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Measuring the Economic Benefits of Saginaw Bay Coastal Marsh with Revealed and Stated Preference Methods

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ABSTRACT

We estimate the economic benefits of Saginaw Bay coastal marsh with the travel cost and contingent valuation methods. The travel cost method is based on revealed preferences: actual recreation behavior. Using a sample of the general population of Michigan and Michigan hunting and fishing license holders we find that Saginaw Bay recreation site selection is negatively related to travel cost and positively related to wetland acreage. The contingent valuation method is based on stated preferences: answers to hypothetical survey questions. We find that willingness-to-pay is negatively related to marsh protection cost and positively related to income and environmental organization membership. Using a combination of theory and empirical results we argue that revealed and stated preference methods are complementary when estimating the total value of coastal marsh. The present value of each acre of coastal marsh is $1870 for the purpose of recreation. The present value to recreation nonusers adds $551 per acre. The total present value of each acre of coastal marsh could be as high as $2421.

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 offer 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.

Measuring the value of wetland services is important because many of these are enjoyed outside markets. In comparison to market values, such as the value of converting wetlands for economic development, these non-monetized “nonmarket” values are difficult to compare to the monetized economic development benefits of wetlands conversion. A comparison of monetized nonmarket values to the market values is needed in order to better determine the most valuable economic use of wetlands.

Economists have grappled with various ways of measuring the dollar value of nonmarket wetland services 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) estimate that the overall value per acre per year of Michigan wetlands is $2288 (2005 dollars) with 58% being contributed by sportfishing values and 28% from nonconsumptive recreation. The remainder of the value is from waterfowl hunting, fur trapping and commercial fishing.

A handful of more recent studies also address the value of various Midwest wetlands with more state-of-the-art valuation methods. These include a travel cost analysis for three small hunting sites and a study of the value for commercial fisheries. In the hunting study van Vuuren and Roy (1993) estimate that the per acre per year values range from a low of $153 for an undiked wetland site to a high of $241 for a diked site. Amacher et al. (1989) studied the value of coastal marsh-related commercial fisheries and found the value of catch of $2076 per acre per year. See also Mullarkey (1997) for a contingent valuation study of Wisconsin wetlands.

In addition to these, more recent studies consider the implicit value of Michigan wetlands and the policy implications of these values. Lupi et al. (2002) consider Michigan residents' willingness to accept different forms of wetlands mitigation. Instead of valuing wetlands per se, they estimate the role of acceptability of mitigated sites as substitutes for natural wetlands. Hoehn et al. (2003) argue that wetland values and implicit tradeoffs between preservation and mitigation could be used for mitigation pricing and discuss the role of technical information communication on public wetland values.

An alternative to original valuation studies is benefit transfer where researchers adapt valuation estimates from other studies to a new policy scenario. One type of benefit transfer approach employs meta-analysis. Meta-analysis requires the collection of a large number of studies related to the policy situation. A data set is constructed with measures of the environmental benefits as the dependent variable and characteristics of the individual studies (e.g., water quality) as the independent variables. Regression models are developed which are used to relate the study characteristics to environmental benefits. Brouwer et al. (1999) performed a meta-analysis of almost 100 contingent valuation estimates of wetland values with attention to wetland services. The authors find that willingness-to-pay is highest for the flood control wetlands function. Other valuable functions are, in order of importance, water supply, water quality and biodiversity. Woodward and Wui (2001) performed a meta-analysis of published U.S. wetlands valuation studies for a number of wetland services including flood control, water quantity and quality, hunting, fishing, wildlife watching, amenities, etc. They find that the contingent valuation method yields lower values than hedonic pricing or replacement cost methods. While there is a large sample of wetlands value estimates, they conclude that the literature is not yet evolved to the point where meta-analysis can be used to accurately use benefit transfer for site-specific values.

Although many researchers study the various biological and ecological contributions of Midwest coastal wetlands, attempts to quantify these contributions in dollars for comparability to wetland development benefits 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. Most previous wetland valuation studies employ either revealed or stated preference approaches (see Braden et al. (2008) for an exception in the context of river cleanup). In contrast we use revealed and stated preference approaches to value Saginaw Bay coastal marsh. In doing so, we illustrate the different values generated by the alternative methods and the gains from using multiple methods.

The revealed preference approach to environmental valuation uses behavioral data to estimate the ex-post willingness-to-pay for various commodities (Boyle, 2003b). Revealed preference approaches consider the relationship between environmental goods and services consumed outside markets and related market goods. For example, wetlands may impact real estate and tourism markets. Isolating the economic effects of wetlands preservation or conversion on housing prices and tourism behavior provides estimates of wetlands values useful for policy analysis.

