**Prairie Wetland Loss is Associated with Substantial Economic Costs to Society**

**Abstract**

1. **Introduction**

The world has lost more than 50 percent of its original wetland area at a faster rate than other ecosystems in the world (Millennium Ecosystem Assessment, 2005; Mitsch and Gosselink, 2007). Canada has approximately 1.5 million km2 of wetlands which is about 28% of total wetlands in the world (Reimer, 2009). However, it has been estimated that up 20 million acres of wetlands have been loss since 1800 in Canada (Environment Canada, 2009), mainly through agricultural development (Badiou et al. 2011; Watmough and Schmoll, 2007). Other drivers of wetland loss in Canada include urban development, transportation, resource extraction and mining, recreational properties. About 40 to 71% of wetland acreage has been lost in the Canadian Prairies since European settlements (Kraus, 2019) at an annual rate of about 0.53% (Watmough and Schmoll, 2007).

Wetlands provide important ecosystem services to society but understanding the economic benefits of these services remain a challenge. Some of the ecosystem services of wetlands are carbon sequestration, recreation, tourism, human and livestock foods, habitat to support diverse biotic communities (Davies et al. 2008; Badiou et al. 2011; Gleason et al. 2011; De Groot et al. 2012), regulating and recharging aquifers (Dixon and Wood 2003) and removal of excess nutrients and pesticides from agricultural lands (Vymazal 2017). The economic value of ecosystem services has been estimated in several regions of the world, including Nakivubo wetlands in Uganda (Schuijt, 2002), Muthurajawela wetland in Sri Lanka (Emerson and Kekulandala, 2003); flood plains of the Elbe river in Germany (Meyerhoff and Dehnhardt, 2004); and Upper Paraná River floodplain in Brazil (Carvalho, 2007). In Canada, the economic value of wetland ecosystem services has been estimated, but the empirical evidence is limited (Lloyd-Smith, et al., 2020). Need for policy-ready valuation tools as wetlands continue to be degraded.

The purpose of this study is to develop a Canadian wetland valuation model using recent advances in meta-analysis modeling of environmental valuation data. To do so, we extend the modeling framework of Moeltner et al. (2019) to include Canadian studies and estimate a Canada-US wetland valuation model. The total number of observations for the combined dataset is 45 from 20 studies (13 and 7 US and Canadian observations, respectively) published between 1991 and 2020. Seven US studies produced multiple observations while 5 Canadian studies produced multiple observations. All the willingness to pay to conserve freshwater wetland values per household per year were converted to 2017 Canadian dollars (Can$).

For the combined dataset, the chosen model (model 1), which had log WTP as the dependent variable and log baseline acreage and log quantity acre change as main independent variables, provided a better fit to the data compared to model (2). Again, it was consistent with the sensitivity to scope condition, and in 1 out of 4 scenarios, the adding up condition was validated. The scenarios were forest landscape and local-level study, forest landscape and Nonlocal-level, nonforest landscape and local-level study and nonforest landscape and nonlocal-level study. Moreover, it validated the law of diminishing marginal utility assumption which is an important condition in utility theory; a 1% increase in the baseline acreage would cause about 0.14% increase in WTP. Also, it showed that a) households value provisioning ecosystem services less than others, b) households would pay more to conserve wetlands in forest landscapes and c) a peer-reviewed paper has a positive effect on WTP. The mean in-sample meta-regression transfer function error when predicting Canadian wetland values using the combined US and Canada data was about 14%, which is significantly lower than that for the US only dataset (1901%). The mean in-sample unit value transfer error was 673%; unlike the meta-regression transfer error which compared the original WTP to predicted WTP, the unit transfer error compared the original WTP values to its average.

The policy application of our estimated model to value wetlands lost between 2001 and 2011 in the Canadian Prairie Habitat Joint Venture landscapes, shows that the mean willingness to pay to restore wetlands are $510/household/year, $115/household/year, and $279/household/year, in Saskatchewan, Alberta, and Manitoba, respectively. Also, there is a positive relationship between willingness to pay to restore wetlands loss and wetland acreage.

We contribute to policy debates on the need to provide reliable benefit estimates for wetland conservation in Canada. Currently, unit value transfer has been the most popular approach to the valuation of wetlands in Canada, where $/ha is derived from prior research to value wetlands in new settings (Belcher et al. 2001; Dupras and Alam, 2015; Dupras et al. 2015). Although unit value transfer is relatively inexpensive and faster to implement, it has a mean transfer error of about 45% (Rosenberger and Loomis, 2017) which is lower than the transfer error of the meta-analysis benefit function at 36% (Rosenberger and Loomis, 2017). Benefit estimates are used in benefit-cost calculations to justify the need to fund projects. Besides contributing to providing reliable benefit transfer values for wetland conservation policy in Canadian Prairies, our paper supports the observation in Johnson and Thomasin (2010) that, relying only on US wetland valuation studies to infer wetland values in Canada is not a best practice. Therefore, the paper agrees with the suggestion of Johnson and Thomasin (2010) for policymakers to adjust benefit transfer values, especially from US original studies to Canadian policy contexts to reduce transfer errors. Again, our paper will improve on the application of benefit transfer of wetland values in Canada, by providing the key factors or variables practitioners could use to control for differences between policy and original study sites.

This paper is structured into five sections. Section two compares and contrasts the few wetland valuations studies that have been conducted in Canada; it also provides background information on the Prairie Habitat Joint Venture landscapes in the Canadian Prairies, which is the policy application area for our proposed meta-transfer function. The data that will be used to estimate our model, and its descriptive statistics are discussed in section 3. The methodology of the study, including meta-data and meta-analysis econometric model, is described in section four. Next, the results of our estimated model, the in-sample meta-function transfer errors, and the policy application of the estimated Bayesian model to the valuation of wetlands in the Canadian Prairies (PHJV landscapes) are reported in section five. We discuss the model results in section 6. Lastly, the conclusion of the study and the limitations of the study, and suggestions for future research are provided in section 7.

