

# The valuation of wetland conservation in an urban/peri urban watershed

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**Abstract** This study estimates the social benefits of wetland conservation in the Credit River watershed, located in an urban/peri urban area in Southern Ontario, Canada. A stated preference approach was employed to value wetland conservation programs which ranged from retaining the existing wetlands to restoring various levels of acres of wetlands over the 2009–2020 period. A total of 1,407 households completed an internet-based survey which presented trade-offs in binary choice scenarios framed as referenda. Responses were analyzed using various models, one of which was a latent class analysis which segmented respondents into three classes. This econometric approach uncovered significant preference heterogeneity for wetland conservation. Assignment of respondents to the classes suggested that about one-third of the sample was willing to pay small amounts to retain the existing wetlands. An additional third was willing to pay several hundred dollars a year for retention and small positive amounts for additional restoration. The final third were apparently willing to pay considerable sums for retention, but lesser amounts for additional restoration. However, further analysis revealed that respondents in this third class largely constituted yea-sayers. These results suggest caution in

interpreting associated economic valuation estimates and highlight the importance of attempting to understand hypothetical bias in wetland and other such valuation studies.

**Keywords** Contingent valuation method · Yea-saying bias · Respondent heterogeneity · Canada

## Introduction

Recent literature estimates that wetlands provide up to 40 % of the value of all ecosystem services worldwide, despite covering only 1.5 % of the Earth's surface (Zedler 2003).<sup>1</sup> In spite of their significance, however, wetlands have declined in many regions of the world (Barbier et al. 1997). In Canada alone, approximately 20 million hectares of wetlands have been lost since 1800 (Cox 1993). Losses have been particularly extensive in Southern Ontario watersheds, where approximately 70 % of land has been converted to residential, commercial, infrastructure, and/or agricultural use (Ducks Unlimited Canada 2010).

Environmental economists contend that such widespread losses result from the public goods nature of wetland services (Schuyt and Brander 2004). Specifically, since many of the services provided by wetlands are not traded in economic markets and thus do not have observable market prices, wetland loss is not adequately considered in the land-conversion process. This outcome may become more extreme in situations where urban development pressures result in highly competitive land markets

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<sup>1</sup> The ecosystem service values reported by Zedler (2003) are based on the research by Costanza et al. (1997) who collate the economics literature focused on valuing ecosystem services.

with significant land price appreciation. Such a case occurs in Southern Ontario, which holds the highest population densities in Canada. This region has seen a significant urban and industrial expansion into rural areas with the result that land prices have appreciated considerably. For example, agricultural land values in this region increased from an average of \$3,500/acre a decade ago to over \$10,000/acre today (Bromberg 2011). The development pressure and increasing land values have led to significant rates of conversion of wetlands to other uses.

To better incorporate wetland services into the land use decision-making process, researchers have increasingly focused on valuing the benefits of these services to society (Brander et al. 2006). Typically, valuation begins with categorizing wetland services into direct use (e.g., fishing, hunting, recreation), indirect use (e.g., flood control, nutrient retention, water filtration, carbon sequestration), option (potential future direct and indirect uses), and existence (e.g., biodiversity, heritage, bequests) values (Barbier et al. 1997). Existence values refer to the utility (or satisfaction) individuals derive from wetlands just from the knowledge that they exist for biodiversity, heritage, bequests, and other such purposes. Often, economists use the term “passive use” values when considering option and existence values together.

Once categorized, the wetland services are then quantified and valued. This literature varies widely in the use of specific valuation techniques, the range of services valued, and the geographical location and scale of the wetlands considered. One of the most common approaches used by researchers to value wetland services are stated preference methods—the most common being the contingent valuation method (CVM) (Bateman et al. 1992; Stevens et al. 1995; Oglethorpe and Miliadou 2000; Wattage and Mardle 2008). CVM presents a sample of households with a questionnaire containing one or more hypothetical environmental improvement scenarios in which they are asked to consider voting for or against at various costs to their household (Haab and McConnell 2002). The information generated from this method is used to estimate the respondent’s willingness to pay (WTP) for the services under consideration. It is widely accepted that the CVM is one of the only methods capable of estimating the full array of use, nonuse, and existence values provided by environmental assets (Arrow et al. 1993).

Contingent valuation method scenarios can be designed using a number of different question formats (open-ended, referendum, payment card, etc.) and can be administered in a number of ways (i.e., mail, in person, internet, etc.). In the case of wetland conservation, CVM studies can be focused on one or more specific wetland services and can

be associated with different geographical scales and/or levels of changes in services. As a result, many biases could exist that may skew WTP estimates (Murphy et al. 2005; Venkatachalam 2004). As such, care must be taken when developing and implementing CVM studies to minimize potential biases (Whitehead and Blomquist 2006).

A number of possible CVM biases have received increased attention in the past decade. One such bias, known as the scope (or embedding) effect, is associated with the finding of insensitive WTP estimates to the scope of the proposed environmental change. Such a finding, it is argued, is at odds with traditional economic theory which predicts that WTP should increase with scope (Diamond and Hausman 1994). One reason for this lack of sensitivity is that respondents embed the issue under consideration in a larger, all encompassing, issue (Kahneman and Knetsch 1992). Carson (1997) argues that such a finding is likely a result of poor survey design. Veisten et al. (2004) emphasize the need to conduct both internal (i.e., within sample) and external (i.e., split-sample) testing of scope effects.

Another potential CVM bias is known as the sequencing effect (Cummings et al. 1986), where the WTP estimate for a particular good differs depending on the order of the good in a sequence of valuation question scenarios. Holmes and Boyle (2005) suggest that learning occurs over a sequence of scenarios. Respondents may learn how to answer valuation questions, which implies that answers to scenarios later in a sequence are more reliable than those appearing earlier. One way to minimize this effect is to randomize the order of questions for each respondent.

Hypothetical bias, where respondents state that they would be willing to pay for a good when in fact they will not (or would pay less) when placed in a real purchase situation, is another bias that concerns CVM researchers (Whitehead and Blomquist 2006). A possible reason for the overestimation of values is the presence of yea-saying, where respondents are sympathetic to an environmental cause or may perceive social pressure to behave in a particular way without regard for their budgetary constraints (Blamey et al. 1999). Numerous valuation studies have found evidence of this bias (e.g., Ready et al. 1995; Kaninen 1995; Blamey et al. 1999). Proposed techniques to help minimize hypothetical bias include (1) a cheap-talk script that is inserted in the survey prior to the WTP question that attempts to remind respondents of their budget constraint, convince them that the survey has policy implications and reminds them of the consequential trade-offs they are making in the valuation scenarios (Cummings and Taylor 1999; List 2001; Lusk 2005); (2) a question format that introduces a dichotomous choice referendum

vote, which respondents have some familiarity with (Whitehead and Blomquist 2006);<sup>2</sup> and (3) certainty questions, where respondents are asked about their level of certainty regarding their WTP response following each of the scenarios. Studies have shown that hypothetical values are not statistically different from real values when respondents are certain of their responses (see Champ et al. 1997; Blumenschein et al. 1998).

