WATER RESOURCES RESEARCH, VOL. 27, NO. 10, PAGES 2523–2531, OCTOBER 1991

Measuring Contingent Values for Wetlands: Effects of Information About Related Environmental Goods

JOHN C. WHITEHEAD

Department of Economics, East Carolina University, Greenville, North Carolina

GLENN C. BLOMQUIST

Department of Economics, University of Kentucky, Lexington

A model of contingent market behavior is developed which emphasizes the role of household information about wetlands and related environmental goods. Information is acquired through previous experience with wetlands and through the contingent market. Households which are unaware of substitute or complement environmental goods when participating in contingent markets may overstate or understate willingness to pay values. This paper estimates willingness to pay for preservation of the Clear Creek wetland in western Kentucky when faced with surface coal mining. We test for the effects of explicit information about related environmental goods on contingent values by measuring the difference in stated willingness to pay. Willingness to pay for preservation of the Clear Creek wetland decreases with information about surface coal mine lake reclamation and, in the initial, independent format increases with information about a nearby publicly owned, wetland area. These findings suggest that the lack of explicit information about related environmental goods in contingent markets can contribute to a misstatement of willingness to pay.

1. Introduction

The western Kentucky coalfield, along the lower Ohio River, contains bottomland hardwood forest wetlands. These wetlands provide water quality maintenance, groundwater recharge, fish and wildlife habitat, flood and erosion control, biological productivity, and outdoor recreation for the area. In addition, several threatened and endangered plant and animal species are found in these wetlands. Since extensive coal resources are also in the western Kentucky coalfield, surface coal mining is a competing use of wetlands. An economic approach to wetlands allocation would be to find a balance between competing uses of wetlands based on their relative values. This research was designed to measure the value of a particular wetland faced with surface coal mining in western Kentucky. The Clear Creek wetland system, the largest wetland tract in the western Kentucky coalfield, was chosen as the study site. The Clear Creek wetland is representative of the competitive use of wetlands since much of the area has been altered directly by surface coal mining or indirectly by acid mine drainage [*Kentucky Division of Water*, 1981]. The preservation value of the Clear Creek wetland is representative of wetland values in the western Kentucky coalfield.

Little empirical attention has been given to the effects of information about related environmental goods on total economic value (see *Samples and Hollyer* [1989] and *Boyle et al.* [1990] for exceptions). The purpose of this paper is to provide a test for the potential effects of information about related environmental goods on contingent values. We model contingent market behavior for households which possess different information sets about wetlands and formulate hypotheses about how stated willingness to pay values may differ for different households. We argue that contingent markets that do not include information about related environmental goods can generate overstatements or understatements of value. We estimate total values for the Clear Creek wetland under different information sets introduced in the contingent market. Results suggest that particular attention should be paid to the effect of information about related environmental goods.

Paper number 91WR01769.
0043-1397/91/91WR-01769$05.00

2. Background

The total economic value of the Clear Creek wetland includes use values derived from wetland functions (e.g., water quality improvement) and nonuse, or existence, values. Existence value for wetlands is defined as the value of a wetland resource received from the knowledge of wetland preservation, even without on-site or off-site use of the wetland. Unique, irreplaceable wetlands may generate positive existence values. If the Clear Creek wetland is perceived to be unique and irreplaceable, existence values may be a significant portion of total value.

Since its introduction by *Krutilla* [1967], theoretical definitions of existence value and discussions of the motives for existence value have strengthened the notion that existence value is a component of total economic value [*McConnell*, 1983; *Randall and Stoll*, 1983; *Fisher and Raucher*, 1984; *Brookshire et al.*, 1987; *Madariaga and McConnell*, 1987; *Smith*, 1987; and *Loomis*, 1988]. Since development of the contingent valuation (CV) method several studies have successfully measured existence value as a component of total value [*Greenley et al.*, 1981; *Schulze et al.*, 1983; *Brookshire et al.*, 1983; *Walsh et al.*, 1984; *Sutherland and Walsh*, 1985; *Boyle and Bishop*, 1987; *Loomis*, 1987; *Bowker and Stoll*, 1988].

When estimating total values that may contain existence values an especially important issue is how much information to present in the contingent market. Information might be about the resource to be valued [*Samples et al.*, 1986; *Boyle*, 1989; *Bergstrom et al.*, 1990], about budget constraints and other peoples' contingent values [*Bergstrom et al.*, 1989], or about related environmental goods [*Boyle et al.*, 1990; *Samples and Hollyer*, 1989]. Effects of good information are desirable since the difference between stated willingness to pay and true willingness to pay is reduced [*Bergstrom et al.*, 1989]. Unfamiliarity with the wetland resource being valued and related environmental goods will increase the effects of information not presented in the contingent market. Statements of willingness to pay across households will not be accurate statements of value if they are based on differing perceptions of the wetland resource and related environmental goods and not on preferences for the wetland resource with good knowledge about related environmental goods.

Households who participate in contingent markets do not possess the same amount of information. Some households are users and will have acquired information through visits to the resource. Some nonusers will have acquired information through a variety of nonvisit means. However, some households will not have information and will learn about the wetland resource only from what is presented in the contingent market. For these households, information about related environmental goods that may be substitutes or complements can influence stated willingness to pay values. If substitute environmental goods are not presented in the contingent market and are not perceived to be present, contingent values can be overstated. If complementary environmental goods are not presented in the contingent market and are not perceived to be present, contingent values can be understated.

3. A Model of Contingent Market Behavior

In this section we model contingent market participant behavior in a household production framework to explicitly identify the role of information about wetlands acquired through use of wetlands and through the contingent market. Define utility over consumption activities and wetland areas

$$U = U(z_1, z_2, Q_i) \tag{1}$$

where $U(\cdot)$ is the utility function, z_1 is a wetlands-related activity, z_2 is a nonwetlands-related activity, and Q_i are wetland areas, $i = 1, \cdots, n$. Wetland areas appear in the utility function conditional on information about wetlands being obtained. For instance, if no information about wetlands has been obtained the relevant utility function is $U(z_1, z_2, 0)$.