1. **Stated Preference Wetland Valuation Studies in Canada**

In many cases, environmental goods and services, such as wetland ecosystem services, have non-use values that are not observed in markets; this attribute makes the valuation of environmental amenities using traditional revealed preference or other market-based valuation methods impossible. Stated preference (SP) provides the only known method to estimate non-use values that are not observed in market conditions (Johnson et al. 2017). Moreover, they provide a means to estimate comparable and welfare consistent values from quantity and/or quality changes associated with environmental goods, such as wetland acreage changes (Vedogbeton and Johnson, 2020). Welfare consistent values from different multiple studies would allow for commodity and welfare consistent meta-regression models. Therefore, for our meta-regression study, we searched for Canadian studies from existing wetland meta-analyses, the Environmental Valuation Reference Inventory (EVRI), and key word searches of environmental and resource economics journals as well as online databases such as EconLit and Google Scholar that used SP to estimate the willingness to pay to retain/restore wetlands.

We identified 8 wetland valuation studies in Canada that estimated resident’s willingness to pay to retain (Tkac, 2002; Pattison et al. 2011; Lantz et al. 2013; Trenholm et al. 2013, Dias and Belcher, 2015; Vossler et al. 2020) or restore (Pattison et al. 2011; Rudd et al 2016; He et al. 2017) wetlands. We retained studies that had information on baseline wetland acreage, the extent of wetland area changes and methodological attributes. If the wetland acreage changes information absent, the study must provide enough information to enable us to obtain it from secondary sources. For instance, we excluded Dias and Belcher (2015) from this study because it did not have information on baseline wetland acreage and extent of wetland change.

Some of the seven Canadian studies estimated multiple willingness to pay estimates for different wetland conservation scenarios. For example, Pattison et al (2011) considered four different wetland restoration scenarios at various percentages (80%, 83%, 89%, 100%) of 1968 wetland acreage and one wetland retention scenario. In total, we obtained 17 value observations for the Canadian meta-analysis dataset.

The contingent valuation method was used by 6 of the 7 studies to value wetlands (Tkay et al. 2002; Pattison et al. 2011; Lantz et al. 2013; Trenholm et al. 2013; He et al. 2017; Vossler et al. 2020). Het et al (2017) compared the accuracy and effectiveness of contingent valuation and choice experiment in valuing wetlands. Two studies (Rudd et al. 2016; He et al. 2017) used a choice experiment to value wetlands. Again, except Tkac (2002), all the studies were published in peer-reviewed journals. Moreover, the studies were different with regards to the sample sizes, location of the study, and data collection year (Table 1).

**Table 1. Comparison of Wetland Valuation Studies in Canada**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Study** | **Prov** | **Data Collection Year** | **Sample Size** | **Restoration/Retention** | **Valuation Format** | **Ecosystem Service** | **Ch. Acres** | **WTP** |
| Vossler et al. 2020 | QC | 2014 | 1048 | Retention | CV (ref) | Reg | 10,0295,714 | 871 |
| He et al. (2017) | QC | 2013 | 930 | Restoration | CE (An Cont) | Reg & Prov | 988,421 | 512 |
| He et al. (2017) | QC | 2013 | 858 | Restoration | CV (An Cont) | Reg & Prov | 988,421 | 498 |
| Rudd et al (2016) | ON | 2011 | 301 | Restoration | CE (An Cont) | Reg & Prov | 106,253 | 12.6 |
| Rudd et al (2016) | ON | 2011 | 301 | Restoration | CE (An Cont) | Reg & Prov | 308,875 | 25.5 |
| Dias & Belcher (2015) | SK | 2010 | 250 | Retention (riparian area) | CE(One Time) | Reg & Prov | - | 72.5 |
| Dias & Belcher (2015) | SK | 2010 | 250 | Retention (wildlife habitat) | CE(One Time) | Prov | - | 64.5 |
| Dias & Belcher (2015) | SK | 2010 | 250 | Retention (water quality) | CE(One Time) | Reg | - | 117.2 |
| Lantz et al. (2013) | ON | 2009 | 1407 | Retention | CV (An Cont) | Reg & Prov | 3000 | 1502 |
| Lantz et al. (2013) | ON | 2009 | 1407 | Retention & 1000acres restoration | CV (An Cont) | Reg & Prov | 4000 | 1483 |
| Trenholm et al. (2013) | NB | 2007 | 299 | Retention (30 m riparian buffer) | CV (An Cont) | Reg, Cul & Prov | 5884 | 36.9 |
| Trenholm et al. (2013) | NB | 2007 | 299 | Retention (60 m riparian buffer) | CV (An Cont) | Reg, Cul & Prov | 11300 | 22.7 |
| Trenholm et al. (2013) | NB | 2007 | 270 | Retention (30 m riparian buffer) | CV (An Cont) | Reg, Cul & Prov | 7408 | 28.9 |
| Trenholm et al. (2013) | NB | 2007 | 256 | Retention (60 m riparian buffer) | CV (An Cont) | Reg, Cul & Prov | 14318 | 17.2 |
| Pattisson et al. (2011) | MB | 2008 | 1980 | Retention and Restoration | CV (An Cont) | Reg & Prov | 94918 | 337 |
| Pattisson et al. (2011) | MB | 2008 | 1980 | Restoration (80% of 1968 WAL) | CV (An Cont) | Reg & Prov | 135598 | 345 |
| Pattisson et al. (2011) | MB | 2008 | 1980 | Restoration (83% of 1968 WAL) | CV (An Cont) | Reg & Prov | 176277 | 352 |
| Pattisson et al. (2011) | MB | 2008 | 1980 | Restoration (89% of 1968 WAL) | CV (An Cont) | Reg & Prov | 257636 | 367 |
| Pattisson et al. (2011) | MB | 2008 | 1980 | Restoration (100% of 1968 WAL) | CV (An Cont) | Reg & Prov | 406793 | 398 |
| Tkac (2002) | ON | 2001 | 339 | Retention | CV (An Cont) | Reg & Prov | 4200 | 196 |

Notes:

Prov: Province where study was conducted; QC: Quebec; ON: Ontario; NB: New Brunswick; MB: Manitoba

WAL: Wetland Acreage Area

Valuation Format: CV: Contingent valuation; Ce: Choice experiment; ref: referendum; An cont: Annual contribution, one time: one time contribution

Eco Serv: Ecosystem service affected; Reg: regulation services regulate environmental processes such as climate change, water quality and flood control; Prov: provision services

provide food and raw materials to society, such as fishing and hunting; Cul: cultural services provide existence value of wetlands (non-extractive recreation) to society.

