Residents' Preferences in Adopting Water Runoff Management Practices: Examining the Effect of Behavioral Nudges in a Field Experiment

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Abstract

Numerous watersheds in the United States have been severely polluted by nutrient-laden runoff, and the pollutants come from industrial, agricultural, and residential sources. Efforts to reduce such pollution have focused almost entirely on industrial and agricultural sources, and little attention has been paid to encouraging residents to manage and reduce runoff from their homes. We conducted a field experiment to study residents' willingness to adopt water runoff-management practices for their lawns and other landscaping. In the experiment, 336 individuals who resided in the Delaware River watershed participated in a series of auctions that revealed their willingness to pay (WTP) for five runoff-management practices. We tested the effects of two behavioral nudges, framing and default priming, on their WTP. The framing treatments examined the effectiveness of two messages: "Adopting the practices can help improve water quality" (positive framing) and "Water quality would keep getting worse if residents do not take action" (negative framing). The results show that positive framing increased average WTP while negative framing had no significant impact. Default priming did not influence participants' decision about whether to bid but did have a positive impact on WTP by participants who placed bids.

JEL Codes: D12, Q24, Q50

Keywords: Residents' Preferences; Water Runoff Management; Field Experiments; Positive versus Negative Framing; Continuous Default Priming

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Introduction

Nutrient pollution occurs when excess nutrients, mainly nitrogen and phosphorus, are transported to bodies of water where they act like fertilizer, causing excessive growth of algae (National Oceanic and Atmospheric Administration (NOAA), 2016). The U.S. Environmental Protection Agency (EPA) (2016) has identified this type of pollution as one of America's most widespread, costly, and challenging environmental problems. As the algal growth expands, the supply oxygen in the water is depleted (eutrophication), which destroys the quality of the water and other aquatic species of plants and animals. Furthermore, some algal blooms are harmful to humans who come in contact with the polluted water or consume tainted fish or shellfish (EPA, 2016). Conservative estimates of the short-term impacts of eutrophication of U.S. fresh waters put the cost at approximately $2.2 billion annually (Dodds et al., 2009).

The primary sources of nutrient pollution are industrial emissions, agricultural runoff, storm water, sewer and septic wastewater, and residential runoff. Industrial point sources of wastewater runoff have received considerable attention, and many in the United States are now well-regulated by EPA under the Clean Water Act (CWA). Agricultural runoff carrying sediment, fertilizers, herbicides, and pesticides is one of the major contributors of nonpoint-source pollution (Stuart et al., 2014) and has been the primary focus of efforts to reduce that type of pollution. For example, the U.S. Department of Agriculture (USDA) and its partners offer a variety of programs that subsidize agricultural conservation practices, including reduction of nutrient runoff (e.g., the Environmental Quality Incentives Program and the Conservation Stewardship Program).

Because of the important role of agriculture in containing nonpoint-source pollution, numerous studies have examined farmers' willingness to adopt nutrient management practices and searched for effective ways to encourage adoption (Segersen, 1988; Suter et al, 2008; Hansen et al., 2012; Savage and Ribaudo, 2016; Miao et al., 2016). Farmers are generally knowledgeable about the effects of agricultural production on water quality, and many feel a sense of environmental responsibility (Paolisso and Maloney, 2006). They have shown a willingness to adopt best management practices, especially when such practices have been offered through incentive programs (Palm-Forster et al., *forthcoming*). Hite et al. (2002) found broad support among the public in the United States for such incentive programs.

Fertilizers used for urban and suburban lawn care also contribute to nutrient runoff (NOAA, 2016). Although the amount of pollution from individual residences is small relative to large agricultural operations, it is far from negligible. Most agricultural operations are specifically exempted as non-point source polluters under the CWA so are not subject to EPA regulation as non-point source polluters. This is one of the reasons that the majority of agricultural water quality programs rely on voluntary payment programs. The EPA does have a regulatory framework that target some residential sourced pollution at the municipal level. In municipalities with a combined sewer system, runoff is routed with sewage to treatment plants which is regulated as a point source under the NPDES (National Pollution Discharge Elimination System) permit program. Municipalities that have dedicated storm water drainage systems are regulated under the municipal separate storm systems (MS4) classification. The MS4 designation was rolled out in two phases. In 1990 Phase I required NPDES permit coverage for large cities, followed by Phase II, which extended this requirement to small cities and non-urban areas in 1999. NPDES for MS4s require municipalities to demonstrate the implementation of six "minimum control measures:" Public Education and Outreach; Public Participation and Involvement; Illicit Discharge Detection and Elimination; Construction Site Runoff Control; Post-Construction Runoff Control; and Pollution Prevention. The most applicable of these to existing residents is the "Post-Construction Runoff Control" measure. This directs the municipality to create and implement a program to control runoff pollution.

