WATER RESOURCES RESEARCH, VOL. 31, NO. 9, PAGES 2341–2351, SEPTEMBER 1995

Testing part-whole valuation effects in contingent valuation of instream flow protection

Thomas C. Brown
Rocky Mountain Forest and Range Experiment Station, U.S. Forest Service, Fort Collins, Colorado

John W. Duffield
Department of Economics, University of Montana, Missoula

Abstract. A review of studies of part-whole valuation effects in contingent valuation highlights the difficulty of distinguishing part-whole bias from the effect of substitution among goods. A contingent valuation of instream flow preservation indicates that respondents with more information about substitutes were more sensitive in their valuations to the number of rivers protected than were respondents with less information. These results, in combination with those of other studies of part-whole valuation effects, suggest that contingent valuation researchers must design guidelines for deciding what information about substitutes should be presented to respondents and how that information should be presented.

Introduction

Economic measures of the recreational value of instream flow have been estimated in several studies (summarized by *Brown et al.* [1991]). Potentially more significant in terms of total value, but less often studied, is the nonuse value of preserving instream flow [*Loomis*, 1987; *Sanders et al.*, 1990]. It is now generally recognized that the value of a natural asset, such as a riparian area, may include nonuse or passive use value, in addition to active use value. Nonuse value of instream flow refers, in the economic context, to a willingness to pay (WTP) even if the person does not expect to visit the river in question, and can include existence value and bequest value (plus, in some formulations, option value) [*Krutilla*, 1967; *Randall and Stoll.*, 1983].

The legitimacy of measuring nonuse value in economic terms was elevated when nonuse value was included by the U.S. Department of Interior in 1986 as a category of value for which losses could be recovered under the CERCLA (Comprehensive Environmental Response, Compensation, and Liability Act of 1980, also known as the Superfund Act, 42 U.S.C. 9601-9675) regulations, and when that inclusion was upheld by the D.C. Court of Appeals in 1989 in *Ohio v. The United States Department of Interior*, 880, F.2d 432 (D.C. Cir.). What remains most controversial is the legitimacy of currently available methods for measuring nonuse value. Contingent valuation (CV), the primary tool for measuring nonuse value, has come under attack as not being a valid method of measuring the total economic value of public goods that may provide nonuse benefits [*Cambridge Economics*, 1992]. Nevertheless, the expert panel convened by the U.S. National Oceanic and Atmospheric Administration (NOAA) [*NOAA*, 1993] upheld the possibility of measuring nonuse value using CV, and NOAA later issued proposed regulations for damage assessments pursuant to the Oil Pollution Act of 1990 [*NOAA*, 1994] that support including nonuse values as a component within natural resource damage assessment. Further, a recent book [*Kopp and Smith*, 1993] offered a hopeful summary of the possibilities of measuring nonuse value. However, each of these treatises voiced sincere concern about the difficulties of properly specifying the good to be valued in CV, and specifically about the focus of this paper, part-whole valuation effects.

Paper number 95WR01744.
0043-1397/95/95WR-01744$05.00

Careful specification of the good is critical when CV is used to value complex and unfamiliar goods such as environmental assets. A key specification issue has to do with the scale or scope of the good. A good can vary in geographic scale (e.g., one river or several rivers), policy scope (e.g., protection of just flow or also adjacent riparian vegetation), or timescale (e.g., protection for one or many years). Studies have shown that CV respondents' estimates of WTP for the good can be surprisingly sensitive, or insensitive, to scale or scope depending on what information is presented about the good and its potential substitutes and about other aspects of the CV. Specifically, WTP for a good appears to depend on whether the good is valued separately or as part of a more inclusive good, and on what information about potential substitutes is salient. The effect of the scale or scope of the good and of information about substitutes on WTP has been called the part-whole valuation effect [*Mitchell and Carson*, 1989] or the embedding effect [*Kahneman and Knetsch*, 1992].

