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Benefit Transfer in the Field: Measuring the Benefits of Heterogeneous Wetlands using Contingent Valuation and Ecological Field Appraisals

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Abstract

Wetlands have functional values that may extend beyond traditional real estate values. This paper uses contingent valuation and ecological field assessments to place heterogeneous values on heterogeneous wetlands. Wetland functions evaluated are water quality, habitat, recreation, storing floodwaters and erosion abatement. The model used incorporates the public value of wetland functions and adds that value to the common local appraisal cost. We use a "percentage willingness-to-pay" value elicitation question in which respondents are asked about the percentage amount that the state government should pay over and above market value to purchase and preserve a wetland function. These values are then mapped into an ecological matrix to value the wetland as a whole. We show how these values can be applied in the field.

Keywords: wetlands, appraisal, evaluation, mitigation, contingent valuation method

Introduction

Economic values for wetland functions differ widely depending on the location and the economic methods used. In order to estimate the economic value of wetlands, either collectively or individually, it is necessary to be able to assign a monetary value to each of them. This is not always an easy task for many technical and economic reasons. The simplest way to approach this would be to apply market prices. However, for many wetland products and services there is no market, and some values are intrinsically non-marketable. Although many researchers study the various biological and ecological contributions of wetlands, attempts to quantify these in dollar values are few. No study has focused on estimating the values of Missouri wetlands. One purpose of this paper is to address this gap in information in an effort to help guide efforts related to wetland preservation in Missouri. Various techniques have been devised to quantify them. The most common revealed preference methods are: hedonic pricing, travel cost, production function and replacement cost. The most common stated preference method is contingent valuation (CVM).

It is costly to use the revealed and stated preference valuation methods to value a diverse set of wetland ecosystems. The travel cost and hedonic pricing method require location specific data sets. A single study would be feasible in the time allotted but a number of studies, as required to assess the environmental benefits of a large number of wetland areas, is not feasible due to time constraints. Also, using a single revealed preference method will exclude large classes of environmental values from the benefits assessment. While the travel cost method focuses on recreation benefits, the hedonic price method focuses on benefits to property owners. Since wetlands can have recreation, property value and other environmental benefits, a focus on one valuation method could lead to large errors. Consideration of multiple revealed preference

valuation methods is costly. The contingent valuation method requires a sample survey that elicits the willingness-to-pay with a hypothetical market or government policy. In the context of wetlands protection, the survey would describe the various functions (i.e., benefits) of wetlands, a method of payment, a policy implementation rule and a value elicitation question. The entire CVM survey and reporting process requires a significant amount of time and effort.

The benefit transfer approach was developed for situations in which the time and/or money costs of primary data collection are prohibitive (Bergstrom and DeCivita, 1999). Environmental benefit estimates from other case studies are spatially and/or temporally transferred to the policy case study. There are three types of benefit transfer: benefit estimate transfer (e.g., Boyle and Bergstrom, 1992), benefit function transfer (e.g., Loomis, 1992), and meta-analysis (e.g, Rosenberger and Loomis, 2000). Benefit estimate transfer uses summary measures of the environmental benefit estimates directly. Researchers simply obtain a benefit estimate from a similar study conducted elsewhere and use it for the current policy analysis case study. Benefit function transfer uses the statistical model to transfer benefits. Characteristics of the current policy situation or case study (e.g., population demographics, site characteristics) are substituted into the statistical model from the transfer case study to develop benefit estimates that are more suitable for the current policy situation than the directly transferred benefit estimates.

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. These regression models are used as benefit function transfer models where the characteristics from the case study are inserted and environmental benefits related to

the case study are developed. There are a large number of wetland valuation studies that makes meta-analysis feasible. 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 pay is highest for the flood control function. Other valuable functions are, in order, 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.

The CVM was chosen for this project because the method applies to urban and rural wetlands and appears to be the most widely applicable methodology for the range of wetland types found in the Midwestern United States (Mitchell and Carson, 1989). The CVM requires computation of a willingness-to-pay component. In the CVM survey respondents are presented with a hypothetical situation and then asked to answer a value elicitation question. The value elicitation question asks whether and how much respondents are willing to pay for the policy. Value elicitation questions include open-ended, dichotomous choice and payment card questions. The way of paying for the change in resource allocation is known as the “payment vehicle.” Typical payment vehicles include increases in water and/or utility bills, increases in state and/or federal taxes, increases in prices of related goods, fishing and hunting licenses, and contributions or donations to special funds. A good payment vehicle is realistic, believable and neutral. Preliminary focus group research led us to use a payment card value elicitation question with

percentage willingness-to-pay by the state government for various wetland functions over and above market land values as the payment vehicle. We assess the internal and divergent validity of the resulting willingness-to-pay responses.

Another feature of this study is the extensive integration of ecological functions with the economic value of functions. Economic function willingness-to-pay values are elicited for a generic wetland and then mapped into a ecological function matrix in order to value location specific, heterogeneous wetlands. We show how these values can be applied in the field with policy relevant Missouri wetland applications. The benefit estimate from the single CVM/biological model could then be transferred to other wetlands at little cost relative to additional CVM studies.

Survey Development

In order to develop a meaningful and valid survey instrument, the Missouri Department of Natural Resources (DNR), in consultation with a 15 member wetlands advisory group (WAG) composed of federal, state, and private company representation, pursued focus group research (McIntosh 2009). The focus groups included a wide variety of participants within the groups to balance opinions on wetlands and valuation of wetlands. Specific groups included farmers, environmentalists, real estate developers, and the general public. Potential participants in these categories were identified by asking various membership and interest groups to recommend individuals. Groups contacted for recommendations included the Missouri Farmers Union, the Conservation Federation of Missouri, the Mid-Missouri Development Council, and the Chambers of Commerce.