Ch. Acres: Difference between post improvement wetland acres and baseline wetland acres

WTP: willingness to pay to retain or restore wetlands per household per year in 2017 CAD$

**3.1. The Canada-United States Wetland Metadata**

Meta-regression involves the application of regression analysis to a pool of comparable empirical estimates (Nelson and Kennedy 2009; Richardson et al. 2015). The first generation of wetland valuation meta-analyses included hundreds of studies from around the world and specified a dollars per hectare value estimate as the dependent variable (Ghermandi et al. 2010; Brander, Florax, and Vermaat 2006; Woodward and Wui 2001; Brouwer et al. 1999).

The huge heterogeneity in value estimates across the world and valuation methods raises some concerns with these early applications. Another concern is with the use of dollar per hectare values as the dependent variable which may not be appropriate as social values are not linked to a specific surface area of a wetland. There are further concerns regarding the commensurability of including value estimates from many different valuation methods such as replacement cost and stated preference as well as studies from such disparate places as the United States and Cameroon which would violate the welfare consistency condition (Nelson and Kennedy 2009; Johnston and Rosenberger 2010; Rosenberger 2010; Boyle and Wooldridge 2018); another issue is the commodity inconsistency problem, which occurs when the commodity being valued is not the same across studies used for the meta-regression (Vedogbeton and Johnson, 2020). A final concern is that these models did not use frameworks that are consistent with economic theory (Moeltner et al., 2019) and key empirical conditions: commodity and welfare consistencies (Kling and Phaneuf, 2018; Newbold and Walsh, 2018; Moeltner, 2019). Sensitivity to scope states that willingness to pay to conserve wetlands should increase with the change in wetland acres, while the adding up condition specifies that the WTP to achieve a target wetland acreage should be equal to or less than the sum of incremental WTP estimates from achieving the same wetland acreage target but in sequential steps (Kling and Phaneuf, 2018; Moeltner, 2019).

We satisfy the welfare consistency condition by collecting meta-data that used stated preference method to estimate the willingness to pay by households to conserve wetlands in US and Canada (Johnson and Bauer, 2019). For this study, we augment the data used in Moeltner et al. (2019) with 2 new US studies and 7 new Canadian studies. From the 7 Canadian studies, we were able to obtain 17 observations and 28 observations from the US studies. Detailed descriptions of the US and Canadian studies that we used in this study are provided in Tables 2a and 2b, respectively (in appendix 1). We focused on freshwater wetlands since the Canadian wetland stated preference studies were conducted on freshwater wetlands. Also, to ensure that our model is compliant with the commodity consistency principle to produce valid and credible parameter estimates (Vedogbeton and Johnson, 2020) we included a dummy variable which equals 1 if the WTP is for specific ecosystem endpoints, including provisioning, regulating, and cultural ecosystem services. Further, following Kling and Phaneuf (2018) and Moeltner et al. (2019) we estimated our model with functional forms that have the best chance of satisfying the sensitivity to scope and adding up conditions.

**3.1.1. Descriptive Statistics Results of Study Variables**

We grouped the variables obtained from these studies into context-specific and moderator variables. The context-specific variables provide socio-economic and wetland attributes that could help context to the explanation of the willingness to pay values to conserve wetlands. The moderator variables describe how the study was conducted, including the valuation method that was employed to elicit willingness to pay responses and the payment characteristics. All the monetary variables from both the US and Canada data studies are converted to 2017 CAD$ per household per year.

The mean willingness to pay for wetland restoration or conservation for the combined US and Canada data is $70 with a standard deviation of $3.53. The mean willingness to pay for Canadian only studies, $129, is about three times more than that for US only studies and $43.26 more than the US and Canadian combined data; this show that, on average, US citizens in this study, could be willing to pay less for wetland conservation than Canadian citizens. Figure 2 provides an overview of the relationship between the log of willingness to pay and the log of the difference between the baseline and policy wetland acreage. The Canadian studies on average have much larger changes in wetland areas (96,760 acres) compared US studies (1,524 acres). Also, overall, there seems to be a positive relation between the WTP and wetland acres; this would suggest that respondents are more likely or will be willing to pay more to conserve larger wetland acres, in spite of the observation that households in the US studies on the average earn more income per year than those in the Canadian studies.

**Figure 2. Relationship between the log of WTP and log wetland acreage**

Moreover, proportionally, more Canadian studies (50%), on the average, informed respondents that the provisioning ecosystem service of wetlands under evaluation was affected than US studies (20%). This is also true for regulating ecosystem service which was 75% in the case of Canadian studies and 50% for US studies. However, regarding cultural ecosystem service, the number of studies in both countries were proportionally the same in both countries (75%). Also, equal percentage of wetlands (50%) in both countries were located in forest landscapes. More studies in the Canada (50%) were conducted at the sub-provincial level compared to 35% in the case of US studies.

In terms of the moderator variables, equal percentage of studies in US and Canada (15% in both cases) employed choice experiment value wetlands. Also, more studies in Canada used voluntary contribution payment mechanism and lump sum to elicit willingness to pay responses (60% in both cases) than in the US studies (40% in both cases). Proportionally, more studies Canadian studies were published in peer reviewed journals (94%) compared to the US studies (20%). The summary statistics are provided in Table 2.

The summary statistic differences of the variables in the US and Canadian data suggest that using US only studies on willing to pay for wetland conservation by households to infer similar values in Canada through a benefit transfer approach, might produce unreliable estimates. In particular, wetland changes, on the average, in the Canadian studies are significantly larger compared to the US studies which might mean that Canada only studies may not be appropriate in valuing small changes in wetland acreage. Therefore, it may be useful to combine US and Canadian studies to infer values of wetland acreage changes in Canada.