Part-whole valuation effects, as they relate to CV measures of economic value, were first raised by A. Randall, J. P. Hoehn, and G. S. Tolley at the 1981 meeting of the Association of Environmental and Resource Economists in Washington, D. C., in a study of WTP of Chicago residents for air quality improvements. As later described by *Hoehn* [1991], one sample was asked their WTP for Grand Canyon air quality improvements, and the other sample was first asked to value air quality improvements in the Chicago area, and then to value the package of air quality improvements in both Chicago and the Grand Canyon. The separate value of Grand Canyon air quality improvement was nearly 7 times the additional WTP for Grand Canyon air quality improvements when individuals were first asked to pay for Chicago air quality improvements.

Kahneman and Knetsch [1992] raised the visibility of the

Table 1. Possible Relations Among Goods and Their Assessed Values

Relations Between Two Goods	Relations Among Their Assessed Values						
	Basic Relations[a]						
1. Independent in valuation	$v(g_1)+v(g_2)$	$=$	$v(c)$	$>$	$v(g_1)$	$=$	$v(g_1)'$
2. Complements	$v(g_1)+v(g_2)$	$<$	$v(c)$	$>$	$v(g_1)$	$=$	$v(g_1)'$
3. Perfect substitutes	$v(g_1)+v(g_2)$	$>$	$v(c)$	$=$	$v(g_1)$	$=$	$v(g_1)'$
4. Imperfect substitutes	$v(g_1)+v(g_2)$	$>$	$v(c)$	$>$	$v(g_1)$	$=$	$v(g_1)'$
	Additional Relations That Can Occur With Part-Whole Bias						
5. Imperfect substitutes, with pure embedding	$v(g_1)+v(g_2)$	$>$	$v(c)$	$=$	$v(g_1)$	$>$	$v(g_1)'$
6. Imperfect substitutes, with partial embedding	$v(g_1)+v(g_2)$	$>$	$v(c)$	$>$	$v(g_1)$	$>$	$v(g_1)'$
7. Perfect substitutes, with value allocation bias	$v(g_1)+v(g_2)$	$>$	$v(c)$	$=$	$v(g_1)$	$>$	$v(g_1)'$
8. Imperfect substitutes, with value allocation bias	$v(g_1)+v(g_2)$	$>$	$v(c)$	$>$	$v(g_1)$	$>$	$v(g_1)'$

[a]Assumes $v(g_1)'$ is estimated by the respondent as the portion of $v(c)$ that is represented by g_1 alone.

part-whole valuation issue when they found evidence of part-whole bias in their survey results and concluded that CV was not a valid procedure for measuring WTP for public goods. Their conclusion has been questioned by many, including *Smith* [1992] and *Harrison* [1992]. In addition to quarreling with the survey methods used by Kahneman and Knetsch, such authors suggest that the findings of studies testing for part-whole valuation effects, although perhaps initially disconcerting, are not necessarily inconsistent with consumption theory. First, WTP is subject to a budget constraint, and the smaller good may be allocated the full budget for such items, especially if respondents are unaware of the other components of the larger good. Second, diminishing marginal utility is likely to apply to additional units of related goods, such that WTP for a good when valued alone would be greater than WTP for that good when valued as a component of a larger, more inclusive, good. Nevertheless, findings such as those presented by *Hoehn* [1991] and *Kahneman and Knetsch* [1992] do indicate that we must gain a better understanding of the effect of CV procedures, and especially the effect of inclusion of information about substitutes, on estimates of WTP where part-whole valuation effects may matter.

This paper examines the implications of consumption theory for part-whole valuation experiments. We review the existing literature in light of our theoretical model and then present a test of part-whole valuation effects focusing on protecting instream flow, utilizing a WTP function that includes quantity of rivers protected as an argument. This formulation generates testable hypotheses concerning the relations among assessed values. Our application is based on data from a CV survey in which participants were asked a dichotomous choice question about their WTP to protect instream flows on one to five Montana rivers. We test the hypothesis that past users of the rivers are more aware of the uniqueness of each river being valued and of substitute rivers and therefore better able than nonusers to discriminate between rivers in the value they place on flow preservation.

Theory and Review of the Literature

Part-whole bias occurs when the respondent values a larger or smaller entity than intended by the survey designer. Amending slightly the categorization of potential biases in CV presented by *Mitchell and Carson* [1989, p. 237], part-whole bias may be caused by differences of geographical or temporal scale or by differences of scope of the policy or benefits. The difference may occur, for example, when the respondent values a larger entity symbolized by the specific good described in the survey or when the respondent simply misinterprets the description of the good.

