Economic Values of Saginaw Bay Coastal Marshes[1]

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Abstract: We estimate the economic values of Saginaw Bay coastal marshes with multiple methods. First we estimate the value of coastal marsh recreation with two variations of the travel cost method: the single-site recreation demand model and the recreation site selection or random utility model. Using the single site model the current level of day trip recreation in the Saginaw Bay coastal marsh area is valued at almost $16 million each year. The present value is $239 million. Using the site selection travel cost model, an increase in 1125 acres of coastal marsh is valued at about $94,000 annually. The present value is $1.83 million. Willingness to pay for recreation and other values of coastal marsh protection is estimated using the contingent valuation method. The annual value of protection of 1125 acres of coastal marsh is $113,000. The present value is $2.2 million.

Introduction

What is the value of Saginaw Bay coastal marsh? If this question is asked of one hundred people in the Bay area, there might be 100 different answers. Those with an ecological perspective would talk about nutrients and productivity, hunters and anglers would talk about migratory bird and fish habitats, and water resource managers would talk about storm water storage and water purification. Others with a more pragmatic bent would also talk about the value of good soil and water for agriculture, or the value of waterfront property for urban development. Some would value Saginaw Bay coastal marsh for purely aesthetic reasons entirely.

Economists have grappled with various ways of measuring the dollar value of coastal wetlands in various locations around the world, and, not surprisingly, depending on the location and the economic tools applied, the results differ widely. Only a few have looked closely at Great Lakes coastal marsh, beginning with a pioneering study of the value of fish, wildlife and recreation of Michigan's coastal wetlands (Jaworski and Raphael, 1978).

A handful of more recent studies also address the value of various Midwest wetlands. These include a travel cost analysis for three small hunting sites (van Vuuren and Roy, 1993), a study of the value for commercial fisheries (Amacher, et al, 1989) and a study of Wisconsin wetlands (Mullarkey, 1997). In addition to these, more recent studies (Lupi et al, 2002 and Hoehn et al, 2003) look at Michigan residents' willingness to accept different forms of wetlands mitigation.

There are a number of other studies that estimate the value of freshwater wetlands on a national scale. Woodward and Wui (2001) performed a meta-analysis of published U.S. wetlands valuation studies for a number of services including flood control, water quantity and quality, hunting, fishing, wildlife watching, amenities, etc. Kazmierczak (2001a) provided similar values per acre for species and habitat protection services.

Although many researchers study the various biological and ecological contributions of Midwest coastal wetlands, attempts to quantify these in dollar values are few. No study has focused on estimating the values of Saginaw Bay coastal marsh. The purpose of this paper is to address this gap in information in an effort to help guide efforts related to coastal marsh conservation in the Great Lakes Region.

The paper is organized as follows. First, the study methodology is described, including details of the survey technique and valuation methods. Next, the demographics of the survey respondents, the survey results, and the analysis of a number of independent variables in the survey are reported and discussed. This is followed by a section that presents an analysis and discussion of the results using a number of economic models. The next section analyzes and demonstrates the aggregate values of Saginaw Bay coastal marsh acreage. The concluding section presents a summary of this research.

Survey Methods

The survey sample was evenly divided into two major groups, licensed sportsmen (anglers and hunters) and the general public. Names and addresses of all sportsmen living within the Saginaw Bay watershed were obtained under a special use agreement with the Michigan

Department of Natural Resources (DNR). From this list, names were randomly selected to receive a survey. A list of randomly selected names from the general public within the Saginaw Bay watershed, Iosco, Arenac, Bay, Tuscola and Huron Counties, were obtained from a private mail list company.

Three rounds of surveys were mailed between February and June of 2005. Ten days after each mailing, a reminder card was sent to all survey recipients. To help increase the response rate, the third round of surveys included an incentive. Survey recipients were notified that $1000 would be divided among five winners. Winners were randomly selected from the third round respondents and a check was sent to each.

For each of the 18 versions of surveys sent to sportsmen, 79 names were randomly selected from the DNR list, for a total of 1422 surveys. Based on past survey experience, a lower response rate was expected from the general public, hence the larger number of surveys needed. All told, 3600 surveys were attempted, 424 were undeliverable, and 704 usable surveys were received for a response rate of 22 percent.

All efforts were made to obtain a fully random sample of names of the general public, and to randomly select licensed hunters and anglers for the sportsmen's mailing. Regardless of these efforts, sample bias is a potential problem. The level of sample bias is unknown, but recognizing the low response rate, such bias is likely. Adjustments and provisions are made in the data analysis to account for potential non-response bias.