Activities must be produced by households. In activity production functions, households combine market goods and wetland resources with time to produce the particular activity

$$z_1 = f_1(x, t, Q_i; s) \tag{2}$$

$$z_2 = f_2(x, t; s) \tag{3}$$

where $f_1(\cdot)$ and $f_2(\cdot)$ are household production technologies, x is a composite commodity market good, t is time inputs, and s is socioeconomic characteristics. With the household production model, wetlands can generate utility indirectly through use of wetlands as an activity input with equation (2) or directly through (1). Households that pursue on-site or off-site activities related to wetlands will gather information about wetlands and Q_i will appear in the household utility function equation (1).

Household behavior is constrained by both time and money. Assuming a constant wage rate and no nonlabor income, households choose activities to pursue based on preferences given in (1) and costs of activities given by the full income constraint

$$Y = px + wt \tag{4}$$

where Y is full income which includes the value of time, p is the market price of the composite commodity, and w is the wage rate. Since Q_i is a nonmarket good, no market prices are available for assigning costs. The household problem is to minimize expenditures of full income (4) while maintaining a constant level of utility (1) with activity production functions substituted into (1). Solution of this consumer problem yields the expenditure function

$$e = e(p, Q_i, U) \tag{5}$$

where $e(\cdot)$ is the expenditure function. The constant wage rate and socioeconomic characteristics have been suppressed for simplicity. The expenditure function defines the amount of time and money necessary to achieve the maximum level of utility defined by $U(\cdot)$. Note that households that have no knowledge of wetland resources will solve the expenditure minimization problem differently, with $Q_i = 0$ substituted into (5) for Q_i.

In a contingent market for wetland preservation households form contingent values for preservation using the expenditure function. Consider a contingent market that presents a contingent market participant with the possibility of surface coal mining of the Clear Creek wetland. The household that has gathered information about wetlands will state willingness to pay to avoid surface coal mining defined by

$$\text{WTP}_1 = e(p, Q_1^n, Q_2, \cdots, Q_n, U) - e(p, Q_1^0, Q_2, \cdots, Q_n, U) \tag{6}$$

where Q_1 is the Clear Creek wetland, WTP_1 is the willingness to pay for preservation of the Clear Creek wetland, Q_1^n is the amount of the Clear Creek wetland preserved after surface coal mining, Q_1^0 is the amount of the Clear Creek wetland preserved prior to surface coal mining, and $Q_2, \cdots, Q_n$ are related environmental goods which may be substitutes or complements to the Clear Creek wetland. Willingness to pay is the increased expenditure on other activities necessary to maintain a constant utility level $U(\cdot)$ after surface coal mining of the Clear Creek wetland. Willingness to pay includes both use and existence values.

Information sets about wetlands acquired through pursuit of wetlands-related activities are more complete than those acquired solely through a contingent market. Consider a household that has not pursued the wetland-related activity and has not gathered information about wetlands. Information about the Clear Creek wetland is presented in a contingent market. The resulting expenditure function is

$$e = e(p, Q_1, O_2, \cdots, O_n, U) \tag{7}$$

where $0_2, \cdots, 0_n$ indicates related environmental goods are not arguments in the expenditure function. A contingent market participant who has information about the Clear Creek wetland only will use (7) when stating willingness to pay instead of (5)

$$\mathrm{WTP}_1' = e(p, Q_1'', 0_2, \cdots, 0_n, U) - e(p, Q_1^0, 0_2, \cdots, 0_n, U) \quad (8)$$

where WTP_1' is willingness to pay when information about the Clear Creek wetland has been acquired through a contingent market that does not contain information about related environmental goods.

An incomplete contingent market is presented to households with incomplete information about the wetland resource since related environmental goods are inadvertently absent. The lack of information about related environmental goods can cause stated willingness to pay for Clear Creek preservation to differ if the previously uninformed contingent market participant is given information about related environmental goods. The amount of the difference is defined by $D = \mathrm{WTP}_1' - \mathrm{WTP}_1$ or

$$D = \{e(p, Q_1'', 0_2, \cdots, 0_n, U) - e(p, Q_1^0, 0_2, \cdots, 0_n, U)\} - \{e(p, Q_1'', Q_2, \cdots, Q_n, U) - e(p, Q_1^0, Q_2, \cdots, Q_n, U)\} \quad (9)$$

where D is the willingness to pay difference. If the difference is not equal to zero, information about related environmental goods has affected stated willingness to pay values. The difference can be either positive or negative depending on the relationship between the Clear Creek wetland and the related environmental goods in household behavior. If substitute environmental goods exist in the information set defined by $Q_2, \cdots, Q_n$, the lack of information about substitutes in the contingent market will cause WTP_1' to be greater than WTP_1 and $D > 0$. If complement environmental goods exist in the information set and not in the contingent market, WTP_1' will be less than WTP_1 and $D < 0$.

An approach that may minimize the willingness to pay difference is to present information about related environmental goods along with information about the Clear Creek wetland. The explicit introduction of information about substitute environmental goods can have a negative effect on willingness to pay for wetlands preservation if the household did not consider related environmental goods without that information. The explicit introduction of information about complement environmental goods can have a positive effect on willingness to pay for wetlands preservation if the household did not consider related environmental goods without that information.

4. MEASUREMENT OF WILLINGNESS TO PAY AND INFORMATION EFFECTS

The contingent valuation (CV) method is a survey approach to the measurement of environmental values [*Cummings et al.*, 1986; *Mitchell and Carson*, 1989]. Contingent valuation surveys contain at least five distinct components: (1) a description of the natural resource that is to be valued, (2) a proposed policy affecting the natural resource, (3) a hypothetical method of paying for the policy, (4) a policy implementation rule, and (5) a value elicitation question. The dichotomous choice form of contingent valuation can be designed so that it contains these five components [*Hoehn and Randall*, 1987]. In the dichotomous choice contingent market, survey respondents are presented with an environmental policy and a randomly chosen policy price and asked to respond yes or no to a close-ended value elicitation question.