The locations of the focus groups were Columbia, St. Charles, and Lake of the Ozarks. These sites were selected as fairly high growth or rural areas where wetlands were being

impacted by population expansion or agriculture. The St. Charles focus group was actually held in nearby St. Peters but most of the participants were recruited from St. Charles. The Lake of the Ozarks focus group was held in Osage Beach.

For the first round of focus groups the sample educational material and survey questions were handed out to participants and their feedback on the materials was requested. For the second round of focus groups, educational materials and survey questions were modified according to feedback gained from the first round of focus groups. For each successive focus group in the second round, the materials handed out to participants was updated based on feedback from the previous groups at all locations.

After focus group participants watched the EPA video "Wetlands in the Farmlands," the moderators discussed the survey, its purpose, and the CVM. Draft survey materials were then handed out and participants' comments were elicited. All groups were given a draft of educational background material that might be included with the survey. The groups were also given draft survey questions on four different benefits of wetlands: storing floodwater, improving water quality, providing habitat for plants and animals, and providing recreation. The draft survey questions asked respondents to provide their opinion of the dollar value of the wetland function in 4 or 5 different ways: (1) How much are you willing to pay per acre (or for one acre) to buy the wetland to protect it from being drained or filled? (2) How much are you willing to pay per acre (or for one acre) in taxes annually to protect the wetland from being drained or filled? (3) How much are you willing to pay per acre (or for one acre) in a one-time amount to a trust fund to protect the wetland from being drained or filled? (4) How much are you willing to have the State of Missouri pay per acre (or for one acre) to buy the wetland to protect it from being drained or filled? And (5) If you owned this wetland, how much would you, as an

individual, be willing to accept as compensation in return for an agreement to protect it from being drained or filled forever?

Focus group participants very frequently commented that they did not have enough information to select or write in a dollar amount in answer to the questions. They often wanted to know much more information than was provided by the question and the paragraphs before the question. They wanted to know where the wetland was located, how large it was, what the market value was, whether it had any functions besides the one function mentioned in the question, whether as a buyer of a wetland they would own it and be able "to put a fence around it" or whether they would just benefit from the function being mentioned in the question.

For the survey question based on taxes, participants wanted to know the kind of tax and how it would be assessed. Also, some participants interpreted the question as indicating they were the landowner and they would be paying an assessment per acre of their land. For the survey question based on a trust fund, participants requested a definition of trust fund and wanted to know how it would be set up and how many people would be participating in it.

For the survey question based on the State of Missouri buying the wetland, participants wanted to know where the funds would come from. Several participants thought that this question was similar to the tax question, but they thought that many survey recipients would not recognize that the State of Missouri would use tax dollars to buy a wetland.

Some of the participants who were most educated about wetlands suggested that information be provided to respondents about such things as how much money it costs to recreate a wetland, how much money it costs for alternative methods of providing the functions that the wetland provides (such as sewage treatment), or how much it costs to replace and rebuild flooded areas.

Participants often struggled with the concept of putting a dollar value on an acre of wetland due to what they felt to be lack of information. They commented that not only did they not have enough information to do so, but were concerned that most people receiving the survey would not have enough money to personally buy a wetland. Participants also pointed out the difficulty of separating out the value of a function from the value of the land.

Many participants offered suggestions for alternatives to asking for a dollar amount in the survey questions. These included using importance scales for each function, asking respondents to indicate which functions were more important than other functions, and asking respondents to indicate a percentage over and above the intrinsic value of the property. Some participants felt that it is too difficult to separate out a dollar value for each function. Others, however, disagreed. Some participants indicated that it is too difficult to create a formula for all cases and that there would often be special circumstances that would affect the value; whereas others indicated that they thought this general methodology would be useful.

Participants suggested alternative measures to having respondents select from a graduated list of specific dollar amounts. These methods included using a percentage or a fraction above or below fair market value rather than a dollar amount. This could be done by either stating in dollar terms the fair market value for a particular scenario, or it could be done by just stating "fair market value" with no dollar amount stated. We implemented these suggestions in the CVM survey.

Internet Survey Data

In 2007, the Missouri DNR's Water Resource Center posted an internet survey on the DNR web site and DNR created a public statewide news release for a water resources survey that yielded 300 responses. Since DNR desired a higher level of participation a second release was

made more specific to the project and posted on the main State of Missouri website to obtain broader participation. The seconding web posting yielded over 700 additional completed surveys. The posted online survey asked Missouri residents about their knowledge and behavior related to wetlands, willingness-to-pay for wetland-related services, and other socioeconomic issues. A copy of the internet survey is presented in Appendix A.

The full sample includes 1103 survey respondents. However, the largest sample size for any single variable is 1032. In total, we deleted 12 percent of 1032 cases due to item non-response and worked with a sample size of 908. Analysis of the characteristics of those respondents deleted from the sample and those included indicate that the complete case sample of 908 is largely representative of the full sample of 1,032. Two-sample t-tests are conducted for 18 key variables. Only one variable is significantly different between the sample of 908 and the discarded sample of 124. Those who remain in the sample are more likely to belong to a sporting club or environmental organization, 56%, than those who are discarded, 38%.

A number of independent variables were considered for the willingness-to-pay models. Variables were chosen for the final models based on their expected theoretical relationship to willingness-to-pay and/or statistical significance in preliminary models (Table 1). Several variables were recoded as independent variables in the regression analysis. Wetlands knowledge is recoded from a four-level variable to a two level variable. If respondents know “very much” about wetlands, KNOW is equal to one and is equal to zero otherwise. Thirty-one percent of respondents know ‘very much’ about wetlands.