Survey Design and Data

The purpose of the “Saginaw Bay Coastal Marshes Survey” is to generate data for use in developing economic values for coastal marsh protection. The survey describes Saginaw Bay coastal marsh resource allocation issues, elicits information about coastal marsh-related recreation, inquires about attitudes regarding economic development, describes a coastal marsh protection program and elicits willingness to pay and socio-economic information.

The survey presents background information on resource allocation issues in Saginaw Bay, then asks people various questions to see how much they know about the coastal marsh and watershed and how much money they would be willing to allocate themselves for further efforts to preserve marshes. For most questions, very little difference is found between the general public and licensed hunters and anglers in their responses, and indeed, about three-quarters of the general public respondents also said they fish, and a third enjoy hunting, so the groups are not much different.

Respondents are asked about their Saginaw Bay coastal marsh-related recreation activities. These activities are defined as any trip where the respondent was on or near the water including the marshes where the typical plants are cattails, rushes, grasses, and shrubs. Sixty percent and 73 percent of the general population and license holder samples had visited the Saginaw Bay or Saginaw Bay coastal marsh area for outdoor recreation or leisure.

The average annual number of recreation trips was 9 and 11 for those in the general and license holder samples, respectively. For the general sample, 7 of these trips were day trips and 2 were overnight trips. The license holders took an average of 9 day trips and 2 overnight trips. The primary recreation activity for both samples was fishing. Forty percent and 55 percent of the general and license holder samples fished. The most popular county for recreation trips was Bay County with almost 50 percent of both samples visiting there on a typical trip.

The next section of the survey elicited the willingness to pay for coastal marsh protection using the contingent valuation method. Respondents are told that 9000 of 18,000 acres of Saginaw Bay coastal marshes are currently protected and that the remaining privately owned marshes could be purchased and protected. A hypothetical "Saginaw Bay Coastal Marsh Protection Program" was introduced. Voluntary contributions would go into a "Saginaw Bay Coastal Marsh Trust Fund" to purchase *X* acres of coastal marsh. The acreage amount, *X*, was randomly assigned from three amounts 1125, 2500 and 4500.

Respondents are told that "Money would be refunded if the total amount is not enough to purchase and manage *X* acres. If the amount of donated money is greater than the amount required to purchase and manage *X* acres, the extra money would be used to provide public access and educational sites at Saginaw Bay coastal marshes." This is known as the "provision point" survey design (Poe, et al., 2002). The provision point design has been shown to minimize "free riding" bias in willingness to pay responses. Free riding is a common response to requests for donations in which respondents will donate less than they are willing to donate for goods that are consumed collectively.

Then respondents are asked: "Would you be willing to make a one-time donation of money to the Saginaw Bay Coastal Marsh Trust Fund within the next 12 months?" Twenty-five percent of the general population would be willing to make a one-time donation. Forty-nine percent would not be willing to make a donation and 26 percent did not know. For the license holder sample, 27 percent, 50 percent, and 23 percent would, would not, and did not know whether they would make a donation.

Respondents who would be willing to make a donation are then told that "if about 1 percent (1 in 100) of all households in Michigan made a one-time donation of $*A*, the Trust Fund would have enough money to purchase and manage *X* acres of coastal marshes. Remember, if you made a one-time donation of $*A* into the Trust Fund, you would have $*A* less to spend on other things. Also remember that protected marsh would no longer be available for conversion to other uses." The dollar amount, $*A*, was randomly assigned from the following amounts: $25, $50, $75, $100, $150 and $200. The dollar amounts were chosen based on revenue streams required to purchase *X* acres of coastal marsh if 1 percent of all Michigan households made the donation.

Respondents are asked if they **"**would make a one-time donation of $*A* to the Saginaw Bay Coastal Marsh Trust Fund within the next 12 months?" According to economic theory, the percentage of respondents willing to pay $*A* should decrease as $*A* increases. This is the pattern of responses found for both the general population and license holder samples. In the general sample, 63 percent were willing to pay $25, 52 percent were willing to pay $50, 33 percent were willing to pay $75, 29 percent were willing to pay $100, 31 percent were willing to pay $150, and 21 percent were willing to pay $200. Sixty-two percent, 42 percent, 36 percent, 42 percent, 26 percent, and 19 percent of the license holders were willing to pay $25, $50, $75, $100, $150 and $200.

One problem that arises with contingent valuation method surveys is hypothetical bias (Whitehead and Cherry, 2004). Hypothetical bias exists if respondents are more likely to say that they would pay a hypothetical sum of money than they would actually pay if placed in the real situation. Since economic values are based on actual behavior, hypothetical bias leads to economic values that are too high. One method that is used to mitigate hypothetical bias is the certainty rating (Champ and Bishop, 2001).

