Property Owners' Willingness to Pay for Water Quality Improvements: Contingent Valuation Estimates in Two Central Minnesota Watersheds

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Improved lake water quality yields environmental benefits that translate into economic benefits. This study estimates the economic value of these benefits by assessing the willingness-to-pay (WTP) of property owners for restoring lakes in two watersheds in Minnesota using the contingent valuation method (CVM). Alternative models generated a range of WTP estimates, with the means for one watershed clustered in the $200 to $300 range, while the other watershed ranged from $11 to $17. Differences between lakeshore and non-lakeshore property ownership patterns, recreational use, and other socio-economic and watershed characteristics were significant influences on WTP.

INTRODUCTION AND BACKGROUND

Restoration of impaired waters is gaining increasing attention across the United States, and from the State of Minnesota. Improving the quality of impaired waters will yield environmental benefits that will also translate into economic and social benefits. The estimation of the total economic value of these environmental benefits is the objective of this study. This study analyzes all components of public values by assessing the total willingness-to- pay (WTP) of property owners for restoring water quality in impaired lakes within two watersheds in the Upper Mississippi River Basin of Minnesota. While the two watersheds are located in the Upper Mississippi River Basin, they are distinctly different in terms of their physical, ecoregion, hydrological, and limnological characteristics. The lakes selected are the Sauk River (also known as the Horseshoe) Chain of Lakes, located in the Sauk River Watershed, near the City of Cold Spring, Minnesota. The second lake-watershed system is Lake Margaret and Gull Lake, which are part of the Gull Lake Chain in the Crow Wing River Watershed, near the City of Brainerd, Minnesota.

Estimating the total economic value of improvements in public goods, such as environmental goods and services, requires a method that utilizes non-price (non-market) data. A stated-preference estimation technique known as the contingent valuation method (CVM) is utilized to estimate the WTP of property owners for water quality improvements resulting from reduced nutrient loads, particularly phosphorus.

Contingent valuation employs a survey that describes the prospective policy and its effects. The percentages of respondents favoring the proposal at different household costs provide information on how much households value the changes, if at all. Logistical regression is utilized to relate the percentages voting YES with the household costs and other variables. Economic theory suggests the level of support should vary inversely with the costs. The results are consistent with these economic principles. Censored logistic regression allows conversion of these relationships into a valuation function that estimates mean WTP of respondents.

The causes of the impairments differ between the two watersheds, so different management options may generate different levels of net benefits. The analysis demonstrates that the watersheds are also different in terms of how property owners in the watershed relate to the impaired lakes. Many property owners are not residents of the watersheds (67% have ZIP codes outside the watershed for Margaret) and are wealthier and older than the average residents of the area. The pattern is less severe in the Sauk Watershed as about 11% of the property owners have mailing addresses outside of the watershed and Stearns County.

The Margaret-Gull Chain has a high degree of surface water as percentage of watershed acreage compared to Sauk, and consequently a high proportion of lakeshore owners relative to the overall population of property owners in the watershed. The Margaret-Gull Chain also has many highly-valued lake properties owned by people with high incomes and a large amount of recreational use by lake owners and visitors.

The contingent-valuation method (CVM) is employed here because it enables estimation of total willingness to pay based on people's direct statements of their preferences. The contingent-valuation method is a survey technique designed to elicit the willingness of a household to pay for a policy that will produce benefits for that household. This is a non-market analogue to the observation of a market transaction in which a consumer reveals his or her willingness to pay the market price for a good.

The Context for Policies to Reduce Nutrient Loads to Impaired Waters

This analysis is relevant to the policy discussion in Minnesota about whether restoring impaired lakes would generate more benefits than costs. Findings should also shed light on the equity implications of alternatives for raising funds to deal with Minnesota's impaired waters. Recent discussions have centered around assessing a water quality improvement fee on water utility use. A fee of $30 a year was a focal point of the discussion. These costs would mostly be borne by property owners. While these revenues would be collected from all water utility customers, those closest to the improved surface waters would stand to benefit more than their costs. Map 1 displays the Impaired Lakes in the Upper Mississippi River Basin with Lake Margaret and the Sauk River Chain of Lakes highlighted.