The standards required to meet this measure vary at the state level. These typically require some combination of enforceable levels of volume and contamination and adoption of best management practices (BMPs). The cost to meet these requirements are borne by the municipality and hence allocated across the municipality through municipal taxes or service fees. This creates an opportunity for free-riding. A resident who chooses to intensify their use of fertilizer imposes an increased cost of remediation on their community, while a resident who opts for a more sustainable lawn care approach produces a benefit which is shared by the community through decreased remediation cost. To our knowledge, only a few studies have investigated instruments that encourage individuals to adopt water runoff-management practices, however there have been some case studies measuring values and knowledge of residential BMPs in Chicago (Ando and Freitas, 2011) and Syracuse (Baptiste et al, 2015). One way of reducing this externality is to subsidize residents to improve their lawn management to compensate them for the benefit they are providing to the community.

Individuals controlling the amount of nutrient runoff from their home landscaping provide a public good by reducing pollution and protecting waterways, and consumers generally are willing to pay a premium for goods that provide both public and private value. Numerous studies have found that providing information about the public component of the good is effective in increasing consumers' valuations (e.g., Lusk, et al 2004; Bougherara and Combris, 2009; Rousseau and Vranken, 2013; Li and McCluskey, 2017; Messer, et al 2017). The effectiveness of such information varies with how it is framed and whether it focuses on the positive aspects of the product of interest or highlights the negative effects of the alternatives (Gifford and Bernard, 2005; Okada and Mais, 2010; Liaukonyte et al, 2013; Wu et al., 2014). Tversky and Kahneman (1981), for example, found that people tended to avoid risk when presented with positive framing and sought risk when presented with negative framing. Other experiments showed that framing had a significant influence on participants' contributions to public goods (Andreoni, 1995), justice judgements (Gamliel and Peer, 2006), and efforts to address climate change (Spence and Pidgeon, 2010).

In addition to framing, the default option presented can influence behavior because people tend to prefer for the status quo over actively opting in favor of an alternative (Thaler and Sunstein, 2008). Status-quo bias has been observed in many fields and a variety of forms (Kahneman et al., 1991, 1993), including retirement savings (Madrian and Shea, 2001), organ donation (Johnson and Goldstein, 2003), charitable giving (Zarghamee et al. 2017), and agricultural marketing (Messer et al., 2008). In addition to asking participants to opt in or out of a bid or purchase, experiments can also use defaults to vary the reference prices for goods in a commodity market.

This study measures consumers' implied values for water runoff-management practices and how those values change in response to different types of framing and default values for participants' bids. In spring 2016, we conducted a field experiment to study residential preferences for adopting lawn-water runoff-management practices involving people who resided in the Delaware River watershed. They were given opportunities to bid on items that could be used to reduce their contributions to residential nutrient runoff. The experiment was designed to investigate three primary questions:

1) Do residents have positive willingness to pay (WTP) to adopt practices that would decrease the amount of nutrient runoff from their landscaping?

2) Do behavioral nudges such as default priming and framing influence WTP, and, if so, which are most effective in encouraging adoption of pollution control methods?

3) Does residents' WTP vary according to any demographic characteristics?

The results from a field experiment involving 336 individuals suggest that the willingness to pay varies by practice and women and individuals who had children were most willing to adopt the practices, and rural residents were less willing to pay for the products than urban residents. Default-priming did not influence participants' likelihood of placing a bid but had a significant impact on WTP by those who chose to bid. Positive framing increased average WTP by $3.14 while negative framing had no significant impact.

Experimental Design

Residents' willingness to adopt nutrient-management practices could be estimated using contingent valuation, a choice-based conjoint analysis, or an experimental auction (Lusk and Hudson, 2004). To draw credible causal inferences about the impacts of framing and priming in a residential nutrient-runoff setting, e used an experimental auction in which participants paid money for actual products that represented pollution-control practices—native plants, biochar, soil test kits, peat moss, and soaker hoses, which had similar market prices at the time—because it allowed us to test our hypotheses with a direct, incentive-compatible instrument.

We conducted a randomized controlled trial with individuals who resided in the Delaware River watershed. The Delaware River begins in upstate New York and flows into Delaware Bay, which separates New Jersey and Delaware. The watershed includes portions of New York, New Jersey, Pennsylvania, Delaware, and Maryland, and the river basin traverses extensive urban and suburban tracts in southeastern Pennsylvania and western New Jersey. In 2001, 18% of the land in the watershed was used for agriculture and 14% was residential (Philadelphia Water Department, 2007). The watershed provides drinking water to approximately 6% of the U.S. population and ranks fifth among the country's most polluted waterways (Environment America, 2012).