The major strength of the revealed preference approach is that it is based on actual observed choices. Revealed preference data is based on individual consideration of the internal costs and benefits of actions. Choices based on perceived costs and benefits best reflect the values of the population and support valid estimates of economic value. A weakness of revealed preference approaches is their reliance on historical data. New government policies and new products may be beyond the range of historical experience and revealed preference data may not be available. 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.

We use the travel cost method (TCM) which 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 stated preference approach to environmental valuation uses hypothetical choice data to estimate the value of nonmarket environmental goods and services (Brown, 2003). A 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., nonuse value, existence value) is the willingness to pay for a change in resource allocation 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. A 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.

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

METHODS

Survey design

The purpose of the "Saginaw Bay Coastal Marshes Survey" was to generate data for use in developing economic values to inform coastal marsh protection policy. The survey describes Saginaw Bay coastal marsh resource allocation issues, elicits information about coastal marsh-related recreation, inquires about attitudes towards 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 marsh.

The next section of the survey elicited the willingness-to-pay for coastal marsh protection using the CVM. Respondents are told that 9000 of 18,000 acres of Saginaw Bay coastal marsh are currently protected and that the remaining privately owned marsh 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 were 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; Groothuis and Whitehead, In press). The provision point design has been shown to reduce 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 pay for goods that are consumed collectively. Then respondents were 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?”

Table 1 Data summary

Variable	Label	General population		License holders		Difference t-value
		Mean	Std dev	Mean	Std dev	
White	White = 1, nonwhite = 0	0.91	0.28	0.96	0.19	−0.05
Male	Male = 1, female = 0	0.69	0.46	0.80	0.40	−0.11
House	Household size	2.57	1.34	3.07	1.49	−0.51
Children	Number of chidren	0.60	0.94	0.86	1.14	−0.25
Age	2005 – year born	51.09	15.77	47.50	15.65	3.60
Educ	Years of schooling	14.27	3.29	13.60	2.58	0.67
Income	Household income	48.20	27.62	48.30	28.05	−0.10
Member	Environmental/conservation organization member	0.31	0.46	0.37	0.48	−0.53
Property	Own shoreline property	0.04	0.21	0.07	0.26	−0.03
Trips	Recreation trips	4.30	12.01	5.87	14.26	−1.57
Travcost	Minimum travel cost to Saginaw Bay	51.02	31.43	42.44	23.31	8.58
Subcost	Travel cost to substitute site	143.85	50.17	129.24	44.52	14.61
Sample size		316		254		

Respondents who would be willing to make a donation were then told “if about 1% (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% of all Michigan households made the donation. Respondents were then asked if they “would make a one-time donation of $*A* to the Saginaw Bay Coastal Marsh Trust Fund within the next 12 months?” Responses include yes, no and don't know. Following Groothuis and Whitehead (2002) the “don't know” responses are receded to “no” responses for a more conservative estimate of willingness-to-pay.

One problem that arises with contingent valuation method surveys is hypothetical bias (Whitehead and Cherry, 2007). 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 oftentimes too high. One method that is used to mitigate hypothetical bias is the certainty rating (Champ et al., 1997). 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*?” We recode those respondents who are not very sure (i.e., 6 or less) about their willingness-to-pay from “yes” to “no” in order to mitigate hypothetical bias.

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 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. To determine the perceived effectiveness of the provision point design we ask “How likely do you think it is that 1% of all households in Michigan would make a one-time donation of $*A* to the Trust Fund within the next 12 months?”

Data collection

The survey considered two major populations, fishing and hunting license holders and the general public (Whitehead et al., 2006). Names and addresses of all license holders 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 counties (Iosco, Arenac, Bay, Tuscola and Huron), was 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 license holders, 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 for both samples, 424 were undeliverable, and 704 usable surveys were returned for a response rate of 22%. Our sample size is 316 f

Revealed preference statistical analysis

The travel cost method is implemented with a site choice random utility model (RUM) (Haab and McConnell, 2002). The RUM employs the assumption that individuals choose their recreation site based on differences in trip costs and site characteristics (e.g., coastal marsh acreage) across the alternative sites. Analysis of data on recreation site choice enables estimation of the monetary benefits of any change in site characteristics.