To illustrate the dichotomous choice decision, consider a contingent market for preservation of the Clear Creek wetland. The household respondent knows its willingness to pay to avoid surface coal mining. Each household is presented with a policy price which, if paid by all households, would finance avoidance of surface coal mining. Comparison of the policy price with household willingness to pay (with full information) creates the following choice problem

$$A \lesseqgtr \mathrm{WTP}_1 \quad (10)$$

where A is the policy price variable. According to (10), if the policy price is greater than willingness to pay the household respondent will answer no to the dichotomous choice. If the policy price is less than willingness to pay the household respondent will answer yes to the dichotomous choice. Equality of the policy price and willingness to pay implies indifference.

Willingness to pay is an unobserved variable which cannot be directly estimated since only the yes and no responses to the dichotomous choice question are observed. The probability of a yes response is the probability that the policy price is less than or equal to willingness to pay

$$\pi(\text{yes}) = \pi(\mathrm{WTP}_1 + \varepsilon \geq A) = \pi(\mathrm{WTP}_1 - A \geq \varepsilon) \quad (11)$$

where $\pi(\cdot)$ is the probability function and ε is a mean zero error term. The mean zero term is specified, assuming willingness to pay is the mean value function to account for unobservable elements of willingness to pay [*McConnell*, 1990]. Assuming a logistic error model, empirical implementation of (11) yields the following:

$$\pi(\text{yes}) = \left\{1 + \exp\left[-\left(\gamma_0 + \alpha A + \sum_{i=1}^{n} \gamma_i Q_i + \sum_{j=n+1}^{m} \gamma_j s_j\right)\right]\right\}^{-1} \quad (12)$$

where γ_0, α, γ_i, and γ_j are estimated logit coefficients and s_j are socioeconomic characteristics. The policy price variable can be specified in either the linear functional form, as presented in (12), or other functional forms. We have chosen the log of the policy price ($\ln A$) for estimation since it statistically outperforms the linear functional form based on χ^2 and McFadden's R^2 statistics.

Analysis of responses to dichotomous choice CV questions provides information about household willingness to pay. Implicit is that when the value of the estimated equation is equal to zero, the probability of a yes response is equal to 0.5. A 50% probability of a yes response means that each household is indifferent between the choices presented in the contingent market. The value of the policy price that drives π(yes) to indifference is a theoretically correct measure of willingness to pay for a household. *Cameron* [1988] shows how the logistic model can be transformed and interpreted as a willingness to pay function using the "censoring" of logistic regression at the policy price value. We use the Cameron willingness to pay estimate which when the logit equation (12) is estimated in log form (ln A) is

$$\ln \text{WTP}^* = \kappa\left(\gamma_0 + \sum_{i=1}^{n} \gamma_i Q_i + \sum_{j=n+1}^{m} \gamma_j s_j\right) \qquad (13)$$

where $\kappa = -1/\alpha$, see *Cameron* [1988].

To estimate the willingness to pay value for each household the independent variables are substituted into (13) and a willingness to pay value is estimated for each household in the sample, WTP* = exp(ln WTP*). WTP* is the median value for each household. To calculate a mean value for each household would require WTP to be scaled by κ. The mean WTP would equal $\text{WTP}^*\Gamma(1 - \kappa)\Gamma(1 + \kappa)$ where Γ is the gamma function [see *Cameron*, 1988; *Patterson and Duffield*, 1991]. The Cameron willingness to pay estimates create data sets which allow tests of hypotheses using dichotomous choice CV data [*Milon*, 1989; *Loomis*, 1990].

5. Survey Design

A contingent valuation survey instrument was designed to measure the value of the Clear Creek wetland when faced with potential surface coal mining and measure the effects of information about related environmental goods on willingness to pay. Preliminary survey work included a focus group and a mailed pretest. The use of color photographs to depict the Clear Creek wetland and related environmental goods were tested during this time.

Focus Group

An important question is which potential substitute and complement environmental goods should be included in the contingent market [*Boyle et al.*, 1990]. Prior to the focus group several potential related environmental goods were considered for inclusion in the contingent market. As a first approximation of the most related goods, surface coal mines reclaimed as lakes and alternative wetland locations were selected for pretesting. Reclaimed lakes are related because if Clear Creek wetland is mined a lake reclaimed on the same site could possible replace it. Other wetland locations are spatially related to Clear Creek, separated by distance.

A focus group was convened to pretest the survey instrument and choose photographs of the Clear Creek wetland, a reclaimed lake, and an alternative wetland location for use in the survey instrument. Focus group participants were led through a photograph similarity exercise to help identify related environmental goods to be used in the mail survey. The more similar the photographs the more related the environmental good [*Williams*, 1988]. Thirty-one slides and negatives were gathered from various government agencies and newspapers. These slides and negatives included scenes with natural wetlands, surface coal mines, reclaimed mines, and reclaimed wetlands and were developed into 5 × 7 inch color prints. A reference photograph of a natural wetland was chosen beforehand based on photograph quality and the number of wetland characteristics in the scene. Ten photographs were chosen for comparison with the reference photograph.

Participants were instructed to compare the reference photograph with the ten preselected photographs and rate them on a seven-point similarity scale according to their perception of the similarity of environmental setting. The reference photograph was shown to each participant and the photographs were turned over one by one for individual comparison. After participants had made their similarity rating the next photograph was turned over for viewing and rating. The photographs which were rated most similar were chosen for presentation in the contingent markets to increase the relatedness of the environmental goods compared to the Clear Creek wetland.

Pretest

A pretest of Lexington, Kentucky, households was conducted to estimate a range of policy prices for insertion into the dichotomous choice questions for the expanded Kentucky sample. The range and distribution of policy prices needed for the dichotomous choice valuation question should be similar to the range and distribution of true willingness to pay. To get some idea of the range and distribution of true willingness to pay, open-ended maximum willingness to pay values were obtained for preservation of the Clear Creek wetland. Open-ended responses are potentially underreported since open-ended valuation questions are not thought to be incentive compatible. However, we use the open-ended responses to choose prices to offer households and not to estimate willingness to pay directly. Twenty-three usable responses were received.

