Credit Valley Conservation

Valuing Wetlands in Southern Ontario's Credit River Watershed

Phase II A Contingent Valuation Analysis - June 2010

Van Lantz, Peter Boxall, Mike Kennedy, Jeff Wilson

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Valuing Wetlands in Southern Ontario's Credit River Watershed: a Contingent Valuation Analysis
June 2010

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About Credit Valley Conservation

Credit Valley Conservation (CVC) was formed on May 13, 1954, and has been working for over 50 years to protect the natural environment. CVC is one of 36 conservation authorities operating in Ontario and is a partnership of the municipalities within the Credit River Watershed. CVC is a community-based environmental organization originally formed by an Act of provincial government and dedicated to conserving, restoring, developing and managing natural resources on a watershed basis. More information about CVC is available at www.creditvalleyca.ca.

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A contingent valuation analysis

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Executive Summary

Wetlands are known to provide a number of important services to society. These services, which include water filtration/regulation, biodiversity habitat, carbon storage, and others, have declined over time in many regions of the world due to wetland area and quality loss. The main reason for this loss is a market failure, where there is no market price to reflect the scarcity of wetland services. Without a market price, wetland services have often not been appropriately accounted-for when evaluating the trade-offs associated with economic development and/or land-use change decisions. Various non-market valuation methods (including the contingent valuation method (CVM), the travel cost method, the replacement cost method, and others) can be used to estimate non-market values associated with wetland services. The estimates produced by these methods can be used in cost-benefit analysis of programs that improve or degrade wetlands.

The purpose of this study was to estimate the value of retaining and restoring wetland services in the Credit River Watershed using the CVM. The CVM is a survey-based technique where a sample of the population is asked a series of questions about their willingness-to-pay for various hypothetical programs that change environmental services. In the current study, a total of 1,400 households were asked their willingness-to-pay (via voting for/against an increase in their property taxes over the next 5 years) for several wetland retention/restoration programs in the Credit River Watershed, ranging from retaining 2,523 acres of wetlands to retaining/restoring 13,523 acres of wetlands over the 2009-20 period. Care was taken in the survey to minimize potential biases associated with the CVM (i.e., hypothetical and 'yea-saying' biases), and to test for the sensitivity of willingness-to-pay estimates to the scope (size) of the wetland programs considered.

Results indicate that while households were willing to pay a significant amount for the wetland programs considered in the study and were sensitive to the tax level (i.e., as the tax level increased, they were less willing to vote for a given proposed program), they were insensitive to the scope (or size) of the wetland program (i.e., they were not willing to pay more for larger wetland programs). This latter finding indicates that households place the same value on a wetland retention program as they do on a wetland restoration program. While some literature suggests that such a finding may reduce confidence in the estimates, recent literature indicates that such a finding may be rational in that households have more familiarity with (and place a significant value in) smaller wetland programs.

Households were on average willing to pay an annual amount in the range of $228.58-$258.78 over the next 5 years for a wetland program, depending on the model specification used in the regression analysis. Using a discount rate of 5%, the household total present value willingness-to-pay estimates were in the range of $1,037.75-$1,176.40. Multiplying the household willingness-to-pay estimates by the current number of households in the Credit River Watershed region (212,865) produced total present value[1] willingness-to-pay estimates in the range of $220.9-250.4 million.

[1] Present value refers to a value (either in the present or in the future) evaluated in the initial (present) year. Here, a discount rate is applied to all future values. In this study, a 5% discount rate is assumed

The above willingness-to-pay estimates, which can be interpreted as the perceived social benefits of a wetland program in the Credit River Watershed, can be used for future cost-benefit analyses of alternative wetland programs. As long as the cost of a particular wetland program (designed along the lines of those considered in this study) does not exceed the social benefits (estimated in the range of $$220.9-250.4 million in present value terms), the program can be justified on economic grounds. Since the benefits of wetland programs in the watershed were not found to increase with the amount of restoration (i.e., benefits are insensitive to the scope of the program), policy-makers would be able to justify wetland programs in the watershed up to a cost of $$220.9-250.4 million in present value terms.

Next steps in this research could include: (i) the implementation of more advanced statistical analysis (e.g., using latent class models) when examining the CVM data to possibly uncover sub-groups that are/are not insensitive to the scope (size) of wetland programs. Results of this analysis could be used to improve the accuracy of the social benefit estimates, by applying unique sub-group willingness-to-pay values at different wetland program levels; (ii) a series of focus group meetings with members of the public to understand why survey respondents: were not willing to pay more for higher levels of wetland restoration in the watershed; preferred wetland restoration in particular regions of the watershed; and other such issues thought to be of importance. These results could be used to help direct educational materials to address issues uncovered in the meetings; and (iii) an applied cost-benefit analysis of specific wetland retention/restoration programs in the Credit River Watershed. Such analysis might involve implementing a landowner survey in order to provide in-depth information to policy-makers about the willingness of landowners to participate in a wetlands program on their property, their willingness to accept compensation, and their preferences over implementation specifics (e.g., types of incentives, extent of commitment, etc). Such information would surely help in the effectiveness of wetland conservation initiatives in the watershed.

1. Introduction

Wetlands are amongst the most productive ecosystems in the world. They provide a wide array of important ecological functions including water filtration and flow control, surface and groundwater rechange and discharge, nutrient retention, biodiversity habitat, carbon sequestration, and others. These functions, in turn, provide a number of services to society including the mainenance of water quality, flood/drought/erosion control, commercial and recreational fishing and hunting, other recreational amenities, climate regulation, and others (Woodward and Wui 2001; Brouwer et al 2003; Brander et al. 2006). Recent literature estimates that wetlands provide up to 40% of all ecosystem services worldwide, despite covering only 1.5% of the Earth's surface (Zedler 2003).

In spite of their significance, wetlands have continued to decline throughout the world. In Canada alone, approximately 20 million hectares of wetlands have been drained or lost since 1800 (Cox 1993). This trend, which represents a 50-70% loss of wetlands over the past century, is similar to what has occurred in Europe and the United States (Barbier et al. 1997). Schuyt and Brander (2004) argue that one of the main causes of wetland degradation is information failure. In this context, policy makers have insufficient information on the economic value of wetlands, and therefore do not adequately consider the full extent of trade-offs when making development decisions. This lack of information comes about due to the fact that most of the services provided by wetlands are public goods, and are not traded in the market.

Economists typically categorize the service values provided by wetlands 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.

A substantial literature has emerged over the past few decades directed toward estimating the value of various wetland services (Brander et al. 2006). This literature varies widely in the use of specific valuation techniques, the consideration 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 is the contingent valuation method (CVM). This method presents a sample of households with a questionnaire containing one or more hypothetical scenarios in which they are asked to consider making market-like transactions for purchasing a range of environmental services (Haab and McConnell 2002). This information is used by researchers to estimate the respondent's willingness-to-pay for the services under consideration. Since the CVM can be designed using a number of different question formats (open-ended, referendum, payment card, etc), administered in a number of different manners (i.e. mail, in person, internet, etc), focused on a number of different services and, associated with different geographical scales and program scopes (or levels), many potential biases exist that may skew the willingness-to-pay estimates. As such, care must be taken when developing and implementing the CVM to minimize the known potential biases.

The purpose of this study was to estimate the value of wetland retention and restoration in the Credit River Watershed, in southern Ontario. To facilitate our analysis, we employed a state-of-the-art CVM to ensure the effectiveness and salience of the survey and the resulting data. 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 discus the implications and usefulness of our findings for policy.

2. 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^2. 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 favours 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 Figure 1).

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. 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 Near-urban region (in the center) of the watershed where urban development has occurred.

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, streamflow, erosion and wildlife habitat.

While a number of policies have been implemented to slow the decline of wetlands in the watershed (e.g., regulations implementing the Ontario Conservation Authorities Act)[2], future urban development and other factors such as climate change continue to put pressure on these declining resources.