Sauk River Chain of Lakes Watershed

The Sauk River Chain of Lakes (Sauk River COL), also known as the Horseshoe Chain of Lakes is a series of reservoir lakes located on the Sauk River, near Cold Spring, Minnesota. The Sauk River enters the chain at Horseshoe Lake and exits through Knaus Lake.

In 2004, the MPCA placed the Sauk River Chain of Lakes (SRCOL) on the Impaired Waters/TMDL List, since the lakes TP was greater than the 40 ug/L threshold for the North Central Hardwoods Forest Ecoregion. At the time of listing, the SRCOL had a mean in-lake TP of approximately 150 ug. A description of the lakes morphometric and watershed characteristics is shown in Table 1.

Lake Margaret – Gull Lake Watershed

Margaret Lake is located in North Central Minnesota near the City of Lakeshore, Minnesota. During the 2005 summer sampling season the in-lake mean TP was 65 ug/L. Because of concerns about the TP, Lake Margaret was placed on the Impaired Waters/TMDL list for excessive levels of phosphorus.

WATERSHED MANAGEMENT PRACTICES TO PROVIDE ENVIRONMENTAL AND ECONOMIC BENEFITS

Both the Lake Margaret and Sauk River Chain of Lakes watersheds are home to several hundred thousand people on a year round or seasonal basis and its water resources are the basis for a multi-million dollar tourism industry. Desired uses of the waters in the watershed would be to continue with quality summer and winter recreation uses of the lake which are contingent on clean water.

For swimming and skiing, lower rates of aquatic weed growth are desired. This also holds true for fishing. A balance of protecting water quality and providing clean water resources are critical. These uses are desired not only for local residents but also for visitors to the area.

The information presented in the economic-valuation survey provides a comprehensive summary of the informational context for policies to restore these impaired lakes. The mail-surveys in the two watersheds for valuation of the policies to improve water quality described the environmental impacts, the proposed program and costs to households. See Figure 1 in Appendix.

TABLE 1
MORPHOMETRIC, AND WATERSHED CHARACTERISTICS FOR THE SAUK RIVER CHAIN OF LAKES, MARGARET, AND GULL LAKES

	Margaret – Gull Lake (See Note 1)	Sauk River Chain of Lakes/Horseshoe Lake (See Note 2)
STORET ID:	11-0222	73-0157 -
MORPHOMETRIC DATA		
Area in Acres (ha):	222 (86.8)	2456 (982.4)
Mean Depth in ft. (m):	10.5 (3.04)	12.5 (3.81)
Max. Depth in ft. (m):	26 (7.92)	79 (24.1)
Volume in acre feet (hm):	2,321.7 (32.2)	30,735 (426.3)
WATERSHED CHARACTERISTICS		
Watershed Area in Acres (ha):	18,340 (7,336)	601,936 (204,774.4)

Source:
Note 1 - Minnesota Pollution Control Agency, Lake Margaret Lake Assessment Report, 1994, page 10. Accessed at www.pca.state.mn.us/publications/reports/lar-11-0222.pdf
Note 2 - Sauk River Watershed District, Sauk River Chain of Lakes Basin, Restoration 319 Project Final Report Phase IIC, 2001-2004, September 2005, Page 8. Accessed at: www.srwdmn.org/pdf/CRCOL%20BASIN%20RESTORATION%20APPROVED%20%20FINAL%20REPORT%2011-14.

Watershed management practices that yield these benefits not only produce improved recreational experiences to individuals but also provide collective benefits that fit the economic definition of "public goods."

Improvements in the quantity or quality of environmental goods and services are typically not the kinds of economic goods that are exchanged based on market transactions. So preferences for these goods and services are not typically observable because often people do not "vote with their dollars" in markets for these effects. Nonetheless, such improvements in environmental services are economic goods in a very real sense.

METHODS FOR INFERRING ECONOMIC VALUE

Methods for estimating the willingness to pay (WTP) for environmental improvements fall into two classes: revealed-preference techniques and stated-preference techniques. Revealed-preference approaches involve examining peoples' behavior and using this information to draw conclusions about WTP. Stated-preference approaches involve the use of surveys to elicit information that can be used to estimate WTP.