First, willingness to pay values were ranked from highest to lowest assigning a rank (R) of 1 to the lowest value and 23 to the highest value with ties receiving the highest value. The probability of a dichotomous choice no response was estimated by dividing the rank of willingness to pay by the number of observations, $\pi(\text{no}) = R/n$. Policy prices are then estimated by pairing willingness to pay with the corresponding probabilities and multiplying, $A = \pi(\text{no})$ WTP. This procedure (and rounding) generated six policy prices in 1989 dollars for use in the survey instrument: $\$A = 2, 7, 9, 17, 23,$ and 50. The six prices represent the low and high ends of the range of open ended willingness to pay values. Policy prices were assigned to individual survey instruments according to the frequency of willingness to pay values reported in the pretest to approximate the distribution of true willingness to pay.

Instrument and Experimental Design

Color photographs were included with the survey instrument to facilitate the formation of willingness to pay statements. The four previously chosen color photographs were arranged side by side, labeled and printed in color on a glossy sheet. "Wetland scene 1" depicts the Clear Creek natural wetland with hardwood trees, standing water, and nonwoody plants characteristic of wetlands. "Wetland scene 2" depicts the reclaimed surface coal mine grassland area (standard reclamation of surface coal mines in the western Kentucky coalfield). "Wetland scene 3" depicts the reclaimed coal mine which was constructed to form a lake with nonwoody plants but no hardwood trees. "Wetland scene 4" depicts the Henderson Sloughs which is the publicly owned wetland area nearest the Clear Creek wetland.

The valuation section of the instrument describes functions and benefits of wetlands including waterfowl habitat, alternative uses of wetlands, the current level of provision of wetlands in Kentucky, and the potential mining of wetlands for coal. The Clear Creek wetland area, its current provision level, and potential coal mining are introduced and a wetland preservation policy is described. The payment vehicle is a hypothetical "Wetland Preservation Fund" (WPF) into which households can donate money for the purpose of acquisition and management of natural wetlands. Survey respondents are informed that Clear Creek has been proposed for acquisition through the WPF and the purchase price is \$*A* for each Kentucky household. The implicit policy implementation rule is majority approval. *Hoehn and Randall* [1987] shows that this rule used with dichotomous choice CV is incentive compatible. That is, revealing true willingness to pay is the household respondents' best answer.

There are three versions of the survey instrument each with a different set of information presented for an initial contingent market. Instrument version 1 presented the reclaimed grassland (Scene 2) as the replacement for the Clear Creek wetland after surface coal mining. No information about related wetlands is presented. Version 2 presented the reclaimed wetland lake (scene 3) as a replacement for the Clear Creek wetland (the related environmental good). Version 3 presented the reclaimed grassland (scene 2) as the replacement and the undisturbed, nearby Henderson Sloughs (scene 4) as the related environmental good. Survey respondents receive one of the three versions of the contingent market and are presented with an initial dichotomous choice valuation question (contingent market 1).

After the initial valuation question the remaining information about related environmental goods is presented to all survey respondents. In version 1 of the survey instrument information about the reclaimed lake and the Henderson Sloughs is presented. In version 2, information about the Henderson Sloughs is presented. In version 3, information about the reclaimed lake is presented. A second dichotomous choice valuation question is presented with information about two related environmental goods included, the reclaimed lake and the Henderson Sloughs (contingent market 2). The appendix contains the first and second contingent markets for each of the three versions of the survey instrument.

Hypotheses

The experimental design of the survey instrument allows five tests of the hypothesis that explicit information about related environmental goods will affect willingness to pay. There are two major tests: (1) tests between responses to the first contingent market in the three versions and (2) tests between responses to the first and second contingent markets. The valuation question of the first contingent market allows comparisons of willingness to pay across households presented with markets containing different related environmental goods. The valuation question of the second contingent market taken together with the first allows comparisons of willingness to pay for the same household as information about additional related environmental goods is presented sequentially.

Comparisons across responses to the initial valuation question in the three versions allows two hypothesis tests. The null hypotheses are that there is no difference in willingness to pay. The null hypotheses are H_1: $\mathrm{WTP}_{11}(Q_1, 0_2, 0_3) = \mathrm{WTP}_{12}(Q_1, Q_2, 0_3)$ and H_2: $\mathrm{WTP}_{11}(Q_1, 0_2, 0_3) = \mathrm{WTP}_{13}(Q_1, 0_2, Q_3)$, where for WTP_{kl} k is the valuation question (1 or 2) and l is the version (1, 2, or 3), Q_1 is the Clear Creek wetland, Q_2 is the reclaimed lake, and Q_3 is Henderson Sloughs. For these two tests across households, $k = 1$. The alternative hypotheses are that there is a difference in willingness to pay. Comparisons between the initial valuation question and the subsequent valuation question for the same household allows three tests. The null hypotheses are H_3: $\mathrm{WTP}_{11}(Q_1, 0_2, 0_3) = \mathrm{WTP}_{21}(Q_1, Q_2, Q_3)$, H_4: $\mathrm{WTP}_{12}(Q_1, Q_2, 0_3) = \mathrm{WTP}_{22}(Q_1, Q_2, Q_3)$, H_5: $\mathrm{WTP}_{13}(Q_1, 0_2, Q_3) = \mathrm{WTP}_{23}(Q_1, Q_2, Q_3)$, where for the instrument versions ($l = 1, 2, 3$) these are the differences between willingness to pay elicited for the first and second questions ($k = 1, 2$). Again, the alternative hypotheses are that there is a difference in willingness to pay.

6. RESULTS

A systematic random cluster sample was drawn from Kentucky telephone directories according to the technique described by *Sudman* [1976]. Survey instruments were designed as booklets and mailed to Kentucky residents, along with the color photograph sheet, during the summer of 1989 following the *Dillman* [1978] Total Design Method. A response rate of 31% was achieved after a follow up postcard and a follow up instrument mailing. After deleting observations which did not respond to both valuation questions and socioeconomic questions, a sample size of 215 remained for the analysis. An abbreviated follow up survey to nonrespondents elicited 67 responses. Comparison suggests no obvious differences between respondents and nonrespondents. A study designed to measure differences between respondents and nonrespondents may detect some difference.