Randomized controlled trials have strong internal validity, allowing one to make accurate assessments of causal relationships. When conducted in naturally occurring contexts (e.g., an actual market) with a representative sample and real market decisions, such trials also have much stronger external validity than laboratory-based economic experiments that frequently involve undergraduate college students making decisions based on induced values and a relatively small monetary stake in situations in which they have relatively little experience (Levitt and List, 2007; Messer et al. 2014).

The field experiment was conducted in spring 2016 at a local community event in northern Delaware that attracts about 8,000 people per day, and the administrators recruited participants by contacting attendants personally and distributing flyers. The 336 individuals who chose to participate were randomly assigned to treatments in the experiment, which took 20 to 30 minutes to complete using a computer program, and were paid $25. After completing the experiment, each participant filled out a survey that collected demographic information regarding their gender, age, and household characteristics (rural vs. urban/suburban, owned or rented, and number of children in the household) and asked them about their environmental attitudes.

The experiment and subsequent survey activities were performed in a Qualtrics platform augmented with JavaScript to randomize selection of the binding product, the market price, and treatment assignments. The order in which the products were presented to participants was also randomized to avoid potential order effects. Participants were seated in a desks with privacy shields to ensure the confidentiality of decisions.

The experiment used a between-subject treatment to test whether positive and negative framing information affected residents' willingness to adopt nutrient runoff-management practices. Specifically, we compared the effectiveness of two messages to a no-information baseline: (1) "Adopting the practices can help improve water quality" (positive) and (2) "Water quality would keep getting worse if residents do not take action" (negative). In addition, we used a within-subject status-quo treatment by varying the default starting bids.

In the experiment, the subjects were randomly assigned to one of three groups: the positive framing treatment, the negative framing treatment, and the no-framing baseline (see Appendix 1). After signing a consent form, they received a brief written introduction to the experiment that explained their potential earnings and the auction format, described the nutrient runoff problems affecting local Delaware River tributaries, and delivered the treatment information. Both of the treatment statements included a green-to-red "gauge" in the form of a graph with a green arrow pointing down for the positive treatment and a red arrow pointing up for the negative treatment. Following the treatment information was a description of the pollution associated with residential runoff and the potential benefit from installing the items offered to them in the auction. The only difference in the material provided in the treatments was the positive and negative framing language highlighted in **bold**:

> **Positive**: "As shown by the arrow, residents that choose to install water conservation items on their lawn **will reduce the amount of pollution they contribute to** local watersheds. The nutrients in your lawn like Nitrogen and Phosphorus can cause algal blooms and kill fish once they enter local water bodies. **Upon installing water conservation items in your lawn, your contribution of nutrients and sediments will decrease. These items encourage healthy habitats and superior water quality in your local waterways.**"
>
> **Negative**: "As shown by the arrow, residents that choose **not** to install water conservation items on their lawn **are continuing to pollute** local watersheds. The nutrients in your lawn like Nitrogen and Phosphorus can cause algal blooms and kill fish once they enter local water bodies. **If you choose not to install water conservation items in your lawn, your contribution of nutrients and sediments will continue. Without installing these items, your local habitats and the water quality in your local waterways will continue to be damaged.**"

Residents WTP was collected using the Becker–DeGroot–Marschak (BDM) auction (1964) auction, which has been shown to be demand revealing in experimental settings (Irwin et al., 1998). Since the potential range of the subjects' valuations was wide, the BDM was an optimal elicitation method because the subjects were not bidding against each other. As described in Irwin et al. (1998) in the BDM utility maximizing participants submit bids, given an initial income Y^0, that maximize:

$$EU = \int_0^B p(C)U(Y^0 + E + V - C)dR + \int_B^E p(C)U(Y^0 + E)dR. \tag{1}$$

Where V is the participants' endogenous value for the item and B is their bid that presents the highest the maximum amount they were willing to pay for the item. Participants were informed that the price, C, of each item would be determined randomly after their bids were submitted.

As seen in the first part of Equation 1, participants would not want to submit bids that understate their true maximum WTP. If the randomly selected price ends up being between a participant's stated WTP and her actual WTP, then she would miss an opportunity to earn additional profit. Similarly, the intuition behind a participant not overstating his WTP is shown in the second part of Equation 1; as a subject would not want to submit a bid higher than his actual WTP as that could lead him to having to pay a price higher than his valuations of the item. The derivative of Equation 1 with respect to *B* leads to

$$\frac{dEU}{dB} = p(B)[U(Y^0 + E + V - B) - U(Y^0 + E)] = 0\,. \qquad (2)$$

Given that the probability of the bid being equal to the price is non-negative ($p(B) > 0$), a utility maximizing subject should submit a WTP bid equal to their value ($B = V$). In this research, if the participant's WTP bid was greater than or equal to the random price ($B \geq C$), the participant received their initial balance minus the randomly selected price and would receive the item. If the participant's WTP bid was less than the price, the participant received just the initial balance and did not receive the item.