[2] See Conservation Authorities Act (2009). Available at: http://www.e-laws.gov.on.ca/html/statutes/english/elaws_statutes_90c27_e.htm

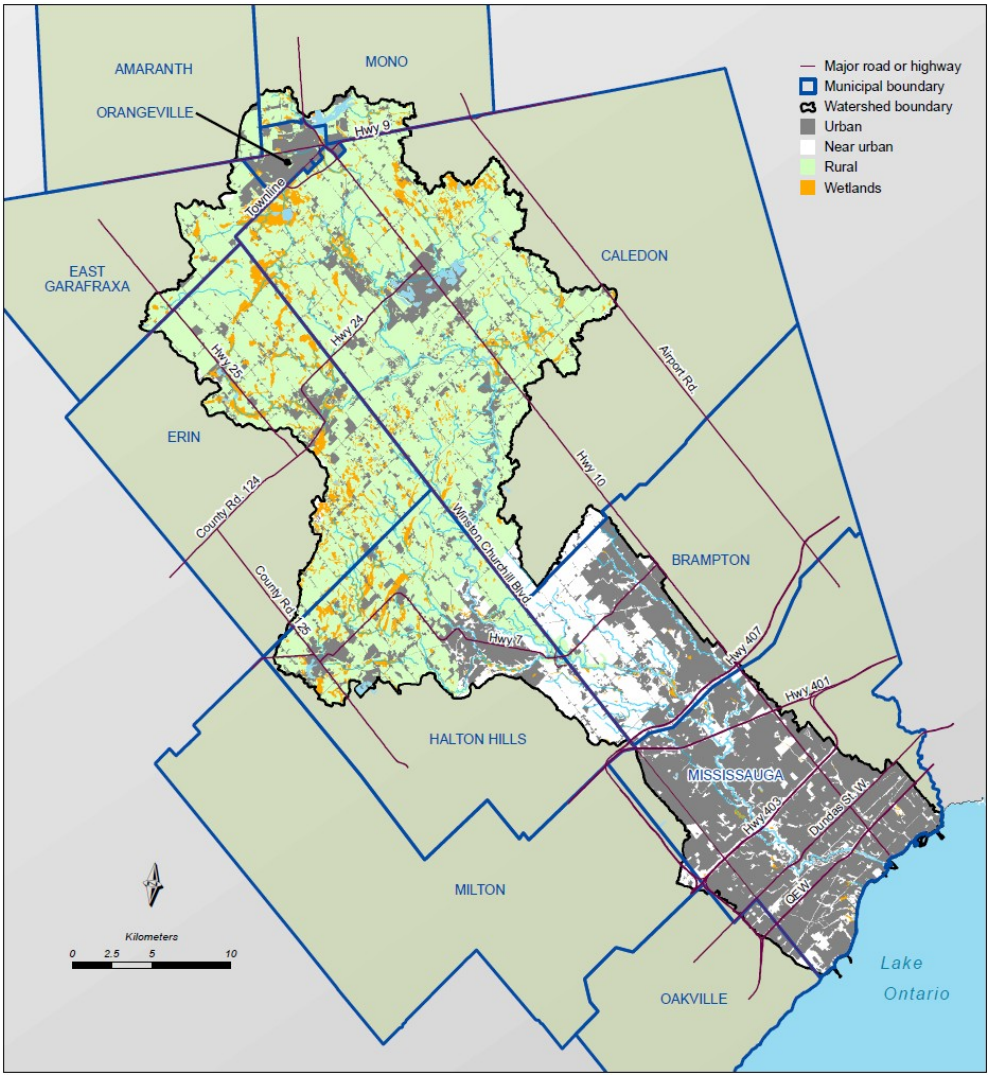


Figure 1. The Credit River Watershed

3. Study Approach

The questionnaire design, survey implementation, and data analysis employed in the CVM generally followed procedures outlined in Carson (2000) and Bateman et al. (2002). The following provides details of the procedures employed.

3.1 Questionnaire design

An initial draft of the questionnaire was developed after an extensive review of the CVM literature focused on valuing wetlands, and the collection of existing biophysical data on the past, present, and projected future state of wetlands in the Credit River Watershed. This draft was presented to a focus group of wetland experts and representatives from the community in order to ensure accuracy of the survey information, readability, and to ensure that the results of the analysis would assist in policy development. A number of modifications were made as a result of feedback from the focus group participants. A series of additional drafts were e-mailed back and forth between researchers and focus group members, as issues of concern were identified and addressed. In the end, the participants generally thought that the final version of the questionnaire would be suitable for distribution to the public in the region.

The final version of the questionnaire consisted of three sections. In the first section, respondents were provided with a description of the questionnaire's purpose, and were asked a series of questions about their knowledge and use of wetlands in the Credit River Watershed. These questions were followed by information on wetland characteristics, existing wetlands in the region, and the services that wetlands provide. Specific services that were focused-on 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 their opinion on: (i) the degree to which these services have become better or worse over the past decade; (ii) the current status of the services; and (iii) 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 tradeoffs associated with wetland conservation. Respondents were asked if they were aware of the 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.[3] 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 to manoeuvre around wetlands), reduced land value, and reduced income in agricultural-dependent businesses. Respondents

[3] In the survey, a distinction was not made between the ecological functioning of existing versus restored wetlands. While differences do exist, we believed that the required explanation might introduce information overload to survey respondents.

were asked 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 CVM scenarios and eliciting willingness-to-pay responses. Here, a choice framework was developed that employed a referendum approach.[4] Specifically, respondents were first informed that they would be asked to vote on four scenarios that would result in different amounts of future 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 or restored to different levels above existing levels through to 2020). Associated with each proposed program was a randomly assigned increased property tax level that respondents would pay annually for the next 5 years (selected from a uniform distribution of tax values, ranging from $50-$600).[5] Respondents were asked to vote on the alternative they preferred.

The use of four voting scenarios was utilized instead of the typical CVM case where only one is used.[6] This permits a "richness" of preference information to be collected from respondents over the scope of the program (i.e., we can determine the extent to which household willingness-to-pay estimates change with different wetland restoration levels) and may allow the use of smaller samples of respondents for appropriate levels of statistical efficiency in estimation of willingness-to-pay values. Furthermore, the presentation of these voting scenarios was randomized in the final administration of the questionnaire. 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 sensitivity-to-scope tests, where willingness-to-pay estimates are examined to see if they increase with larger wetland programs (Carson and Mitchell 1993). To further investigate the issue of sensitivity-to-scope, two versions of the questionnaire were developed, each with unique restoration program levels. Version 1 considered the restoration of 3000, 7000, and 11000 acres of previously lost wetlands, while Version 2 considered restoration of 1000, 5000, and 9000 acres. These two versions were specified and administered to two different samples within the watershed region for a split-sample test of sensitivity to scope. Previous literature using this technique for various environmental improvements has found mixed results (Carson 1997).

To help respondents understand the extent of differences between the current trend of wetland loss and the various proposed programs that would retain or restore wetlands, graphs of the different amounts (hectares) of wetlands under each alternative were presented, along with the associated percentage changes. Additionally, to help respondents better understand the consequences of changes in wetland area, estimates of the associated changes in wetland

[4] The referendum format is generally favoured over other formats in the literature as it is thought to be incentive compatible, where respondents have an incentive to report their true willingness-to-pay (Arrow et al. 1993).

[5] The use of household taxes as the payment vehicle effectively described a realistic method for payment for a public good. For the payment vehicle to be incentive compatible it needs to be consequential, and credibly impose costs on the entire sample of interest while avoiding voluntary contributions (Arrow *et al.* 1993; Carson and Hanemann 2005).

[6] 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 present study we varied the wetland level which provides more detail on preferences over the environmental quality change of interest.

services were also provided. These services included: removal of nitrogen and phosphorus (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 previous research in Alberta by Yang *et al.* (2008) and Cowardin *et al.* (1995). Figure 2 provides an example of a voting scenario used in the questionnaires.