The number of times the respondent typically sees wetlands was recoded from a categorical variable to an integer variable (SEE). Respondents who typically see wetlands daily or almost daily were assigned a value of 365. Respondents who typically see wetlands weekly

were assigned a value of 52. Likewise, if respondents typically see wetlands two or three times a month, once a month, a few times a year and once a year were assigned values equal to 30, 12, 3 and 1. Respondents who have seen a wetland less than once a year, have not seen a wetland in the past five years or are not sure if they have seen a wetland in the past five years were assigned a value of zero. The average number of times that respondents typically see a wetland is 74 each year.

Fifty-six percent of respondents have, at one time, belonged to a hunting club, fishing club or an environmental group (CLUB). Seven percent of respondents have applied for a permit to impact a wetland (PERMIT). Eighteen percent of respondents have owned property containing a wetland (OWN). In an exploratory empirical analysis, respondents see wetlands more often if they are members of a hunting club, fishing club or an environmental group and if they have ever owned property containing a wetland.

Respondents were asked for the highest grade of school or college that they have completed. The categorical variable was recoded to a numerical variable (EDUC). If respondents have schooling less than a high school graduate then EDUC is equal to 10. If respondents are a high school graduate then EDUC is 12. Likewise, if respondents have some college, are college graduates, have a master's degree or law degree or a doctorate degree or an MD degree then EDUC is equal to 14, 16, 18 and 20. The average number of years schooling is 16.

Other demographic variables are sex, age, number of years having lived in Missouri and income. Males are 67% of respondents (MALE) and the average age is 48 (AGE). The average number of years in Missouri is 36 (TENURE). Income was not asked. In an attempt to measure ability-to-pay, we match the zip code level median household income from the Census Bureau with the respondents' reported home zip code. Average household zip code level income is

$46,000 with a range of $15,000 - $126,000 (INCOME).

Willingness-to-Pay for Wetlands Acquisition

Section B of the survey presents willingness-to-pay questions for five wetland functions: water quality, floodwater storage, providing habitat for animals and plants, recreation, and erosion reduction. In five sets of questions, after each of the five wetland functions were initially described, respondents were asked if an acre of Missouri "wetland is worth more, less or the same dollar amount … as the market value of a piece of land?" Respondents were then asked for the maximum amount that the state should pay over and above the current market value for the particular wetland function. Respondents were given eight choices: 1%, 5%, 10%, 50%, 100%, 200%, 300% and some other dollar amount for which respondents are asked to specify. Willingness-to-pay questions are often unfamiliar to survey respondents, generating uncertainty about answers. To determine the extent of the uncertainty respondents are also asked how certain they are about their willingness-to-pay responses.

Seventy-nine percent of 1022 respondents state that wetlands, when water quality improvements are part of the parcel's purpose, are worth more than the market value of a piece of land alone. Sixteen percent state that a wetland is worth the same and 4% state that it is worth less. One percent failed to answer this question. Of the respondents, 814 state that the wetland is worth more than market value for the water quality function and are instructed to answer the next question. But, 105 respondents who may have answered the "same amount" or "less" in the previous question also participated in the willingness-to-pay question. The impact of this is unclear, but likely results in lower willingness-to-pay results. How much lower the results could be are not known. This pattern of responses arises for each of the five sets of willingness-to-pay questions. Twenty-five respondents chose to give a dollar amount instead of a percentage and are

deleted from the analysis. Twenty-six percent of 944 respondents are very sure about their percentage willingness-to-pay response, 51% are somewhat sure, 19% are not very sure and 4% are not sure at all.

Seventy-eight percent of 1019 respondents stated that wetlands are worth more than the market value of a piece of land alone with floodwater storage in mind. Seventeen percent state that a wetland is worth the same and 4% state that it is worth less. One percent failed to answer this question. Twenty-six respondents choose to give a dollar amount instead of a percentage and are deleted from the analysis. Twenty-eight percent of 923 respondents are very sure about their percentage willingness-to-pay response, 51% are somewhat sure, 18% are not very sure and 3% are not sure at all.

Eighty percent of 1019 respondents stated that wetlands are worth more than the market value of a piece of land alone with habitat in mind. Sixteen percent state that a wetland is worth the same and 3% state that it is worth less. One percent failed to answer this question. As in the previous questions, more respondents than the number that expressed a higher market value for wetlands answered the percentage increase question. Twenty-three respondents give a dollar amount instead of a percentage and are deleted from the analysis. Thirty-four percent of 924 respondents are very sure about their willingness-to-pay response, 49% are somewhat sure, 15% are not very sure and 2% are not sure at all.

Seventy percent of 1011 respondents stated that wetlands are worth more than the market value of a piece of land alone with recreation in mind. Twenty-nine percent stated that a wetland is worth the same or less. Two percent do not answer this question. Sixteen respondents choose to give a dollar amount instead of a percentage and are deleted from the analysis. Thirty-two percent of 864 respondents are very sure about their willingness-to-pay response, 49% are

somewhat sure, 16% are not very sure and 3% are not sure at all.

Seventy-nine percent of 1015 respondents stated that wetlands are worth more than the market value of a piece of land alone with erosion control in mind. Twenty-one percent stated that it is worth the same or less and 2% do not answer. Twenty respondents choose to give a dollar amount instead of a percentage and are deleted from the analysis. Thirty percent of 894 respondents are very sure about their willingness-to-pay response, 51% are somewhat sure, 16% are not very sure and 3% are not sure at all.