For those respondents who said that they were willing to pay we asked: "On a scale of 1 to 10 where 1 is "not sure at all" and 10 is "definitely sure", how sure are you that you would make the one-time donation of $*A*?" Twenty-four percent and 34% of the general population and license holder samples were definitely sure that they would pay. Fifty-two percent of the general population survey were very sure (i.e., their rating was 7, 8 or 9) that they would pay. Forty-percent of the license holder sample was very sure that they would pay.

To determine how likely respondents find the donation mechanism to work we ask "how likely do you think it is that 1 percent of all households in Michigan would make a one-time donation of $*A* to the Trust Fund within the next 12 months?" Forty-two percent of the general population and 47 percent of the license holders thought that it would be somewhat likely or very likely.

As stated earlier, the two samples are similar. Considering first the general population sample, the typical household had 2.57 people with 0.57 children. The general population sample was 70 percent male and 92 percent white. The average age was 52 years. Thirty-three percent were members of conservation and/or environmental organizations and 5 percent owned Saginaw Bay shoreline property. The average number of years in school was 14. Household income is $48 thousand. The typical license holder household had 3 people with 0.82 children. The license holder sample was 79 percent male and 97 percent white. The average age was 48 years. Thirty-seven percent were members of conservation and/or environmental organizations and 8 percent owned Saginaw Bay shoreline property. The average number of years in school was 14. Household income is $49 thousand.

We next compared some of the characteristics of the general population sample with population measures from the U.S. Census Bureau. The sample is slightly more elderly than the population. Nineteen percent of the sample is older than 65 where only 16 percent of the population is older than 65. The sample is 70 percent male while the population is 50 percent male. This last difference should not necessarily be attributed to sample bias. If the survey is more salient to males, as expected, then the males of multi-person households will have completed the survey even if the survey was addressed to a female. The sample is 92 percent white while the population is 97 percent white.

The sample is better educated than the population. Ninety-three percent of the sample, 25 or more years old, graduated from high school (measured as 12 years of schooling). Only 80 percent of the population graduated from high school. Thirty-eight percent of the sample, 25 or more years old, graduated from college (measured as 17 years of schooling). Only 12 percent of the population aged 25 or more graduated from college.

The general population sample has higher incomes than the population which is consistent with the education results. The median household income is $42 thousand for the population. The median household income for the sample is found by using predicted household income from a regression model used to impute a few missing income values. The median household income for the sample is $50 thousand. Since income is a theoretically important predictor of economic value we weight the data on income. All regression results reported below are weighted to mitigate sample bias.

Valuation Methods

We use revealed and stated preference approaches to value Saginaw Bay coastal marsh. The revealed preference approach uses behavioral data to estimate the ex-post willingness to pay for various commodities (Boyle, 2003b). The major strength of the revealed preference approach is that it is based on actual observed choices. With revealed preference data, individuals consider the internal costs and benefits of their actions and experience the consequences. Choices based on the perceived costs and benefits better reflect the values of the population and allow more valid estimates of economic value. The major weakness of revealed preference approaches is their reliance on historical data. By definition, new government policies and new products are beyond the range of historical experience. For example, few Michigan residents may have experience with an increased amount of protected Saginaw Bay coastal marsh. Behavior in response to policies designed to protect marsh is nonexistent. In this situation, the stated preference approach is useful.

The stated preference approach uses hypothetical choice data to estimate the ex-ante willingness to pay for various commodities (Brown, 2003). One strength of the stated preference approach is its flexibility. Stated preference methods can be used to construct realistic policy scenarios for most new policies. Oftentimes, hypothetical choices are the only way to gain policy relevant information. Another strength of the stated preference approach is the ability to measure passive-use values. Passive use value (i.e., non-use value, existence value) is the willingness to pay for the resource allocation change that is motivated by concerns other than direct, on-site use of the resource. These concerns may include altruism towards other users, bequests to future generations and ecological integrity. The major weakness of the stated preference approach is the hypothetical nature of the exercise. Respondents are placed in unfamiliar situations in which complete information is not available.

The travel cost method (TCM) is a revealed preference approach to environmental valuation that is used to estimate the benefits of outdoor recreation activities (Freeman, 2003; Parsons, 2003). The travel cost method begins with the insight that the major cost of outdoor recreation is the travel and time costs incurred to get to the recreation site. Since individuals reside at varying distances from the recreation site, the variation in travel costs and the number of trips taken are used to trace out a demand curve for the recreation site. The demand curve is then used to derive the economic value associated with using the site.