Efforts to specifically reduce potential yea-saying bias in CVM studies include (1) ex post identification of yea-sayers through the use of follow-up questions and omitting them from the sample prior to estimating WTP (e.g., Spash and Hanley 1995) and (2) ex ante approaches involving the inclusion of additional response categories that permit respondents to express support for an environmental program without committing dollars (e.g., Blamey et al. 1999), among others (e.g., Caudill et al. 2011).

A polar-opposite bias to yea-saying is known as nay-saying (protesting). This can occur when a respondent who has a positive WTP for a good indicates they would not be willing to pay for it. There are a number of possible reasons for such an outcome, ranging from a rejection of the legitimacy of the scenario presented to strategic behavior (Carson 2000). Studies have shown that respondents may provide different WTP responses depending on their preferences over payment vehicles (e.g., they may prefer voluntary contributions rather than increased taxes),<sup>3</sup> elicitation techniques (e.g., they may not respond as truthfully to mail surveys compared to in-person interviews), and other such techniques. Approaches to minimizing this potential bias range from asking follow-up questions (to identify and omit protest responses) to combining the data from both stated and revealed preference approaches (Bateman et al. 2002; Carson 2000). Such approaches, however, are not universally supported. For instance, Meyerhoff and Liebe (2005) argue that censoring some responses may actually increase bias in WTP estimates.

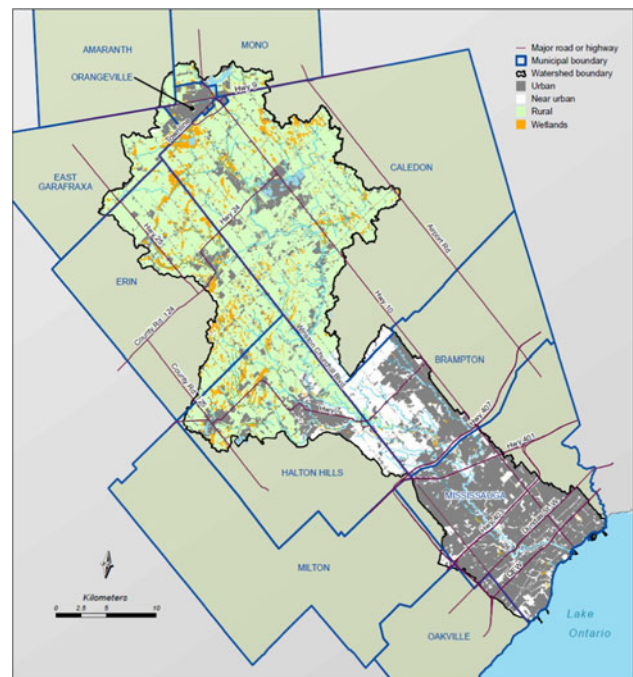
The current paper utilized a CVM approach to estimate the WTP for wetland retention and restoration in a watershed heavily impacted by urban and industrial expansion. The CVM study design incorporated a number of design

and analytical techniques to uncover and minimize the existence of various forms of bias. Careful analysis of the resulting data raised questions about the validity of the responses in the context of scope effects, which led to further investigation uncovering the presence of considerable yea-saying. This ex post approach uncovered significant yea-saying that occurred despite the use of the ex ante design measures. Knowledge of this bias is important in developing accurate and policy-relevant estimates of wetland economic values.

In the following sections, we provide an overview of the current state of wetlands in the Credit River watershed, present our methods and results, and discuss the implications and usefulness of our findings for policy.

### Wetlands in the Credit River watershed

The Credit River watershed, located in the Greater Toronto Area, is home to roughly 750,000 people and covers nearly 1,000 km<sup>2</sup>. The watershed has 1,500 km of tributaries and discharges into Lake Ontario. The headwaters of the Credit River are located above the Niagara Escarpment, a World Biosphere Reserve, which cuts through the middle portion of the watershed. Land use in the watershed favors urban and agriculture, with 33 % classified as urban, 29 % classified as agriculture, and 23 % classified as wetlands/forest. Currently, there are 1,075 wetlands covering 14,520 acres (or 6 %) of the Credit River watershed area (see Fig. 1).



**Fig. 1** The Credit River watershed

<sup>2</sup> The referendum format is generally favored over other formats in the literature as it is thought to be incentive compatible, where respondents have an incentive to report their true WTP (Arrow et al. 1993).

<sup>3</sup> However, for a payment vehicle to be incentive compatible, it needs to be consequential. Thus, taxes tend to more credibly impose costs on the entire sample of interest while avoiding issues associated with voluntary contributions (Arrow et al. 1993; Carson and Hanemann 2005).

Wetland areas in the watershed have been significantly reduced over the past century largely due to human activities such as expansion of urban areas, agriculture, and industrial developments. The Credit Valley Conservation Authority estimates that 48 %, or 13,331 acres, of wetlands in the watershed have been lost or degraded since 1954 (Credit Valley Conservation Authority 2009). This represents an annual loss of 0.87 % (or 242 acres per year) of wetlands. Most of the wetland loss has occurred in the urban region (in the south) and the near-urban region (in the center) of the watershed where urban development has occurred (Fig. 1).

As wetlands have declined in the watershed, so to have the ecosystem functions and services they help support. According to the Credit Valley Conservation Authority, the southern region of the watershed in particular is experiencing serious issues related to surface and groundwater quality and quantity, stream flow, erosion and wildlife habitat. These issues align with related research in Manitoba by Yang et al. (2008) and Cowardin et al. (1995) who examine the connection between wetlands and ecosystem services and find that, on average, each hectare of wetland is capable of removing the equivalent of 0.015 semi-truck loads of fertilizer per year, controlling 2,939 m<sup>3</sup> of water and 16.3 tonnes of soil erosion, providing habitat for 0.16 breeding pairs of ducks per year, and storing the carbon equivalent of emissions from 1.96 cars per year. While a number of policies have been implemented to slow the decline of wetlands in the watershed to help protect these services (e.g., regulations implementing the Ontario Conservation Authorities Act 2011), future urban development and other factors such as climate change continue to put pressure on these declining resources.

## Methods

The CVM approach used in this study was essentially similar to the methods employed by Pattison et al. (2011) who examined WTP for wetland retention and restoration at a provincial scale. However, this study focused on retention and restoration in a specific watershed rather than a province-wide program—hence the questionnaire design and survey implementation were somewhat more straightforward.