The principal stated-preference technique for environmental-policy analysis is the contingent valuation method (CVM). CVM employs a survey method that characterizes the object of choice (e.g., the bundle of effects associated with a policy change). It is for the defined object of choice that CVM is designed to produce a monetized value. The object of choice must be framed within a credible choice context and with clear financial consequences attached to the choice. A survey format in common use is to place the object of choice in a referendum-voting context. The respondent is asked whether they would vote yes or no on the policy, where adoption of the policy will have specific financial consequences to the respondent. These mechanisms must be credible (higher taxes, higher product prices, etc. as appropriate) in order for the stated choices to be meaningful. Under circumstances where the object of choice is properly framed and the credibility conditions are satisfied, the stated choices provided by respondents provide the basis for estimating WTP for the effects produced by the prospective policy change.

Pre-Testing of the Survey Instrument

Four levels of pre-testing were utilized: pre-testing key sections with individuals, discussing key sections with focus groups, conducting a limited number of interviews with recreational users of these lakes, and testing all elements of survey administration through a pilot study. Two focus groups were conducted in each watershed with advisory committees assembled by watershed staff. One was an initial discussion of the method and drafts of the key sections mentioned above including descriptions of the policy context and the payment vehicle for this study. After the initial discussion, participants read drafts of sections describing the proposal and its expected environmental impacts and consequences for household budgets. The second focus group in each watershed was a discussion of pre-testing results and recreational interviews to settle on the final draft for the pilot study.

Pre-testing fit the three types of pretests recommended by Dillman.[1] Recommended pretests involve the following three groups: (1) professionals experienced in survey design, (2) users of the information, and (3) members of the survey population. The professionals who critiqued the numerous versions of the survey instruments included economists and other social scientists familiar with and environmental policy, practitioners of CV and survey research, and professionals in related fields.

Survey design and the overall study benefited from the involvement of staff from the Minnesota Pollution Control Agency, the Minnesota Department of Natural Resources, staff in and board members of the watersheds districts, local county environmental services officers, and lake association leaders. This provided scrutiny as to how the information gathered might be used for decision-making and provided a useful lens for improving the survey instrument.

The Contingent Valuation Method is termed as such because values are elicited based on described policy changes which would produce public goods. Benefits would accrue if the effects of the policy are regarded as economic goods. The survey design process becomes all the more crucial because it defines the elements of the policy that would generate these benefits. Hence benefits estimates depend on (or are contingent upon) these described policy impacts.

The policy consequences that people may value in this case are improvements in water quality due to reductions in nutrients loads. The effects are improvements in Secchi disk readings, reduced numbers and durations of algae blooms and better conditions for water-based recreation. Through pre-testing and focus group discussions these effects were identified as economic goods to the extent that people value improved environmental quality.

Pre-test results indicated that people sensed a high degree of realism in both policy consequences and household budget consequences. Empirical results below provide further evidence from follow-up (debriefing) questions regarding the credibility of the payment mechanism and the magnitude of the payment. The study established a payment vehicle that is realistic: higher prices, higher utility rates and special assessments. The costs to households were explained carefully according to suggestions offered in focus groups and pre-testing. As noted above, the description of costs is designed to put respondents in the proper frame of mind in recognizing the economic trade-offs in allocating scarce resources to such a program.

The Purpose of Using Two Different Watersheds for the Mail Survey

This study is part of a larger initiative of the Minnesota Pollution Control Agency to analyze the economics of restoring impaired lakes. While these two watersheds are high profile for the state, they also have distinct environmental and social aspects and varied sources of nutrient loads. The estimation of benefits from improving water quality in these two watersheds does allow investigation of whether mean willingness-to-pay (WTP) differs between the populations of these two areas. This will support some generalization to the Minnesota population, or at least within the Upper Mississippi River Basin, to the extent that demographics and other variables are found to influence economic values. These two watersheds have social aspects that stake out extremes on the continuum in terms of size of watershed in proportion to surface water acreage, percentage of watershed property that is riparian, and prestige and value of lakeshore frontage. As will be seen in the Results Section, differences between the watersheds imply that averaging over these two watersheds to infer values and preferences elsewhere in the State would not be methodologically sound. Rather, these samples should prove useful in representing opposite ends of the spectrum to indicate what policy preferences and WTP might be in other watersheds within the Upper Mississippi River Basin. This can be done by interpolating to those populations based on the degree to which characteristics are more similar to either the Margaret-Gull Chain or the Sauk Chain, or somewhere in between.