Table 1 presents logistic regression results of dichotomous choice valuation questions from the two contingent markets. The mean of each independent variable is presented beneath the variable name. Fifty-seven percent of the sample had previous knowledge that wetlands in western Kentucky existed. The sample averaged 2.8 members per household and 0.71 children. The average age and education are 47.54 and 13.62 years. Sixty-seven percent of the population is male. The average hourly wage is \$16.17, which implies an annual income of approximately a \$32,000. In addition to the summary statistics presented in Table 1 the sample is characterized by nonusers of wetland resources. Only 16% of the sample had ever visited a wetland area in western Kentucky. Of those who had visited, 74% had fished, 54% had hunted, 74% had photographed nature, 25% had observed nature, and 20% had pursued other activities. A very small number had visited a wetland area in the location of Clear Creek suggesting that much of the total willingness to pay value is existence value.

The dependent variable in Table 1 is 1 for yes and 0 for no and when estimated we get the log odds of the probability of a yes response to the dichotomous choice CV question. We pool data across the three versions of the survey instrument.

TABLE 1. Logistic Regression Results of Responses to Contingent Markets 1 and 2

Variable	Contingent Market 1	Contingent Market 2
Constant	1.078	1.189
	(1.00)*	(1.09)
ln A = ln (policy price)	−0.786†	−0.747†
(2.36)	(4.46)	(4.22)
Q_2 = reclaimed lake	−0.682§	−0.547
(lake = 1, 0.37)	(1.79)	(1.42)
Q_3 = Henderson Sloughs	0.263	0.056
(sloughs = 1, 0.33)	(0.68)	(0.14)
Knowledge of wetlands	0.261	0.386
(knowledge = 1, 0.57)	(0.81)	(1.17)
Household size	0.188	0.180
(2.80 people)	(0.98)	(0.92)
Children	−0.240	−0.177
(0.71)	(0.93)	(0.68)
Gender	0.228	0.010
(male = 1, 0.67)	(0.65)	(0.03)
Age	−0.023‡	−0.026‡
(47.54 years)	(2.13)	(2.33)
Education	0.102§	0.069
(13.62 years)	(1.92)	(1.28)
Wage	−0.016	−0.010
($16.17 per hour)	(0.93)	(0.56)
Sample size	215	215
Percent yes	45%	38%
Chi-square	40.85†	34.24†
McFadden's R^2	0.14	0.12

Dependent variable equals one if yes and zero if no, and we get ln [π (yes)/1-π (yes)] when estimated.
*Absolute value of the asymptotic t ratio in parentheses.
†Significant at the 0.01 level.
‡Significant at the 0.05 level.
§Significant at the 0.10 level.

Versions 2 and 3 are included as dummy variables. Column 1 reports results from the (initial) valuation question of contingent market 1 and column 2 reports results from the (sequential) valuation question of contingent market 2. The log odds of the probability of a yes response to the dichotomous choice valuation question is specified to depend on the policy price variable, instrument version dummy variables, and socioeconomic characteristics.

The coefficient on the log of the policy price variable is negative and significant indicating that as the price variable increases the probability of a YES response decreases. For contingent market 1 the coefficient on the questionnaire version 2 reclaimed lake dummy variable is negative and significant. The negative sign suggests that the lake is a substitute environmental good for the Clear Creek wetland.

TABLE 3. Comparisons of Willingness to Pay Differences Under Different Information Sets: Based on (Initial) Contingent Market 1 for Three Versions

Hypothesis*	WTP Difference (D)	t value†
H_1: $WTP_{11} = WTP_{12}$	$5.81‡	6.18
	(53%)§	
H_2: $WTP_{11} = WTP_{13}$	−$5.71‡	3.64
	(52%)	

*The null hypothesis for each test is that the difference is 0; the alternative is that the difference is not zero.
†Wilcoxon rank-sum test.
‡Significant at the 0.01 level.
§Percentage change in willingness to pay in parentheses.

The coefficient on the version 3 Henderson Sloughs dummy variable is positive suggesting a complementary (but insignificant) relationship. Age and education are also determinants of the probability of a yes response in contingent market 1. Neither the coefficient on the reclaimed lake or Henderson Sloughs variables are significant in contingent market 2. This insignificance is expected since the amount of information about related environmental goods in each contingent market of valuation question 2 is the same, only the order of information presentation differs. The log of the policy price and age variables are the only significant determinants of a yes response in contingent market 2.

Table 2 presents estimates of willingness to pay using the estimated coefficients from Table 1 and the *Cameron* [1988] approach. Since our estimate of κ is 1.27, which is greater than 1, the mean WTP for each household is undefined [*Patterson and Duffield*, 1991]. Accordingly, we estimate the median WTP for each household and calculate the mean of these values for each subsample. All coefficients in Table 1 are divided by the coefficient on the log of the policy price variable to generate the log of the willingness to pay function shown above in (13). Socioeconomic and dummy variables are then substituted to generate a willingness to pay data set for each subsample: versions 1, 2, and 3. Mean willingness to pay is calculated for each subsample. Rows 1–3 of Table 2 report willingness to pay for each instrument version in each contingent market. Willingness to pay estimates range from $5 to $17 for contingent market 1 and from $4 to $8 for contingent market 2.

Comparisons of the willingness to pay difference (D) under different information sets are made in Tables 3 and 4. Tests of hypotheses 1 and 2 are found in Table 3 and tests of hypotheses 3, 4, and 5 are found in Table 4. The estimated willingness to pay values are taken from Table 2. In general.

TABLE 2. Willingness to Pay Estimates

Version	Contingent Market 1	Contingent Market 2
1: n = 63	$WTP_{11}(Q_1, 0_2, 0_3)^*$ = $10.90	$WTP_{21}(Q_1, Q_2, Q_3)$ = $7.35
	(0.86)†	(0.60)
2: n = 80	$WTP_{12}(Q_1, Q_2, 0_3)$ = $5.09	$WTP_{22}(Q_1, Q_2, Q_3)$ = $3.75
	(0.39)	(0.28)
3: n = 72	$WTP_{13}(Q_1, 0_2, Q_3)$ = $16.61	$WTP_{23}(Q_1, Q_2, Q_3)$ = $8.13
	(1.32)	(0.63)

The exp (ln WTP*) value is estimated for each individual following (13) in the text. The mean of the estimated willingness to pay values are reported in this table.
*Q_1 is the Clear Creek wetland, Q_2 is the reclaimed lake, and Q_3 is the Henderson Sloughs.
†Standard error of the mean of the estimated willingness to pay values is reported in parentheses.