In Table 2 we present means and standard deviations of the dependent variables in the statistical analysis. The dependent variable is the percentage over and above the market price that the respondent is willing for the state to pay to purchase wetlands that provide various functions. The dependent variable is measured in two ways. First, the raw percentage willingness to pay is presented. The second measure is the raw percentage adjusted for certainty of willingness to pay. If the respondent is “not very sure” or “not sure at all” about their willingness-to-pay statement, willingness to pay is recoded to zero. This provides a more conservative estimate of willingness-to-pay (Blumenschein et al. 2008). The raw percentage willingness-to-pay ranges above the market value from a low of 60% for recreation to a high of 71% for habitat. The “somewhat sure” percentage ranges from 55% for recreation to 64% for habitat.

Determinants of Willingness-to-Pay

We use the Tobit model to analyze the determinants of percentage willingness to pay since the dependent variable is censored at zero (Table 3). Respondents who indicated that a wetland is worth less or the same dollar amount as the market value of land are coded as willing to pay zero dollars. Also, all positive willingness-to-pay percentages are recoded to zero if the respondent is not at least somewhat sure about their answer.

Willingness-to-pay for the water quality function increases with wetlands knowledge and the number of times that the respondent annually sees wetlands. Members of clubs are also willing to pay more. In terms of socioeconomic variables, willingness-to-pay increases with education and is lower for males. The results from the storing floodwater function Tobit regression model are similar to the water quality model results but with one additional statistically significant variable: willingness-to-pay decreases with age. The qualitative results of the protecting habitat wetland function model are identical to that of the storing floodwater model. Willingness-to-pay for the recreation wetland function increases with wetlands knowledge and the number of times that the respondent annually sees wetlands. No other variable is statistically significant. The qualitative results of the erosion reduction model are similar to the others. Willingness-to-pay increases with wetlands knowledge and the number of times that the respondent annually sees wetlands. Willingness-to-pay increases with years of education and is lower for males.

As mentioned previously, the complete case sample of 908 respondents is statistically representative of the full sample except for the club variable. Club and environmental organization members are over-represented in the full sample, 56%, relative to those excluded respondents, 38%. In the full sample, 54% of respondents are club and/or organization members. The over-representation of club/organization members has potential to upwardly bias willingness-to-pay estimates since the coefficient on the club variable is statistically significant in each model. However, the over-representation has little practical impact. For example, club/organization membership has the largest impact on the willingness-to-pay for storing floodwater. Based on the marginal effect of this coefficient, club/organization members are willing to pay about $13 more than nonmembers. Considering the 2% difference in

club/organization membership between the full sample and the complete case sample, the willingness to pay estimate is overstated by only $0.25.

Analysis of Wetland Types and Functions

Table 4 provides an analysis of the biological productivity of wetland functions by Missouri wetland types. Each cell represents the relative percentage of the function that each wetland provides as determined by expert opinion within the Missouri DNR and the Wetlands Advisory Group. For example, swamp wetlands provide up to 75% of the maximum water quality function performance, 100% of the maximum recreation performance, 25% of the maximum flood control performance, 100% of the maximum species habitat performance and 100% of the maximum erosion control performance. Summing these totals across functions provides a total function index that ranges from 100 for streams or riverine wetlands to 450 for wet meadow wetlands.

The values in Table 4 can be used to determine the maximum ratio per function for each wetland type when acquiring or protecting wetlands. However, wetlands vary in their health and productivity. Very few wetlands provide the full range of ecological and recreational attributes and those that do will likely not have 100 percent of service from each attribute due to effects from levees, travel distance for recreational users, degraded conditions, and more. We use the wetland types and functions scoring in Table 4 to develop estimates for the percentage willingness to pay over and above market price for different types of wetlands. Recognizing that each wetland type does not provide 100% value for all wetland functions, we scale each willingness-to-pay amount by the biological percentage value.

For example, each cell of Table 4 represents the biological percentage value of five wetland functions, $F = 1, \ldots, 5$, produced by eight wetland types, $T = 1, \ldots, 8$. Let each cell be

denoted as γ_{FT}. The maximum total percentage value produced by each of eight wetland types is: $Total_T = \sum_{F=1}^{5} \gamma_{FT}, T = 1,...,8$. In order to convert the biological function values to economic wetland function values we multiply the value of each cell by the corresponding percentage willingness to pay for that function, WTP_F (Table 3). The total willingness to pay for each wetland type is: $TWTP_T = \sum_{F=1}^{5} WTP_F \gamma_{FT}, T = 1,...,8$.

These results are presented in Table 5. Reflecting the expected ecological function scores and the willingness-to-pay survey results, the most economically valuable wetland types are wet meadow wetlands. The amount that respondents are willing to pay is 268% over and above market price for this type of wetland. The amount that respondents are willing to pay is 236% over and above market price for swamp and marsh, 222% for shrub swamp and 135% for forested wetlands. The less valuable practical functions to the public are represented by fens and seeps, 106% over and above market price, natural ponds and lakes-lacustrine wetlands, 87%, and streams-riverine wetlands, 58%.

Field Appraisal Applications

In this section we present percentage willingness-to-pay values that result from ecological field appraisal adjustments (Table 6). We consider river floodplain wetlands, glacial till floodplains, prairie wetlands and fens. These values are used in conjunction with site-specific field adjustments that account for deficiencies accompanying specific wetlands. The first step requires a qualified appraiser to assess the functionality of each attribute. Using a swamp as an example, the appraiser determines how functional each attribute is compared to a completely healthy and fully functioning swamp. This is done for each attribute provided by the wetland in question, and then the results for all attributes are summed to arrive at the appraised value for

that wetland. The next step is to match each function level ratio to the function willingness-to-pay values. We consider Mississippi River lowlands in Southeast Missouri, Missouri Ozarks, Missouri River floodplain, Missouri glacial till floodplains in North Missouri, and the Osage River floodplain in west Missouri and Missouri fen or limestone glade wetlands.