### Questionnaire design

An initial draft of the questionnaire was developed and presented to a focus group of wetland experts and representatives from the community in order to ensure accuracy of the survey information, comprehension, and to ensure that the results of the analysis would assist in policy

development. A number of modifications were made as a result of initial and on-going feedback from the focus group participants. The resulting final questionnaire consisted of three sections. In the first, respondents were provided with a description of the study's purpose and were asked about their knowledge and use of wetlands in the Credit River watershed. These questions were followed by information on wetland characteristics, the existing wetlands in the region, and the services that wetlands provide. Specific services included water quality, flood/drought/erosion control, wildlife habitat, and carbon storage. These services were identified as among the most important in the focus group meeting described above. Respondents were then asked to provide their opinions on the degree to which these services had become better or worse over the past decade; the current status of the services; and the degree to which these services will become better or worse over the next decade.

Respondents were then provided information on the historical loss of wetlands in the watershed (and associated loss in services), the reasons for the wetland loss, and the trade-offs associated with wetland conservation. Respondents were asked whether they were aware of wetland losses and the degree to which they were concerned about it.

The questionnaire subsequently informed respondents that wetland retention and restoration programs could be implemented that would stop or reverse the declining trend of wetlands and their services in the watershed.<sup>4</sup> At this point, the financial costs of implementing the programs were identified. These included direct retention/restoration expenditures (on vegetation maintenance, irrigation, planning, and administration), foregone farm income (having land taken out of production), production inefficiencies (added time and costs to maneuver equipment around wetlands), reduced land value, and reduced income in agricultural-dependent businesses. Respondents were asked to provide their opinion on the financial share that private landowners, the government (i.e., tax payers), and conservation organizations should contribute toward wetland retention and restoration. It was thought that the information and questions presented to respondents in this way set the stage for respondents to understand that trade-offs would be necessary for addressing wetland loss.

The second section of the questionnaire consisted of developing the stated preference scenarios and eliciting WTP responses. Here, a choice framework was employed

<sup>4</sup> In the survey, a distinction was not made between the ecological functioning of natural versus restored wetlands. While differences do exist, we believed that the required explanation would introduce information overload to survey respondents.

that used a referendum approach. Specifically, respondents were first informed that they would be asked to vote four times on voting scenarios that would result in different amounts of wetlands in the watershed. In each scenario, two alternatives were presented: the “current trend” (where wetlands would continue to decline at historical rates through to 2020) and a “proposed program” (where wetlands would be either be retained and/or restored to different levels above the existing levels through to 2020). Associated with each proposed program was a randomly assigned increase in property taxes that respondents would pay annually for the next 5 years (selected from a uniform distribution of tax values, ranging from \$50 to \$600). Respondents were asked to vote on the alternative they preferred.

The use of a sequence of four voting scenarios was utilized instead of a single scenario which has been typical in most CVM wetland studies.<sup>5</sup> The sequence permits a “richness” of preference information to be collected from respondents over the scope of the program. This is useful because the researcher can determine the extent to which household WTP estimates change with different wetland restoration levels and may allow the use of smaller samples of respondents for appropriate levels of statistical efficiency in the estimation of WTP values. Furthermore, the presentation of these voting scenarios was randomized in the final administration of the questionnaire in order to help minimize possible sequencing effects. Thus, one is able to assess the responses to the first vote as well as the series of votes provided by the sample of respondents. This is important for within-sample scope effect tests, where WTP estimates can be examined to see whether they increase with programs that provide greater levels of wetland improvements (Carson and Mitchell 1993).

To further investigate the issue of scope effects, two versions of the questionnaire were developed, each with unique restoration program levels. Version 1 considered the restoration of 3,000, 7,000, and 11,000 acres of previously lost wetlands, while Version 2 considered restoration of 1,000, 5,000, and 9,000 acres of previously lost wetlands. These two versions were administered to two different samples within the watershed region for a split-sample test of scope effects.

To help respondents understand the differences between the current trend of wetland loss and the various proposed

retention and restoration programs, illustrations of the different amounts (acres) of wetlands under each alternative were presented, along with associated percentage changes. To help respondents better understand the consequences of changes in wetland area, the approach of Pattison et al. (2011) was employed, and estimates of the associated changes in wetland services were conveyed in what was thought to be common language. These services included the removal of nitrogen and phosphorus in run-off from the watershed (interpreted as reduction in  $X$  number of semi-truck loads of fertilizer per year); flood/drought/erosion control (interpreted as control of  $X$  millions of  $m^3$  of water and  $X$  thousands of tonnes of soil erosion); wildlife habitat (interpreted as providing habitat for  $X$  number of breeding pairs of ducks per year); and carbon storage (interpreted as storing the carbon equivalent of emissions from  $X$  number of cars per year). Estimates for these service changes came from Yang et al. (2008) and Cowardin et al. (1995), as previously discussed. Figure 2 provides an example of one voting scenario used in the questionnaire.

To reduce potential hypothetical bias, a cheap-talk script was used. A portion of the script is as follows: “It is very important that you ‘vote’ as if this were a real vote. You need to imagine that you would actually have to dig into your household budget and pay additional taxes when voting for a proposed wetland program”. The cheap-talk script appeared immediately prior to the voting scenarios to remind respondents of the consequential trade-offs they are making by voting for, or not for, the proposed programs.

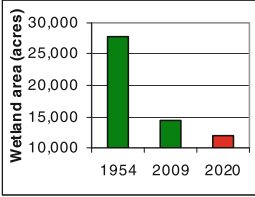
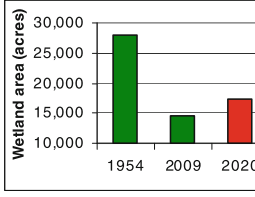
Another technique that was used to help reduce hypothetical bias was to ask respondents about their level of certainty following each of their choices in the wetland voting scenarios. If a respondent indicated uncertainty in their response to a vote, their answer was considered a vote of “no” to the proposed wetland program.<sup>6</sup>

Finally, to identify potential yea-sayers *ex ante*, debriefing questions were incorporated following the voting scenarios (see Spash and Hanley 1995). Respondents were asked why they voted for the restoration scenarios, and those that chose the answer “I think we should protect wetlands regardless of the cost” as their most important reason (and voted as such for all programs considered) were classified as potential yea-sayers. This approach enabled examination of their voting choices, and as we will show in the analyses described below, identification of these individuals formed an important component of the analysis in examining potential bias in the results.