Table 2 Willingness-to-pay summary

Bid	General population		License holders		Combined samples	
	Sure yes	Sample size	Sure yes	Sample size	Sure yes	Sample size
25	46%	24	67%	27	57%	51
50	42%	26	23%	22	33%	48
75	22%	23	31%	29	27%	52
100	25%	28	38%	21	31%	49
150	28%	32	12%	17	22%	49
200	18%	28	19%	16	18%	44
χ^2[df]	7.87[5]		19.74[5]		21.18[5]	

Cochran–Mantel–Haenszel Statistic for equality across sample: $\chi^2[\text{df}] = 20.54[5]$.

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

$$u_{ij} = v_{ij} + \varepsilon_{ij} \qquad (1)$$

where v_{ij} is the deterministic portion of the indirect utility function and ε_{ij} is the random error term. If the error term is Type-I extreme value distributed random error then the conditional logit model is

$$\Pr(ij) = \frac{\exp\left(v_{ij}\right)}{\sum_{j=1}^{m} \exp\left(v_{ij}\right)} \qquad (2)$$

where Pr(*ij*) is the probability of individual *i* selecting site *j*. 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 choosing 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. Since socio-economic variables do not differ across alternatives they are not included in the regression analysis.

The deterministic part of the utility function is linear

$$v_{ij} = \gamma_1 \mathrm{tc}_{ij} + \gamma_2 m_j + \gamma_3 q_{ij} \quad (3)$$

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 a change in wetland acres (*q*) is

$$\frac{\mathrm{WTP}(\Delta q)}{x} = \frac{-\Delta q \gamma_3}{\gamma_1} \quad (4)$$

where WTP is willingness-to-pay and *x* is the number of recreation trips (Haab and McConnell, 2002). Willingness-to-pay per trip is the amount of money that would make the respondent indifferent between taking the trip or not. For example, if the willingness-to-pay of adding 100 wetland acres is $10, the respondent is indifferent between having $10 or having 100 acres available for recreation.

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):

$$\mathrm{PV} = \sum_{t=1}^{T} \frac{n \times \mathrm{CV}_t}{(1+r)^t} \quad (5)$$

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. We use the 3.5% rate suggested by Moore et al., (2004) for our initial comparison.

Stated preference statistical analysis

The contingent valuation willingness-to-pay scenario in the coastal marsh survey involves two decisions. First, the respondent must decide if they are willing to pay something and, if they are willing to pay something, the respondent 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 censored probit model (Cameron and James, 1987). The probability of a “yes” response is the probability that willingness-to-pay, WTP, is greater than the dollar amount, *A*:

$$\begin{aligned} \Pr(\text{yes}) &= \Pr(\mathrm{WTP}(\Delta q) > A) \\ &= \Phi\left(\frac{\alpha' X - \ln A}{\sigma}\right) \end{aligned} \quad (6)$$

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

$$\mathrm{WTP}(\Delta q) = \exp(\sigma[\alpha' X]). \quad (7)$$

The *t*-statistics are developed from standard errors approximated by the Delta Method (Cameron, 1991). Willingness-to-pay is the amount of money that would make the respondent indifferent between having the policy or not. For example, if the willingness-to-pay to preserve the marsh is $50, then the respondent is indifferent between having $50 extra to spend on other things or being able to enjoy the preserved marsh.

Willingness-to-pay is the total value of wetlands preservation and is composed of use value and passive use value:

$$\mathrm{WTP}(\Delta q) = \mathrm{UV}(\Delta q) + \mathrm{PUV}(\Delta q) \quad (8)$$

Use value is the amount that the respondent is willing to pay for recreation and other on-site uses of the resource. It is conceptually similar to the willingness-to-pay recreation value in Eq. (4) summed over all trips. Passive use value is the amount that the respondent is willing to pay if recreation and other on-site uses of the resource are precluded. Passive use values may be motivated by altruism towards other users, bequests to future generations or an ecological ethic. In the empirical analysis we split the sample into recreation users (i.e., those who had taken a Saginaw Bay marsh-related recreation trip) and recreation nonusers. Willingness-to-pay in the recreation user model includes use value and nonuse value. Willingness-to-pay in the nonuser model includes only passive use value unless the change in acres of protected marsh would lead to more trip taking in the future.

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:

$$\mathrm{WTP}_t = \frac{n \times \mathrm{WTP} \times i}{1 - (1 + i)^{-T}} \quad (9)$$

where *i* is the interest rate. Similar to the recreation demand analysis, we use a real interest rate of 3.5% to annualize the present value.