Sample Selection and Source

Agency and watershed district staff determined that the relevant populations are property owners within each watershed. This was based in large part on background policy discussions of financing watershed management options through assessments on water utilities/property. In the Lake Margaret/ Gull Chain there were a total of 1,044 households on the property owner list so the entire population was sampled. For the Sauk Chain of Lakes the cooperators within the counties and watershed district provided a list of roughly 11,000 property owners from which 1,500 households were randomly selected.

In the main mailings of 1,200 in the Sauk watershed and 744 in Margaret-Gull, four mail contacts were made with potential respondents. The first and fourth mailings included a survey booklet, while the second contact was a post card reminder and the third a reminder letter, each with an invitation to request a replacement booklet, if needed. The four mailings were sent on January 29, February 5, February 19, and March 11, 2008.

EMPIRICAL RESULTS

Response Rate

Self-administered mail surveys were distributed to property owners in both watersheds: the entire population of 1,044 property owners in the Lake Margaret-Gull Lake Chain and a sample of 1500 (about 1 out of 7) property owners in the Sauk Chain. On the basis of responses to this survey, a valuation function was statistically estimated. These estimates provide information on the economic value households would receive from the improved water quality projected to result from the described policy.

A total of 1,081 booklets were returned by property owners in the two watersheds after being completed in whole or in large part. About another dozen booklets were received that were mostly blank except that open-ended responses were provided in sentence or paragraph form. The 1,081 responses were split between the two watersheds with 571 from Sauk and 510 from Margaret-Gull. The total Sauk response of 571 as a percentage of 1,380 potential respondents is 41.4%.

The Margaret-Gull mailing list covered the entire population of 1,044 property owners in the watershed of which only 22 were returned as undeliverable or with responses indicating that the person was deceased, etc. The effective response rate for the main mailing exceeded 50%, but the overall response including the pilot was 510 in Margaret-Gull which is 49.9% of 1,022 potential respondents. These response rates are solid in light of the typical range of response rates for CV studies conducted in recent years.

Regression Analysis

Choice of a Dependent Variable

The survey instrument contains two referendum questions: (1) a standard dichotomous choice question roughly midway through the booklet (Q11); and (2) a second, multi-category referendum question at the end which allows the respondent to revisit their vote. Statistical analysis shows high consistency between responses to both questions, with many of those who stated “Not sure” to the final question having left Q11 blank, so they are excluded from the analysis. For the regression results presented below, the first question is used to define the dependent variable.

Regression Results: Simple Specification

The following results were obtained by estimating three versions of censored logistic regression: two that estimate the model for each watershed separately and a third that combined the samples and assigned a dummy variable to distinguish the watershed of the respondents. The first results shown are from overly simplified models chosen for ease in demonstrating the technique. Then more complex models are offered that yield higher quality estimates that are robust for various specifications and assumptions. In each case, the dependent variable (vote on Q11) is regressed on the stated household cost. Table 2 shows results from the simplest logistic regression using costs as the sole explanatory variable in each watershed and the third model which combines the samples and includes the watershed dummy as a second explanatory variable. The regression parameters are then transformed into a censored logistic regression model for which the dependent variable is expected Willingness-To-Pay (WTP).