<sup>5</sup> In some CVM application, multiple votes are employed but the level of the environmental quality change is held constant, and the tax level is varied depending on whether the respondent agreed to pay some original level or not. This is called double-bounded CVM. This provides a great level of detail on the marginal utility of income. However, in this study, we varied the wetland level which provides more detail on preferences over the environmental quality change of interest.

<sup>6</sup> This treatment of uncertain responses has become a standard procedure in the literature (Blumenschein et al. 2008). However, Caudill et al. (2011) and others have proposed alternative treatments of uncertain responses.

**Fig. 2** Example of a voting scenario

	Alternatives to Choose Between	
	CURRENT TREND	PROPOSED PROGRAM
<b>Wetland Area</b>	<ul style="list-style-type: none"> <li>Wetlands continue to decline by <b>0.87%</b> (242 acres) annually.</li> <li>Wetlands would decrease by <b>18.3%</b> (2,573 acres) below current levels by 2020.</li> <li><b>11,997</b> acres of wetlands would remain by 2020.</li> </ul> 	<ul style="list-style-type: none"> <li><b>Retain</b> existing wetlands and <b>restore</b> an additional <b>3,000</b> acres through 2020.</li> <li>Wetlands would increase by <b>21%</b> above current levels through 2020.</li> <li><b>17,520</b> acres of wetlands would remain from now to 2020.</li> </ul> 
<b>Water Quality</b> Wetlands would...	Remove <b>71</b> semi-truck loads of fertilizer per year	Remove <b>104</b> semi-truck loads of fertilizer per year
<b>Flood, Drought &amp; Erosion Control</b> Wetlands would...	Control <b>14</b> million m <sup>3</sup> of water and <b>79</b> thousand tonnes of soil erosion per year	Control <b>21</b> million m <sup>3</sup> of water and <b>116</b> thousand tonnes of soil erosion per year
<b>Wildlife Habitat</b> Wetlands would...	Provide habitat for <b>793</b> breeding pairs of ducks per year	Provide habitat for <b>1,158</b> breeding pairs of ducks per year
<b>Carbon Storage</b> Wetlands would...	Store carbon equivalent to the emissions of <b>60,366</b> cars	Store carbon equivalent to the emissions of <b>88,156</b> cars
<b>Cost to you</b> Your property taxes would increase by...	<b>\$ 0</b>	<b>\$ 100</b> annually for 5 years

21. Please carefully compare the two alternatives presented in the table above. If you had to vote on these two options, which one would you choose?

- Current Trend       Proposed Program

The final section of the survey elicited individual-specific information such as demographics and environmental attitudes. This information was collected in order to provide additional information on households in the region for potential use in testing the construct validity of the WTP estimates.

#### Survey administration

The two versions of the questionnaire were administered to respective samples of respondents residing in municipalities located within (or partially within) the Credit River watershed boundaries. Ipsos Reid, a survey-based marketing research firm, was contracted to conduct the survey through an internet panel.<sup>7</sup> Internet panels are now a preferred mode of administration and offer a number of

advantages over mail, telephone, and other methods (Dillman 1999). While some thought was given to the fact that this form of survey would preclude the participation of households without access to the internet, statistics show that a high percentage of Southern Ontario households have access to the internet either at home or at work (Statistics Canada 2007).

A pretest of the survey (Version 1) involving 100 respondents was launched by Ipsos Reid to their internet panel located in municipalities within the watershed boundaries in November 2009. The main purpose of the pretest was to examine responses to the range of taxes and to adjust as deemed appropriate. The initial distribution of tax levels for each vote ranged from \$25 to \$400, and once the pretest data were collected, the endpoints of the response distribution for these tax levels and programs were examined and were found to be relatively “thick” (i.e., a relatively large percentage of respondents were voting for the restoration programs when the lowest and highest tax levels were specified). Therefore, the tax level range was increased for a second pretest, ranging from \$50 to \$500. Following a second pretest involving 100 respondents, the tax range was further increased to 50–\$600 for the final survey.

The final surveys (Versions 1 and 2) were administered in early December of 2009. About 700 respondents

<sup>7</sup> Ipsos Reid maintains a panel of approximately 7,620 residents within municipalities located in the Credit River watershed region for survey purposes. Panel members are selected through a rigorous screening process with the intent to ensure representation of all demographic and market segments, and panel members receive various coupons and perks as an incentive to respond to various surveys that are sent to them. It is also important to note that the Ipsos Reid panel is frequently “refreshed” (new members added and old ones excused) to ensure accurate representation of the changing demographics of the current population of interest.

completed each version of the questionnaire, for a total sample of 1,407 households with complete information.

### Econometric analysis

Economists assume that people maximize their utility when make choices. To use this theoretical approach to understand preferences for wetland conservation, utility was specified as a linear function of the quantity of wetland acres affected in each program and the respondents' characteristics and income. For a given respondent  $j$ , a linear utility function for program  $i$  can be written as:  $u_i = \alpha + \gamma S_j + \delta(y_j - C_i) + \beta Z_i + \varepsilon_i$ , where  $u$  indicates the indirect utility for program  $i$ . The constant,  $\alpha$ , represents the level of utility of the "base" or current wetland situation. The coefficient  $\gamma$  reflects the impact of the respondent's characteristics on the utility from choosing a program (relative to choosing no program) where  $S$  is a vector of household characteristics of respondent  $j$ . The utility respondents derive from one more dollar of income (the marginal utility of income) is represented by  $\delta$  where  $y$  represents  $j$ 's income and  $C$  is the cost of the wetland restoration program  $i$ . This coefficient is considered constant across the restoration programs because it is unlikely that different programs pose a substantial change in respondents' income. The  $\beta$  term represents the marginal utility of the size of the restoration program, relative to the current situation. The variable  $Z$  denotes the number of acres of wetland area restored in the proposed program  $i$ . Introducing a random utility framework to this specification assumes that an individual's utility has elements that are unknown to the researcher, and this randomness is captured by the error term  $\varepsilon_i$  which appears because the researcher cannot know all of the factors influencing the respondent's utility.

In the scenarios posed in the questionnaire, a respondent faced a choice between the current situation exemplified by continued wetland decline and a proposed improvement program which would arrest this loss or increase wetlands through restoration. Thus, a respondent would compare the two utilities and vote for the proposed program if it provided them higher utility. This is expressed as  $u_1 - u_0 \geq 0$  where program  $i = 1$  and the current situation is  $i = 0$ . Conversely, if the current situation provided higher utility,  $u_1 - u_0 < 0$ . Due to the binary nature of this choice framework, logit or probit econometric models can be employed using maximum likelihood procedures to estimate the coefficients associated with these utility differences and assess their impact on the probability of a vote for the proposed program. The dependent variable holds a value of "1" if the vote is for the proposed program or "0" if it is for the current situation.