Missouri and Mississippi River Floodplain wetlands form two major types. The first and historically more common is where wetlands are connected hydraulically to the Missouri River. These wetlands were historically seasonally flooded by surface water overflows from the River and hydraulically connected by groundwater to the river during drier time periods. These forested wetlands are probably more important to river species and less important to water quality improvements. In the Marion Bottoms Forested Wetland case study, the erosion reduction function is increased from 15% for a forested wetland in Table 5 to 60% due to placement in Missouri River floodway. The total willingness-to-pay is 245% above market value.

The second major geographic type is one that is located in historic, perhaps ancient Missouri River flood plains that are now cut-off from all but extreme river flood events, and obtain their moisture from watersheds eventually flowing to the river either by surface or subsurface flows. Marsh habitat is important in terms of biotic diversity and water quality improvements in surface runoff prior to surface or sub-surface discharge to the river. In the Van Meter State Park Marsh case study, the erosion reduction potential was reduced from 60% to 20% due to the wetland's placement in watershed and the water quality component was increased from 43% to 57% since it is capturing runoff from intensive row crop agricultural lands. The total willingness-to-pay is 212% above market value.

Missouri Glacial Till Floodplains can be fairly distinct wetland types. Wetlands in upper watersheds are often residual wetlands from historic stream channel meanders. Many are impacted by channel straightening which lowers the stream channel and causes a disconnect with historic oxbows except during overbank flows. These cut-off wetlands may be reliant upon direct floodplain runoff and often receive direct runoff from agricultural production crop fields. The field appraisal resulted in a reduction of each of these functions from their full functionality. In the shrub swamp case study, the total willingness-to-pay is 213% above market value.

Lower in these same watersheds, wet meadow wetlands are often more distributive and braided and may form wet prairies or swamp habitat. These unique habitats show ecosystem diversity and store surface overflow waters that without them will flow directly to rivers. The total willingness-to-pay for the Pershing State Park prairie wetland is 272% above market value. This is a higher value than for a typical prairie wetland since the recreation function is adjusted upwards from 27% to 55% due to state park access.

Missouri Fens are calcareous glades that are formed from seeps and springs from bedrock limestone and dolomite formations. Often on slopes and dependent upon subsurface flows, these wetlands have unique species that are tied to their micro systems and may have been biologically distinct since glacial periods. In the Self Fen case study flood reduction and recreation ranked higher due to proximity to a state highway. The total willingness-to-pay for the Self Fen is 147% above market value.

Conclusions

Wetlands have functional values that may extend beyond traditional real estate values. Since wetlands often have some or most of the five major functions surveyed, true public values can be much higher than market prices for land without those functions. In this study we use the

CVM with a “percentage willingness-to-pay” value elicitation question and market price payment vehicle. We find that respondents value each wetland function at 55% to 64% higher than market prices relative to lands without wetland functions. Willingness-to-pay values are mapped into an ecological matrix to value the wetland as a whole. We show how these values can be applied in the field with five case studies.

Our results could be used for other Midwestern United States wetlands. However, professional judgment is a subjective measure, with opinions varying among different users and their experiences. The accuracy and reproducibility of the functional assessment for the individual wetland will depend upon the skill of the wetlands appraiser. An appraiser accustomed to seeing pristine wetlands may judge lower quality wetlands more harshly than a person accustomed to seeing highly impacted wetlands. Types of wetlands can also be affected by placement in a watershed. For example, a low erosion control ranking for a forested wetland in an upper watershed will not be correct for a forested floodway wetland protecting a critical dike structure from the erosive forces present in the Missouri River floodway. Another caveat concerns the CVM application. We use a new payment vehicle: the percentage of government willingness-to-pay above market price. Further research is needed in order to determine how it compares to more commonly used vehicles and if it is incentive compatible.

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Table 1. Data Summary: Independent Variables

	Mean	Std	Min	Max
KNOW	0.31	0.46	0	1
SEE	73.68	126.31	0	365
CLUB	0.56	0.50	0	1
PERMIT	0.07	0.25	0	1
OWN	0.18	0.38	0	1
EDUC	16.25	1.95	10	20
MALE	0.67	0.47	0	1
AGE	47.72	13.16	18	85
TENURE	35.57	17.41	0	80
INCOME ($2000)	45.94	17.17	15.48	126.47
Cases	908			

Table 2. Data Summary: Dependent Variables

	Raw Percentage		Somewhat Sure Percentage	
	Mean Percentage	Standard Deviation	Mean Percentage	Standard Deviation
Water Quality	64.27	79.70	57.04	80.70
Storing Floodwater	67.12	82.61	59.93	83.16
Habitat	71.34	86.28	64.18	86.75
Recreation	60.25	81.11	54.56	81.36
Erosion Reduction	67.04	84.84	59.62	85.06
Cases	908			

Table 3. Tobit Models: Determinants of Maximum Percentage Willingness-to-pay

	Water Quality		Storing Floodwater		Providing Habitat		Providing Recreation		Providing Erosion Reduction	
	Coeff	t-value	Coeff	t-value	Coeff	t-value	Coeff	t-value	Coeff	t-value
Constant	-23.27	-0.72	0.69	0.02	-5.04	-0.15	-7.29	-0.21	-21.91	-0.64
KNOW	36.33	4.53	37.74	4.59	36.69	4.44	35.08	4.15	41.02	4.82
SEE	0.08	2.90	0.09	3.10	0.08	2.74	0.09	3.09	0.10	3.45
CLUB	14.99	2.08	19.41	2.62	18.13	2.43	7.96	1.04	10.92	1.42
PERMIT	0.11	0.01	-2.16	-0.15	-5.78	-0.39	1.30	0.09	-10.61	-0.69
OWN	-6.57	-0.69	-6.53	-0.67	-2.38	-0.24	2.90	0.29	-0.40	-0.04
EDUC	3.91	2.10	3.11	1.63	4.00	2.08	1.17	0.60	3.55	1.80
MALE	-12.67	-1.68	-21.12	-2.73	-15.62	-2.01	-7.05	-0.88	-18.59	-2.32
AGE	-0.37	-1.15	-0.63	-1.88	-0.57	-1.70	-0.15	-0.44	-0.25	-0.74
TENURE	-0.10	-0.43	-0.10	-0.40	-0.22	-0.87	-0.19	-0.76	-0.16	-0.64
INCOME	0.06	0.31	0.18	0.87	0.12	0.57	0.34	1.58	0.16	0.73
Sigma	99.25	34.57	101.93	34.56	103.13	35.51	104.13	33.62	105.29	34.36
LL	-4147		-4164		-4330		-4019		-4146	
Cases	908		908		908		908		908	