TABLE 4. Comparisons of Willingness to Pay Differences Under Different Information Sets: Based on (Sequential) Contingent Markets 1 and 2 for Three Versions

Hypothesis*	WTP Difference (*D*)	*t* Value†
H_3: $WTP_{11} = WTP_{21}$	$3.55‡ (33%)§	6.80
H_4: $WTP_{12} = WTP_{22}$	$1.34‡ (26)	7.47
H_5: $WTP_{13} = WTP_{23}$	$8.48‡ (51%)	7.37

*The null hypothesis for each test is that the difference is 0; the alternative is that the difference is not zero.
†Wilcoxon signed-rank test.
‡Significant at the 0.01 level.
§Percentage change in willingness to pay in parentheses.

these tests confirm the results of Table 1 in terms of the relationship between the Clear Creek wetland, the reclaimed lake, and the Henderson Sloughs. Test 1, which compares responses to the first valuation question on versions 1 and 2, produced a 53% reduction in willingness to pay for the sample presented information about the reclaimed lake. Test 2, which compares responses to the first valuation question of versions 1 and 3 produced a 52% increase in willingness to pay for the sample that was presented information about the Henderson Sloughs. These results suggest that the reclaimed lake is a substitute environmental good, and the Henderson Sloughs is a complementary environmental good for the Clear Creek wetland.

The willingness to pay data for each of the three versions have nonnormal distributions. The distribution is truncated at zero with a thick upper tail. Nonparametric methods, which do not require distribution assumptions, are appropriate for hypothesis testing. For hypotheses 1 and 2 the Wilcoxon rank-sum test is used to determine whether the willingness to pay distributions have equal means. The test involves ranking the data from the lowest to the highest. If the distributions have unequal means the sum of the ranks from the two samples will be different [*Freund and Walpole*, 1980]. Performance of these tests for hypotheses 1 and 2 reveals that the means of willingness to pay distributions are not equal at the 1% level of significance.

Tests 3–5 compare willingness to pay for each household from the first and second contingent markets for each version. Test 3, which is for the two questions of version 1, produced an decrease in willingness to pay as information about the reclaimed lake and Henderson Sloughs is presented in contingent market 2. The willingness to pay difference is smaller (a reduction of 33%) than the differences across instrument versions (tests 1 and 2). Information about both the reclaimed lake and the Henderson Sloughs is presented between valuation questions for test 1 so that the willingness to pay reduction can only be termed a substitutable relationship for the combined information about the related environmental goods.

Test 4, which is for the two questions of version 2 and tests the effects of additional information about Henderson Sloughs, generated a decrease in willingness to pay (26%). The willingness to pay reduction is inconsistent with prior results that suggest the Henderson Sloughs is a complement for Clear Creek (test 2). Test 5, which is for the two questions of version 3 and tests the effect of additional information about reclaimed lakes at Clear Creek, generated a decrease in willingness to pay (51%). This is consistent with prior results (test 1).

For hypotheses 3–5 the willingness to pay data is again nonnormally distributed. Further, we cannot assume that the samples are independent since comparisons of willingness to pay are made between the same household in different contingent markets. Households could have anchored their response to contingent market 2 to their response in contingent market 1. Or, households could have looked beyond the information in contingent market 1 when responding to contingent market 1. The Wilcoxon signed-rank test provides a test for comparing sample means without assumptions of normal distribution or independent samples [*Freund and Walpole*, 1980]. The signed-rank test ranks the absolute values of the differences in willingness to pay for each household and calculates the sum of the ranks assigned a positive difference and the sum of the ranks assigned a negative difference. If the distributions have equal means, the sum of the positive and negative ranks will be equal. Performance of this test for hypotheses 3–5 indicates that mean willingness to pay values are not equal at the 1% level of significance. Results of hypotheses 3–5 provide some evidence that information effects are significant. However, we attach more significance to the results of hypotheses 1 and 2 since the comparisons made in 3 through 5 are from samples which are not independent. Willingness to pay statements in contingent market 2 could be influenced by information ordering and statements made in contingent market 1 since the same household participates sequentially. Some evidence of an information ordering effect can be found in Table 2 where WTP_{22} is less than half of WTP_{21} and WTP_{23}. These values should be equal since contingent market 2 contains the same information for all respondents.

7. CONCLUSIONS

Overstatement and understatement of willingness to pay can result from a lack of information about related environmental goods in contingent markets. The CV method typically assumes that households consider related environmental goods when stating willingness to pay. However, it is argued that household respondents state willingness to pay based on their information sets acquired through activity participation and from the contingent market. Households which do not use natural resources as environmental goods generally lack information about the particular environmental good to be valued and potential related environmental goods. These households may have existence values for the natural resource and be willing to pay money for preservation. In the contingent market the natural resource to be valued may appear to be without substitutes and/or complements. The reduction or increase in willingness to pay upon the introduction of information about related environmental goods measures the effects of information about related environmental goods.

Considering results from the initial (not sequential) contingent market reported here, the value of the Clear Creek wetland in western Kentucky is estimated to be between $5 and $17 for each Kentucky household each year depending on information provided in the contingent market. Introduction of information about substitute environmental goods (reclaimed lakes) lowers willingness to pay values for the

Clear Creek wetland. The estimated information effects are reflected in the $5.81 difference (decrease) in willingness to pay. We also find that willingness to pay rises when information about a complement (Henderson Sloughs) is introduced. The estimated information effects are reflected in the $5.71 difference (increase) in willingness to pay with information about the Henderson Sloughs. The results from the sequential contingent market (number 2) are not entirely consistent, but we think the initial market (number 1) is more credible.