Estimates of the WTP for a recovery program can be calculated from the coefficients of the econometric model. To illustrate this, let  $u_{1j}$  indicate the utility of respondent  $j$  when proposed program  $i$  is implemented and  $u_{0j}$  the level of utility associated with the current situation. To simplify, suppose that utility depends only on income and a program summarized by  $\theta_i$ . WTP is the sum of money that will be taken away from respondent  $j$  after program  $i$  has been implemented in order to keep their utility at the same level as the current situation. Thus:  $u_1(y - \text{WTP}_j, \theta_1) = u_0(y, \theta_0)$  and substituting the linear indirect utility function for into this expression yields:  $\alpha_1 + \delta(y_j - \text{WTP}_j) + \varepsilon_{1j} = \alpha_0 + \delta y_j + \varepsilon_{0j}$ ,

and therefore:

$$\text{WTP}_j = \frac{(\alpha_1 - \alpha_0)}{\delta} + \frac{(\varepsilon_{1j} - \varepsilon_{0j})}{\delta}.$$

Assuming the difference in error means is equal to 0 and normalizing the utility of the current situation to 0 (i.e.,  $\alpha_0 = 0$ ), yields the following expression:  $E(\text{WTP}) = \frac{\alpha_1}{\delta}$ . Other explanatory variables incorporated into the utility function, such as the size of the wetland improvement (i.e.,  $\beta Z$ ), are included with the numerator in this calculation when used in the analysis.

There are also other binary choice model specifications that can be employed to examine particular issues in explaining the observed choices. In this research, two formulations were employed. The first is a random parameters logit model (see Train 1998) where particular coefficients can be specified as normally distributed random parameters. Using this approach provides information on the distribution of the effect of a particular variable on choice and is commonly used to understand heterogeneity of the affect in a sample of respondents. This model provides two parameters for a variable specified as random—a parameter for the mean and an additional parameter for the standard deviation. While this procedure incorporates and accounts for heterogeneity, it is not well-suited to explaining the sources of heterogeneity.

The second is a specification that assumes the existence of latent classes in the data and attempts to characterize segments from the observed individual responses in the observed choice scenarios as well as individual-specific characteristics (e.g., Boxall and Adamowicz 2002). Using this specification offers an opportunity to both understand and incorporate preference heterogeneity in a set of choices. This modeling approach was used by Milon and Scrogin (2006) to identify three groups who varied in their preferences for ecosystem restoration in Florida.

The latent class procedure involves imposing on the choice data the number of segments assumed to exist and then letting the econometric model determine the choice

parameters of each segment as well as a set of parameters that assist in assigning respondents to each class. This procedure involves probabilistic assignment to the classes, and as mentioned above, includes information from their choices as well as their individual-specific characteristics.

The selection of the final number of segments in the model is an iterative process in which the analyst imposes a number of segments (e.g., 2), estimates the model, and then increases the number of segments and reestimates the model. While there can be some statistical criterion used to select the “optimal” number of segments in a series of estimations (e.g., Akaike’s and Bayesian information criteria (AIC and BIC), see Boxall and Adamowicz 2002), conventional rules for this purpose do not exist, and judgment and simplicity play a critical role in the final selection of the number of segments (Swait 1994).

## Results

### Socio-demographic characteristics

Several socio-demographic characteristics of the sample and population within the study region are shown in Fig. 3. Here, it is shown that employment, age, education, gender, and annual household income characteristics of the samples matched quite closely with those of the population in the region. Marginal differences between the samples and the population were observed for each characteristic. Specifically, compared to the population, our samples exhibited (1) a slightly smaller proportion of employed individuals, and larger proportion of unemployed/not employed individuals; (2) a slightly larger proportion of individuals in the 50–60 years of age category; (3) a slightly smaller proportion of individuals with grade school/collage/tech school levels of education, and a slightly larger proportion of individuals with university level education; (4) a slightly smaller proportion of males, and a slightly larger proportion of females; and (5) a slightly smaller proportion of individuals in almost all household income categories (since over 20 % declined to respond). Using  $\chi^2$  tests, however, we confirmed that there was no statistically significant difference between the distributions of these socio-demographic characteristics in the samples and those of the population at the 95 % level of confidence.

Additional socio-demographic information revealed that over 50 % of the respondents in both samples (1) lived in one of the two large cities in the watershed region (i.e., Brampton and Mississauga); (2) lived inside the watershed boundaries; and (3) have had a recreation experience at least one time in the watershed over the past

year. Small proportions (less than 10 %) of respondents were members of environmental, forestry, fishing, or farming organizations.