Since the goal of the research was to understand participant WTP and not to test the BDM mechanism, the instructions sought to facilitate learning by directly informing participants that it was always in their best interest to submit a bid equal to their maximum willingness to pay for the item. Furthermore, experiment program first presented participants with two practice rounds in which participants bid on a pen and a pencil using the BDM procedure. After each practice round, the program asked "Do you understand how the bidding mechanism works?" If the participant answered "yes," the experiment proceeded; if the subject answered "no," the program brought the subject back to the practice rounds to ensure that they understood the auction.

After the practice rounds, participants were given an opportunity to submit a bid using the BDM on each of the five items being offered. At the end of the five auction rounds, one of the items/services was randomly selected to be implemented and the price was randomly determined for that item.

Participants were told that the randomly determined prices were distributed around the true market mean, but the participants were not given specific information about the amount of the true market mean or the magnitude of this variation. After the bids were submitted, a market price for each practice was randomly determined from a normal distribution with the mean at the average price for the practice and a standard deviation of one-fourth of the mean.

All of the bids were submitted using a slider that enabled the participant to set the price (see Appendix 2). To test whether the default value would impact the bid amount, the starting value for the slider was set randomly following a uniform distribution between $0 and $25 for each participant.

Once all of the bids were submitted and the survey completed, the administrators gave the item to the participants who won it in the auction (submit a bid that was equal to or greater than the randomly selected price) along with the remainder, if any, of the $25 they were originally given. Participants who did not win the item in the auction (submitted a bid that was less than the randomly selected price) received no item and the full $25 in cash.

Results

Each of the 336 adult participants placed five bids (one for each item), resulting in 1,680 observations. The average age of the participants was 32, 62.6% were female, 62.9% owned their residences, and 86.9% lived in urban or suburban areas. In general, the sampled population was aware of water pollution issues; more than 80% indicated that they were concerned about drinking water and more than 90% indicated that they were concerned about pollution in the watershed.

The survey also solicited participants' self-reported risk preferences. Previous studies have shown that attitudes about risk can significantly influence consumers' preferences for environmentally friendly products (Li and McCluskey, 2017). In our sample, most reported a preference for a moderate amount of risk—on a scale where 1 indicated risk-averse and 10 indicated risk-philic—the median was 6.

We report the participants' average WTP for each item in Figure 1. On average, the residents were least willing to pay for native plants ($4.55) and most willing to pay for soaker hoses ($7.34). Note that the average market price for each practice was around $12 at the time of this study. Therefore, the average WTPs for native plants and soaker hoses account for approximately 40% and 60% of the average market price, respective. The average bid for those who received the positively framed message ($6.90) were higher than the average bid of the baseline group who received no message ($5.22); the average bid was higher under the positive message treatment for each practice. The average bids for those who received the negatively framed message ($5.47) were also higher than the baseline averages but to a smaller degree.

To analyze the results from the auctions, we estimated three models that test several hypotheses formed when we designed the experiment. First, we expected the WTP for water runoff-management practices among participants who received the information treatment would be different from those who did not. Second, consistent with previous studies, we expected that positive framing would work differently than negative framing in encouraging residents to adopt water conservation practices. Third, we expected that framing of the default choices would have a significant influence and that participants' bids would increase when presented with large default values. Finally, we expected that WTP would vary according to demographic characteristics such as age and gender.

Random-effects Tobit Regression

Since participants' bids were confined to a range of \$0 to \$25 and we found some clustering of bids at those extremes, especially at the \$0 value, we first used a random-effects two-limit Tobit model to analyze the data. We assumed that a latent variable, B^*, existed that represented the participant's true WTP for the practice offered in the auction round. The latent variables were related to the observed bid_{ij} by

$$B_{ij} = \begin{cases} 0 & \text{if } B_{ij}^* \leq 0 \\ B_{ij}^* = \mathbf{X}'_{ij}\boldsymbol{\beta} + \mathrm{u}_i + \varepsilon_{ij} & \text{if } 0 < B_{ij}^* < 25 \\ 25 & \text{if } B_{ij}^* \geq 25, \end{cases} \tag{3}$$

where i represented the subject and j represented the bidding practices. $\mathbf{X}_{ij}$ represented the relevant independent variables (demographic and attitudinal) and a series of dummy variables indicated the practice on which they were bidding in the round. In the model, two dummy variables represent the positive and negative framing treatments and a continuous variable measures the default starting value. See Table 1 for a list of the variables and their definitions and Table 2 for summary statistics. $\boldsymbol{\beta}$ is a vector of the coefficients to be estimated, u_i is the between-entity error term, and ε_{ij} is the within-entity error term.