TABLE 2
LOGISTIC REGRESSION RESULTS AND ESTIMATES OF WILLINGNESS-TO-PAY BY WATERSHED

Watershed	Constant	Coefficient on Household Costs	Coefficient on Watershed	Estimated WTP*	n
Combined	-.042	.004	-1.142	$145	993
Margaret	-1.225	.004		$296	480
Sauk	-.007	.004		$11	513

** Estimated WTP is the mean Willingness-To-Pay under the graph of the logistic function, or the average cost value at which respondents would just favor the proposal. WTP is based on percentages who favor at different cost levels shown in Figure 2 below. The three estimates provided here are from the combined model with the watershed values assigned as 0 and 1 for Sauk and Margaret, respectively.*

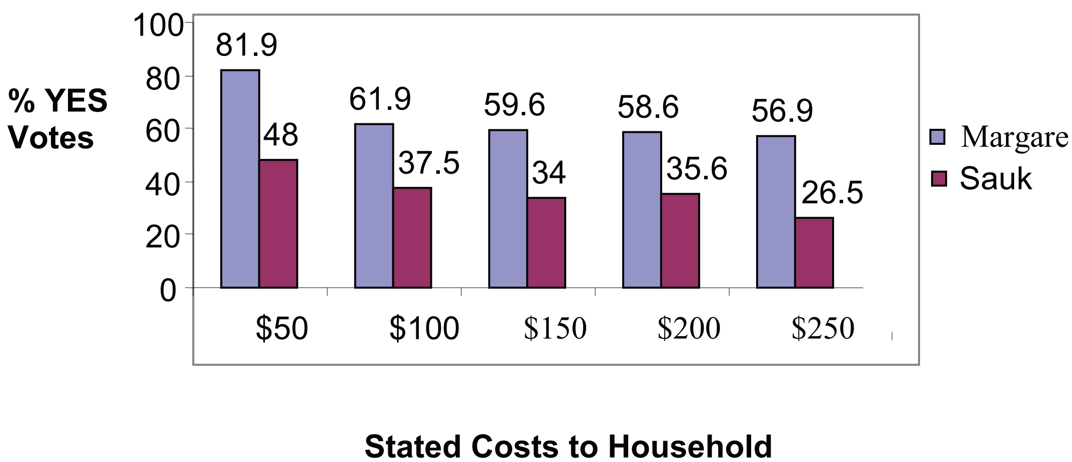
The results show strong support for the proposal to reduce phosphorus loads in the Margaret-Gull Watershed at the costs stated to households and mixed support in the Sauk Watershed. The results are consistent with economic theory (analogous to downward-sloping demand) in both watersheds in that the percentage of support declines as the stated cost goes up. In the simple specification and in more complicated alternative models with multiple explanatory variables, the results are robust in that cost is statistically significant at the 1% level and inversely related to the percentage supporting the proposal.

Figure 2 shows the higher level of support in the Margaret Watershed at all cost amounts compared to Sauk. The watershed dummy variable is significant in explaining the percentage of support for the proposal in the simple regressions. The percentages in Figure 2 make the abstractness and complexity of logistic regression more concrete and indicate why the WTP estimates in Margaret are so much higher.[2]

The results from the simplified models in Table 2 demonstrate the mechanics and potential limitations of the approach. The results accentuate the substantial differences in WTP between the watersheds. Given the level of support is so different between the watersheds, relying on results from the combined model to infer average values is not sound. The regression function on the combined data fits all observations to one equation, but the results imply that the relationships are more complex, suggesting different coefficients on key variables.

However the combined model has appeal for generating an average for the entire sample. The mean of $145 makes intuitive sense based on the patterns of YES votes shown in Figure 2 because just under half of respondents who answered based on costs of $150 voted YES. More than half of the combined sample favored the policy at $50 and $100, but much less than half did so at $200 and $250. The logistic function fits these percentages to generate the overall average of $145. In an oversimplified sense, the responses indicate that around $145 is a "happy medium."

FIGURE 2
PERCENTAGE OF YES VOTES (Q11) BY WATERSHED



While it is tempting to reduce the results to one number, the results from the two watersheds are too different to justify reliance on the combined mean. The wide variability of these estimates is very informative and should not be overlooked. These results can enhance our understanding of people's WTP for restoring impaired lakes, but the findings on the dispersion of the estimates is as important as the measures of central tendency. The average between the two watersheds could be misleading if applied to other watersheds, but the range of values could be transferred to approximate mean WTP in other watersheds where enough is known about the underlying characteristics of the watershed and the population. The wide variation of WTP estimates also implies that some people stand to gain a great deal from lake restoration while others will feel the costs are not worth it to them. For subsequent analyses it is deemed most appropriate to generate estimates based on statistical relationships derived separately from the two watersheds, rather than together.