### Econometric analysis

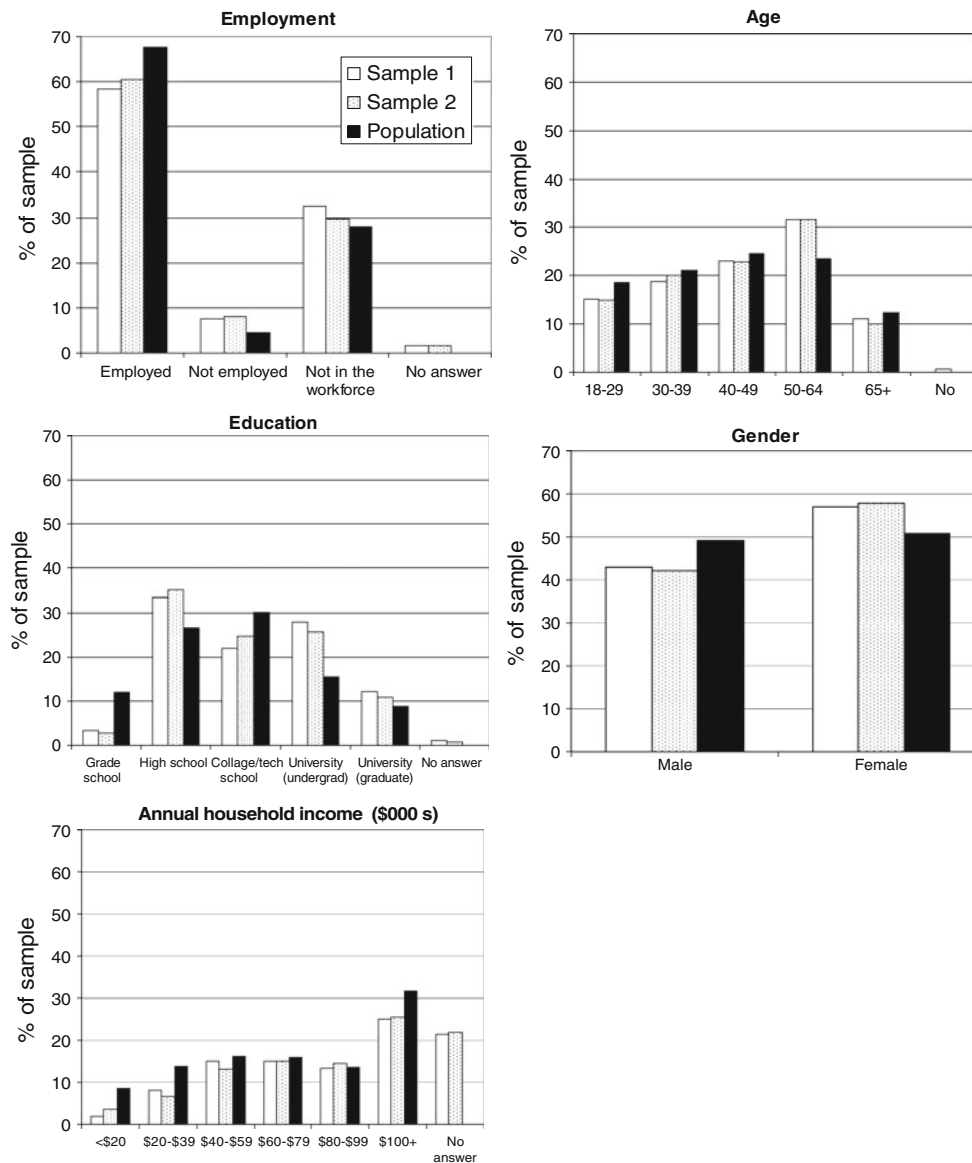
Coefficients for simple binary logit specifications with the votes pooled across the two versions in the sample were estimated via maximum likelihood using LIMDEP software (Greene 2007). The results are reported in Table 1 (Model 1) for the entire sample ( $N = 1,407$ ) and for the sample less 94 yea-sayers ( $N = 1,313$ ) identified by the debriefing question explained above. The explanatory variables included a constant, cost, and the number acres of wetlands restored. Since wetland retention involved 0 acres restored (and 0 acres lost), the value of the constant represents retention. The parameters on cost are negative and statistically significant as expected in both models. However, the parameters on wetland restoration, while positive as expected, are not statistically significant. This suggests that the respondents were not sensitive to the scope of the wetland improvements offered to them in the survey. Other initial models (not reported) compared the results from the two versions in which the magnitudes of the wetland improvements differed between versions, and this finding of no significant preference for the scale of restoration held within versions. This finding is contrary to that of Pattison et al. (2011) who found that respondents were willing to pay more for higher levels of wetland improvements in Manitoba.

Model 2 provides information on the individual-specific determinants of the WTP for wetland restoration with and without identified yea-sayers. Increasing age, membership in an environmental organization, and participation in outdoor recreation has positive effects on the choice of a restoration program. Completing a university degree or college diploma and ownership of land in the watershed had a negative but statistically insignificant effect on restoration. Other variables were tried (e.g., income, gender, etc.) but were found to be statistically insignificant.

In most cases, these results would be sufficient to understand the WTP for wetland improvements in the watershed, and estimates of WTP to retain wetlands are reported for each model in Table 1. For the entire sample, the estimated WTP for retention is about \$245/household per year, and when identified yea-sayers are excluded, the estimate is smaller as expected due to their exclusion from the model estimation.<sup>8</sup> One cannot assess the value of

<sup>8</sup> Note that this estimate is smaller because the identified yea-sayers excluded from the estimation were more likely to vote in support of any wetland improvement program regardless of its cost.





**Fig. 3** Selected socio-demographic characteristics of survey respondents and the population

wetland restoration due to the insignificance of the restoration parameter. These model estimates suggest that respondents were willing to pay to avoid further losses in wetlands, but were ambivalent toward increasing wetlands in the watershed.

The finding of lack of scope regarding the level of the wetland improvements in these data is a concern and could suggest issues regarding validity of the data—the simple specifications uncovered insignificant parameters on the level of wetland restoration; either within a survey version or with the two versions pooled in the analysis (Table 1). The lack of scope remains even when individuals who were suspected to be yea-sayers were excluded from the analysis. Accordingly, more sophisticated choice modeling

frameworks were employed to further understand these results.

First, we confirmed that the preferences for the size of wetland improvements were characterized by considerable heterogeneity. This was done using a mixed logit model (see Train 1998) where the parameter on the wetland acres restored was specified as a normally distributed random parameter (Model 3; Table 1). The parameter for the mean acres restored was not statistically significant as expected for the entire sample and was negative and significant for the sample less yea-sayers. However, the parameter on the standard deviation or restoration was found to be large in magnitude and statistically significant, confirming the presence of heterogeneity in the sample for the scope of the

**Table 1** Parameters and WTP estimates for various choice models on probability of respondents supporting wetland restoration programs in the Credit Valley at various costs and quantities of wetland acres restored

Variables	Pooled logit model				Mixed logit model	
	Model 1		Model 2		Model 3	
	All data ( <i>N</i> = 1,407)	Without YEASAY ( <i>N</i> = 1,313)	All data ( <i>N</i> = 1,088)	Without YEASAY ( <i>N</i> = 1,005)	All data ( <i>N</i> = 1,407)	Without YEASAY ( <i>N</i> = 1,313)
Constant	0.8339*	0.7981*	0.0835	0.0645	0.7769*	0.7623*
Cost	-0.0034*	-0.0036*	-0.0034*	-0.0036*	-0.0031*	-0.0032*
Wetland acres restored (1,000 s)	-0.0008	-0.0009	-0.0017	-0.0022	0.0111	-0.0169*
SD of wetland acres (1,000 s)					0.3464*	0.3404*
Age (years)			0.0125*	0.0121*		
Higher education attainment			-0.0921	-0.0551		
Land owned in the watershed			-0.1710	-0.1856		
Member of an ENGO			0.4148*	0.3191*		
Participation in outdoor recreation			0.4511*	0.4632*		
LL at convergence	-3,574.16	-3,296.71	-2,736.28	-2,497.06	-3,376.29	-3,119.53
WTP (\$/respondent/year) for wetland retention (SD) <sup>b</sup>	\$246.31 (12.67)	\$224.45 (12.66)	\$269.52 <sup>a</sup> (13.46)	\$243.92 <sup>a</sup> (13.48)	\$254.47 (9.46)	\$237.28 (9.37)

\*  $P < 0.05$

<sup>a</sup> Calculated at the means of the individual-specific characteristics used in the model

<sup>b</sup> Standard deviations (SD) of the WTP estimates were calculated using procedures developed by Krinsky and Robb (1986) using 5,000 draws from the covariance matrix of parameters

wetland improvement. This heterogeneity suggests that a component of this sample is positively sensitive to the scope of the environmental change or, in other words, was willing to pay to further increase wetland areas through restoration.