RESULTS

Data summary

The general population sample is 91 % white and 69% male (Table 1). The typical general population sample household has 2.57 people with one child. The average age is 51 years. The average number of years of formal schooling is 14. Household income is $48,000 (2005 dollars). Thirty-one percent of the sample are members of conservation and/or environmental organizations and 4% owned Saginaw Bay shoreline property.

The typical license holder household is white (96%) and male (80%) with three people and one child. The average age is 48 years. The average number of years of formal schooling is 14. Household income is $48,000 (2005 dollars). Thirty-seven percent of the license holder sample are members of conservation and/or environmental organizations and 7% owned Saginaw Bay shoreline property.

Saginaw Bay coastal marsh-related recreation 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 of the general population sample and 73% of the license holder sample had visited the Saginaw Bay or Saginaw Bay coastal marsh area for outdoor recreation or leisure. The general population sample took an average of four Saginaw Bay recreation trips and the license holder sample took an average of six Saginaw Bay recreation trips.

For the revealed preference analysis we estimate the travel cost of trips to each of the five county level recreation sites. We computed 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 using ZIPFIP (Hellerstein, 2005). Travel cost per mile was 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. The average travel cost is $65.

In the stated preference analysis, the travel cost is that which is associated with the county of their typical trip. We computed 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. Travel cost is associated with the county in closest proximity for respondents who did not take trips. The substitute site travel cost is the minimum of the travel costs to two urban centers of popular recreation areas not in the Saginaw Bay area: Traverse City on Lake Michigan and Alpena on Lake Huron. In the stated preference analysis the average travel cost is $51 to the Saginaw Bay typical trip site and $144 for a substitute trip for the general population sample. The average Saginaw Bay travel cost is $42 and $129 for a substitute recreation site for the license holders.

We conduct t-tests to statistically test for differences in means across samples. Only three of 12 means are significantly different at the $p = 0.10$ level. The general population sample is significantly older than the license holder sample. The license holder sample has significantly lower travel costs to Saginaw Bay and the substitute recreation site. While there are some differences across sample, there is evidence that the two samples are similar in terms of wetland valuation. Respondent age is not a statistically significant factor in explaining either recreation site choice or willingness-to-pay and there are no differences in respondent travel behavior across samples (see Whitehead et al., 2006). Also, about three-quarters of the general population sample also said they fish, and a third enjoy hunting. Based on their similarity we pool the samples in order to increase econometric efficiency in the statistical analysis that follows.

We next compared some of the characteristics of the general population sample with population measures from the U.S. Census Bureau. The general population sample is slightly more elderly than the population. Nineteen percent of the sample are older than 65 where only 16% of the population is older than 65. The sample is 70% male while the population is 50% 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% white while the population is 97% 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% 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% 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 $42,000 for the population. The median household income for the general population 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.

Sample bias is a potential problem for estimation of marsh values. In order to address this concern, we weight the data on income with weights below (above) one reflecting the proportion of the sample with income above (below) the population median. All regression results reported below are weighted to mitigate sample bias. The level of sample selection bias is unknown but, recognizing the low response rate, such bias is likely. Adjustments when aggregating individual values to the population can be made to account for potential sample selection bias. We describe these below.

Twenty-five percent of the general population would be willing to make a one-time donation to the coastal marsh protection fund. Forty-nine percent would not be willing to make a donation and 26% did not know. For the license holder sample, 27% would make a donation, 50% would not, and 23% did not know whether they would make a donation. These proportions are not statistically significantly different across sample at the $p = 0.10$ level (χ^2[df] = 0.41 [2]).

The percentage of respondents willing to pay decrease as the requested amount increases. This is the pattern of responses found for both the general population and license holder samples. In the general sample, 71% are willing to pay $25,58% are willing to pay $50,35% are willing to pay $75,36% are willing to pay $100,38% are willing to pay $150, and 21% are willing to pay $200. While in the license holders sample 78%, 45%, 41%, 48%, 24%, and 25% are willing to pay $25, $50, $75, $100, $150 and $200. The declining proportion of willingness-to-pay percentages are statistically significant at the $p = 0.05$ level according to the chi-square statistic: χ^2[df] = 17.53[5] and χ^2 [df] = 19.73[5] in the general population and license holder samples, respectively. The differences in the proportion of willingness-to-pay responses across samples are statistically significant at the $p = 0.05$ level (χ^2[df] = 24.83(5]).