The results of the random-effects Tobit model and general linear regressions are reported in Table 3. We find that positive framing has a much stronger effect on contributions to the public good than negative framing. In our case, the positively framed treatment message had a significant positive effect of $2.11 on residents' WTP for the water runoff-management practices. The negatively framed treatment message did not have a significant effect. These results indicate that residents are more likely to adopt a water conservation practice when they are given information about how those practices reduce nutrient pollution.

In terms of demographic characteristics, older residents were more likely than younger ones to adopt a water runoff-management practice; as age increased by one year, the average bid rose 5 cents. And individuals who were relatively comfortable with taking risks reported significantly higher WTP than risk-averse individuals. Perhaps younger participants were less familiar with the practices. Female gender, the presence of children in the household, and home ownership had small positive effects on WTP but the effects were not statistically significant. As expected, residents who were relatively concerned about pollution in the watershed had a relatively high WTP for the practices.

We found only weak support for default-priming and membership in environmental organizations in the Tobit model as the results for both were positive but not significant. Perhaps individuals who belonged to environmental organizations already used one or more of the practices addressed in the experiment or other practices so had no need to add those items. They might also view their membership as contributing to controlling pollution in the watershed and/or are contributing to controlling pollution in the watershed in other ways and thus were not interested in spending a large amount on the proposed practices.

Random-effects Hurdle Regression

The Tobit model was based on an assumption that the process of censoring at $0 was identical to the process of submitting positive bids. In other words, participants formed a value for the item, and censoring was based entirely on that value. However, individuals first chose whether they were interested in the product, and that decision was based on a choice function that could have been different from the bidding function. We therefore estimated an additional regression model in which the bids were a function of $\mathbf{X}_{ij}$ and $\boldsymbol{\beta}$ (as in the Tobit model) and we added a set of variables and parameters, $\mathbf{Z}_{ij}$ and $\boldsymbol{\alpha}$, to describe the decision function in which $\mathbf{Z}_{ij}$ included the treatment variables:

$$B_{ij} = \begin{cases} 0 & \text{if } \mathbf{Z}'_{ij}\boldsymbol{\alpha} + \varepsilon_{1j} \leq 0 \text{ and } B^*_{ij} \leq 0 \\ & \text{or } \mathbf{Z}'_{ij}\boldsymbol{\alpha} + \varepsilon_{1j} > 0 \text{ and } B^*_{ij} \leq 0 \\ B^*_{ij} = \mathbf{X}'_{ij}\boldsymbol{\beta} + \varepsilon_{2j} & \text{if } \mathbf{Z}'_{ij}\boldsymbol{\alpha} + \varepsilon_{1j} > 0 \text{ and } 0 < B^*_{ij} < 25 \\ 25 & \text{if } \mathbf{Z}'_{ij}\boldsymbol{\alpha} + \varepsilon_{1j} > 0 \text{ and } B^*_{ij} \geq 25 \end{cases} \qquad (2)$$

Note that we included the "hurdle" specification only on the lower end of the censoring. We assumed that a $0 bid could represent both participants who explicitly chose not to bid and participants who wanted to bid less than or equal to $0 but could not because of the experiment design. At the upper limit, we include only the Tobit censoring and assumed that those participant had well-formed valuations that were greater than 25. We found that only 10 of the 1,655 observations were affected by this distinction.

Table 4 summarizes the marginal effects from the hurdle model. In general, the signs on these coefficients are consistent with the coefficients from the Tobit model. However, the hurdle model provides greater insight into how the behavioral nudge encouraged participants to bid a positive amount. The positively framed treatment significantly increased the likelihood that a participant would place a nonzero bid by 20%. Moreover, it increased the average non-zero bid by $3.10. On the other hand, neither the negatively framed treatment nor higher default bid values had a significant effect on the likelihood of submitting a bid. However, among non-zero bids, a one-dollar increase in the primed position of the slider increased the average bid by 19 cents.

Conclusion

Nutrient pollution originating from industrial, agricultural, and residential sources is a widespread, costly, and challenging environmental problem. There is a large body of research on efforts to control such pollution from agricultural and industrial sources, but little attention has been paid to encouraging individuals to restrict the amount of nutrients transported from lawns and landscaping to waterways, a relatively small but consequential contributor. We conducted a field experiment to study the willingness of residents of northern Delaware to pay for five runoff-management practices for their landscaping under positive and negative behavioral nudges using serial BDM auctions. The experiment involved a positively framed message about reducing pollution in the local watershed, a nearly identical but negatively framed message about reducing pollution, and priming of the default bids listed to encourage higher bids.