**Table 2. Summary statistics of the variables included in the Meta-regression**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | **Canada-US Obs.** | | **US Only Obs.** | | **Canada Only Obs.** | |
| **Model Variables** |  | **Mean**  **(SD)** | **Min**  **(Max)** | **Mean**  **(SD)** | **Min**  **(Max)** | **Mean**  **(SD)** | **Min**  **(Max)** |
| **Dependent Variable** |  |  |  |  |  |  |  |
| Lnwtp |  | 4.26  (1.51) | 0.91  (6.84) | 3.78  (1.39) | 0.91  (6.4) | 4.90  (1.47) | 2.55  (6.84) |
| **Context-specific** |  |  |  |  |  |  |  |
| Lnyear | Log (year of data collection - oldest year +1) | 1.87  (1.58) | 0.00  (7.61) | 1.58  (0.85) | 0.00  (2.89) | 2.23  (2.16) | 1.45  (7.61) |
| Lninc | Log (target population income in Canadian $) | 11.44  (0.45) | 10.88  (12.31) | 5.12  (0.11) | 10.88  (11.13) | 4.77  (0.04) | 4.72  (4.83) |
| US | 1=study country =US | 0.44  (0.50) | 0.00  (1.00) |  |  |  |  |
| Local | 1 = target population at sub-state level | 0.42  (0.50) | 0.00  (1.00) | 0.35  (0.49) | 0.00  (1.00) | 0.50  (0.52) | 0.00  (1.00) |
| Prov | 1 = provisioning function affected | 0.33  (0.48) | 0.00  (1.00) | 0.20  (0.41) | 0.00  (1.00) | 0.50  (0.52) | 0.00  (1.00) |
| Reg | 1 = regulating function affected | 0.61  (0.49) | 0.00  (1.00) | 0.50  (0.51) | 0.00  (1.00) | 0.75  (0.45) | 0.00  (1.00) |
| Cult | 1 = cultural function affected | 0.47  (0.51) | 0.00  (1.00) | 0.75  (0.44) | 0.00  (1.00) | 0.75  (0.44) | 0.00  (1.00) |
| Forest | 1 = forested wetland | 0.44  (0.50) | 0.00  (1.00) | 0.50  (0.51) | 0.00  (1.00) | 0.50  (0.51) | 0.00  (1.00) |
| Acreage change | Log (Difference between post improvement wetland acres and baseline wetland acres) | 9.17  (3.26) | 3.37  (18.4) | 7.33  (2.41) | 3.37  (11.10) | 11.48  (2.70) | 7.83  (18.42) |
| **Moderator** |  |  |  |  |  |  |  |
| Volunt | 1=payment mechanism=voluntary contribution | 0.25  (0.44) | 0.00  (1.00) | 0.40  (0.50) | 0.00  (1.00) | 0.06  (0.25) | 0.00  (1.00) |
| lumpsum | 1=payment frequency=lump sum (single payment) | 0.25  (0.44) | 0.00  (1.00) | 0.40  (0.5) | 0.00  (1.00) | 0.06  (0.25) | 0.00  (1.00) |
| Ce | 1=elicitation method=choice experiment | 0.17  (0.38) | 0.00  (1.00) | 0.15  (0.37) | 0.00  (1.00) | 0.15  (0.37) | 0.00  (1.00) |
| Nrev | 1=study was not peer-reviewed | 0.53  (0.51) | 0.00  (1.00) | 0.20  (0.41) | 0.00  (1.00) | 0.94  (0.25) | 0.00  (1.00) |

SD denotes standard deviation; Min denotes minimum; Max denotes maximum, obs. Denotes observation

**4.1. Meta-Regression Econometric Model**

We used a random intercept meta-regression model to explain the variation in the willingness to pay to conserve wetlands in the US and Canada, because 7 (out of 13) and 5 (out of 7) US and Canadian studies, respectively, reported multiple observations (Nelson and Kennedy, 2008). The model is given as equation 1:

where: denotes the willingness to pay to conserve wetlands; is a vector of explanatory variables, including the baseline wetland acreage and quantity acreage change; is model parameters to be estimated; the stochastic error term for the ith observation, which is assumed to be normally distributed with mean 0 and a constant variance (: it accounts for variation in wetland values due to differences between individual observations; stochastic error term for the ith study, which is assumed to be normally distributed with mean 0 and a variance (: it accounts for variation in wetland values due to differences between study observations; is functional form.

We will test if the random intercept model is appropriate for our study or the null hypothesis that (in equation 1) is significantly different from zero using a likelihood ratio test (Dias and Belcher, 2015) with the “ranova” function in the “lmer” package in R statistical software; we will use an ordinary least squares if the null hypothesis is rejected. Also, we will use a heteroscedastic consistent estimator for equation 1 if we reject the null hypothesis that the observation level model error is homoscedastic or has constant variance; a non-constant error variance can affect the reliability of estimated standard errors of model parameters and, therefore, the credibility of model inferences. Again, even though multicollinearity will not affect the reliability of estimated standard errors of model parameters, they could inflate them; thus, variables that have variance inflation factors (VIF) of more than 10 will not be used to estimate the model. Variables with high VIF’s could be sources of multicollinearity in the model.

The choice of functional form for equation 1 will be instrumental in determining if the estimated model will conform to economic theory and/or whether the meta-regression value function can be useful for benefit transfer (Kling and Phaneuf, 2018; Moeltner, 2019). Our chosen functional form must be consistent to two theoretical constructs of sensitivity to scope and adding up, which are important in assessing the validity of benefit transfer applications (Kling and Phaneuf, 2018; Newbold and Walsh, 2018; Moeltner, 2019). However, according to Kling and Phaneuf (2018), the validity of sensibility scope could provide a better judgement of the usefulness of the meta-regression to benefit transfer compared to the adding up criteria; since it is “a conceptually difficult test to implement” and empirical tests conducted to date using real goods payments and private goods fail to show consistency with adding up (Kling and Phaneuf, 2018). Following, the above, we will estimate 3 models and choose the one that satisfies sensitivity to scope, closest to satisfying the adding up condition and consistent to the assumptions of utility theory, in particular, the diminishing marginal utility that is associated with a wetland quality acreage change.

The first model, model 1, will use a log-log linear functional form which is given as equation 2:

where: is the natural logarithm of baseline wetland acreage for the ith observation and is the associated parameter to be estimated; is the natural logarithm of the quantity acreage change and is the associated parameter to be estimated; all the other variables and have already been defined in equation 1.

The coefficient of the log of baseline wetland acres, if negative, shows a diminishing marginal utility of additional improvements (or wetland acreage increase) which is expected from economic utility theory (Kling and Phaneuf, 2018). Moeltner et al. (2019), estimated this functional form in a meta-regression study and found severe departure from the adding up condition.

Like equation 2, the second model, model 2, will also follow a log-log functional form. However, unlike in equation 2, the dependent variable is the log of willingness to pay minus the log of quantity acreage change. Also, the independent variables include the log of baseline wetland acreage (but not the log wetland acres change).

The transformation in the dependent variable is necessary to convert the willingness to pay values into the same units because of the differing values in the quantity acreage change (Kling and Phaneuf, 2018). Moeltner et al. (2019) has estimated a meta-regression model with this function form and could not find serious violation of the adding up condition.