Regression Results: More Sophisticated Specifications

There are numerous alternative approaches for estimating logistic regression functions to explain support for the proposal using other variables in the samples. These alternatives will yield slightly different estimates of mean WTP, though not as different as various assumptions about how to use responses to follow-up questions after the vote.

One important extension of the analysis is to add variables to the regressions equations, in order to better understand underlying causes of support or opposition to the proposal. While support is very different between the watersheds, it would be enlightening to learn the varied characteristics of respondents that explain the differences in preferences, rather than simply attributing this to watershed per se. As a methodological contribution of this research, it will be helpful to know the underlying characteristics of households and watersheds that influence WTP so that these may be generalized to other areas with impaired lakes. The contrasts between these two watersheds suggest that they are near the ends of the spectrum and may be useful as indicators of where public support for restoring other impaired lakes may lie on this spectrum.

Insight is gained by identifying other significant causal variables in the regression. Various logistic regression equations were estimated to account for the variation in vote percentages using other characteristics, in addition to costs. Other variables included in the models are: Q1 (own lakeshore), Q2 (level of recreational activity), Q20 (anticipated effectiveness of the policy), Q23 (gender), Q26 (age), Q27 (education), Q28 (dependence on farming), Q29 (income) and Q30 (difficulty paying the costs). Elaborate models were run using all of these variables. As would be expected Q29 and Q30 (income and difficulty paying) did not perform well together in that when combined with the cost variable, these were capturing the same influence. These are two ways of measuring respondents' ability to pay. The close relationship of these explanatory variables exemplifies the problem of multicollinearity. As would be expected, regressions to explain Q30 (difficulty paying as the Y variable) using income and costs as explanatory variables showed a strong relationship. Given difficulty paying is a function of the other two variables, income was used instead of Q30.

The results from these alternative specifications were extremely consistent in terms of variables being significant or not and the magnitude of regression coefficients. Demographic characteristics of gender, age and education were consistently insignificant, as was dependence on farming. A strong pattern emerged across versions of the model in showing Q1 (lakeshore ownership), Q2 (water-based recreation on these impaired lakes), Q20 (anticipated effectiveness of the policy) and Q29 (income) as being significant at the 1% level. A couple of versions of the models showed one or more of these variables to be slightly less significant - at the 5% level.

Equations 1a and 1b show the preferred versions of the logistic regression model for the Margaret and Sauk watersheds, respectively. It is noteworthy that estimation of this model on the entire sample does not show the watershed variable to be significant. Even though Margaret has a much higher mean WTP, the watershed variable is not significant because the difference is explained by the other variables. This is a key finding for attaining the methodological objective noted above: the differences in mean WTP between these watersheds are due to differences in these underlying characteristics.

Another major finding is that the coefficients vary between watersheds but are identical in terms of significance and the same signs. Another key result is that as COSTS go up Y goes up, meaning a greater likelihood of a NO vote. OWN is lakeshore ownership (YES=1, NO=2) so the positive signs mean "not owning" lakeshore causes more NO votes. REC is frequency of recreating on the lakes with an increasing scale: NEVER=0 to DAILY=5. EFFECT is anticipated effectiveness of the policy ranging from MOSTLY EFFECTIVE=1 to NOT EFFECTIVE=4 so higher values increase chances of a NO vote, corresponding to the positive sign. INCOME is household income (measured in 5,000-dollar increments) with the negative sign resulting from higher incomes reducing likelihood of a NO vote. In the above logistic regression, all of the slope coefficients have the expected sign.