Our results showed that, in general, women were more willing to adopt the practices than other participants and individuals who lived in rural areas had relatively low WTP. Default-priming did not influence participants' decisions about placing a bid but did affect their WTP when they chose to bid on a practice. We further found that positive framing increased the overall average WTP by $3.14 while negative framing did not have a significant impact. Framing the decision as an opportunity to provide an environmental public good increased the WTP of those purchasing items by more than 26 percentage points over neutral and relatively negative messages meant to provoke a feeling of “guilt.”

For policymakers who want to further decrease the amount of nutrient pollution entering waterways, residential runoff presents a so-far untouched source. This research demonstrates that many consumers are willing to adopt practices that would decrease the amount of runoff they contribute. The average WTP bid for the items in this study ranged from about 60% of the true market price for the soaker hose (which likely has a large private value) to about 40% of the true market price for native plants, which is in line with the cost-shares included in agricultural programs. The Environmental Quality Incentives Program, for example, pays up to 75% of the cost in standard contracts. The relative effectiveness of the items offered in this study is uncertain, but the results demonstrate that providing subsidies to install such practices could be a feasible way to reduce nonpoint-source pollution.

We find some demographic differences in WTP. Rural households, in particular, had a low WTP for the conservation practices. This result points to the potential value of targeting efforts to encourage individual conservation geographically. Rural residents likely deal with much larger areas of landscaping, may use relatively little fertilizer, and could find some urban/suburban practices impractical.

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Table 1. Description of Explanatory Variables

Variable	Definition
Female	Gender (Dummy, 1 if Female)
Age	Age (in years)
Children	Have children under 18 in household (Dummy, 1 if Yes)
Concern Drinking Water	Have concerns about the pollution of drinking water (Categorical, 1- not at all 4- a great deal)
Concern Watershed	Have concerns about the pollution of rivers, lakes, or reservoirs (Categorical, 1- not at all 4- a great deal)
Rural	Reside in rural areas (Dummy, 1 if Yes)
In State	Reside in Delaware (Dummy, 1 if Yes)
Environmental	Belong to environmental organizations (Dummy, 1 if Yes)
Risk Preference	Risk preferences (Categorical, 1- completely unwilling to take risks 10- completely willing to take risks)
Native Plant	Auction product (Dummy, 1 if product is native plant)
Biochar	Auction product (Dummy, 1 if product is biochar)
Soil Test Kits	Auction product (Dummy, 1 if product is soil test kits)
Peat Moss	Auction product (Dummy, 1 if product is peat moss)
Soaker Hose	Auction product (Dummy, 1 if product is soaker hose)
Default Priming	Starting value on slider (Continuous, uniformly distributed between 0 and 25)
Positive Framing	If conserve, water quality will be better (Dummy, 1 if information displayed)
Negative Framing	If don’t conserve, water quality will keep getting worse (Dummy, 1 if information displayed)

Table 2. Summary statistics for variables

Variables	
Number of respondents	336
Average age	32
	Percentage of respondents
Female	62. 6%
Children under 18 present in household	27.6%
Own Residence	62.9%
In State	72.7%
Environmental	35.0%
Rural	13.1%
Concerned about drinking water	
Not at all	1.2%
Only a little	14.1%
A fair amount	40.7%
A great deal	44.0%
Concerned about watershed	
Not at all	0.6%
Only a little	6.9%
A fair amount	37.1%
A great deal	55.4%
Risk preference	
1 (completely unwilling to take risks)	2.1%
2	6.3%
3	6.6%
4	9.2%
5	17.6%
6	18.1%
7	20.1%
8	13.4%
9	3.3%
10 (completely willing to take risks)	2.7%

Table 3. Random Effects Tobit Regression Results and General Linear Regression

	Tobit			General Linear		
Variable	Coefficient		Standard Error	Coefficient		Standard Error
Default Priming	0.06		0.05	0.06	*	0.04
Positive Framing	2.11	***	0.82	1.67	***	0.61
Negative Framing	0.70		0.83	0.41		0.63
Native Plant	–2.95	***	0.28	–2.65	***	0.28
Biochar	–0.60	**	0.27	–0.61	***	0.24
Soil Test Kit	–2.76	***	0.28	–2.49	***	0.25
Peat Moss	–1.76	***	0.27	–1.67	***	0.25
Soaker Hose (Baseline)	–		–	–		–
Female	0.39		0.71	0.52		0.53
Age	0.05	**	0.02	0.04	**	0.02
Own Residence	1.01		0.75	0.76		0.57
Children	1.09		0.76	0.77		0.58
In State	0.22		0.76	0.05		0.61
Environmental	0.65		0.72	–0.41		0.54
Rural	–1.48		1.04	–1.35	*	0.72
Concern Drinking Water	–0.39		0.42	–0.18		0.40
Concern Watershed	0.91	*	0.52	0.56		0.44
Risk Preferences	0.62	***	0.17	0.40	***	0.13
Constant	–2.62		1.85	0.53		1.33

Note: *10% significance level, **5% significance level, ***1% significance level.
Tobit Model: N=1665, 302 left-censored, 1353 uncensored, 10 right-censored
Wald Chi^2 = 216.00; Prob > Chi^2 = 0.00.
GL with robust standard errors clustered by individual participants, N=1665
Wald Chi^2 = 209.23; Prob > Chi^2 = 0.00.