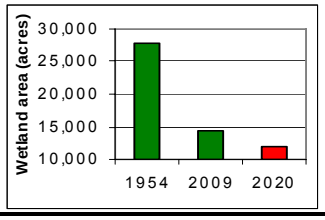
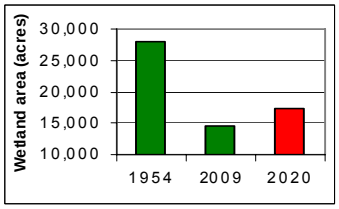
	Alternatives to Choose Between	
	CURRENT TREND	**PROPOSED PROGRAM**
Wetland Area	• Wetlands continue to decline by 0.87% (242 acres) annually. • Wetlands would decrease by 18.3% (2,573 acres) below current levels by 2020. • 11,997 acres of wetlands would remain by 2020. 	• **Retain** existing wetlands and **restore** an additional 3,000 acres through 2020. • Wetlands would increase by 21% above current levels through 2020. • 17,520 acres of wetlands would remain from now to 2020. 
Water Quality *Wetlands would…*	Remove 71 semi-truck loads of fertilizer per year	Remove 104 semi-truck loads of fertilizer per year
Flood, Drought & Erosion Control *Wetlands would…*	Control 14 million m^3 of water and 79 thousand tonnes of soil erosion per year	Control 21 million m^3 of water and 116 thousand tonnes of soil erosion per year
Wildlife Habitat *Wetlands would…*	Provide habitat for 793 breeding pairs of ducks per year	Provide habitat for 1,158 breeding pairs of ducks per year
Carbon Storage *Wetlands would…*	Store carbon equivalent to the emissions of 60,366 cars	Store carbon equivalent to the emissions of 88,156 cars
Cost to you *Your property taxes would increase by…*	**$ 0**	**$ 100** annually for 5 years

Figure 2. Example of a voting scenario used in the questionnaires.

To mitigate potential 'yea-saying' bias, where some respondents vote for a proposed program at any cost while ignoring their budget constraints because they are sympathetic to an environmental cause, we incorporated debriefing questions following the voting scenarios (Blamey *et al.* 1999). We asked respondents why they voted for the restoration scenarios and those that chose the answer "I think we should protect wetlands regardless of the cost" their most important reason (and voted as such for all programs considered) were termed yea-sayers and were deleted from the final dataset.

To reduce potential 'hypothetical' bias, where the use of hypothetical scenarios may not convincingly replace the absence of real market transactions, we used 'cheap talk' scripts (Cummings *et al.* 1999; List 2001; Lusk 2005). A "cheap talk" script consists of additional text provided in the survey just prior to the willingness-to-pay question that attempts to convince respondents that the survey has policy implications and reminds them of the consequential trade-offs they are making in the valuation scenarios. The cheap talk script also makes respondents aware of hypothetical bias and how it can skew willingness to pay results upward (Cummings *et al.* 1999; List 2001; Lusk 2005). 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". We used cheap talk script 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. Studies have shown that hypothetical values are not statistically significant from real values when respondents are certain of their responses (Champ *et al*. 1997; Blumenschein *et al*. 1998). Furthermore, uncertain responses are not as appealing for policy guiding purposes as certain responses (Champ *et al*. 2003). Therefore, if a respondent indicated uncertainty in their response to a vote, their answer was considered a vote of "no" to the proposed wetland program.

The final section of the survey contained a series of debriefing questions and 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 Credit Valley Conservation, and to examine the construct validity of the willingness-to-pay estimates (discussed in detail below).

3.2 Survey implementation

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. Internet panels are now a preferred mode of administration and offer a number of advantages over mail, telephone and other methods (Dillman1999). 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).

Ipsos Reid maintains a panel of approximately 7,620 residents within Municipalities located in the Credit River Watershed region for survey purposes. Ipsos Reid staff actively manage their panel members and can provide data on panel member's demographic characteristics (e.g. city/town of residence, gender, age, income, children in household, household size, education, etc.). 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.

A pre-test of the survey (Version 1) was launched by Ipsos Reid to their internet panel located in municipalities within the watershed boundaries in November of 2009. The main purpose of the pre-test was to examine responses to the range of taxes, and to adjust as deemed appropriate. The initial distribution of tax levels were aligned with those in previous studies, and ranged from $25 to $400. A total of 100 individuals were surveyed and completed the questionnarie. The data was collected and examined. The endpoints of the response distribution for different tax

levels and programs were initially 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 pre-test, ranging from $50 - $500. Following a similar analysis, the highest endpoint was further increased for the final survey, ranging from $50 - $600. The final surveys (Versions 1 and 2) were administered in early December of 2009. A total of 700 respondents completed each version of the survey, for a total number of 1,400 households surveyed.

3.3 Data analysis

The socio-demographic characteristics of respondents and their responses to knowledge, attitude, and preference-related questions were summarized using histograms, which describe the proportion of responses that fall into each characteristic/response option category. Additionally, the distributions of several socio-demographic characteristics (i.e., employment status, age, education, gender, and annual household income) in the samples were compared to the relevant population. Here, the relevant population was defined as those living in municipalities located within (or partially within) the Credit River Watershed boundaries. A Chi-Square test was used to examine whether or not the distributions of each characteristic differed from those of the population. If found to differ, the typical way to proceed would be to weight responses in the sample in a way that better reflects population characteristics.

Responses to CVM voting scenarios were analyzed using logit regressions. Here, the dependent variable is binary, where a vote indicating choice of a 'wetland program' is recorded as a 1, and a vote indicating choice of the 'current trend' is recorded as a 0. The independent variables represent attitudinal, behavioural, socioeconomic, and scenario-specific factors that are thought to be significant determinants of voting choices. A number of different model specifications were estimated, ensuring that independent variables included in each specification were not collinear with one another or endogenous and thus suspect for inclusion in the model. In the end, 2 models were selected for presentation. Model 1 examined the basic relationship between voting responses and the scope of wetland restoration. The scope of wetland restoration variable was considered under a number of alternative specifications (i.e., as a continuous variable from 1=retention to 4=highest level of restoration, as a continuous variable with the addition of a sample dummy variable, as individual wetland acre dummy variables, in logarithms, etc) to test for insensitivity-to-scope. The wetland scope specification that provided the best fit for Model 1 was a simple continuous variable. Model 2 included a number of additional independent variables that provided the best fit to the data. Estimation involved maximum likelihood procedures using LIMDEP software (Greene 2007).

Household annual willingness-to-pay values (in current value terms) were estimated using the parameters of Model 1 and Model 2 (where significant independent variables were held at their mid-points). Since the survey specified that respondents who voted for a wetland program would be required to pay a certain increase in their property taxes over the next 5 years, the stream of payments for restoration level *i* can be discounted to the present using a net present value formula:

$$NPV = \sum_{t=1}^{5} \frac{WTP_i^t}{(1+r)^t} \qquad (1)$$

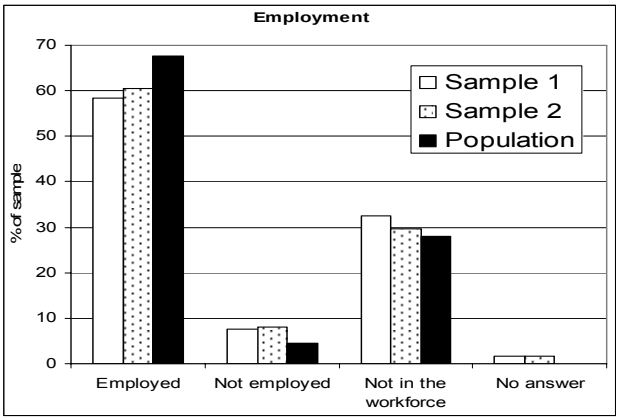
where WTP_i^t is the willingness to pay estimate for wetland program *i* in time *t,* and *r* is the discount rate. Household annualized present value willingness-to-pay estimates were calculated

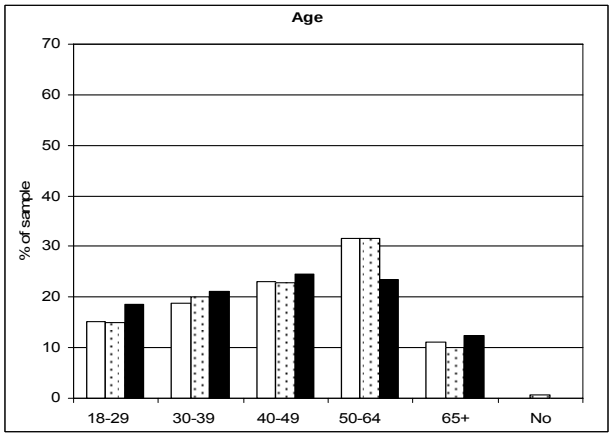
using equation *(1)* together with a 5% discount rate. Total willingness-to-pay values (in current and present value terms) were estimated by multiplying the household willingness-to-pay estimates from each model by the number of households in the Credit River Watershed region, which equals 212,865, according to the 2006 Statistics Canada National Census.