Lastly, for the third model (model 3) we will use a non-linear functional form (equation 3) that is, by definition, adding up compliant (Newbold and Walsh, 2018; Moeltner et al. 2019; Moeltner, 2019). This model is specified as equation 4. More details of this functional form including its derivation can be found in Moeltner (2019).

where q0 and q1 are baseline and target (policy) acreage and is the corresponding quantity parameter; all the other variables are already defined in equation 2.

The sensitivity to scope condition and the law of diminishing marginal utility are satisfied if coefficients of the log of quantity acreage change and the log of baseline acreage are positive and negative, respectively (Kling and Phaneuf (2018). Further, we will follow Moeltner et al. (2019) to test the validity of the adding up condition for the estimated models. Specifically, we will apply the estimated models to four wetland scenarios, namely a) wetlands located in forested landscapes and valuation study was at the sub-province or state level, b) wetlands located in forested landscape and valuation study was at the province or state level, c) wetlands located in non-forested landscape and valuation study was at the state level, and d) wetlands located in non-forested and valuation study was at the sub-province or state level. For each scenario, we calculated a) the total WTP to pay to conserve wetland given a hypothetical change from baseline (10000acres) to new state (10050acres), b) the incremental willing to pay to conserve wetlands from baseline (10000acres) to new state (10030acres), and c) incremental willing to pay to conserve wetlands from baseline (10030acres) to new state (10050acres). We defined Lnyear as (log (2017-1991) +1), lumpsum = 0 (so that we can interpret WTP in per year units), Lninc was defined at the sample mean, volunt =1, choice experiment = 1, peer review = 1; the variables are described in Table 2.

* 1. **Meta-Regression Results**

The random coefficient model is appropriate for our study, because the null hypothesis that the observation level random error component of equation is significantly different from zero is rejected in all the estimated models (the likelihood ratio test statistics are all significant at the1 percent level (Table 4). However, model 1 is the best fit to our study data; it has the lowest Akaike Information Criteria value of 108 compared to the model 2. Therefore, the results of model 1 are reported in this section.

The model has an adjusted coefficient of determination of 0.99; it shows that about 98% of the variation in the dependent variable is explained by the model. This is a very high adjusted R square; but Vedogbeton and Johnson (2020) also estimated an adjusted R square of about 95% in their estimated meta-regression model. The sensitivity of scope criteria is not rejected in this model because the coefficient (0.02) of the log (quantity acreage change) is positive, even though, it is not significant at the 10 percent level. Also, the model upheld the law of diminishing marginal utility in wetland acreage, because of the negative coefficient of the log of baseline acreage (-0.14) which is significant at the 1 percent level; this estimated coefficient means that a 1 percent increase in base line wetland acres will cause a decrease of 0.14% in wetland values. Further, the model showed that a) households value provisioning wetland ecosystem service less than other services, 2) households value wetlands in forest landscapes more than wetlands other landscapes, and c) studies that are published in peer-reviewed journals have positive impact on wetland values. The adding up condition was satisfied only in 1 out of the four scenarios (forest wetland landscape and provincial or state study level); but in the case of model 2, it was satisfied in two scenarios (forest landscape - local study level and non-forest – nonlocal study level) (Table 5).

Regarding the US only model, we chose model 2 because model 1 violated the sensitivity to scope condition (Table 4); Model 2 had a very high adjusted coefficient of determination value of 0.99. Also, the law of diminishing marginal utility was validated with a negative coefficient value of log of baseline (-0.11), which means that for a one percent increase in baseline acreage, wetland values will decline by 0.11%. Again, the results showed that a) households value wetlands closer to them more than wetlands in distant regions, b) households value provisioning ecosystem service less than other services, c) households value wetlands in forest landscapes more than otherwise, and d) studies published in peer-reviewed journals will have a positive impact on wetland values. The adding condition was satisfied in the non-forested -nonlocal and the Nonforested-local scenarios (Table 5).

**Table 4. Meta-regression results**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | | | | | | |
|  | **Model 1** | | | | **Model 2** | | | |
| **Exp. Variables** | **US-Canada**  **(whole data)** | | | **US-Only**  **(Only US data)** | **US-Canada**  **(whole data)** | | | **US-Only**  **(Only US data)** |
|  | | | | | | |
| Constant | -11.209  (33.578) | | | 4.876  (42.068) | -3.387  (2.914) | | | -17.611  (23.467) |
| Log baseline acreage (lnq0) | -0.139\*\*  (0.070) | | | -0.198\*\*\*  (0.076) | -0.131  (0.108) | | | -0.105  (0.166) |
| Log of quantity acreage change (lnq\_change) | 0.022  (0.106) | | | -0.023  (0.137) |  | | |  |
| Log year | -0.248  (0.705) | | | 0.151  (1.334) | -0.942  (0.621) | | | -1.160  (0.750) |
| Local | 0.909  (1.383) | | | 0.770  (2.628) | 3.425\*\*\*  (1.244) | | | 4.600\*\*\*  (1.264) |
| Provisioning ecosystem service (prov) | -2.580\*  (1.347) | | | 0.454  (2.267) | -2.380\*\*  (1.129) | | | -3.751\*\*\*  (1.151) |
| Regulation ecosystem service (reg) | -0.082  (1.494) | | | -0.741  (1.955) | 1.392  (1.293) | | | -0.774  (1.543) |
| Cultural ecosystem service (cult) | 0.057  (1.507) | | | 0.175  (2.566) | -2.021\*  (1.181) | | | -1.237  (1.347) |
| Log income (lninc) | 1.588  (2.860) | | | 0.147  (3.578) |  | | | 1.342  (1.921) |
| N | | 45 | 28 | | | 45 | | 28 |
| Log Likelihood | | -37.220 | -17.911 | | | -55.275 | | -23.409 |
| Likelihood Ratio Test | | 17\*\*\* | 23\*\*\* | | | 34\*\*\* | | 3.1\* |
| Akaike Inf. Crit. | | 108.439 | 65.822 | | | 140.551 | | 76.817 |
| Adjusted R2 | | 0.99 | 0.99 | | | 0.97 | | 0.93 |
| Adjusted ICC | | 0.99 | 0.99 | | | 0.92 | | 0.77 |

**Notes**:

1. Model 1: the dependent variable is Log wtp and main independent variables are log of quantity acre

change and log of baseline acres.

1. Model 2: the dependent variable is Log wtp - log of quantity acre change and main independent variable is log of baseline acres.

\*\*\*,\*\*,\*denotes significance at 1%, 5% and 10%, respectively.

