to reflect college educated respondents who were aware of the TMDL. Thus, an interaction term of *TMDL* and *EDU* was utilized as a variable.

[4] Filion (1976) found significant bias when explaining hunting success between early and late respondents. More related to this study, however, Wellman et al. (1980) found minimal differences in respondent attitudes and socio-demographic characteristics when initial and subsequent waves of responses were compared in a water-based outdoor recreation survey.