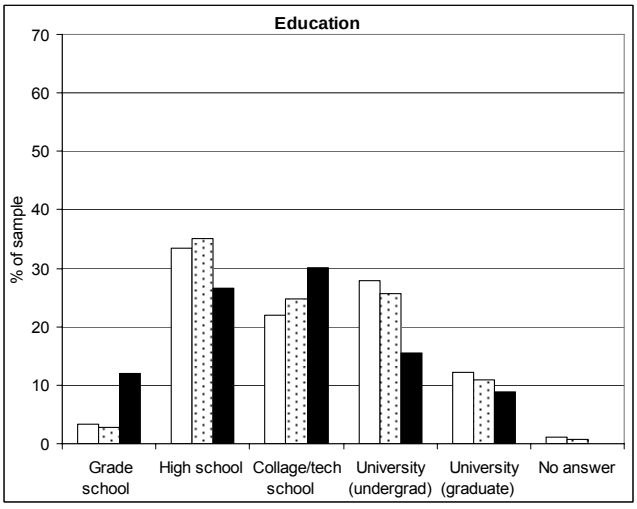
4. Results

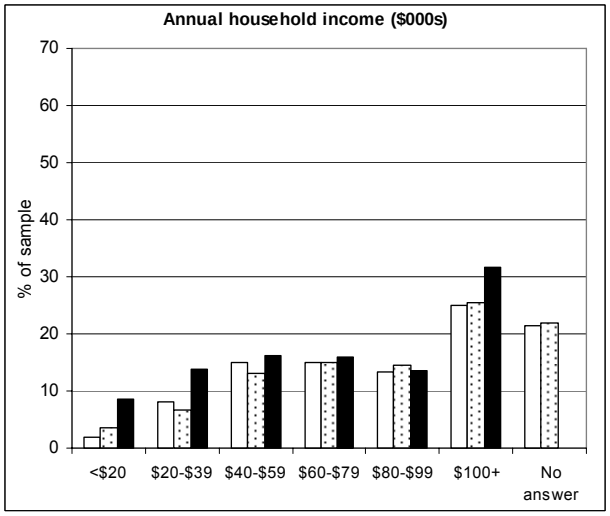
4.1 Socio-demographic characteristics

Several socio-demographic characteristics of the sample and population within the study region are shown in Figure 3.









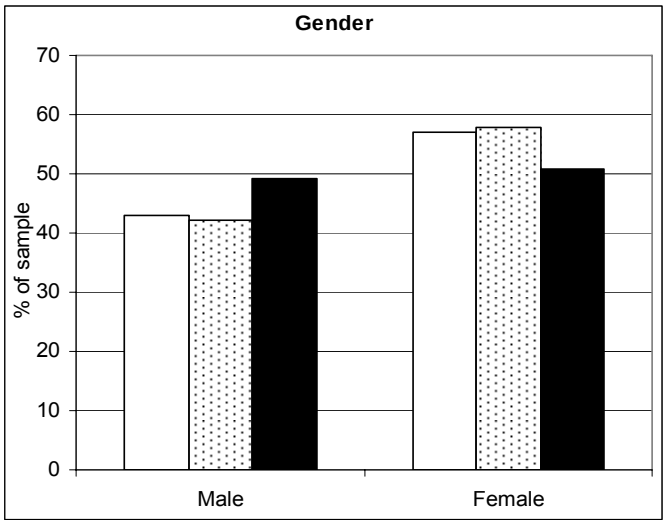


Figure 3. Socio-demographic characteristics of survey respondents and the population.

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: (i) a slightly smaller proportion of employed individuals, and larger proportion of unemployed/not employed individuals; (ii) a slightly larger proportion of individuals in the 50-60 years of age category; (iii) 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; (iv) a slightly smaller proportion of males, and a slightly larger proportion of females; and (v) a slightly smaller proportion of individuals in almost all household income categories (since over 20% declined to respond). Using a Chi-Square test, we confirmed that there was no evidence of a statistical 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 characteristics are shown in Figure 4.

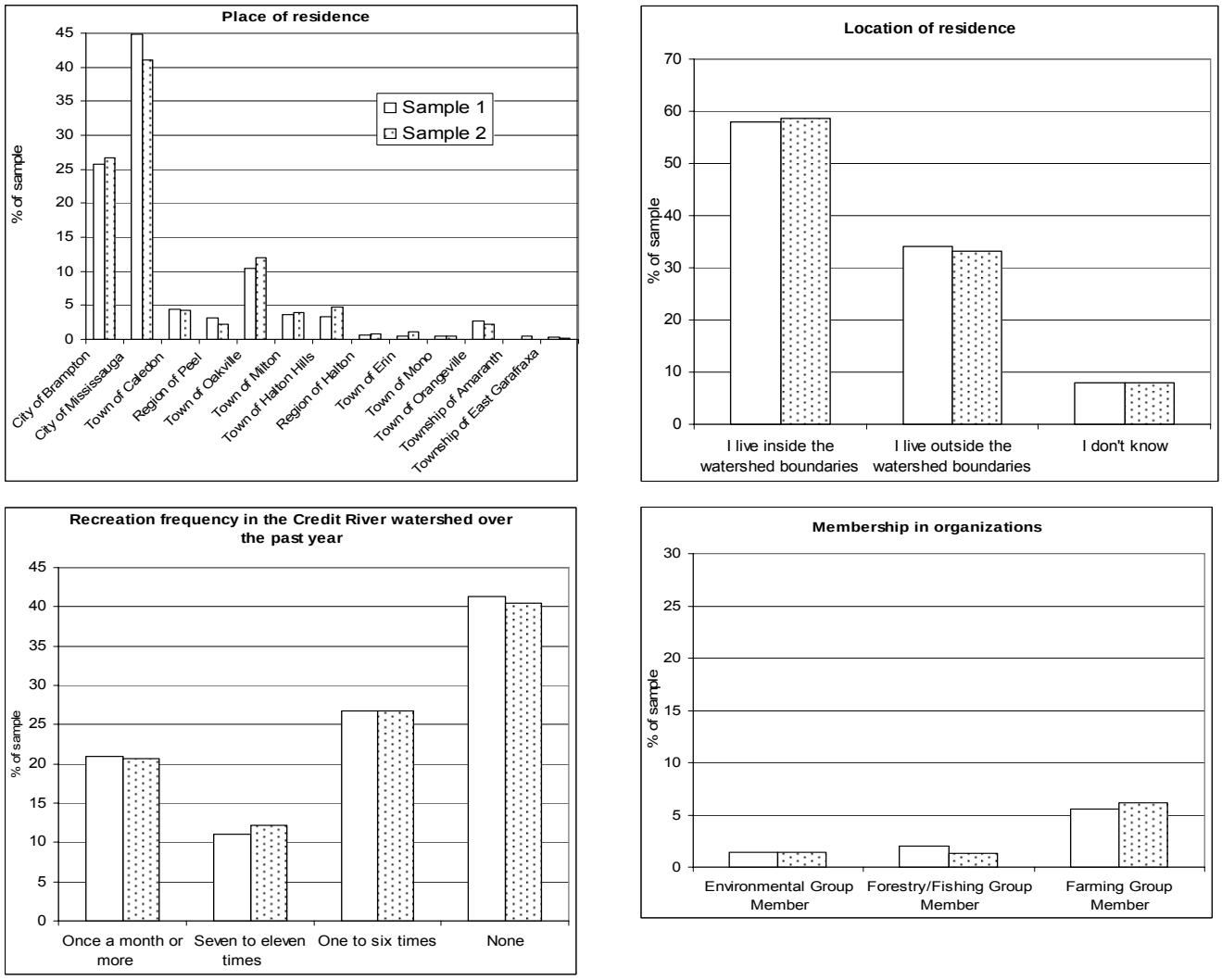
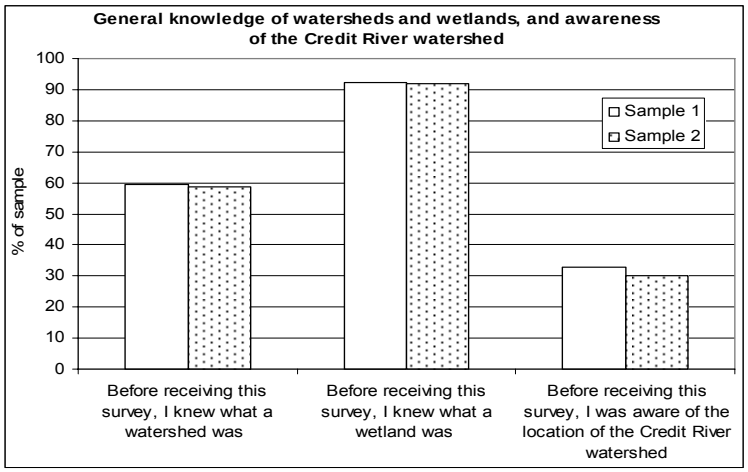