The single site TCM recreation demand models are estimated using the Poisson and negative binomial regression model (Haab and McConnell, 2002). The typical ordinary least squares regression model employs a normal distribution and requires that the data is continuous and normally distributed. The negative binomial makes adjustments for the fact that trips are not continuous variables but integers (e.g., 0, 1, 2, etc). Recreation demand count data tends to be clustered at zero and low integer values. The Poisson estimates the probability of trips at each integer value

(1) $$\Pr(x) = \frac{e^{-\lambda}\lambda^{x}}{x!}$$

(2) $$\ln(\lambda) = \beta_0 + \beta_1 tc_1 + \beta_2 tc_2 + \beta_3 y + \beta_4 z$$

where $x = 0, 1, 2, \ldots$ is the number of trips, λ is the mean and variance of the trip distribution, tc_1 is the travel cost to the site, tc_2 is the travel cost to a substitute site, y is income and z represents other variables. The negative binomial model relaxes the equality restriction on the mean and variance of trips (Haab and McConnell, 2002).

Consumer surplus is the amount that the recreationist would be willing to pay to take the trip over and beyond the expenditures actually made for the trip. Since the trip expenditures are less than gross willingness to pay the recreationist is made better off by the trip. The magnitude of the gain in welfare is the economic value of the trip. With the semi-log functional form of the negative binomial model the total consumer surplus and consumer surplus per trip is (Haab and McConnell, 2002):

(3) $$CS = \frac{-\lambda}{\beta_1}$$

(4) $$CS / \lambda = \frac{-1}{\beta_1}$$

With data on appropriate independent variables that might influence the number of trips taken (e.g., measures of coastal marsh acreage), the economic benefits (i.e., changes in consumer surplus) associated with changes in the independent variables (i.e., changes in coastal marsh) can be derived.

A variation of the travel cost method is the site selection (i.e., random utility, RUM) model (Freeman, 2003; Parsons, 2003). In the random utility model, it is assumed that individuals choose their recreation site based on differences in trip costs and site characteristics (e.g., coastal marsh acreage) between the alternative sites. Analysis of data on recreation site choices enables estimation of the monetary benefits of any change in site characteristics.

A site choice RUM is estimated using the conditional logit model (Haab and McConnell, 2002). A conditional logit is a regression model in which the dependent variable is a choice among a set of alternatives. The independent variables are alternative specific. For example, a recreationist chooses among a set of recreation sites might consider the travel costs to each site and the characteristics of each site. The conditional logit model estimates the impact of travel costs and characteristics on the probability that each site is chosen.

Following the standard derivation of the conditional logit RUM, we assume that the recreationist will choose to visit the site that provides the maximum utility of all the available alternatives. The choice between alternatives is viewed as random since only the recreationist knows the ranking of site-specific utility levels. The individual, *i*, and site, *j*, specific utility function is additively separable with a Type-I extreme value distributed random error term

$$(5) \qquad u_{ij} = v_{ij} + \varepsilon_{ij}$$

where v_{ij} is the deterministic portion of the indirect utility function and ε_{ij} is the random error term. The conditional logit model is

$$(6) \qquad \Pr(ij) = \frac{\exp(v_{ij})}{\sum_{j=1}^{m} \exp(v_{ij})}$$

where $\Pr(ij)$ is the probability of individual *i* selecting site *j*.

The deterministic part of the utility function is linear

(7) $$v_{ij} = \gamma_1 tc_{ij} + \gamma_2 m_j + \gamma_3 q_{ij}$$

where tc_{ij} is the travel cost, m_j is the number of access sites in the county and q_j is the acres of wetlands in the county. The value of site access and the value of a change in an attribute (*m* or *q*) is

(8) $$CV(j) = \frac{-\ln(1-\Pr(j))}{\gamma_1}$$

(9) $$CV(\Delta m) = \frac{\Delta m \gamma_2}{\gamma_1}$$

(10) $$CV(\Delta q) = \frac{\Delta q \gamma_3}{\gamma_1}$$

where *CV* is the compensating variation measure of welfare (Freeman, 2002) and Pr(*j*) is the probability that the individual will visit site *j*. See Haab and McConnell (2002) for derivation of these formulas.

The contingent valuation method (CVM) is used to estimate the willingness to pay for coastal marsh protection (Mitchell and Carson, 1989; Boyle, 2003). The contingent valuation method is a stated preference approach that directly elicits willingness (and ability) to pay statements from survey respondents. Respondents are directly asked about their willingness to pay (i.e., change in compensating variation) for environmental improvement.