Table 4. Percentage Maximum Performance of Missouri Wetland Functions

Missouri Wetland Types	Water Quality	Recreation	Storing Floodwater	Habitat	Erosion Reduction	Total
Swamp	75	100	25	100	100	400
Marsh	75	100	25	100	100	400
Wet Meadow	100	50	100	100	100	450
Fens and Seeps	25	50	0	100	0	175
Shrub Swamp	75	75	25	100	100	375
Forested Wetland	25	25	100	50	25	225
Natural Ponds and Lakes-Lacustrine	25	50	25	25	25	150
Streams-Riverine	25	50	0	25	0	100

Table 5. Percentage Willingness to Pay above Market Value by Wetland Type and Function

Missouri Wetland Types	Water Quality	Recreation	Storing Floodwater	Habitat	Erosion Reduction	Total
Swamp	43%	55%	15%	64%	60%	236%
Marsh	43%	55%	15%	64%	60%	236%
Wet Meadow	57%	27%	60%	64%	60%	268%
Fens and Seeps	14%	27%	0%	64%	0%	106%
Shrub Swamp	43%	41%	15%	64%	60%	222%
Forested Wetland	14%	14%	60%	32%	15%	135%
Natural Ponds and Lakes-Lacustrine	14%	27%	15%	16%	15%	87%
Streams-Riverine	14%	27%	0%	16%	0%	58%

Table 6. Adjusting Percentage Willingness to Pay for Degraded Wetlands

Marion Bottoms Forested Wetland	Appraised Functionality	Raw WTP	Adjusted WTP
Water Quality	30%	57%	17%
Recreation	80%	55%	44%
Storing Floodwater	100%	60%	60%
Habitat	100%	64%	64%
Erosion Reduction	100%	60%	60%
Total			245%
Van Meter State Park Marsh			
Water Quality	100%	57%	57%
Recreation	100%	55%	55%
Storing Floodwater	40%	60%	24%
Habitat	100%	64%	64%
Erosion Reduction	20%	60%	12%
Total			212%
Shrub Swamp			
Water Quality	80%	57%	46%
Recreation	80%	55%	44%
Storing Floodwater	80%	60%	48%
Habitat	70%	64%	45%
Erosion Reduction	50%	60%	30%
Total			213%
Pershing State Park Prairie Wetland			
Water Quality	100%	57%	57%
Recreation	100%	55%	55%
Storing Floodwater	80%	60%	48%
Habitat	100%	64%	64%
Erosion Reduction	80%	60%	48%
Total			272%
Self Fen			
Water Quality	33%	57%	19%
Recreation	80%	55%	44%
Storing Floodwater	100%	60%	60%
Habitat	60%	64%	38%
Erosion Reduction	30%	60%	18%
Total			179%

Appendix A: Internet Survey

About Wetlands

What are wetlands?

- Wetlands are transition areas between dry land and open waters; however, they are not always wet.
- Usually wetlands contain plant-life adapted to survive in water-saturated soils, normally without oxygen (anaerobic).
- Some of the plants found in wetlands include duckweed, water lilies, cattails, pondweed, reeds, sedges and bulrushes.

Why is it important to preserve wetlands?

- Wetlands can provide habitat for fish and wildlife and recreation areas for people to hunt, fish and enjoy watching nature. Wetlands store floodwaters and maintain surface water flow during dry periods. Wetlands protect and improve water quality.

Missouri has eight types of natural wetlands: swamps, shrub swamps, forested wetlands, marshes, wet meadows, fens and seeps, pond and lake borders and stream banks.

Restoring vs. Preserving Wetlands

Wetlands are impacted during construction of highways, roads, businesses and homes. The Federal Water Pollution Control Act, Title IV Permits and Licenses, Section 401 and Section 404 empower the state and federal government to regulate permit applicants that may discharge, dredge or place fill material into navigable waters and adjacent wetlands. Within the permit process the federal government or the state may require compensation, replacement or restoration to mitigate wetland impacts. In theory wetland restoration may help to ensure that there is no net loss of wetlands. However, a restored wetland is never exactly the same as the drained or filled wetland. First, soil and water conditions will vary between wetlands and restored wetland functions may take many years before they can mimic a natural wetland. With different soil and water conditions, the mix of plants and animals also varies. In addition, the public may have accessibility to one wetland but not the other. Consequently, the functions and values of a restored wetland may vary from the drained or filled wetland.

The Value of Wetlands

Every piece of wetlands provides value through social and environmental benefits (such as flood control, water quality improvements and wildlife habitat) in addition to the property's economic value. The property's market value is recognized by the owner. The social benefits are recognized by the public as well as the private owner.

About the Following Questions

In order to determine what value is being placed on preserving wetlands, the Missouri Department of Natural Resources is asking Missouri residents to answer a series of questions.

Included in the first section of the questionnaire (Section A), are a few general questions about your experience with wetlands and related activities. This will help group responses by experience level.