Considering the hypothetical bias correction, 24% and 34% of the general population and license holder samples are definitely sure that they would pay into the fund. Fifty-two percent of the general population survey are very sure (i.e., their rating was seven, eight or nine) that they would pay. Forty-percent of the license holder sample are very sure that they would pay. After receding “yes” respondents to “no” respondents according to their certainty rating (Table 2), 46% of the general sample are willing to pay $25,42% are willing to pay $50, 22% are willing to pay $75,25% are willing to pay $100,28% are willing to pay $150, and 18% are willing to pay $200. The declining proportion of willingness-to-pay percentages is not statistically significant at the P = 0.10 level (χ^2[df] = 7.87(5]). In the license holders sample 67%, 23%, 31%, 38%, 12%, and 19% are willing to pay $25, $50, $75, $100, $150 and $200. The declining proportion of willingness-to-pay percentages is statistically significant at the p = 0.05 level (χ^2[df] = 19.74(5]). The differences in the proportion of willingness-to-pay across samples are statistically significant (χ^2[df] = 20.54(5]).

In terms of perceived effectiveness of the provision point design, 45% of the general population and 52% of the license holders thought that it would be somewhat likely or very likely that at least 1% of all Michigan households would pay. This difference is not statistically significant across samples at the p = 0.10 level (χ^2[df] = 1.11(1]).

Revealed preference model

The dependent variable for the revealed preference analysis is the typical county chosen for a recreation trip. As is fairly standard in the TCM literature we consider only those respondents who took day trips (n = 251), deleting 19 recreation users who took only overnight trips (see Parsons, 2003). The average annual number of day trips was seven and nine for those recreation users in the general and license holder samples. The most popular county for recreation trips is Bay County with almost 50% of both samples visiting there on a typical trip. Twelve percent go to Iosco and Arenac Counties, 11% goes to Tuscola County and 24% goes 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 acreage in the county as an independent variable. Coastal marsh acreage is a subset of wetlands acreage. Therefore, wetlands acreage is used as a proxy for coastal marsh. The average amount of wetland acres in each county is 46,000 (Table 3). Other variables 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. A number of other county level recreational activity attribute variables were attempted in the regression model. None of these provided statistically significant explanations of recreation site choice in the theoretically expected direction.

Table 3 Random utility model (dependent variable is typical recreation site)

Independent variables	Mean	Std. dev.	Conditional logit	
			Coeff.	*t*-ratio
Travel costs	$64.69	31.33	−0.048	−9.319
Access points	7.00	1.67	0.339	5.44
Wetland acres (1000s)	45.95	19.35	0.023	3.515
LL function			−307.18	
Cases	251			
Choices	5			
Observations	1255			

The average travel cost is $65 over all trip occasions (n = 1255) and the average number of access points is seven. In the conditional logit model the probability of typical site choice decreases as the travel costs to the site increase and increases with wetland acres and access points. Using Eq. (4) the willingness-to-pay value of an additional 1125 acres of coastal marsh is $0.53 per trip.

Stated preference model

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. The selection of independent variables is guided by economic theory. 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 (Whitehead, 1995).

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 (see Whitehead et al., 2006). We also include a dummy variable equal to one if the respondent thinks it is somewhat or very likely that enough Michigan residents would make the required donation for the program to be a success. The variable is equal to zero otherwise.

Table 4 Probit models of willingness-to-pay

Independent Variables	Recreation users				Recreation nonusers			
	Would donate a positive amount		Very sure that they would donate $A		Would donate a positive amount		Very sure that they would donate $A	
	Coeff.	*t*-ratio	Coeff.	*t*-ratio	Coeff.	*t*-ratio	Coeff.	*t*-ratio
Intercept	−0.221	−0.83	0.629	0.76	−1.036	−4.71	0.203	0.20
Natural log of bid amount ($A)			−0.592	−3.52			−0.335	−1.69
Acres protected			0.000	0.74			0.000	−0.48
Travcost	0.003	0.83	−0.002	−0.30	−0.002	−0.66	0.001	0.09
Subcost	0.001	0.50	0.001	0.25	0.007	2.82	0.000	−0.05
Income	−0.001	−0.14	0.015	2.84	0.000	0.02	0.002	0.36
Member	0.356	2.15	0.243	1.00	0.377	2.19	0.558	2.10
PPM likely/somewhat likely			0.673	2.88			0.859	3.36
Willingness-to-pay			$62.76	3.71			$53.68	1.90
χ^2	7.98		47.93		22.22		23.05	
Cases	270		160		300		133	

1/Median value evaluated at means of independent variables except PPM likelihood of success = 1.