The CVM involves the development of a hypothetical market via household surveys. In the hypothetical situation respondents are informed about the current problem and the policy designed to mitigate the problem. Other contextual details about the policy are provided such as the policy implementation rule (e.g., provision point design) and the payment vehicle (e.g., a special fund). Finally, a hypothetical question presents respondents with a choice about the improvement and increased costs versus the status quo. Statistical analysis of these data leads to the development of willingness to pay estimates.

The hypothetical situation in the coastal marsh survey involves two decisions. First, the respondents must decide if they are willing to pay something and, if they are willing to pay something, the respondents must decide if they are willing to pay a specific amount of money that would lead to a set number of acres being protected. These decisions are analyzed separately with the probit model (Cameron and James, 1987). The probit model is implemented by recoding "don't know" responses to the willingness to pay question to "no," the most conservative approach to dealing with "don't know" responses (Groothuis and Whitehead, 2002). The probability of a "yes" response is the probability that willingness to pay, *WTP*, is greater than the bid amount, *B* (Cameron and James, 1987):

$$\text{(11)} \qquad \begin{aligned} \Pr(yes) &= \Pr(WTP > A) \\ &= \Phi\left(\frac{\alpha' X - \ln A}{\sigma}\right) \end{aligned}$$

where Φ is the standard normal cumulative density, α is a vector of coeffcients, X is a vector of independent variables and $\frac{-1}{\sigma}$ is the coefficient on the log of the bid amount. Mean willingness to pay is (Haab and McConnell, 2002):

$$(12) \quad WTP = \exp\left(\sigma[\alpha' X] + \frac{\sigma^2}{2} \right)$$

The t-statistics are developed using standard errors approximated by the Delta Method (Cameron, 1991).

Recreation Demand Results

Single-site Model

In order to facilitate comparison of the resulting recreation values to the willingness to pay values we use the same sample size for the recreation demand and willingness to pay analysis. The dependent variable for a single-site TCM model is the number of recreation trips. Data are available for day, and overnight trips. Data on coastal marsh acreage and wetlands acreage for each Saginaw Bay county was provided by Ducks Unlimited. These data are used as independent variables in the single-site TCM demand models. Unfortunately, these variables are not found to be determinants of the number of recreation trips. This eliminates the possibility of developing estimates of the economic value of additional coastal marsh protection with the single-site TCM.

Recreation participants and non-participants are included. Non-participants are those who took zero trips. Forty-seven percent of the sample took at least one recreation trip. Forty-four percent took at least one day trip and 14 percent took at least one overnight trip. Including those with zero trips, the average number of trips is 4 and 1 for the day and overnight trips.

The independent variables included are guided by economic theory. Demand models should include own-travel costs, substitute travel costs and income. The own-price of a recreation trip is measured by the round trip travel cost. For respondents who took trips, the travel cost is that which is associated with the county of their typical trip. For respondents who did not take trips, the travel cost is associated with the county in closest proximity.

We compute round trip distance traveled from the home zip code of the respondent to the zip code of the most commonly visited city in the county of the typical recreation trip destination using ZIPFIP software (Hellerstein, 2005). Travel cost per mile is set at $0.37, time costs are valued at one-third of the wage rate, and average miles per hour is 60 to form the travel cost variable. In the TCM model the substitute site travel cost is the minimum of the travel costs to two urban centers of popular recreation areas: Traverse City on Lake Michigan and Alpena on Lake Huron.

In each recreation demand model the number of trips decreases with increases in travel costs as predicted by economic theory (Table 1). The coefficient on the substitute site travel cost is only statistically significant in the overnight trips model. The number of day trips increases with income indicating that day trips are normal goods. The number of trips taken is not different for the general population and license holder samples.

For those respondents who took at least one trip, dummy variables are included for the county where they took their typical trip. For example, if the respondent took their typical trip to Iosco County, the dummy variable takes on a value of one. Otherwise, the dummy variable is equal to zero. Four dummy variables are included in the model. In order to avoid statistical problems with the model we exclude Bay County.

Relative to Bay County, more trips are taken to Iosco, Arenac, Tuscola and Huron Counties in the day trips model. More trips are taken to Iosco, Arenac and Huron Counties for overnight trips. This interpretation of differences in trips rests on the assumption that all trips are taken to the typical county. To the extent that this assumption does not hold, differences in trips by county are overstated.