To further understand this heterogeneity, we used latent class models to uncover different segments or classes of respondents in the sample with similar preferences for the costs and levels of wetland improvements. We estimated models with two, three, and four classes with the entire sample. For each specification, we attempted to explain class membership with the same individual-specific variables used in Table 2, although many other variables were examined in preliminary analyses. We also included all individuals in the sample so that the variable that we assumed identified yeasayers could be used as a class membership variable.

Based on econometric results, the 3-class solution was chosen as the model to represent heterogeneity in preferences for the costs and levels of wetland improvements (see Model 4, Table 2). Based on the results from the 2-class solution, the 3-class model provided an improvement in the log likelihood at convergence of about 121 points, an increase in estimated explanatory power of 3.5 % (pseudo  $R^2$ ), and superior measures for the Akaike and Bayesian information criteria (AIC and BIC, respectively). While the 4-class solution provided slightly better

measures of these diagnostic features,<sup>9</sup> the gains in improvement from those of the 3-class solution were judged to not be sufficient enough to discard the 3-class outcome. In addition, the extra class discriminated by this particular model did not provide any new insights into the restoration preferences of the respondents.

The results, shown in Table 2 (Model 4), provide an interesting pattern of income and wetland conservation preferences across the 3 classes. Explanators of class membership included age, education attainment, ENGO membership, and participation in outdoor recreation. An additional variable included in this analysis was called YEASAY, which was a dummy variable that equaled 1 if the respondent indicated “I think we should protect wetlands regardless of the cost” as their most important reason for voting for a proposed program. Note that the parameters for the class 3 are equal to 0 due to their normalization during estimation; thus, class membership for classes 1 and 2 must be described relative to this third class.

<sup>9</sup> For example, moving from the 3-class to the 4-class solution improved the log likelihood value by 48 points and the rho squared by about 1 %. The 4-class solution also did not reveal classes that were markedly different from the 3-class model, except one in which all of the coefficients were not statistically significant and included a very small part of the sample (6 %). As discussed by Swait (1994), the final selection of classes in these models should be parsimonious and involves judgment rather than the formal use of specific criteria.

**Table 2** Parameter estimates for a latent class binary choice model with three classes of respondents supporting wetland conservation programs in the Credit Valley at various costs and quantities of wetland acres affected (including identified “yea-sayers”)

	Model 4 ( <i>N</i> = 1,371)		
	Class 1	Class 2	Class 3
<i>Choice parameters</i>			
Constant	1.4954**	2.8352**	3.0348**
Cost	−0.0428**	−0.0128**	−0.0029**
Wetland acres restored (1,000 s)	0.0547**	0.0671**	−0.0671**
<i>Class membership parameters</i>			
Constant	1.1197**	0.5810	0
Age	−0.0133**	−0.0111	0
High education	0.3059*	0.6939**	0
Member of an ENGO	−1.3438**	−0.7361**	0
Participation in outdoor recreation	−0.6797**	−0.2385	0
Yea-sayer identification	−2.4291**	−1.5452**	0
Class membership probability	0.3250	0.3467	0.3283
LL at convergence		−2,682.03	
Rho squared		0.2274	
AIC		5,406.07	
BIC		5,544.87	
<i>WTP (\$/respondent/year)</i>			
Wetland retention (SD) <sup>a</sup>	\$34.49 (5.52)	\$222.22 (16.23)	\$1060.70 (119.62)
Wetland retention and restoration (an additional 1,000 acres)	\$35.77	\$227.46	\$1,037.56

\*  $P < 0.05$ ; \*\*  $P < 0.01$

<sup>a</sup> Standard deviations (SD) of the WTP estimates were calculated using procedures developed by Krinsky and Robb (1986) using 5,000 draws from the covariance matrix of parameters

Respondents on average have a 32 % chance on being in class 1. Those likely to be in this class have weak positive preferences for wetland retention (i.e., a small positive constant term), positive preferences for wetland restoration and are highly sensitive to costs. Accordingly, these individuals have a relatively small WTP for retention, and a very small WTP for increases in wetlands restored beyond retention. These individuals tend to be younger, are highly educated, are not members of an ENGO, and do not participate in outdoor recreation.

Respondents have a similar chance of being in class 2, and while these respondents hold positive preferences for wetland retention like those in class 1, they have greater positive preferences for wetland restoration. These individuals are similar to those of class 1 except that they are even more likely to be highly educated, less likely to hold membership in an ENGO, and possibly do participate in outdoor recreation. Since the parameters on the constant and restoration are higher than those for class 1, and the cost parameter is less negative, their WTP for retention is much higher than the WTP for class 1 as is their WTP for restoration.

Finally, the probability of being in class 3 is similar to the other two, and members of this class are characterized by quite different cost and wetland retention preferences

and appear to prefer fewer acres of wetlands restored.<sup>10</sup> The normalized class membership parameters when compared to the estimated parameters of the other two classes suggest that class 3 individuals are older, less educated, are members of an ENGO, and participate in outdoor recreation.

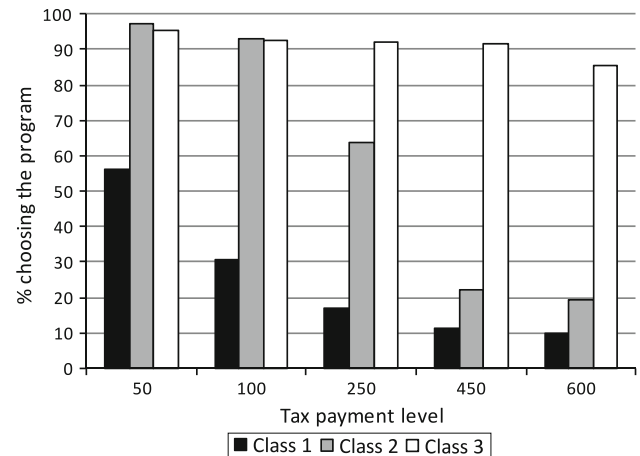
The results of using the YEASAY variable in defining class membership are instructive. Classes 1 and 2 hold statistically significant negative values for this variable suggesting that when they voted for a restoration program that they did not feel that wetlands should be protected regardless of cost. On the other hand, class 3 individuals were more likely to have selected this as a reason behind their voting choice for a proposed program. This suggests that individuals likely to be in classes 1 and 2 were not yeasayers while those in class 3 were. Note that these observations are reflected in the estimates of the WTP to retain wetlands (Table 2). Class 3 individuals are estimated to be

<sup>10</sup> This observation is not as puzzling as it may seem due to the fact that the large positive constant in the choice parameter vector would dominate the calculation of welfare measures for the size of wetland restoration, effectively turning the negative effect of the wetland acre parameter into an overall positive WTP for restoration. The negative sign on the restoration variable signifies declining WTP as acres restored increase.

willing to pay \$1,060.70/household/year over a 5-year period which is significantly higher than the associated WTP estimates for the other two classes (at \$34.49 and \$222.22, respectively).