EQUATION 1
LOGISTIC REGRESSION

Eqn. 1a. Margaret:

$$\ln[P_i/(1-P_i)] = \underset{(1.04)}{-3.93} + \underset{(.002)}{.007}\ COSTS + \underset{(.339)}{1.017}\ OWN - \underset{(.109)}{.291}\ REC + \underset{(.292)}{1.786}\ EFFECT - \underset{(.028)}{.143}\ INCOME$$

Eqn. 1b. Sauk:

$$\ln[P_i/(1-P_i)] = \underset{(1.02)}{-3.16} + \underset{(.002)}{.005}\ COSTS + \underset{(.396)}{.941}\ OWN - \underset{(.092)}{.344}\ REC + \underset{(.215)}{1.223}\ EFFECT - \underset{(.022)}{.087}\ INCOME$$

(Standard errors in parentheses, Pi = probability of YES vote. YES vote coded = 1, NO = 2 so a variable that increases the probability of a YES vote as it increases has a negative sign.)

Transformations of the above equation yield the following censored logistic regression equations:

EQUATION 2
EXPECTED WTP BASED ON CENSORED LOGISTIC REGRESSION (DERIVED FROM EQUATION 1)

Eqn. 2a. Margaret:

$$E(WTP_i) = 561 - 145.29\ OWN + 41.57\ REC - 255.14\ EFFECT + 20.43\ INCOME$$

Eqn. 2b. Sauk:

$$E(WTP_i) = 631.4 - 188.2\ OWN + 68.8\ REC - 244.6\ EFFECT + 17.4\ INCOME$$

Coefficients in the WTP function are found by dividing each coefficient from Equation 1 by the negative of the slope coefficient on COSTS. The expected WTP is found by multiplying each coefficient by the mean on that variable. Means for Margaret are: OWN = 1.38, REC = 3.23, EFFECT = 2.1 and INCOME (in $5,000 increments) = 14.9. This yields an expected WTP for Margaret of $267. Means for Sauk are: OWN = 1.84, REC= 1.18, EFFECT = 2.25 and INCOME (in $5,000 increments) = 11.56. This yields an expected WTP for Sauk of $17. The equations reveal that the substantially higher WTP for Margaret respondents is driven by the higher proportion of lakeshore ownership in the watershed, the higher level of recreation, greater confidence in the effectiveness of the policy and higher average income.

These findings have important methodological implications. Despite the stark contrasts in these watersheds, especially overall WTP, the valuation functions are quite similar in that the same variables emerge as significant and have coefficients of the same sign. The magnitudes of the coefficients vary somewhat which partially explains the dramatic variation in WTP between the two watersheds. But it must also be noted that the differences in WTP are largely driven by the differences in means on the variables such as proportions who own lakeshore, levels of recreational activity, and income. These findings are promising for extension to other watersheds where these characteristics can be compared to these two watersheds.

The mean WTP estimates for each watershed do not vary much between alternative specifications of the model. The estimates in Table 2 are not that different from those yielded by the more complex models. Equations 2a and 2b yield more reliable estimates of mean WTP by separating the two watersheds rather than combining them.

SUMMARY AND CONCLUSIONS

This study provides estimates of the willingness-to-pay (WTP) of property owners for restoration of impaired lakes in two Minnesota watersheds. The watersheds are the Sauk River (also known as the Horseshoe) Chain of Lakes and the Lake Margaret-Gull Lake Chain. While the two watersheds are located in the Upper Mississippi River Basin, they are distinctly different in terms of their physical, ecoregion, hydrological, and limnological characteristics. The causes of the impairments differ between the two watersheds, so different management options may generate different levels of net benefits, or benefits in excess of costs. The analysis demonstrates that the watersheds are also different in terms of how property owners in the watershed relate to the impaired lakes. The Margaret-Gull Chain has a high degree of surface water as percentage of watershed acreage compared to the Sauk, and consequently a high proportion of lakeshore owners relative to the population of property owners in the watershed. The Margaret-Gull Chain also has many highly-valued lake properties owned by people with high income and a large amount of recreational use by lake owners and visitors. Many see restoration of water quality in Lake Margaret as a preventive measure to avoid downstream degradation of Gall Lake.

The contingent valuation survey described the prospective policy and its effects. The survey also indicated to the respondent how much adoption of the policy could cost their household in terms of higher taxes and higher prices for goods and services. Citizens' willingness to pay for the benefits of the policy are elicited from their responses on how they would vote in a referendum on this policy, given its effects and financial consequences.