The consumer surplus estimates presented are per trip to each county (Table 2). In the day trips model, trips to Bay County have the lowest value, $26 in each model. Trips to Tuscola County are valued the highest, $51 and $53 in the day trips model. In contrast, the value of overnight trips to Tuscola County is not statistically different from zero. In the day trip model, the differences in the value of a trip to Tuscola County and the values of trips to Arenac, Bay, and Huron Counties is statistically significant. In the overnight model, only the difference in consumer surplus between Iosco County, $61, and Tuscola County, $14, is statistically significant.[5]

Site Choice Model

The dependent variable for the RUM is the typical county chosen for a recreation trip. The most popular county for recreation trips was Bay County with almost 50 percent of both samples visiting there on a typical trip. Twelve percent go to Iosco and Arenac Counties, 11 percent goes to Tuscola County and 24 percent go to Huron County on a typical trip. Coastal marsh acreage is not a reliable predictor of the site of the typical trip. Instead, we use wetland

[5] Note that the consumer surplus estimates for overnight trips may be biased upwards due to multiple purposes of these trips.

acreage in the county as an independent variable. Coastal marsh acreage is a subset of wetlands acreage. Therefore, wetlands acreage can be used as a proxy for coastal marsh. The average amount of wetland acres in each county is 46,000 (Table 3). Other variables that are used to explain recreation site selection are the travel costs to the county site and the number of water access points in the county site. The average travel cost is $65 and the average number of access points is 7.

As expected, the probability of site choice decreases as the travel costs to the site increase and increases with wetland acres and access points (Table 36). The value of Bay County site access is $14 (t = 9.32). The other site access values are less than 30% of the Bay County site access value. This is because the probability of a Bay County visit is four times larger than the probability for the other counties. The value of an additional 1,000 acres of coastal marsh is $0.47 per trip (t = 4.23). The value of an additional access point is $7 per trip (t = 5.09).

Empirical Results: Willingness to Pay

The dependent variables in the willingness to pay analysis are whether the respondent is willing to pay something above zero and, if so, willing to pay more than the requested donation. Following Groothuis and Whitehead (2002) the "don't know" responses are recoded to "no" responses for a conservative estimate. Since economic values are revealed by behavior, correction of hypothetical bias is necessary to develop more accurate willingness to pay estimates. We recode "yes" responses where the respondent is not sure that they would be willing to pay, these respondents answered less than 7 on the follow-up certainty scale, to "no" responses.

The selection of independent variables is guided by economic theory (Whitehead, 1995). As the bid ($*A*) amount increases, the probability of a "yes" response (i.e., willingness to pay) should decrease. The natural log of the bid ($*A*) amount is used to improve statistical fit. The travel cost to Saginaw Bay should be inversely related to willingness to pay. The travel cost to the substitute recreation site should be positively related to willingness to pay. Income should be positively related to willingness to pay if marsh protection is a normal good.

The only demographic variable we include in the model is organization membership because it is the only variable that consistently explains variation in attitudes towards use of coastal marsh. We also include a dummy variable equal to one if the respondent thinks it is likely that enough Michigan residents would make the required donation for the program to be a success. The variable is equal to zero otherwise.[6]

Respondents who live farther away from the substitute recreation sites and who are organization members are more likely to be willing to donate some positive amount of money for coastal marsh protection (Table 4).[7] Certain willingness to pay falls with increases in the bid amount, increases with income, is lower if the respondent did not report their income, and is higher for organization members and if the respondent believed that enough Michigan respondents would be willing to pay.

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[6] A variable is included to control for the different survey samples in preliminary models. This variable did not help explain the variation in yes responses and it was subsequently dropped.

[7] A bivariate probit model does not provide a reliable estimate of willingness to pay due to the extremely high correlation in error terms between the two probit models.

An important test of the validity of willingness to pay responses is whether willingness to pay increases with the quantity of the good being purchased. This is known as the scope test (Whitehead, Haab, and Huang, 1998). The Saginaw Bay willingness to pay values do not pass the scope test. This does not necessarily invalidate the willingness to pay values. Economic theory only requires that willingness to pay be non-decreasing with quantity. Under this interpretation of the results, respondents are willing to pay for 1125 acres but their marginal (i.e., additional) willingness to pay for additional acreage is zero.[8]

The provision point design is intended to provide respondents with incentives to reveal their true willingness to pay. One reason why respondents might state that they would not donate even if their willingness to pay is above the requested donation is that they believe the money would be wasted if total donations are not sufficient to fund the program. With the provision point design respondents are told that if that occurs, their money would be refunded. Survey respondents who did not believe that the donations would be sufficient were less likely to be willing to pay.

Actual donation behavior is best predicted by the model evaluated at the mean of the

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[8] Recent research in behavioral economics indicates that individuals do not always follow the dictates of neoclassical consumer theory. Heberlein, et al. (2005) found that individual respondents do not pass the scope test internally for a variety of reasons. Market forces act to discipline irrational behavior for market goods. In valuation surveys this behavior is allowed to flourish. They conclude that behavior that flows from complex individual preferences and does not strictly follow neoclassical economic theory should not be considered invalid.