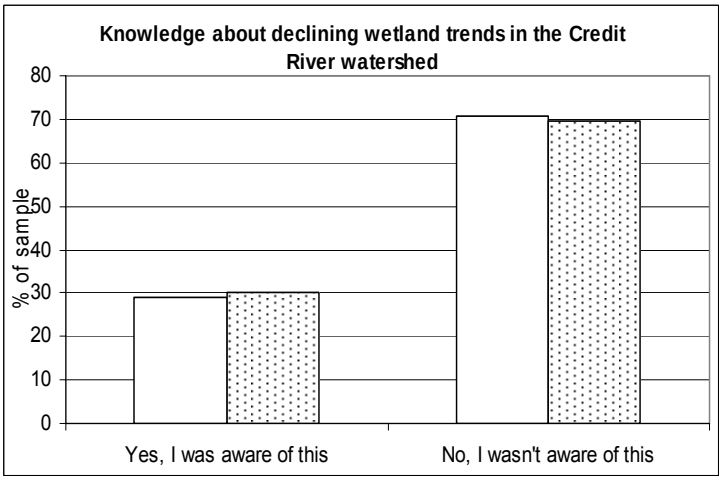
Figure 4. Additional socio-demographic characteristics of survey respondents.

Here it is shown that the over 50% of the respondents in both samples: (i) lived in one of the two large cities in the watershed region (i.e., Brampton and Mississauga); (ii) lived inside the watershed boundaries; and (iii) have had a recreation experience at least one time in the watershed over the past year. A much smaller proportion (less than 10%) of respondents were members of environmental, forestry, fishing, or farming organizations.

4.2 Responses to knowledge and preference questions

Responses to questions regarding respondent knowledge of wetlands in the watershed and their level of concern about the declining trends are summarized in Figure 5. As shown, the majority of respondents knew what wetlands and watersheds were prior to the survey, while a slightly smaller percentage knowing about watersheds (at approximately 60%) compared to wetlands (at approximately 90%). A much smaller percentage of respondents (at 30%) knew the location of the Credit River Watershed.





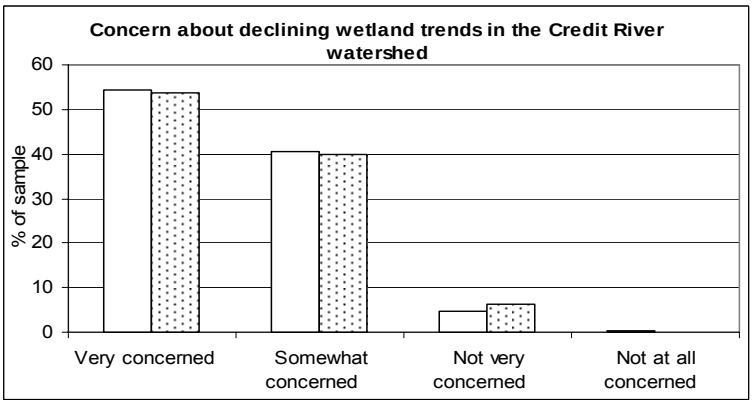


Figure 5. Responses to questions regarding knowledge and level of concern about wetlands in the Credit River Watershed.

When provided with information regarding the declining wetland trends in the Credit River Watershed over the past 55 years (1954-2009), approximately 70% of respondents indicated that they were not aware of this trend (Figure 6).

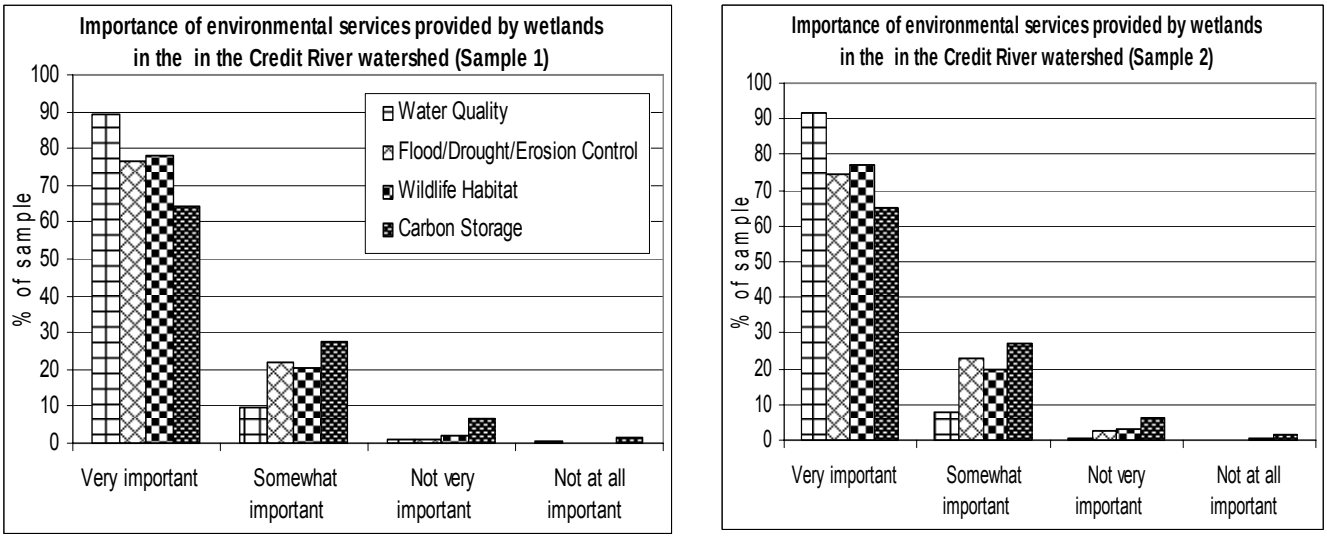
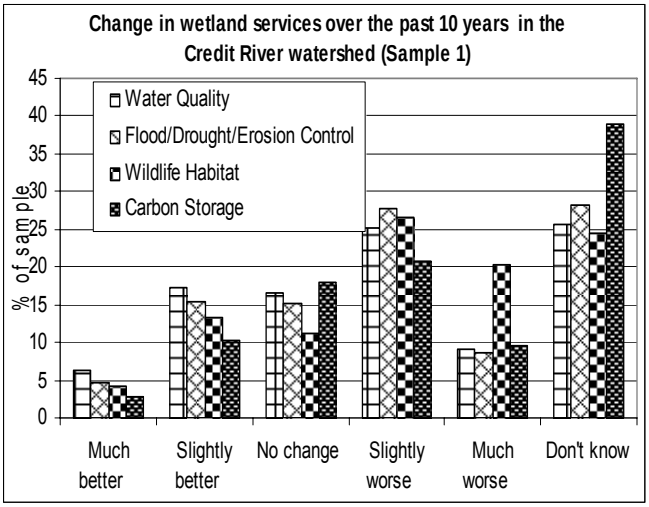
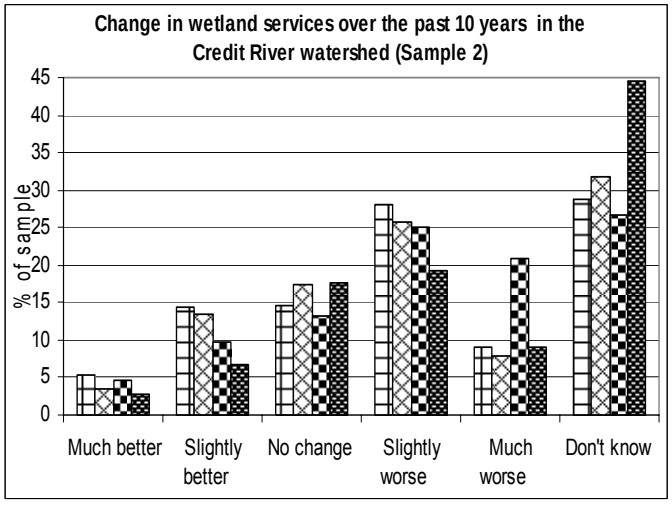