Table 5 Aggregate value of protecting 1125 coastal marsh acres (2005 $)

Method	Population	Scenario	Annual	Present value
TCM	Users	Use value	$114,385	$2,103,779
CVM	Users	Use and nonuse value	$36,624	673,583
CVM	Nonusers	Nonuse value	$33,693	619,678

Note. Discount rate = 3.5%.

In the recreation user probit model, respondents who are organization members are more likely to be willing to donate a positive amount for coastal marsh protection (Table 4). In the recreation nonusers model respondents who live farther away from the substitute recreation sites (suggesting some potential use value) and who are organization members are more likely to be willing to donate some positive amount of money. Willingness-to-pay falls with increases in the bid amount and if the respondent believed that enough Michigan respondents would be willing to pay for both users and nonusers. Willingness-to-pay increases with income for recreation users and is higher for organization members who are nonusers. These results suggest that the CVM data has a degree of internal validity.

Another test of the internal 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 et al., 1998). The Saginaw Bay willingness-to-pay responses do not pass the scope test. This does not, however, 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. 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. Note, however, that the willingness to donate a positive amount passes the scope test for the license holder sample.

Concerning the provision point design we find that survey respondents who did not believe that the donations would be sufficient were less likely to be willing to pay. Groothuis and Whitehead in press argue that actual donation behavior is best predicted by the model evaluated at the mean of the “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. We measure willingness-to-pay when all respondents believe that Michigan residents will donate enough money. Median willingness-to-pay for 1125 acres is $63 and $54 for the recreation user and nonuser subsamples, respectively.

Aggregation of values

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. Based on our earlier results the annual individual welfare gain from an increase of 1125 acres of wetlands is $2.28. Annual willingness-to-pay is the product of $0.53 per trip and 4.30 annual trips (the average number of annual trips for users and nonusers in the general population sample). Multiplying this value by the number of households in the five county Saginaw Bay region, 50,191, yields the annual aggregate value of an increase in 1125 acres, $114,385, or about $102 per acre per year (Table 5). The aggregate discounted present value of wetlands preservation is $2.1 million, or about $1870 per acre.

We use the willingness-to-pay estimates from the hypothetical bias correction model with the “likelihood of payment” correction presented in Table 4. In other words, these willingness-to-pay estimates may better reflect the value of coastal marsh relative to the amount that might actually be collected through voluntary donations. Aggregate willingness-to-pay for 1125 acres of protected marsh is the median willingness-to-pay multiplied by the relevant household population. The household population for the recreation users segment of the population is the product of 50,191 households and the 28% of the recreation user sample with positive willingness-to-pay. Aggregate present value of willingness-to-pay for recreation users is $674 thousand, or about $599 per acre for 1125 acres. After annualizing the one-time payment, recreation users are willing to pay about $36,000 per year in aggregate. The household population for the nonusers segment of the population is the product of 50,191 households and the 23% of the nonuser sample with positive willingness-to-pay. Aggregate present value of willingness-to-pay for nonusers is $620 thousand, or about $551 per acre. Nonusers are willing to pay about $34,000 thousand per year for coastal marsh protection.

DISCUSSION

Total willingness-to-pay is the sum of use and nonuse value. The revealed preference TCM generates use value estimates while the stated preference CVM generates both use and nonuse value estimates. Conceptually, the numbers in Table 5 are therefore inconsistent since the stated preference values are significantly less than the revealed preference values while the sample used to estimate the models is almost identical. There are several explanations for this result, none completely satisfactory. First, we adjusted willingness-to-pay downward with the certainty rating hypothetical bias correction and recoded don't know responses as no responses. These adjustments could be too conservative. However, ignoring these adjustments doubles household willingness-to-pay which is still lower than the TCM estimate. Second, our donation payment vehicle could lead to free rider bias even with the provision point adjustment. Third, the revealed preference TCM estimates of marsh value per trip may be upward biased due to the independence of irrelevant alternatives constraint in the conditional logit and failure to account for diminishing returns with our “typical trip” dependent variable. Finally, we use wetlands acreage instead of marsh acreage in our RUM. Measurement error may bias willingness-to-pay per trip upwards.

Nevertheless, since the nonuser and user samples do not overlap it is appropriate to add the willingness-to-pay values from separate analyses. The aggregate present value of willingness-to-pay for users and nonusers is $2.7 million when the TCM and CVM (nonuser sample) estimates are summed (about $2421 per acre). It is also appropriate to sum the willingness-to-pay values from the separate CVM analyses. The aggregate present value of willingness-to-pay for users and nonusers is $1.3 million when the CVM estimates are summed (about $1150 per acre) over the user and non-user samples.