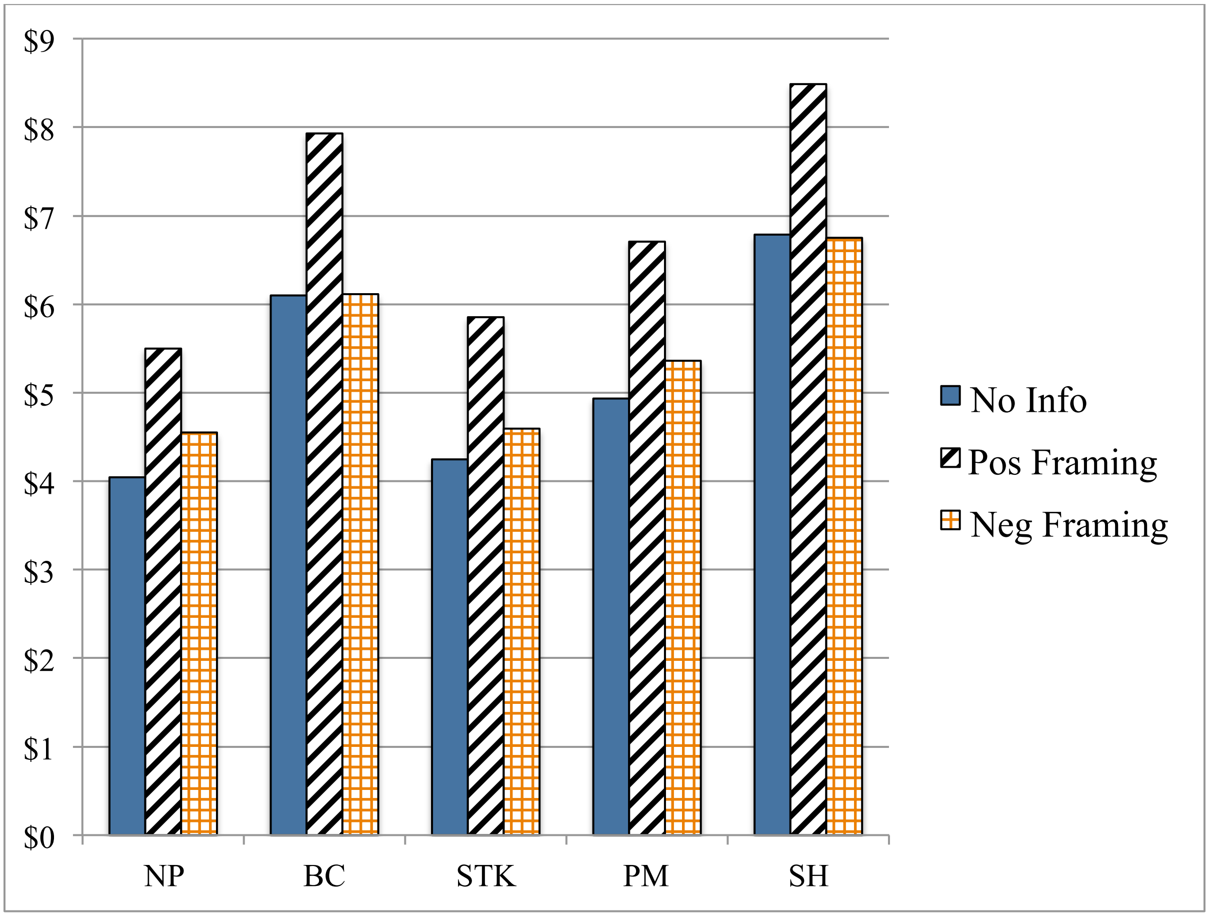
Table 4. Random Effects Hurdle Regression Results

Variable	Coefficient		Standard Error
Default Priming	0.19	***	0.06
Positive Framing	3.10	***	0.85
Negative Framing	0.04		1.06
Native Plant	–7.84	***	1.29
Biochar	–2.05		1.35
Soil Test Kit	–7.24	***	1.61
Peat Moss	–5.04	***	1.18
Soaker Hose (Baseline)	–		–
Female	2.78	***	0.56
Age	0.09	***	0.02
Own Residence	2.08	**	0.86
Children	1.13		0.72
In State	–0.65		0.96
Environmental	–0.92		0.57
Rural	–3.50	***	1.12
Concern Drinking Water	0.37		0.64
Concern Watershed	0.65		0.90
Risk Preferences	0.65	***	0.16
Constant	–8.99		1.95
Selection — Lower Limit			
Default Priming	–0.00		0.00
Positive Framing	0.20	***	0.07
Negative Framing	0.09		0.10

Note: *10% significance level, **5% significance level, ***1% significance level.
N = 1665; Wald Chi^2 = 164.28; Prob > Chi^2 = 0.00.