"likelihood of success" variable. True willingness to pay, on the other hand, is best predicted when the "likelihood of success" variable is set equal to one; in other words, simulating willingness to pay when respondents do not reduce their donations out of fear that the money would be wasted. When willingness to pay is assessed when all respondents believe that Michigan residents will donate enough money, willingness to pay is $72 when hypothetical bias is mitigated.

Aggregate Values

The recreation values derived from the travel cost method are annual values. In order to assess the recreation values over time, we calculate the present value (*PV*) using the standard formula:

$$(13) \qquad PV = \sum_{t=1}^{T} \frac{n \times CS(\text{or } CV)_t}{(1+r)^t}$$

where *n* is the population, *r* is the discount rate, *t* is time period (i.e., year) and *T* is the number of years. We aggregate over *T* = 30 years. The federal government uses discount/interest rates of 3 percent and 7 percent for benefit cost analysis. We use the 3 percent discount rate since the 7 percent discount rate is most appropriate for investment projects.

The lump sum willingness to pay values derived from the contingent valuation method are present values. The annual willingness to pay value, WTP_t, over *t* years that could be received from a lump sum amount, *WTP*, that earns an interest rate of *i* percent is derived from the present value formula above:

(14) $$WTP_t = \frac{n \times WTP \times i}{1-(1+i)^{-T}}$$

where *i* is the interest rate.

The baseline recreation value of coastal marsh trips is estimated using the single-site TCM model. First, we assume that all of the respondents' day trips take place in the county of the typical trip. The product of the consumer surplus per trip and the number of trips is the annual consumer surplus. Since the consumer surplus per trip estimates are derived from the demand model that includes recreation non-participants, the aggregate recreation value is the product of the consumer surplus per year and the number of households in the 5 county study region, 98,414. The sum of the county level recreation values is the baseline recreation value. The baseline annual value of Saginaw Bay coastal marsh-related recreation is $12.2 million for day trips and another $3.7 million for overnight trips. The discounted present value of the baseline annual value is $239 million.

The value of an increase in coastal marsh acreage per trip is interpreted as the gain in welfare that a recreationist would experience on every trip occasion. For comparability with the willingness to pay results we scale the recreation value of wetland acres from 1000 acres to 1125 acres. The individual welfare gain from an increase of 1125 acres of wetlands is $2.12 (i.e., $0.47/trip × 4.02 annual trips × 1.125 scale factor). Multiplying this value by the product of the percentage of respondents who take trips and the number of households in the five county Saginaw Bay region, 44,030, yields the aggregate value of an increase in 1125 acres, $93,589, or about $83/acre/year. The aggregate discounted present value of the quality improvement is $1.83 million.

The aggregate willingness to pay values must be interpreted with caution due to the lack of scope sensitivity and low survey response rate. We interpret the total coastal marsh value as the marginal willingness to pay for 1125 acres. The marginal value of any additional acreage must be assumed to be zero. The average value per acre can be found with this estimate but this average must not be extrapolated beyond 1125 acres.

Aggregate willingness to pay for 1125 acres of protected marsh is the mean willingness to pay multiplied by household population. The willingness to pay estimates are those from the hypothetical bias correction model with the "likelihood of payment" correction. In other words, these willingness to pay estimates are higher and better reflect the value of coastal wetlands relative to the amount that might be actually collected through voluntary donations.

With a low response rate, aggregate willingness to pay should be aggregated over a range of population estimates. The high end of the range of household population that we consider is the product of the population and the proportion of respondents who are willing to pay a positive amount, 51 percent. The low end of the range of household population is the product of the population, survey response rate, 22 percent, and the proportion of respondents who are willing to pay a positive amount, 51 percent. This population is based on the assumption that survey nonrespondents have a zero willingness to pay. This estimate should be considered a lower bound estimate.

The low and high estimates provide a wide range of value estimates. This is due to the low response rate and extremity of the assumptions used to derive these values. In a simulation study of willingness to pay, survey response rates and alternative sample bias correction methods, Whitehead et al. (1994) find that the midpoint of the low and high bounds is a reasonable estimate of true aggregate willingness to pay. Using the midpoints, the aggregate present value of 1125 acres is $2.2 million. The aggregate average value of 1125 acres is $1969/acre. The aggregate annual value of 1125 acres of coastal marsh protection is $113,000.

Conclusions

We provide an overall economic assessment of the value of Saginaw Bay coastal marshes to area residents. Using alternative methods we have estimated three basic forms of value associated with coastal marshes: baseline recreation value of Saginaw Bay recreation trips, recreation value of an additional 1125 acres of coastal marsh, and total value (i.e., recreation and other values) of protecting 1125 acres of coastal marsh.