Our finding hints that the assumption that all households are aware of related environmental goods which they would consider substitutes or complements may often be inadequate, especially for natural resources that generate existence value. Results support the notion that information introduced in contingent markets produces a desirable information effect [*Bergstrom et al.*, 1989] when all participants do not possess the same information sets. Explicit introduction of information about related environmental goods may minimize misstatements of willingness to pay that result from different prior information across households. These results may have implications for President Bush's "no net loss" wetlands retention policy. The economic value of a particular wetland area depends on other areas which individuals think are related. The total value of wetlands depends on the configuration of existing quantities and types of wetlands.

APPENDIX: CONTINGENT MARKETS

Wetland Benefits and Alternative Uses

Wetlands include lakes, ponds, marshes, swamps, oxbows, sloughs, and other similar bodies of water which have been created naturally. Wetlands provide a natural habitat for many species of fish, wildlife, and plants. In western Kentucky, wetlands provide a summer nesting habitat for wood ducks and a winter habitat for mallard ducks and Canadian geese. Other benefits of wetland preservation include flood and erosion control, water quality enhancement, groundwater recharge, and outdoor recreation such as hunting and nature observation.

With this in mind, consider that preservation of natural wetlands involves giving up other potential uses. Commercial development of wetlands includes coal mining, agricultural production, residential, and urban and highway development. These alternative uses of wetlands are desirable also.

Current Status and Wetland Preservation Fund

It has been estimated that over one half of Kentucky's natural wetlands have been drained for various alternative uses. Over 36,000 acres of wetlands are currently protected from development in western Kentucky, while 48,000 more acres have been proposed for protection.

The map on the following page illustrates the Clear Creek wetland area in Hopkins County, Kentucky. This creek and its tributaries once accounted for about 10,000 acres of wetlands. Because of coal mining and other alternative uses, about 5000 acres of wetlands remain in the Clear Creek area.

A recently proposed wetland preservation policy would establish a Wetland Preservation Fund in Kentucky. Money from the Fund would be used to purchase and manage natural wetlands, such as Clear Creek, which are desired for alternative uses. Households would be able to donate money into the fund and gain the knowledge that natural wetlands would be preserved in Kentucky. Without the wetland preservation policy, many of Kentucky's remaining natural wetlands will be converted to alternative uses.

Contingent market 1. First look at the enclosed sheet of color photographs. Wetland scene 1 pictures the Clear Creek wetland area in western Kentucky. About 5000 acres (about 7 square miles) of wetlands along Clear Creek and its tributaries lie within the western Kentucky coal field.

Now look at wetland scene 2 which pictures a reclaimed, surface-mined wetland. Coal companies are required to reclaim wetlands after mining the coal. Even with this type of reclamation, however, the natural wetlands will be lost. Hardwood trees would be removed and waterfowl would leave the Clear Creek area.

Instrument version 1: No information about related environmental goods is presented.

Instrument version 2: Look at wetland scene 3 which pictures a reclaimed surface mined wetland and compare it to wetland scene 1. Surface coal mining companies are able to reclaim mined areas to provide lakes which function as wetlands. To build the lakes, the coal pit is not filled with excess dirt and rock as is usually required. Instead, equipment is used to grade the pit to provide shallow and deep water areas. Organic bases are then laid to neutralize water pollution.

Instrument version 3: Look at wetland scene 4 which pictures the Henderson Sloughs wetland area and compare it to wetland scene 1. This area is located in Henderson County, shown on the map on page 4, about 35 miles from the Clear Creek wetland. These 10,000 acres (about 14 square miles) of wetlands are not threatened by surface coal mining since they are publicly owned and protected.

Suppose policy makers target the Clear Creek wetland as a priority wetland preservation site. It has been estimated that preservation of the Clear Creek wetlands would cost each Kentucky household $\$A$ each year. If this money is raised in contributions, it would be used to preserve the Clear Creek wetlands. Suppose that without the Wetland Preservation Fund, Clear Creek would be mined and reclaimed as a grassland (scene 2). Would you be willing to contribute $\$A$ each year, out of your own household budget, to the Wetland Preservation Fund to preserve the Clear Creek wetland as shown in wetland scene 1 (yes or no)?

Contingent market. Suppose a coal company is granted a permit to mine the Clear Creek wetland area. In cooperation with state agencies, the coal company will go beyond the reclamation shown in wetland scene 2. It would construct wetland lakes, stock ducks and geese on the lakes, and manage the area to insure that waterfowl populations do not fall. Because Henderson Sloughs are an existing wildlife management area, they would be preserved.

Suppose that without the Wetland Preservation Fund, Clear Creek would be mined and reclaimed as a lake (scene 3). Henderson Sloughs would be preserved (scene 4). Would you be willing to contribute $\$A$ each year, out of your own household budget, to the Wetland Preservation Fund to preserve the Clear Creek wetland as shown in scene 1 (yes or no)?

Acknowledgments. This research was supported in part with funds from the National Science Foundation (grant RII-8610671) and the Commonwealth of Kentucky through the Kentucky EPSCoR Program. We gratefully acknowledge comments from John Stoll, Kip Viscusi, two anonymous reviewers, an associate editor, and especially Richard Ready as well as participants in the Applied Microeconomics Workshop at the University of Kentucky and the Natural Resource Economics Workshop at North Carolina State University. An earlier version of this paper was presented at the Association of Environmental and Resource Economists/ASSA meetings held in Atlanta on December 28–30, 1989.

REFERENCES

Bergstrom, J. C., J. R. Stoll, and A. Randall, Information effects in contingent markets, *Am. J. Agric. Econ.*, *71*, 685–691, 1989.

Bergstrom, J. C., J. R. Stoll, and A. Randall, The impact of information on environmental commodity valuation decisions, *Am. J. Agric. Econ.*, *72*, 614–621, 1990.

Bowker, J. M., and J. R. Stoll, Use of dichotomous choice nonmarket methods to value the whooping crane resource, *Am. J. Agric. Econ.*, *70*, 372–381, 1988.

Boyle, K. J., Commodity specification and the framing of contingent-valuation questions, *Land Econ.*, *65*, 57–63, 1989.