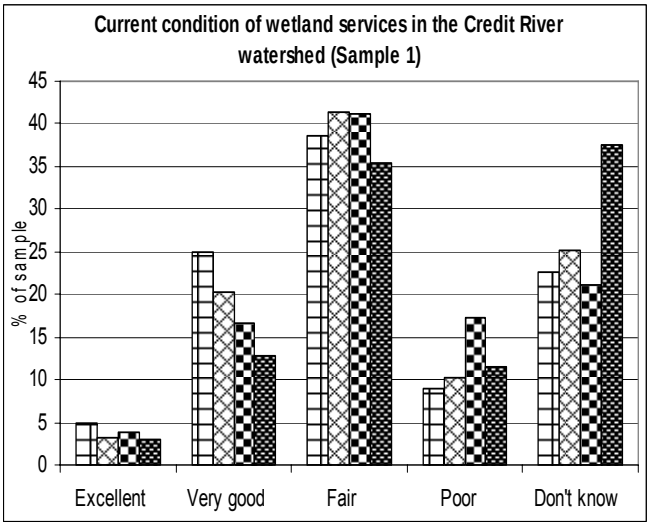
Figure 6. Responses to questions regarding the importance of environmental services provided by wetlands in the Credit River Watershed.

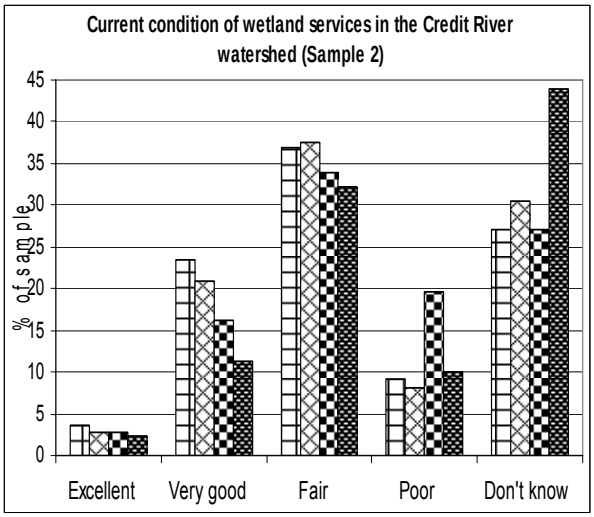
When asked about their level of concern, almost 95% percent indicated they were either very concerned (approximately 55%) or somewhat concerned (approximately 40%) about the issue.

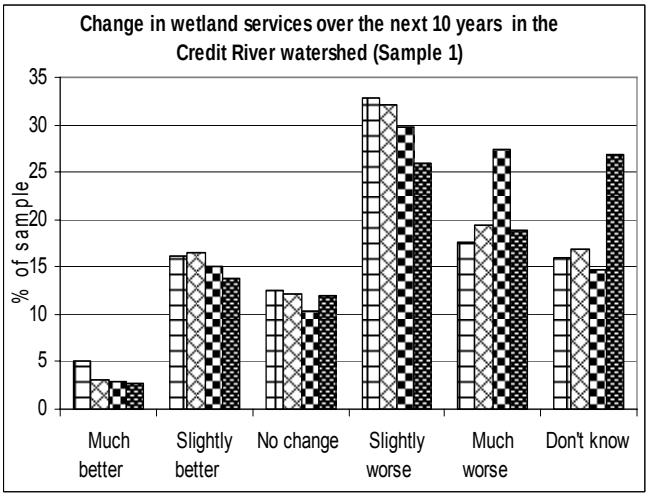
When asked about the importance of various environmental services provided by wetlands in the watershed, a large majority of respondents (between 64-91%) in both samples indicated that water quality, flood/drought/erosion control, wildlife habitat, and carbon storage services were very important to them. Here, water quality services ranked first with approximately 90% of respondents indicating it was very important to them. This was followed closely by wildlife habitat, flood/drought/erosion control, and carbon storage services.
Respondents also had some differences in opinions about the past, present, and future conditions of wetland services in the watershed (Figure 7). For instance, there was a slightly higher percentage of respondents who thought specific wetland services had become slightly or much worse over the past 10 years in the watershed (at approximately 30-45%) compared to those who thought the opposite (at approximately 10-20%). Additionally, while a majority of respondents thought that the current condition of individual wetland services in the watershed was either fair, very good, or excellent, many did not have an opinion. Finally, there was a slightly higher percentage of respondents who thought specific wetland services will become slightly or much worse over the next 10 years in the watershed (at approximately 42-55%) compared to those who thought the opposite (at approximately 10-20%). In both samples, a relatively large percentage of respondents had no opinion (at approximately 15-45%), with the largest percentage consistently being for carbon storage (which likely is a result of respondents having the least amount of knowledge about this service).











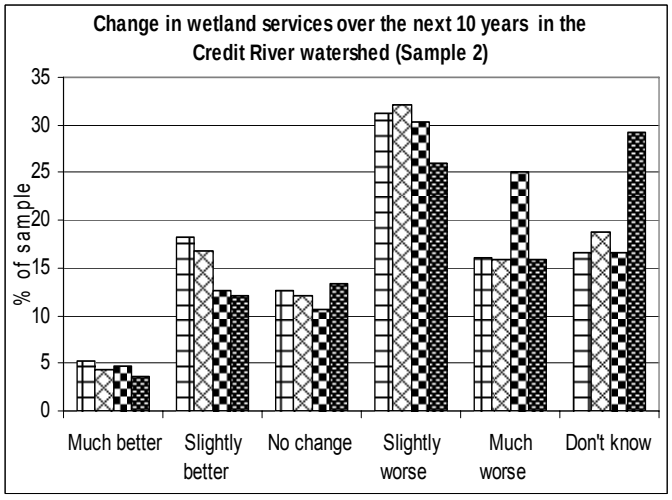


Figure 7. Responses to questions regarding past, present and future trends in wetland services provided in the Credit River Watershed.

While most respondents felt that landowners should bear some responsibility for wetlands restoration, few felt that they should bear the full costs of addressing the issue (Figure 8).