**Table 4. Meta-regression results. Continued.**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Model 1** | | **Model 2** | |
| **Exp. Variables** | **US-Canada**  **(Whole data)** | **US-Only**  **(Only US data)** | **US-Canada**  **(Whole Data)** | **US-Only**  **(Only US data)** |
| Wetland in forest landscape (forest) | 1.541\*\*\*  (0.299) | 1.721\*\*\*  (0.298) | 1.384\*\*  (0.578) | 1.600\*\*  (0.640) |
| Payment mechanism is voluntary (volunt) | 0.413  (1.439) | -2.254  (2.351) | -0.070  (1.258) | 1.420  (1.249) |
| Payment frequency is one time (Lumpsum) | -1.919  (1.705) | -0.116  (1.765) | 1.027  (1.422) | -1.533  (1.546) |
| Stated preference method is choice experiment (ce) | -0.013  (0.357) | -4.331  (2.966) | 0.192  (0.732) | 1.155  (1.387) |
| Study is peer reviewed (nrev) | 3.033\*  (1.669) |  | 1.208  (1.464) | 5.271\*\*  (2.286) |
| Study was conducted in the US | -2.020  (1.800) |  | 1.785  (1.568) |  |
| N | 45 | 28 | 45 | 28 |
| Log Likelihood | -37.220 | -17.911 | -55.275 | -23.409 |
| Likelihood Ratio Test | 17\*\*\* | 23\*\*\* | 34\*\*\* | 3.1\* |
| Akaike Inf. Crit. | 108.439 | 65.822 | 140.551 | 76.817 |
| Adjusted R2 |  |  |  |  |
| Adjusted ICC |  |  |  |  |
|  | | | | |

**Notes**:

1. Model 1: the dependent variable is Log wtp and main independent variables are log of quantity acres

change and log of baseline acres.

1. Model 2: the dependent variable is Log wtp and main independent variable is log of baseline acres.

\*\*\*,\*\*,\*denotes significance at 1%, 5% and 10%, respectively.

**Table 5. Adding up Test Results**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  | **Model 1**  **(US-Canada Data)** | | **Model 2**  **(US-Canada Data)** | | **Model 2**  **(US Data)** | |
| **Wetland**  **Scenario** | **Baseline Acreage** | **Acreage Change** | **WTP** | **AU Test** | **WTP** | **AU Test** | **WTP** | **AU Test** |
| F-L | 10000 | 10030 | 221.33 |  | 0.22 |  | 124.88 |  |
| F-L | 10030 | 10050 | 3342.61 |  | 0.55 |  | 89.69 |  |
| F-L | 10000 | 10050 | 3364.28 | -199.66 | 1.45 | 0.68 | 211.71 | -2.86 |
| F-NL | 10000 | 10030 | 865.64 |  | 0.15 |  | 1.39 |  |
| F-NL | 10030 | 10050 | 1397.80 |  | 0.02 |  | 0.93 |  |
| F-NL | 10000 | 10050 | 6611.81 | 4348.37 | 0.14 | -0.02 | 2.29 | -0.03 |
| NF-L | 10000 | 10030 | 1398.83 |  | 0.47 |  | 19.26 |  |
| NF-L | 10030 | 10050 | 355.49 |  | 0.10 |  | 9.85 |  |
| NF-L | 10000 | 10050 | 709.94 | -1044.38 | 0.25 | -0.32 | 68.93 | 39.81 |
| NF-NL | 10000 | 10030 | 444.72 |  | 0.00 |  | 0.24 |  |
| NF-NL | 10030 | 10050 | 1132.62 |  | 0.03 |  | 0.18 |  |
| NF-NL | 10000 | 10050 | 62.99 | -1514.35 | 0.05 | 0.01 | 0.44 | 0.01 |

Notes

1. WTP denotes willing to pay; LCIV denotes lower confidence interval value; UCIV denotes upper confidence interval value, AU is adding up.
2. The AU test values, for each scenario, is the difference between the total WTP (from 10,000 to 10,050) and the sum of incremental WTP values, that is the sum of WTP (10,000 to 10,030) and WTP (10,030 to 10,050).
3. Following Kling and Phaneuf (2018), adding up will hold if the sum of the incremental WTP is less than or equal to the total WTP (in our case, the AU Test value must be at least positive)
   1. **Freshwater Bayesian Meta-Function Benefit Transfer Errors**

Following Lindhjem and Navrud (2008) and Johnson and Thomassin (2010), the in-sample transfer error for each Canadian observation is calculated in two steps; first, the absolute difference between the original wetland value and predicted wetland value is multiplied by 100, and second, the estimate is divided by original wetland value. For the unit transfer error, the predicted WTP value is replaced by the mean WTP from the data (which is $227). The results (Table 6) show that the mean in-sample meta-function transfer error for the US-Canada chosen model (Model 1) is 14%, which is about 136 times less than the mean transfer error of 1900% for model 2, or the US only data.

The mean meta-function transfer error for the combined dataset is about 3 times lower than what has been reported in Johnson and Thomassin (2010) at 46.5%. However, the general observation from our study is consistent with that from Johnson and Thomassin (2010) that using US only wetland valuation studies to infer the value of Canadian wetlands could result in unreliable estimates for policy analysis. When it is not feasible to use original Canadian wetland studies to value new wetlands because of insufficient data, the practitioner could use a multinational meta-function such as the US and Canada model. This study has shown that it will misleading use a US only meta-function to value Canadian wetlands. Also, if for some reason the US only meta-function is to be used to value Canada wetlands, the wetland values will have to be adjusted downwards; since it has been shown in this study that wetland values in Canada are about 0.95 times less than those in the US. Also, in general, the observation from our results that meta-function transfer errors are lower than unit transfer errors are consistent with the literature on benefit transfer errors.