This latent class analysis has uncovered a significant component of the data that are sensitive to the scope of wetland restoration in the expected manner. About two-thirds of the sample (i.e., classes 1 and 2) is willing to pay small positive increases in taxes for wetland restoration in this watershed, and this amount increases as the acres restored rises. However, the analysis has uncovered another third that are apparently willing to pay considerable sums for retention and restoration, and while this amount decreases at a very small rate as the acres restored increases, the WTP estimate would still be very large. While the variable we used to identify yeasayers in these data suggested that class 3 membership was associated with yeasaying, it appears that this variable did not do a good job of identifying all of the yeasayers in these data, as only 94 respondents were identified. The presence of more than the 94 identified yeasayers is one reason for very large WTP estimate arising from this component of the sample (Table 2).

To examine this yeasaying outcome further, each respondent was assigned to one of the three classes using the highest estimated probability of class membership produced from the latent class parameters. For each class, a bar chart was prepared that plotted the percentage of class members that voted for a wetland improvement program at each level of tax offered. These results are shown in Fig. 4. These results suggest that respondents classified into classes 1 and 2 respond as expected to the levels of payment required for the restoration programs. However, respondents in class 3 virtually appear to be willing to pay any amount offered in the survey for restoration activity. These outcomes are reflected in the WTP measures in Table 2—the WTP for individuals in class 3 was estimated to be \$1,037.56/year over 5 years for retaining the existing wetlands and restoring 1,000 ha of additional wetlands, much higher than the estimate for individuals in the other two classes (at \$35.77 and \$227.46/year, respectively). If one were to omit class 3 when calculating mean WTP for this level of restoration, more conservative WTP estimates would result. Since the number of respondents in classes 1 and 2 is approximately equal, the average of the WTP estimates from these classes could serve as a suitable WTP estimate. These are \$128.22/household/year for retention and \$131.48/household/year for retention and restoration of an additional 1,000 wetland acres. Thus, yeasayers (identified by the YEASAY variable as well as others in class 3) cause the WTP estimates generated from Models 1 to 3 (ranging from \$224.45 to \$269.52) to be biased upwards.



**Fig. 4** Bar charts of the level of support for wetland retention or restoration by level of tax payment required for respondents to the survey in the Credit River, Ontario

## Discussion

One feature of this Canadian study is that the watershed in which the wetland programs would be operating is located within the largest urban area in Canada. This, and the fact that the majority of respondents was recruited from within the watershed, could explain the disparity of the valuation estimates across the three segments of respondent uncovered in the analysis. For example, the latent class model identified a group of respondents that were willing to pay only small amounts of their income to retain or restore wetlands in the watershed. One could speculate that these individuals may not enjoy significant personal benefits in the increase in services provided by improved wetland conservation activity. The characteristics of these individuals suggest perhaps that they are young working professionals and are not participating in environmental groups or outdoor recreation where they may interact with wetland areas outside of the urban areas. As such, these individuals may be unaware of the value of wetland services, but could be aware of market values associated with the lands that wetlands would be associated with. Thus, these individuals may not support reductions in urban and industrial expansion. This rationale is consistent with related literature that finds a positive association between (1) the lack of outdoor activities and the lack of environmental concern (e.g., Thapa and Graefe 2003) and (2) the lack of environmental concern and a lower WTP for wetland conservation (e.g., Birol et al. 2006; Othman et al. 2004). Furthermore, research has shown that urban residents tend to have less pro-environmental orientations compared to rural residents (Huddart-Kennedy et al. 2009; Berenguer et al. 2005), which might explain why some respondents have lower WTP values than respondents in similar studies

(e.g., Birol et al. 2006; Pattison et al. 2011) where a mix of urban and rural respondents were surveyed. Thus, it is not surprising that a large component of respondents in our survey were not willing to pay large sums for wetland conservation efforts.

The model also identified members of a second group of respondents (class 2) who hold high levels of education, are not likely to be members of an ENGO, but are likely to participate in outdoor recreation. The important differences between this group and those in the previous group are that they are older and also more likely to participate in outdoor recreation. As explained above, this connection with the outdoors may largely explain their higher WTP for wetland retention and restoration. The higher age levels (relative to class 1) may also imply that this group is more likely to have grown up in a rural environment, since the rate of urban expansion into wetlands has intensified only recently. Thus, the rural versus urban household differences described above may be at work here as well.<sup>11</sup>

The final group of respondents (class 3) have relatively lower education levels, are likely to be members of an ENGO, and are likely to be identified as yea-sayers. This group is quite unique from the other two, in that they have a much higher WTP for wetland retention and a negative WTP for wetland restoration. The relatively high wetland retention value found here is consistent with findings in the literature that ENGO members place a higher value on wetland conservation (e.g., Pate and Loomis 1997; Stevens et al. 1995; Whitehead 1991). However, the fact that this value is far above the highest payment level used in our valuation scenarios and that the value for wetland restoration is lower than that for retention, indicates possible inconsistencies in responses for this group, which may be typical of yea-sayers who may not give much thought to budget constraints implicit in the valuation scenarios.

Overall, our findings indicate that a significant proportion of respondents in our urban/peri urban wetland valuation study may be associated with a yea-saying bias, despite trying to account for this bias in the design phase of the questionnaire scenarios and the use of debriefing questions to identify such individuals. This bias, if left unaccounted for, would significantly inflate WTP estimates for wetland conservation efforts derived from the sample of respondents.

The extent to which this is an issue in other wetland valuation studies (particularly those conducted prior to the development of methods used to address potential biases) is an open question. Various meta-analyses of wetland

values (e.g., Brouwer et al. 1999; Brander et al. 2006) uncover significant variation in the valuation estimates. While these are obviously related to the different services provided by the wetlands across the various studies included in the meta-analyses, there could also be different levels of hypothetical bias in these estimates. One contributing factor could be the urban/peri-urban nature of the watershed we examined as well as the fact that the respondents were largely resident in the watershed. These possible influences may be important to consider in other wetland valuation studies and to control for in future meta-analyses of wetland values. The extent to which hypothetical bias and heterogeneity in valuation estimates persists in small versus large-scale wetlands and in urban versus rural regions is an area for further research.

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<sup>11</sup> Unfortunately, we did not include a question related to where respondents grew up and therefore cannot confirm this conjecture. Future research on valuing urban and peri urban wetlands should likely include such a variable.

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