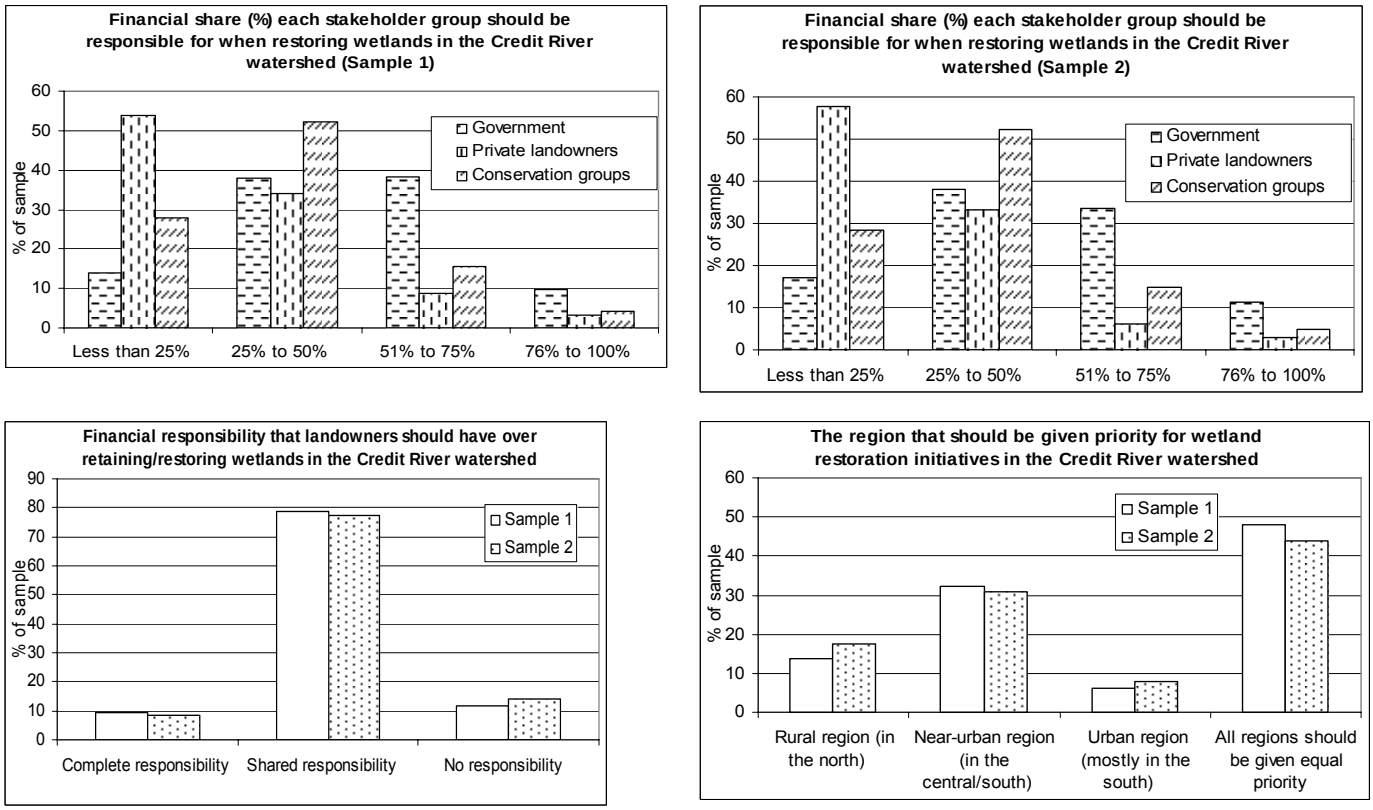


Figure 8. Responses to questions regarding financial responsibility of stakeholders when restoring wetlands in the Credit River Watershed, and priority regions for wetlands restoration.

In fact, respondents in both samples indicated that the costs of restoration should be shared across government, conservation groups, and private landowners. Here, they felt that the government should pay the largest share, followed by conservation groups, followed by private landowners. Taking the midpoints of the categories, the mean financial contributions of each group toward restoration are approximately 42%, 33%, and 25%, respectively (the estimates range plus or minus 1% depending on the sample considered).

4.3 Responses to contingent valuation method scenario questions

Responses to the CVM scenario debriefing questions were first examined to identify yea-sayers and uncertain votes (to help reduce the potential hypothetical bias discussed previously). For yea-sayer identification, we examined the most important reasons why respondents chose at least one of the proposed wetland programs, and the number of times respondents voted for a proposed program (Table 1). Overall, only 58 of the 94 respondents who indicated that wetlands should be protected regardless of the cost (our yea-sayer identifier) also voted for all 4 proposed programs. These 58 respondents were therefore excluded from the data for further

analysis of willingness-to-pay values. Exclusion of the yea-sayers will effectively make the willingness-to-pay estimates more conservative/accurate.

Table 1. Most important reason why respondents chose at least one proposed program, and the number of times respondents voted for a proposed program (combined samples)

Reason	# of times respondents voted for a proposed program				Total
	1	2	3	4	
I think that this is a small amount to pay for the benefits	102	75	52	83	312
I think we should protect wetlands regardless of the cost	5	14	17	58	94
I feel it is the 'right' thing to do	31	29	36	62	158
It is important to invest in protecting wetlands for future generations	59	81	67	198	405
The program is important but I don't really think it will cost me directly	11	10	7	5	33
I might be affected by the loss of wetlands directly	6	12	9	13	40
I think that our government does not do enough to protect our water and wetland resources	30	25	28	44	127
Total	244	246	216	463	1169

For uncertain vote identification, we examined the proportion of respondents indicating they were somewhat or very uncertain about their vote (Table 2). These represented approximately 17% of total votes for proposed programs, and were coded as voting for the current trend.

Table 2. **Certainty of vote assessments (combined samples, N=5630 votes)**.

Level of Certainty	% of total votes	Cumulative % of total votes
Very Certain	43.50	43.50
Somewhat Certain	38.17	81.67
Somewhat Uncertain	13.62	95.29
Very Uncertain	4.71	100.00

Regression analyses of the willingness-to-pay models are shown in Table 3. In Model 1, the parameter estimates show that the tax was negative and highly significant, indicating that as the tax level increased, respondents were less willing to vote for a proposed wetland program. Additionally, the constant term was positive and highly significant, indicating that respondents were willing to pay some amount of money for a wetland program. However, the insignificance of the restoration level variable indicated that respondents were not willing to pay an additional

amount for higher levels (i.e., more acres) of wetland restoration. This implies that respondents were insensitive to the scope of the wetland programs under consideration.
The finding of insensitivity-to-scope is re-confirmed in Model 2 where additional independent variables were included. The statistically significant variables in this model indicated that respondents who: (i) are members of environmental organizations; (ii) are in older age categories; and (iii) have participated in outdoor recreation activities in the watershed, were willing to pay more for a wetland program than those who did not have these characteristics.

Table 3. Parameter estimates (t-statistics) for two binary logit models

Variable	Model 1	Model 2
Intercept	0.7799***	-0.0488
	(0.1495)	(0.1982)
Tax level ($)	-0.0035***	-0.0036***
	(0.0002)	(0.0002)
Restoration level (%)	0.1599E-06	-0.1202E-06
	(0.7465E-05)	(0.7647E-05)
Member of an environmental organization		0.4772***
		(0.1305)
Age		0.0113***
		(0.0023)
Participated in outdoor recreation in region		0.4263***
		(0.0623)
Reside in a city (Brampton or Mississauga)		0.1222*
		(0.0659)
Log-likelihood	-3303.6780	-3177.3470

*, **, and *** indicate that the coefficient estimate is significant at the 90%, 95%, and 99% level, respectively. Standard errors are in parentheses.

In an attempt to understand respondents' voting behaviour, questions were asked following the votes probing why respondents voted the way they did. Of the respondents who voted for the current trend and not for a wetland program in any one of the scenarios considered, 70-72% indicated that the increase in taxes was the reason they voted the way they did (Table 4). This was consistent with the results of the logit models where tax parameters were negative and highly significant. Other issues were relatively small by comparison. Specifically, very few people felt the program would lead to more wetland regulations that would cause them to lose income they generated on their land, would be too large a wetland expansion, or felt that the issue was not important. Some individuals did feel that taxes could be better spent on other issues, and some respondents felt that they did not have enough information to make an informed decision.

Table 4. **Major reason why respondents voted for the 'current trend' instead of the 'proposed program' in any scenario**

Reason	% of Respondents	
	Sample 1	Sample 2
I do not believe the programs presented will actually benefit the environment	4.4	2.7
I think tax money could be better spent on other issues	5.4	8.3
I do not have enough information to make this decision	10.8	9.1
I thought the proposed programs would lead to more wetland regulations that would cause me to lose income I generate on my land	2.9	2.7
I thought the total size of the proposed wetland expansion was too large	2.7	0.8
The cost to me (increase in tax) was too high	72.0	70.1
I do not think wetland loss is an important issue	1.9	2.1

Of respondents who voted for a wetland program instead of the current trend in any one of the scenarios considered, most respondents felt that it was either little to pay for the benefits received (31-34%) or that it was important to invest for the future (41-42%) (Table 5). This is corresponds directly with the concept of passive use values. Additionally, some voted for the program because of moral reasons – "it is the right thing to do" (14-19%), while others felt that the government does not do enough to protect the natural environment (13-14%). The number of respondents who felt that they would be directly impacted was similar to the number who felt they would not be directly impacted by the project (at 5% or less).