Several decisions are made in order to provide a more consistent comparison of revealed and stated preference estimates of the benefits of coastal marsh protection. However, in terms of using these estimates in policy analysis, several issues should be considered to determine the sensitivity of the estimates to our decisions. First, with our relatively low response rate we have potential for selfselection bias. Self-selection bias might arise if those respondents with the highest willingness-to-pay values are most likely to respond to the survey. Therefore, 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. A lower estimate that should be used in a benefitcost sensitivity analysis is the product of household population, survey response rate (22%), and the proportion of respondents who are willing to pay a positive amount (see Whitehead et al., 1994). This aggregation rule is based on the conservative assumption that survey non-respondents have zero willingness-to-pay and should be considered a lower bound estimate. Under this assumption, the aggregate present value of 1125 acres is $148,000 and $136,000 for recreation users and nonusers, respectively.

Second, the aggregate willingness-to-pay CVM values must be interpreted with caution due to the lack of scope sensitivity. We interpret the total coastal marsh value as the marginal willingness-to-pay for 1125 acres and the marginal value of any additional acreage is 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. In order to extrapolate values beyond 1125 acres it is necessary to calculate the average willingness-to-pay per acre at the highest range of scope, 4500 acres. The average value per acre that can be extrapolated beyond 4500 acres is $150 and $138 for recreation users and nonusers.

Third, the present value of aggregate willingness-to-pay is sensitive to alternative discount rates. Using a 2% discount rate and the revealed preference TCM estimate the aggregate discounted present value of marsh preservation is $2.3 million, or about $2072 per acre. With the lower rate aggregate discounted present value is 22% greater than the present value in Table 5. When a 7% rate is applied the values are much lower. The aggregate discounted present value of marsh preservation is $1.4 million, or about $1261 per acre: 33% lower than the values estimated with the 3.5% rate.

Finally, several other valuation issues are not addressed. Michigan residents beyond the five county study region may hold values for Saginaw Bay coastal marsh and these are not accounted. Also, our survey did not achieve a large sample of property owners. This subsample might have different values for Saginaw Bay coastal marsh. Location decisions are endogenous in all travel cost applications and typically ignored since data collection necessary to implement the models is typically infeasible (Phaneuf et al., 2008). 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. These issues are left for future research.

CONCLUSIONS

We provide an overall economic assessment of the value of Saginaw Bay coastal marshes to area residents. Using both revealed and stated preference methods, we have estimated two types of value associated with coastal marshes: recreation value and total value. The total value is the sum of use value and passive use value. Revealed and stated preference methods are complementary when estimating the total value of coastal marsh. The present value of each acre of coastal marsh is $1870 to recreation users. The present value to recreation nonusers adds $551 per acre. The total present value of each acre of coastal marsh could be as high as $2421. This value is much less than the Jaworski and Raphael (1978) estimate for Michigan wetlands developed over 30 years ago. State-of-the-art valuation methods may explain the difference rather than declining wetland values over time. Nevertheless, it is clear that the value of Saginaw Bay coastal marsh is considerable, if only in terms of recreational benefits and passive use value. Future research should continue to refine wetland economic values, in order to accurately compare them to the market benefits of their development.

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REFERENCES

Amacher, G.S., Brazee, R.J., Bulldey, J.W., Moll, R.A., 1989. Application of wetland valuation techniques: Examples from great lakes coastal wetlands. Michigan Institute of Water Research, East Lansing, Technical Report 88-G1569-02, 48 pp.

Boyle, K.J., 2003a. Contingent valuation in practice. In: Champ, P.A., Boyle, K.J., Brown, T.C. (Eds.), A primer on nonmarket valuation. Kluwer.

Boyle, K.J., 2003b. Introduction to revealed preference methods, In: Champ, P.A., Boyle, K.J., Brown, T.C. (Eds.), A primer on nonmarket valuation. Kluwer.

Braden, J.B., Taylor, L.O., Won, D., Mays, N., Cangelosi, A., Patunru, A.A., 2008. Economic benefits of remediating the Buffalo River, New York area of concern. J. Great Lakes Res. 34, 631–648.

Brown, T.C., 2003. Introduction to stated preference methods. In: Champ, P.A., Boyle, K.J., Brown, T.C. (Eds.), A primer on nonmarket valuation. Kluwer.

Brouwer, R., Langford, I.H., Bateman, I.J., Crowards, T.C., Turner, R.K., 1999. A meta-analysis of wetland contingent valuation studies. Reg. Environ. Change 1, 47–57.