The second section of the questionnaire (Section B), asks five sets of distinct wetland questions. Each set describes a particular wetland function followed by questions about a hypothetical wetland. One question in each set will ask the respondent to place a dollar value above, below, or the same as market value. Do not be concerned if you are unsure what dollar amount to select. Select the answer that best fits your values and opinions. The answers will give us important information from all those who respond to the survey.

In the third section of the questionnaire (Section C), there are a few questions about your background and formal education. In the analysis of the results, these questions will be used to group respondents' answers in order to learn how different segments of Missouri's population differ in their opinions.

SECTION A

1. How much would you say you know about wetlands?
   - ☐ Very much
   - ☐ Somewhat
   - ☐ Not very much
   - ☐ Nothing at all

2. Have you seen or visited a wetland in the last five years?
   ☐ Yes ☐ No ☐ Not sure

3. (If yes) During the past two years, how frequently do you typically see wetlands?
   - ☐ Daily or almost daily
   - ☐ Weekly
   - ☐ Two or three times a month
   - ☐ Once a month

☐ A few times a year
☐ Once a year
☐ Less than once a year

4. Have you ever-owned property containing a wetland?
   ☐ Yes ☐ No ☐ Not sure

5. Have you ever applied for a permit to impact a wetland?
   ☐ Yes ☐ No ☐ Not sure

6. When you go to a wetland, what do you do there? (Check all that apply.)
   ☐ Fish
   ☐ Hunt
   ☐ Farm
   ☐ Conserve and manage the wetland
   ☐ Watch for birds or other wildlife
   ☐ Look for plants or wild flowers
   ☐ Enjoy the outdoors
   ☐ Other (please specify) _____
   ☐ I have never been to a wetland

7. In the past two years, which of the following activities have you engaged in? (Please check all that apply.)
   ☐ Hiking or biking in a natural area
   ☐ Watching birds or other wildlife, or viewing plants or scenery, in a natural area
   ☐ Hunting
   ☐ Fishing
   ☐ Swimming in a lake (not a swimming pool)
   ☐ Swimming in the ocean
   ☐ Boating in a river
   ☐ Boating in a lake
   ☐ Boating in the ocean

8. Have you ever belonged to a hunting club, fishing club, or any environmental group that required annual dues of its members?

   ☐ Yes ☐ No

SECTION B

Function #1 – Water Quality

Wetlands improve water quality in nearby rivers and streams, and have considerable value as filters for future drinking water. A wetland's natural biological and chemical processes can remove excess nutrients and bacteria before water leaves a wetland, making it healthier for drinking, swimming and supporting plants and animals. For example, the Congaree Bottomland

Hardwood Swamp in South Carolina removes a quantity of pollutants from the watershed equivalent to that which would be removed by a $5 million treatment plant.

It is difficult to assess a dollar value for the benefits provided by a wetland. The standard market value of wetland per acre may not capture the public benefit, such as improving water quality, storing floodwater, providing habitat for animals and plants, providing recreation and reducing erosion.

9. **With improving water quality in mind**, is the wetland worth more, less, or the same dollar amount to you as the market value of a piece of land? (Please check one box.)
   - ☐ More than the market value of a piece of land alone. (proceed to Question #10)
   - ☐ Less than the market value of a piece of land alone. By how much $_____
   - ☐ The same amount as the market value of a piece of land. (proceed to Function#2)

10 If the state is willing to acquire the wetland in order to protect it from being drained or filled, what is the maximum amount you believe the state should pay per acre over and above the market value of wetland as a piece of land for the public benefit of improving water quality. *Please select one box or amount that satisfies you.*
   - ☐ 1 % of the land market value
   - ☐ 5 % of the land market value
   - ☐ 10 % of the land market value
   - ☐ 50 % of the land market value
   - ☐ 100% of the land market value
   - ☐ 200 % of the land market value
   - ☐ 300% of the land market value
   - ☐ OTHER (Please specify) $_____

11. How sure are you about the amount you did choose? (Please check one box.)
   - ☐ Very sure
   - ☐ Somewhat sure
   - ☐ Not very sure
   - ☐ Not sure at all

Function #2 – Storing Floodwater

In 1993, the flooding of the Mississippi and Missouri rivers resulted in the deaths of 47 people and caused between $15 billion and $20 billion in damage. Flood damages in the U.S. average $2 billion each year, causing significant loss of life and property. Wetlands can play a role in reducing the frequency and intensity of floods by acting as natural buffers, soaking up and storing a significant amount of floodwater. A one-acre wetland can typically store up to three-acre-feet of water, or about 1 million gallons. An acre-foot is one-acre of land (about three-quarters the size of a football field) covered one foot deep in water.

12. **With storing floodwater in mind**, is the wetland worth more, less, or the same dollar amount to you as the market value of a piece of land? (Please check one box.)
   - ☐ More than the market value of a piece of land alone. (proceed to Question #13)

☐ Less than the market value of a piece of land alone. By how much $_____
☐ The same amount as the market value of a piece of land. (proceed to Function#3)

13. If the state is willing to acquire the wetland in order to protect it from being drained or filled, what is the maximum amount you believe the state should pay per acre over and above the market value of wetland as a piece of land for the public benefit of storing floodwater. *Please select one box or amount that satisfies you.*

☐ 1 % of the land market value
☐ 5 % of the land market value
☐ 10 % of the land market value
☐ 50 % of the land market value
☐ 100 % of the land market value
☐ 200 % of the land market value
☐ 300% of the land market value
☐ OTHER (Please specify) $_____

14. How sure are you about the amount you did choose? (Please check one box.)

☐ Very sure
☐ Somewhat sure
☐ Not very sure
☐ Not sure at all

Function #3 – Providing habitat for animals and plants

Diverse species of mammals, plants, insects, amphibians, reptiles, birds and fish rely on wetlands for food, habitat or shelter. Wetlands are some of the most biologically productive natural ecosystems in the world, comparable to tropical rain forests or coral reefs in the number and variety of species they support. Although wetlands make up only about five percent of the land area of the lower 48 states, more than one-third of threatened and endangered species use or inhabit wetlands at some time in their life.