First, the baseline value of Saginaw Bay coastal marsh recreation is large. Using the travel cost method for single sites, the annual value of day and overnight trips is $15.9 million. Aggregating this value over 30 years and taking the present value yields a capital value (i.e., lump sum value today) of $239 million. The recreation value of an additional 1125 acres is estimated with the site selection travel cost method (TCM). The annual recreation value is $94,000 and the present value is $1.83 million. The contingent valuation method is used to estimate the recreation and other values held by the public for protecting 1125 acres of existing coastal marsh. The annual value is $113,000 and the present value is $2.2 million.

Each acre of coastal marsh is worth $1,627 over a recreational user's lifetime. And, over and above the recreational value are the other values that come to light using the willingness to pay results. These values add $1,969 per acre over a lifetime. The recreation value and the willingness to pay value can be combined because analysis of the willingness to pay values indicated that they were not associated with increases in recreation trips. They are entirely passive use values. Therefore, the total value of each acre of coastal marsh is $3,596 over the lifetime of a resident of the sampled region.

In conclusion, it is clear that the value of Saginaw Bay coastal marshes is considerable, if only in terms of recreational benefits and willingness to pay. These values show only a part of the overall importance of Saginaw Bay coastal marsh. Michigan residents beyond the 5 county study region may hold values for Saginaw Bay coastal marsh. Our survey did not achieve a large sample of property owners. This sub-sample might have different values for Saginaw Bay coastal marsh. Other studies attempt to put numbers on the value of wetlands for ecological services such as flood control, storm protection, water quality and quantity and various other aesthetic and biological values. To the extent that the willingness to pay values do not include these functions, the values presented here are too low. It is only when all of these values are taken as a whole that the total value of these resources can be quantified.

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Table 1. Negative Binomial Models of Recreation Demand

	Day Trips		Overnight Trips	
Independent Variables	Coeff.	t-ratio	Coeff.	t-ratio
Intercept	1.322	4.726	-2.737	-4.205
Travel Cost	-0.039	-9.674	-0.044	-4.547
Substitute site travel cost	0.001	0.358	0.022	3.040
Income	0.016	4.399	0.004	0.604
Iosco County	1.426	4.157	2.673	4.070
Arenac County	1.143	3.289	2.175	3.256
Tuscola County	2.052	5.481	0.640	0.863
Huron County	1.148	3.853	2.064	3.655
License sample	-0.098	-0.555	0.035	0.098
Alpha	3.331	11.214	12.350	6.396
LL function	-1058.77		-401.16	
Cases	570		570	

Table 2. Consumer Surplus per Trip

	Day Trips		Overnight Trips	
County	Mean $ per Trip	t-ratio	Mean $ per Trip	t-ratio
Iosco County	$36.74	3.82	$60.90	3.14
Arenac County	$29.45	3.12	$49.55	2.70
Bay County	$25.77	9.67	$22.78	4.55
Tuscola County	$52.87	5.08	$14.57	0.83
Huron County	$29.57	3.68	$47.01	2.99

Table 3. Random Utility Model

			Typical County Recreation Site	
Independent Variables	Mean	Std.Dev.	Coeff.	t-ratio
Travel Costs	$64.69	31.33	-0.048	-9.319
Access Points	7.00	1.67	0.339	5.440
Wetland Acres (1000s)	45.95	19.35	0.023	3.515
LL Function			-307.18	

Table 4. Probit Models of Willingness to Pay

Independent Variables	Would donate a positive amount of money		Very sure that they would donate $A	
	Coeff.	t-ratio	Coeff.	t-ratio
Intercept	-0.699	-4.18	0.626	0.98
Natural log of $A			-0.496	-3.98
Acres protected			0.00003	0.51
Travel cost	-0.002	-0.84	-0.001	-0.31
Substitute travel cost	0.005	2.82	-0.0006	-0.18
Income	0.001	0.27	0.010	2.65
Missing income	-0.415	-1.81	-1.275	-2.09
Organization membership	0.394	3.34	0.408	2.36
Likelihood of success			0.827	4.82
$\chi 2$	34.62		63.94	
Cases	570		293	

Table 5. Aggregate Value Summary (in millions of 2005 $)			
Method	Scenario	Annual	Present Value
TCM-single site	Saginaw Bay coastal marsh recreation	$15.9 million	$239 million
TCM-site selection	Recreation value of an additional 1125 acres	$94,000	$1.83 million
CVM	Total value of protecting 1125 acres	$113,000	$2.2 million