Cameron, T.A., James, M., 1987. Efficient estimation methods for “closed ended” contingent valuation surveys. Rev. Econ. Stat. 69, 269–276.

Cameron, T.A., 1991. Interval estimates of non-market resource values from referendum contingent valuation surveys. Land Econ. 67, 413–421.

Champ, P.A., Bishop, R.C., Brown, T.C., McCollum, D.W., 1997. Using donation mechanisms to value nonuse benefits from public goods. J. Environ. Econ. Manage. 33, 151–162.

Freeman, A., 2003. The measurement of environmental and resource values: theory and methods, Second Edition. Resources for the Future, Washington, DC.

Groothuis, P.A., Whitehead, J.C., 2002. Does don't know mean no? Analysis of “don't know” responses in dichotomous choice contingent valuation questions. Appl. Econ. 34, 1935–1940.

Groothuis, P.A., Whitehead, J.C., In Press. The provision point mechanism and scenario rejection in contingent valuation. Agric. Resour. Econ. Rev. 38.

Haab, T.C., McConnell, K.E., 2002. Valuing environmental and natural resources: the econometrics of non-market valuation. Northampton, MA, Edward Elgar.

Heberlein, T.A., Wilson, M.A., Bishop, R.C., Schaeffer, N.C., 2005. Rethinking the scope test as a criterion for validity in contingent valuation. J. Environ. Econ. Manage. 50, 1–22.

Hellerstein, D., 2005. ZIPFIP databases and software. US Department of Agriculture, Economic Research Service, Washington, DC.

Hoehn, J.P., Lupi, F., Kaplowitz, M.D., 2003. Untying a Lancastrian bundle: valuing ecosystems and ecosystem services for wetland mitigation, J. Environ. Manage. 68, 263–272.

Jaworski, E., Raphael, C.N., 1978. Fish, Wildlife and Recreational Values of Michigan's Coastal Wetlands. Great Lakes Shorelands Section, Division of Land Resource Programs. Department of Natural Resources, Michigan.

Lupi, F., Kaplowitz, M.D., Hoehn, J.P., 2002. The economic equivalency of drained and restored wetlands in Michigan. Am. J. Agric. Econ. 5, 1355–1361.

Moore, M.A., Boardman, A.E., Vining, A.R., Weimer, D.L., Greenberg, D.H., 2004. Just give me a number I Practical values for the social discount rate, J. Policy Anal. Manag. 23, 789–812.

Mullarkey, D., 1997. Contingent valuation of wetlands: testing sensitivity to scope. PhD dissertation. University of Wisconsin.

Parsons, G.R., 2003. The travel cost model. In: Champ, P.A., Boyle, K.J., Brown, T.C. (Eds.), A primer on nonmarket valuation. Kluwer.

Poe, G.L., Clark, J.E., Rondeau, D., Schulze, W.D., 2002. Provision point mechanisms and field validity tests of contingent valuation. Environ. Resour. Econ. 23, 105–131.

Phaneuf, D.J., Smith, V.K., Palmquist, R.B., Pope, J.C., 2008. Integrating property value and local recreation models to value ecosystem services in urban watersheds. Land Econ. 84, 361–381.

van Vuuren, W., Roy, P., 1993. Private and social returns from wetland preservation versus those from wetland conversion to agriculture. Ecol. Econ. 8, 289–305.

Whitehead, J.C., 1995. Willingness to pay for quality improvements: Comparative statics and theoretical interpretations of contingent valuation results. Land Econ. 71, 207–215.

Whitehead, J.C., Groothuis, P.A., Hoban, T.J., Clifford, W.B., 1994. Sample bias in contingent valuation: A comparison of the correction methods. Leis. Sci. 16, 249–258.

Whitehead, J.C., Cherry, T.L, 2007. Mitigating the hypothetical bias of willingness to pay: A comparison of ex-Ante and ex-Post approaches, Resour. Energy Econ. 29, 247–261.

Whitehead, J.C., Groothuis, P.A., Southwick, R., Foster-Turley, P., 2006. Economic values of Saginaw Bay coastal marshes with a focus on recreational values. Inc. Fernandina Beach, FL, Southwick Associates.

Whitehead, J.C., Haab, T., Huang, J.-C., 1998. Part-whole bias in contingent valuation: will scope effects be detected with inexpensive survey methods? South. Econ. J. 65, 160–168.

Woodward, R.T., Wui, Y.S., 2001. The economic value of wetland services: a metaanalysis. Ecol. Econ. 37, 257–270.