For this study a mail survey was sent to a randomly selected sample of 1,500 property owners in the Sauk Watershed and to the entire population of 1,044 property owners in the Margaret-Gull watershed. There were 1,081 responses overall, split between the two watersheds with 571 from Sauk and 510 from Margaret-Gull. These response rates (41.4% for Sauk and 49.9% for Margaret-Gull) are solid in light of the typical range of response rates for CV studies conducted in recent years.

The responses exhibited patterns that strongly fit economic theory. The percentages of respondents who expressed support for the proposal varied inversely with the stated cost to the household. The influence of cost on the percentage favoring the policy to restore these impaired lakes was significant in all specifications of logistic regression models. The simplest specification explained the percentage voting YES on the proposal with COST and WATERSHED as the explanatory variables. When additional explanatory variables are included, the watershed is no longer significant because the characteristics of the respondents within the watersheds dominate. Robust results are yielded in that Lakeshore Ownership, Frequency of Lake Use, Perception of Effectiveness of the Policy, and Income were consistently found to be significant at the 1% level under various assumptions and alternative models.

The alternative models also generated a range of WTP estimates, but in each case the averages for Margaret were substantially higher than for Sauk. Margaret estimates were clustered in the $200-$300 range, while the estimates for Sauk were from the high to low double digits. The preferred model is converted using censored logistic regression to estimate mean WTP. The average for respondents in the Margaret sample is $267 and for Sauk it is $17. These stark differences fulfill the methodological goal of studying watersheds that are at opposite ends of the spectrum in order to interpolate values that might occur in other watersheds. While the estimated equations for the two watersheds have slightly different coefficients on the variables listed above (again all significant in both equations), the extreme contrasts in WTP are yielded because the average values for the variables are so different between the watersheds. For other systems with impaired lakes, the closer they are on the Margaret end of the spectrum (high proportion of lakeshore ownership, frequent lake use, high confidence in policy effectiveness and high income) the closer the average value will be to the Margaret value of $267. The closer these characteristics are to the Sauk situation, the more likely the average WTP will be in the low double digits.

The results are relevant to the policy discussion about whether restoring impaired lakes would generate more benefits than costs. These results also shed light on the equity implications of alternatives for raising funds to deal with Minnesota's impaired waters. Recent discussions have centered around assessing a water quality improvement fee on water utility use. A fee of $30 a year was a focal point of the discussion. These costs would mostly be borne by property owners. While these revenues would be collected from all water utility customers, those closest to the improved surface waters would stand to benefit more than their costs.

These findings imply that mean WTP would exceed the $30 amount for many households, so total benefits would be expected to exceed costs. It is also likely that some households would pay more than they benefit, and that might be the case even for most people in some watersheds. The more disconnected people feel from the impaired lakes in their watershed (low proportion of lakeshore owners, few users, no memory of lakes not being impaired, disparity between the wealth of lakeshore owners and the rest of the residents) the less likely that the average person will sense a net gain from these policies. So there are important equity implications as well.

The comments on the surveys offer insight into people's ideas for designing the best policies for restoring impaired lakes. Many property owners/water utility users might oppose a policy funded solely out of such taxes/fees because they would feel they are not getting their money's worth. If creative mechanisms could be developed to incorporate the benefits principle by having a larger share paid by the lakeshore owners who stand to benefit the most, and from lake visitors who might otherwise avoid sharing in the costs, many households that would otherwise oppose the policy might see it as more equitable, if not economically efficient.

ENDNOTES

1. See Dillman (1979) and (2007) for authoritative guides to survey design and administration.
2. While there is no theoretical justification for assuming that non-respondents (58% of the Sauk sample and 50% of the Margaret sample) have zero WTP, a curious reader may be interested in determining what the WTP would be under such a conservative assumption. Such estimates could be produced by multiplying the WTP figures in Table 3 by 0.47, the response rate.

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APPENDIX

FIGURE 1
IMPAIRED LAKES OF THE UPPER MISSISSIPPI RIVER BASIN AND LOCATION OF LAKE MARGARET AND
THE SAUK RIVER CHAIN OF LAKES