**Table 6. In-Sample Transfer Accuracy for Canadian Observations**

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  | **Model 1 (US-Canada Data)** | | | **Model 2 (US-Canada Data)** | | | **US Model 2 (US only data)** | | |
| **Obs\_id** | **Quantity Acre Change** | **WTP (Original)** | **Predicted WTP** | **Meta-Function Transfer Error (%)** | **Unit Transfer Error (%)** | **Predicted WTP** | **Meta-Function Transfer Error (%)** | **Unit**  **Transfer**  **Error (%)** | **Predicted WTP** | **Meta-Function Transfer Error (%)** | **Unit Transfer Error (%)** |
| 1 | 4200 | 196.04 | 195.70 | 0.18 | 110.09 | 152.73 | 22.09 | 110.09 | 16.16 | 91.76 | 110.09 |
| 2 | 5884 | 36.93 | 22.08 | 40.22 | 1015.19 | 15.65 | 57.62 | 1015.19 | 69.88 | 89.20 | 1015.19 |
| 3 | 11300 | 22.68 | 22.61 | 0.30 | 1716.06 | 30.62 | 35.00 | 1716.06 | 141.16 | 522.40 | 1716.06 |
| 4 | 7408 | 28.91 | 22.22 | 23.14 | 1324.91 | 19.32 | 33.15 | 1324.91 | 106.05 | 266.90 | 1324.91 |
| 5 | 14318 | 17.20 | 21.84 | 26.98 | 2294.24 | 36.95 | 114.78 | 2294.24 | 206.55 | 1100.70 | 2294.24 |
| 6 | 94918 | 337.35 | 373.76 | 10.79 | 22.09 | 169.33 | 49.80 | 22.09 | 13.70 | 95.94 | 22.09 |
| 7 | 135598 | 344.83 | 373.93 | 8.44 | 19.44 | 247.34 | 28.27 | 19.44 | 19.95 | 94.22 | 19.44 |
| 8 | 176277 | 352.45 | 381.59 | 8.27 | 16.86 | 310.57 | 11.88 | 16.86 | 22.57 | 93.60 | 16.86 |
| 9 | 257636 | 367.48 | 380.16 | 3.45 | 12.08 | 483.81 | 31.66 | 12.08 | 35.36 | 90.38 | 12.08 |
| 10 | 406793 | 397.57 | 384.40 | 3.31 | 3.60 | 727.91 | 83.09 | 3.60 | 61.73 | 84.47 | 3.60 |
| 11 | 3000 | 1502.07 | 1652.32 | 10.00 | 72.58 | 1182.32 | 21.29 | 72.58 | 13199.55 | 778.76 | 72.58 |
| 12 | 4000 | 1483.38 | 1761.09 | 18.72 | 72.23 | 1578.31 | 6.40 | 72.23 | 17085.87 | 1051.82 | 72.23 |
| 13 | 106253 | 12.62 | 15.70 | 24.35 | 3162.98 | 14.91 | 18.14 | 3162.98 | 0.41 | 96.75 | 3162.98 |
| 14 | 106253 | 25.51 | 15.07 | 40.92 | 1514.79 | 14.47 | 43.26 | 1514.79 | 0.28 | 98.89 | 1514.79 |
| 15 | 988421 | 511.86 | 539.12 | 5.33 | 19.53 | 607.29 | 18.64 | 19.53 | 23791.81 | 4548.12 | 19.53 |
| 16 | 988421 | 493.81 | 548.42 | 11.06 | 16.59 | 492.79 | 0.20 | 16.59 | 8590.67 | 1639.69 | 16.59 |
| 17 | 1E+08 | 871.18 | 794.18 | 8.84 | 52.72 | 877.53 | 0.73 | 52.72 | 188807.10 | 21572.60 | 52.72 |
| Mean |  | 411.87 | 441.42 | 14.37 | 673.29 | 409.52 | 33.88 | 673.29 | 14833.46 | 1900.95 | 673.29 |
| SD |  | 469.70 | 530.29 | 12.74 | 987.87 | 460.74 | 29.75 | 987.87 | 45424.16 | 5188.12 | 987.87 |
| MIN |  | 12.62 | 15.07 | 0.18 | 3.60 | 14.47 | 0.20 | 3.60 | 0.28 | 84.47 | 3.60 |
| Max |  | 1502.07 | 1761.09 | 40.92 | 3162.98 | 1578.31 | 114.78 | 3162.98 | 188807.10 | 21572.60 | 3162.98 |

Willingness to pay (WTP) is measured in 2017C$/household/year; obs is observation.

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**Appendix**

**Table 2A. Description of US studies used in this study**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Author | | Year | | Type | | Target Population | | Wetland type | | BA | PA | | WTP | |
| Awondo et al. | | 2011 | | J | | Maumee Bay SP, OH, visitors | | Freshwater, unspec. | | 0.00 | 2,499.00 | | 193.00 | |
| Beran, L.J. | | 1995 | | D | | All SC HHs | | Freshwater, forested | | 6,000.00 | 8,500.00 | | 36.00 | |
| Beran, L.J. | | 1995 | | D | | All SC HHs | | Freshwater, forested | | 6,000.00 | 8,500.00 | | 27.00 | |
| Beran, L.J. | | 1995 | | D | | All SC HHs | | Freshwater, forested | | 6,000.00 | 8,500.00 | | 33.00 | |
| Blomquist & Whitehead | | 1998 | | J | | All KY HHs | | Freshwater | | 3,468.00 | 3,968.00 | | 3.00 | |
| Blomquist & Whitehead | | 1998 | | J | | All KY HHs | | Freshwater, forested | | 69,580.00 | 70,080.00 | | 8.00 | |
| Blomquist & Whitehead | | 1998 | | J | | All KY HHs | | Freshwater, forested | | 21,716.00 | 22,216.00 | | 6.00 | |
| Blomquist & Whitehead | | 1998 | | J | | All KY HHs | | Freshwater, forested | | 908.00 | 1,408.00 | | 19.00 | |
| deZoysa | | 1995 | | D | | Selected MSAs, OH | | Freshwater, unspec. | | 10,000.00 | 13,000.00 | | 109.00 | |
| Loomis et al. | 1991 | | BC | | All CA HHs | | Freshwater, unspec. | | 27,000.00 | | | 85,000.00 | | 258.00 |
| Loomis et al. | 1991 | | BC | | All CA HHs | | Freshwater, unspec. | | 85,000.00 | | | 125,000.00 | | 426.00 |
| MacDonald et al. | 1998 | | J | | Atlanta region, GA | | Freshwater, unspec. | | 212,378.00 | | | 212,708.00 | | 108.00 |
| Mullarkey & Bishop | 1999 | | CP | | All WI HHs | | Freshwater, forested | | 219,890.00 | | | 220,000.00 | | 64.00 |
| Newell & Swallow | 2013 | | J | | Two townships, RI | | Freshwater, forested | | 5,838.00 | | | 5,867.00 | | 9.00 |
| Newell & Swallow | 2013 | | J | | Two townships, RI | | Freshwater, forested | | 5,822.00 | | | 5,867.00 | | 12.00 |
| Newell & Swallow | 2013 | | J | | Two townships, RI | | Freshwater, forested | | 5,807.00 | | | 5,867.00 | | 16.00 |
| Poor | 1999 | | J | | All NE HHs | | Freshwater, unspec. | | 34,000.00 | | | 50,000.00 | | 47.00 |
| Poor | 1999 | | J | | All NE HHs | | Freshwater, unspec. | | 34,000.00 | | | 75,000.00 | | 42.00 |
| Poor | 1999 | | J | | All NE HHs | | Freshwater, unspec. | | 34,000.00 | | | 100,000.00 | | 47.00 |
| Whitehead et al. | 2009 | | J | | Selected counties, MI | | Freshwater, unspec. | | 9,000.00 | | | 10,125.00 | | 73.00 |
| Whitehead & Blomquist | 1991 | | J | | All KY HHs | | Freshwater, forested | | 36,000.00 | | | 41,000.00 | | 19.00 |