15. **With providing habitat for animals and plants in mind**, is the wetland worth more, less, or the same dollar amount to you as the market value of a piece of land? (Please check one box.)

☐ More than the market value of a piece of land alone. (proceed to Question #16)
☐ Less than the market value of a piece of land alone. By how much $_____
☐ The same amount as the market value of a piece of land. (proceed to Function#4)

16. If the state is willing to acquire the wetland in order to protect it from being drained or filled, what is the maximum amount you believe the state should pay per acre over and above the market value of wetland as a piece of land for the public benefit of providing habitat for animals and plants. *Please select one box or amount that satisfies you.*

☐ 1 % of the land market value
☐ 5 % of the land market value

☐ 10% of the land market value
☐ 50 % of the land market value
☐ 100% of the land market value
☐ 200 % of the land market value
☐ 300% of the land market value
☐ OTHER (Please specify) $_____

17. How sure are you about the amount you did choose? (Please check one box.)
☐ Very sure
☐ Somewhat sure
☐ Not very sure
☐ Not sure at all

Function #4 – Providing recreation
Wetlands are often inviting places for popular recreational activities including hiking, fishing, bird watching, photography and hunting. More than 82 million Americans took part in these activities in 2001, spending more than $108 billion on these pursuits. For example, over 34 million people went fishing in 2001, spending an average of $2,046 and an average 16 days on the water. Anglers spent $14.7 billion in 2001 for fishing trips, $17 billion on equipment and $4 billion for licenses, stamps, tags, land leasing and ownership, membership dues, contributions and magazines.

18. **With providing recreation opportunities in mind**, is the wetland worth more, less, or the same dollar amount to you as the market value of a piece of land? (Please check one box.)
☐ More than the market value of a piece of land alone. (proceed to Question #19)
☐ Less than the market value of a piece of land alone. By how much $_____
☐ The same amount as the market value of a piece of land. (proceed to Function#5)

19. If the state is willing to acquire the wetland in order to protect it from being drained or filled, what is the maximum amount you believe the state should pay per acre over and above the market value of wetland as a piece of land for the public benefit of providing recreation opportunities for the public. *Please select one box or amount that satisfies you.*
☐ 1 % of the land market value
☐ 5 % of the land market value
☐ 10 % of the land market value
☐ 50 % of the land market value
☐ 100 % of the land market value
☐ 200% of the land market value
☐ 300% of the land market value
☐ OTHER (Please specify) $_____

20. How sure are you about the amount you did choose? (Please check one box.)
☐ Very sure

☐ Somewhat sure
☐ Not very sure
☐ Not sure at all

Function #5 – Erosion Reduction
The ability of wetlands to control erosion is so valuable that some states are restoring wetlands in coastal areas to buffer the storm surges from hurricanes and tropical storms. Wetlands at the margins of lakes, rivers, bays and the ocean protect shorelines and stream banks against erosion. Wetland plants hold the soil in place with their roots, absorb the energy of waves and break up the flow of stream or river currents.

21. **With erosion reduction in mind**, is the wetland worth more, less, or the same dollar amount to you as the market value of a piece of land? (Please check one box.)
    ☐ More than the market value of a piece of land alone. (proceed to Question # 22)
    ☐ Less than the market value of a piece of land alone. By how much $_____
    ☐ The same amount as the market value of a piece of land. (proceed to Section #C)

22. If the state is willing to acquire the wetland in order to protect it from being drained or filled, what is the maximum amount you believe the state should pay per acre over and above the market value of wetland as a piece of land for the public benefit of erosion reduction. *Please select one box or amount that satisfies you.*
    ☐ 1 % of the land market value
    ☐ 5 % of the land market value
    ☐ 10 % of the land market value
    ☐ 50 % of the land market value
    ☐ 100 % of the land market value
    ☐ 200% of the land market value
    ☐ 300% of the land market value
    ☐ OTHER (Please specify) $_____

23. How sure are you about the amount you did choose? (Please check one box.)
    ☐ Very sure
    ☐ Somewhat sure
    ☐ Not very sure
    ☐ Not sure at all

SECTION C

24. Please check your gender.
    ☐ Male ☐ Female

25. In what year were you born? _____

26. Last week, which of the following best describes your activity?
    ☐ Unpaid homemaker
    ☐ Full-time paid employment

☐ Part-time paid employment
☐ With a job, but not at work (illness, vacation, strike)
☐ Unemployed, laid off, looking for work
☐ Retired
☐ Disabled
☐ In school, not working
☐ In school and working full-time or part-time
☐ Other (Please specify) _____

27. Does your current or former employment have anything to do with environmental protection or conservation?
☐ Yes ☐ No

28. If yes, please describe that employment:
_____
_____
_____

29. Does your current or former employment have anything to do with real estate or development?
☐ Yes ☐ No

30. If yes, please describe that employment:
_____
_____
_____

31. What is the highest grade of school or college that you have completed?
☐ Less than high school graduate
☐ High school graduate
☐ Some college
☐ College graduate
☐ Master's degree or law degree
☐ Doctorate degree or MD degree

32. How many years have you lived in Missouri? _____ years

33. What is your ZIP code? _____

What other comments or suggestions do you have for the Missouri Department of Natural Resources?
_____
_____
_____
_____

Thank you very much for your help!