Table 5. **Major reason why respondents voted for the 'proposed program' instead of the 'current trend' in any scenario**

Reason	% of Respondents	
	Sample 1	Sample 2
I think that this is a small amount to pay for the benefits	31.3	33.4
I think we should protect wetlands regardless of the cost	10.0	9.5
I feel it is the 'right' thing to do	13.9	18.9
It is important to invest in protecting wetlands for future generations	42.7	41.3
The program is important but I don't really think it will cost me directly	5.4	1.5
I might be affected by the loss of wetlands directly	4.8	3.5
I think that our government does not do enough to protect our water and wetland resources	13.7	12.7

4.4 Willingness-to-pay estimates

Using the procedures developed by Hanemann (1984) and Krinsky and Robb (1986), an annual household willingness-to-pay value for a wetland program (including retention and/restoration) was estimated to be $228.58 using Model 1, and $258.78 using Model 2. These annual values are assumed to be valid for 5 years, since it was specified in the survey that respondents who voted for a wetland program would be required to pay a certain increase in their property taxes over the next 5 years. Using a discount rate of 5% and a 5-year time horizon, the household total present value willingness-to-pay estimates were $1,037.75 and $1,176.40 using Model 1 and Model 2, respectively.

Multiplying the household total present value willingness-to-pay estimates by the current number of households in the Credit River Watershed region (212,865) produced total present value[7] willingness-to-pay estimates of $220.9 million and $250.4 million,, using Model 1 and 2, respectively. Table 6 summarizes these results.

Table 6. **Benefit estimates for wetland retention**

WTP Component	WTP Amount	
	Model 1	**Model 2**
Household annual WTP (for a 5-year period)	$228.28 (40.89)	$258.78 (35.79)
Household total present value WTP over 5 years (discounted at 5%)	$1,037.75	$1,176.40
Total present value WTP over 5 years (discounted at 5%)	$220,900,564.58	$250,414,614.08

* Standard deviations are in parentheses.

[7] Present value refers to a value (either in the present or in the future) evaluated in the initial (present) year. Here, a discount rate is applied to all future values. In this study, a 5% discount rate is assumed

5. Discussion and conclusions

Wetlands have been widely recognized for providing valuable ecological functions and services to society. In spite of this recognition, wetlands have continued to decline, particularly in regions such as the Credit River Watershed region of Southern Ontario where urban sprawl is intensifying. Since most wetland services are not traded in the market, and therefore do not have market value, they are often not appropriately considered by policy makers when making land-use development choices. Non-market valuation techniques can be used to help estimate the value of wetland services, and thus aid in examining the trade-offs involved in various land-use options.

This study implemented a survey to investigate pubic knowledge, preference, and valuation of wetland services in the Credit River Watershed. A survey was designed and implemented in late 2009 that sampled opinions from approximately 1,400 households in the Credit River Watershed region. Survey respondents had a relatively moderate level of knowledge about wetlands in the watershed. However, a large majority indicated that water quality, flood/drought/erosion control, wildlife habitat, and carbon storage services provided by the wetlands are very important to them. Many believed that these services have become worse over the past 10 years, and will continue to degrade over the next 10 years. Most respondents were previously unaware of the declining trends and, once informed about the historical rate of wetland loss in the region, indicated a high level of concern about it. These results imply that the general public in the region perceives wetlands as providing very important services that need to be protected.

The survey also determined that Credit River Watershed households expect their government to play an important role in wetland conservation. Specifically, while the public thinks that the cost of wetland restoration initiatives should be shared among government, conservation groups and private landowners, they believe their government should bear a slightly larger share of the cost. This finding is consistent with recent programs initiated by governments across Canada that provide cost-share and direct payment programs for environmental service improvements implemented by landowners (Gagnon 2005).

In terms of wetland service valuation, the survey found that the general public in the region is willing to pay a significant amount of money through increased property taxes to fund a program that would retain/restore wetlands in the Credit River Watershed. The total present value of retaining/restoring wetlands through to the year 2020 ranged from $220.9 million to $250.4 million, depending on the model specification used.

An important finding in this survey was that the public was not sensitive to the scope (size) of the wetland program scenarios. That is, they were willing to pay the same amount for a wetland retention program as any of the wetland restoration programs considered in the survey. This finding indicates that households in the region place the same value on a wetland retention

program as they do on a wetland restoration program. Some researchers such as Diamond et al. (1994) assert that a finding of insensitivity to scope implies that the willingness-to-pay estimates produced are unreliable, since according to economic theory, more is always preferred to less. Other studies such as Mullarkey and Bishop (1999) emphasize that such a finding in the case of wetland valuation is likely due to the public's lack of understanding of the benefits provided at the various levels of wetland service provision. However, our survey employed clear quantification of the benefits, so we expected that it would pass the scope test.

Recent literature by Heberlein *et al.* (2005) indicates that it may be rational for individuals to be insensitive to the scope of environmental service improvements. Here, they suggest that individuals may have either 'positive affective scope' (liking the whole more than the part) or 'negative affective scope' (liking the part more than the whole). Additionally, they may have either 'positive cognitive scope' (knowing more and thinking more about the whole than the part) or 'negative cognitive scope' (knowing more and thinking more about the part than the whole). If respondents have positive affective and cognitive scope, then they should express a higher willingness-to-pay as the environmental service increases (according to the standard scope test). However, if respondents have neutral or negative affective and/or cognitive scope, then they should not express a higher willingness-to-pay (and may even express a lower willingness-to-pay) as the environmental service increases. In the context of the current study, it may be that respondents prefer the current wetland services (as many indicated that current levels are 'fair' or 'good') and may not think or care much about what further increases in wetland services might provide them.

Notwithstanding the above issue, the willingness-to-pay estimates produced in this study provide useful information to policy-makers. Specifically, the estimates, which can be interpreted as the perceived social benefits of wetland programs in the Credit River Watershed, can be used in cost-benefit analyses of alternative wetland programs. As long as the cost of a particular wetland program (designed along the lines of those considered in this study) does not exceed the social benefits (estimated in the range of $$220.9-$250.4 million in present value terms), the program can be justified on economic grounds. Since the benefits of wetland programs in the watershed were not found to increase with the amount of restoration (i.e., benefits are insensitive to the scope of the program), policy-makers would be able to justify wetland programs in the watershed up to a cost of $$220.9 million to $250.4 million in present value terms.

There are many areas of this study that could be refined or advanced in the future. For instance, while our statistical analysis found that survey respondents were generally not willing to pay more for higher levels of wetland restoration in the watershed, it may be that this does not hold for all sub-groups of the population. More advanced statistical analysis (e.g., using latent class models) could be conducted in the future to uncover the sub-groups that are/are not insensitive to scope. Results of this analysis could be used to improve the accuracy of the social benefit estimates, by applying unique sub-group willingness-to-pay values at different wetland program levels.

It would also be of interest in the future to conduct focus group meetings with members of the public to understand why survey respondents: (i) were not willing to pay more for higher levels of wetland restoration in the watershed; (ii) preferred wetland restoration in particular regions of

the watershed; and other such issues thought to be of importance. These results could be used to help direct educational materials to address issues uncovered in the meetings.[8]

Finally, a next step to this study would be to conduct an applied cost-benefit analysis of specific wetland retention/restoration programs in the Credit River watershed. Estimating precise retention/restoration costs for particular wetland programs is challenging due to the context-specific nature of the factors that influence costs. Traditional costing analysis has tended to focus on the establishment, maintenance, and market opportunity costs (i.e., the foregone potential revenue generated) of the wetland programs under consideration. However, these estimates may not reflect a landowner's willingness-to-accept compensation for retaining/restoring wetlands. Specifically, in some cases, landowners may not need much compensation for retaining/restoring wetlands if it provides them with a greater sense of stewardship, or other similar perceived benefit. In other cases, landowners may require more compensation than the market cost for the added hassle, stress, or similar perceived cost. Recent literature has used a variety of techniques to uncover these costs, ranging from landowner surveys (Yu 2009) to reverse auctions (Ferris and Siikamaki 2009). Implementing a landowner survey for wetlands in the Credit River watershed would provide in-depth information to policy-makers about the willingness of landowners to implement wetlands on their property, their willingness to accept compensation, and their preferences over implementation specifics (e.g., types of incentives, extent of commitment, etc).[9] Such information would surely help in the effectiveness of wetland conservation initiatives in the watershed.

[8] The recommendation to conduct focus group meetings with the public regarding these issues was also made in the Credit Valley Conservation Authority's Wetland Strategy (see Credit Valley Conservation Authority 2009).

[9] The recommendation to conduct landowner surveys regarding these issues was also made in the Credit Valley Conservation Authority's Wetland Strategy (see Credit Valley Conservation Authority 2009).

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