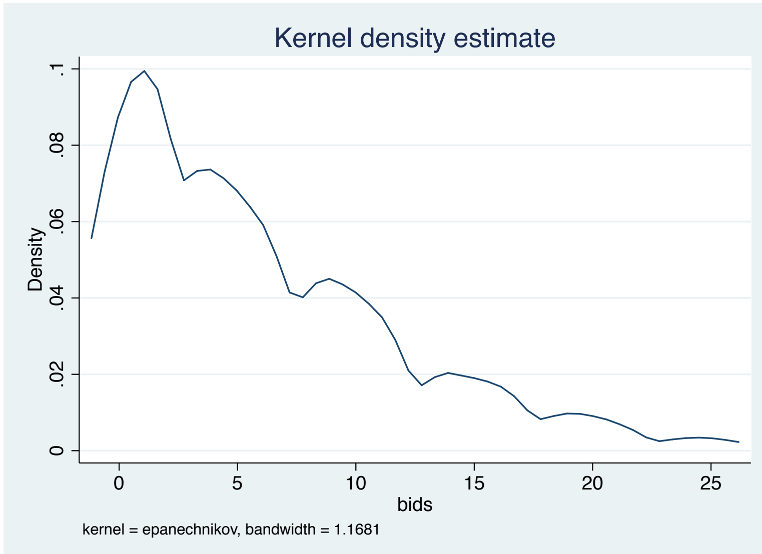
Figures

Figure 1. Average WTP Bids for each Water Runoff Management Practice by Framing



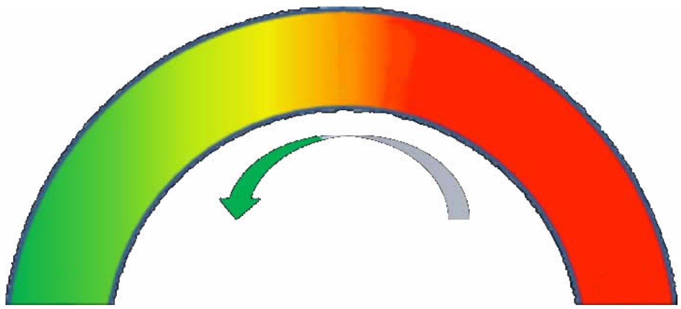
Note: NP is abbreviation for native plant; BC for Biochar; STK for soil test kit; PM for peat moss; SH for soaker hose; Vertical axis measures average bids in USD.

Figure 2. Bids Density for Water Runoff Management Practices



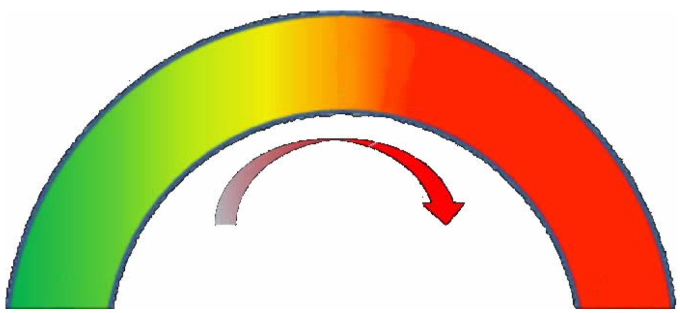
Appendix 1 (Positive versus Negative Framing)

Treatment 1 Positive Framing



As shown by the arrow, residents that choose to install water conservation items on their lawn will reduce the amount of pollution they contribute to local watersheds. The nutrients in your lawn like Nitrogen and Phosphorus can cause algal blooms and kill fish once they enter local water bodies. Once installing water conservation items in your lawn, your contribution of nutrients and sediments will decrease. These items encourage healthy habitats and superior water quality in your local waterways.

Treatment 2 Negative Framing



As shown by the arrow, residents that choose not to install water conservation items on their lawn are continuing to pollute local watersheds. The nutrients in your lawn like Nitrogen and Phosphorus can cause algal blooms and kill fish once they enter local water bodies. If you choose not to install water conservation items in your lawn, your contribution of nutrients and sediments will continue. Without installing these items, your local habitats and the water quality in your local waterways will continue to be damaged.

Appendix 2 (Sliders and default settings)