Notes: BA is base wetland acreage; PA is policy wetland acreage; WTP is willingness to pay

**Table 2B. Description of Canadian studies used in this study**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Author | Year | Type | Target Population | Wetland type | BA | PA | WTP |
| Rudd et al | 2016 | J | Southern Ontario | Freshwater, forested | 1307159 | 1413412 | 11.5 |
| Trenholm et al | 2013 | J | Southern New Brunswick | Freshwater, forested | 0 | 14318 | 14.6 |
| Trenholm et al | 2013 | J | Southern New Brunswick | Freshwater, forested | 0 | 11300 | 19.38 |
| Rudd et al | 2016 | J | Southern Ontario | Freshwater, forested | 1307159 | 1616034 | 24.3 |
| Trenholm et al | 2013 | J | Southern New Brunswick | Freshwater, forested | 0 | 7408 | 24.7 |
| Trenholm et al | 2013 | J | Southern New Brunswick | Freshwater, forested | 0 | 5884 | 31.56 |
| Lantz et al. | 2013 | J | Greater Toronto Area | Freshwater, unspec | 11997 | 14520 | 36.2 |
| Tkac | 2002 | D | Southern Ontario | Freshwater, unspec | 4200 | 8400 | 146.98 |
| Pattisson et al | 2011 | J | Manitoba | Freshwater, unspec | 945184 | 1044702 | 318.33 |
| Pattisson et al | 2011 | J | Manitoba | Freshwater, unspec | 945189 | 1084782 | 325.36 |
| Pattisson et al | 2011 | J | Manitoba | Freshwater, unspec | 945189 | 1125461 | 332.37 |
| Pattisson et al | 2011 | J | Manitoba | Freshwater, unspec | 945189 | 1206820 | 346.76 |
| Pattisson et al | 2011 | J | Manitoba | Freshwater, unspec | 945189 | 1355977 | 375.6 |
| He et al | 2017 | J | Southern Quebec | Freshwater, unspec | 988422 | 1976843 | 483 |
| He et al | 2017 | J | Southern Quebec | Freshwater, unspec | 988422 | 1976843 | 506 |
| Vossler et al. | 2020 | J | Quebec | Freshwater, unspec | 29652646 | 129948360 | 887 |

Notes: BA is base wetland acreage; PA is policy wetland acreage; WTP is willingness to pay which is measured in C$ in the year of study per household per year

**Table 3A. In-Sample Transfer Accuracy for Canadian Observations**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Observation\_id** | **Quantity Acre Change** | **WTP (Original)** | **Predicted WTP** | **Meta-Function Transfer Error (%)** | **Unit Transfer Error (%)** |
| 1 | 700 | 94.74 | 141.53 | 49.39 | 20.63 |
| 2 | 600 | 97.11 | 123.32 | 26.99 | 17.69 |
| 3 | 500 | 99.48 | 94.73 | 4.77 | 14.88 |
| 4 | 200 | 106.58 | 39.45 | 62.99 | 7.23 |
| 5 | 700 | 3.87 | 5.91 | 52.60 | 2851.07 |
| 6 | 600 | 3.97 | 4.66 | 17.43 | 2779.10 |
| 7 | 200 | 4.36 | 0.85 | 80.42 | 2523.18 |
| 8 | 2499 | 349.63 | 354.80 | 1.48 | 67.31 |
| 9 | 500 | 3.39 | 2.70 | 20.40 | 3270.75 |
| 10 | 500 | 12.67 | 11.33 | 10.55 | 802.20 |
| 11 | 500 | 9.53 | 14.04 | 47.29 | 1099.04 |
| 12 | 500 | 32.79 | 18.89 | 42.40 | 248.54 |
| 13 | 3000 | 196.94 | 219.65 | 11.53 | 41.97 |
| 14 | 110 | 115.05 | 112.01 | 2.64 | 0.67 |
| 15 | 29 | 14.53 | 13.15 | 9.47 | 686.53 |
| 16 | 45 | 19.92 | 22.84 | 14.66 | 473.69 |
| 17 | 60 | 26.38 | 28.06 | 6.37 | 333.30 |
| 18 | 58000 | 467.40 | 725.29 | 55.18 | 75.55 |
| 19 | 40000 | 772.56 | 446.64 | 42.19 | 85.21 |
| 20 | 16000 | 83.82 | 39.35 | 53.05 | 36.35 |
| 21 | 41000 | 74.21 | 95.39 | 28.55 | 54.01 |
| 22 | 66000 | 84.16 | 157.30 | 86.91 | 35.80 |
| 23 | 1125 | 130.35 | 115.16 | 11.65 | 12.32 |
| 24 | 5000 | 32.28 | 28.84 | 10.64 | 254.10 |
| 25 | 330 | 194.96 | 196.95 | 1.02 | 41.38 |
| 26 | 2500 | 63.75 | 59.62 | 6.48 | 79.27 |
| 27 | 2500 | 47.79 | 52.95 | 10.81 | 139.16 |
| 28 | 2500 | 57.81 | 55.43 | 4.12 | 97.70 |
| Mean |  | 114.29 | 113.60 | 27.57 | 576.74 |
| SD |  | 163.83 | 157.72 | 24.56 | 971.93 |
| MIN |  | 3.39 | 0.85 | 1.02 | 0.67 |
| Max |  | 772.56 | 725.29 | 86.91 | 3270.75 |

Willingness to pay (WTP) is measured in 2017C$/household/year