Boyle, K. J., and R. C. Bishop, Valuing wildlife in benefit-cost analyses: A case study involving endangered species, *Water Resour. Res.*, *23*, 943–950, 1987.

Boyle, K. J., S. D. Reiling, and M. L. Phillips, Species substitution and question sequencing in contingent valuation surveys evaluating the hunting of several types of wildlife, *Leisure Sci.*, *12*, 103–118, 1990.

Brookshire, D. S., L. S. Eubanks, and A. Randall, Estimating option prices and existence values for wildlife resources, *Land Econ.*, *59*, 1–15, 1983.

Brookshire, D. S., L. S. Eubanks, and C. F. Sorg, Existence values and normative economics: Implications for valuing water resources, *Water Resour. Res.*, *22*, 1509–1518, 1987.

Cameron, T. A., A new paradigm for valuing non-market goods using referendum data: Maximum likelihood estimation by censored logistic regression, *J. Environ. Econ. Manag.*, *15*, 355–379, 1988.

Cummings, R. G., D. S. Brookshire, and W. D. Schulze, *Valuing Environmental Goods: An Assessment of the Contingent Valuation Method*, Rowman and Allanheld, Totowa, N. J., 1986.

Dillman, D. A., *Mail and Telephone Surveys: The Total Design Method*, John Wiley, New York, 1978.

Fisher, A., and R. Raucher, Intrinsic benefits of improved water quality: Conceptual and empirical perspectives, in *Advances in Applied Micro-Economics*, edited by V. K. Smith and D. White, pp. 37–66, JAI, Greenwich, Conn., 1984.

Freund, J. E., and R. E. Walpole, *Mathematical Statistics*, 3rd ed., Prentice-Hall, Englewood Cliffs, N. J., 1980.

Greenley, D. A., R. G. Walsh, and R. A. Young, Option value: Empirical evidence from a case study of recreation and water quality, *Q. J. Econ.*, *96*, 657–673, 1981.

Hoehn, J. P., and A. Randall, A satisfactory benefit-cost indicator from contingent valuation, *J. Environ. Econ. Manag.*, *14*, 226–247, 1987.

Kentucky Department for Natural Resources and Environmental Protection, Division of Water, *The Effects of Coal Mining Activities on the Water Quality of Streams in the Western and Eastern Coalfields of Kentucky*, Frankfort, Ky., April 1981.

Krutilla, J. V., Conservation reconsidered, *Am. Econ. Rev.*, *57*, 777–784, 1967.

Loomis, J. B., Balancing public trust resources of Mono Lake and Los Angeles' water right: An economic approach, *Water Resour. Res.*, *23*, 1449–1456, 1987.

Loomis, J., Broadening the concept and measurement of existence value, *Northeastern J. Agric. Resour. Econ.*, *17*, 23–29, 1988.

Loomis, J. B., Comparative reliability of the dichotomous choice and open-ended contingent valuation techniques, *J. Environ. Econ. Manag.*, *18*, 78–85, 1990.

Madariaga, B., and K. E. McConnell, Exploring existence value, *Water Resour. Res.*, *23*, 936–942, 1987.

McConnell, K. E., Existence and bequest value, in *Managing Air Quality and Scenic Resources at National Parks and Wilderness Areas*, edited by Robert D. Rowe and Lauraine G. Chestnut, pp. 254–264, Boulder, Colo., 1983.

McConnell, K. E., Models for referendum data: The structure of discrete choice models for contingent valuation, *J. Environ. Econ. Manag.*, *18*, 19–34, 1990.

Milon, J. W., Contingent valuation experiments for strategic behavior, *J. Environ. Econ. Manag.*, *17*, 293–308, 1989.

Mitchell, R. C., and R. T. Carson, *Using Surveys to Value Public Goods: The Contingent Valuation Method*, Resources for the Future, Washington, D. C., 1989.

Patterson, D. A., and J. W. Duffield, Comment on Cameron's Censored Logistic Regression Model for referendum data, *J. Environ. Econ. Manag.*, *20*, 275–283, 1991.

Randall, A., and J. R. Stoll, Existence value in a total valuation framework, in *Managing Air Quality and Scenic Resources at National Parks and Wilderness Areas*, edited by Robert D. Rowe and Lauraine G. Chestnut, pp. 265–274, Westview, Boulder, Colo., 1983.

Samples, K. C., J. A. Dixon, and M. M. Gowen, Information disclosure and endangered species valuation, *Land Econ.*, *62*, 306–312, 1986.

Samples, K. C., and J. R. Hollyer, Contingent valuation of wildlife resources in the presence of substitutes and complements, in *Economic Valuation of Natural Resources: Issues, Theory and Application*, edited by R. L. Johnson and G. V. Johnson, pp. 177–192, Westview, Boulder, Colo., 1989.

Schulze, W. D., D. S. Brookshire, E. G. Walther, K. K. MacFarland, M. A. Thayer, R. L. Whitworth, S. Ben-David, W. Malm, and J. Molenar, The economic benefits of preserving visibility in the national parklands of the southwest, *Nat. Resour. J.*, *23*, 148–173, 1983.

Smith, V. K., Nonuse values in benefit cost analysis, *S. Econ. J.*, *54*, 19–26, 1987.

Sudman, S., *Applied Sampling*, Academic, San Diego, Calif., 1976.

Sutherland, R. J., and R. G. Walsh, Effects of distance on the preservation value of water quality, *Land Econ.*, *61*, 281–291, 1985.

Walsh, R. G., J. B. Loomis, and R. A. Gillman, Valuing option, existence, and bequest demands for wilderness, *Land Econ.*, *60*, 14–29, 1984.

Williams, D. R., Measuring perceived similarity among outdoor recreation activities: A comparison of visual and verbal stimulus presentations, *Leisure Sci.*, *10*, 153–166, 1988.

G. C. Blomquist, Department of Economics, University of Kentucky, Lexington, KY 40506.

J. C. Whitehead, Department of Economics, East Carolina University, Greenville, NC 27858.

(Received July 10, 1990;
revised June 3, 1991;
accepted June 28, 1991.)