To explore the possible relations among goods and their values, assume two goods, g_1 and g_2, where g_1 is the good of primary interest and g_2 is the remainder of a more inclusive or composite good c (i.e., $c = g_1 + g_2$). Let $v(g_1)$ and $v(g_2)$ indicate the separately assessed values of the two goods, $v(c)$ indicate the separately assessed value of the composite good, and $v(g_1)'$ indicate the value of g_1 when assigned in the context of also valuing c or g_2. The relations among the separately assessed values and the value of a component assigned in the context of other valuations depend on the nature of the goods themselves in light of a person's preferences, on the presence of part-whole bias, if any, and on the procedure (the valuation "path") used to segregate $v(g_1)'$. Table 1 summarizes several of the basic possibilities.

The first four cases of Table 1 (see also *Hoehn* [1991]) may occur without the presence of part-whole bias. The first three of these are special cases: (1) the two goods (g_1 and g_2) belong to mutually exclusive budget categories, each with a separate budget constraint, so that their values are not affected by whether or not they are valued jointly; (2) the two goods are complements, so the value of the composite is greater than the sum of the separately assessed values; and (3) the two goods are perfect substitutes, so the value of either good is equal to the value of the composite. A more common relation between two goods is for them to fall under the same budget constraint but be neither complements nor perfect substitutes (case 4). In this case the value of the composite exceeds the value of either good valued separately, but is less than the sum of the separately assessed values.

The relation between $v(g_1)$ and $v(g_1)'$ depends on the procedure used to estimate $v(g_1)'$. The first four cases of Table 1 assume that $v(g_1)'$ is the portion of $v(c)$ that is represented by g_1 alone (i.e., that the valuation path calls for valuing g_1 alone, with the remainder of $v(c)$ essentially allocated to g_2). Thus, for example, if a person who considered g_1 and g_2 to be perfect substitutes were asked how much of $v(c)$ could be represented by g_1 alone, the person would, in the absence of part-whole bias, allocate all of $v(c)$ to g_1. Or, if a person who considered g_1 and g_2 to be partial substitutes were asked how much of $v(c)$ could be represented by g_1 alone, the person would allocate enough to cover the separate value of g_1.

A very different valuation path was used by *Hoehn* [1991], who asked respondents to first estimate $v(g_2)$ without information about g_1 and then estimate $v(c)$, so that $v(g_1)'$ was later computed by the analyst as the difference $v(c) - v(g_2)$. If this procedure is used and g_1 and g_2 are perfect substitutes, $v(g_1)' = 0$ (a distinctly different result from that depicted in Table 1 for case 3). Similarly, if g_1 and g_2 are imperfect substitutes, $v(g_1) > v(g_1)'$; and if g_1 and g_2 are complements, $v(g_1) < v(g_1)'$.

A third procedure was used by several empirical part-whole bias studies, which asked respondents to estimate $v(g_1)'$ in relation to $v(c)$ but did not specify a path. Thus, for example, they asked respondents to first estimate $v(c)$ and then asked "what part of the total amount... should go" to g_1 [*Kahneman and Knetsch*, 1992], or they simply made respondents aware of the larger good and the succeeding task of valuing it before asking respondents to estimate the value of g_1 [*Walsh et al.*, 1990]. We note that where $v(g_1)'$ is estimated as a portion of $v(c)$ and g_1 and g_2 are substitutes or complements, estimation of $v(g_1)'$ is problematic unless a path of valuation is specified. In the absence of a specified path, allocating $v(c)$ among g_1 and g_2 if they are substitutes or complements is akin to the allocation of joint costs among several outputs: The allocation is, within bounds, arbitrary [*Herfindahl and Kneese*, 1974, p. 290]. Arbitrary allocation of value can be considered a kind of part-whole bias, as described below under cases 7 and 8.

The last four cases of Table 1 (cases 5–8) are some of the possibilities that involve part-whole bias (there are other variants of part-whole bias, but these four suffice for current purposes). In case 5 the goods are imperfect substitutes, but the respondent interprets g_1 as c (values c instead of g_1), leading to $v(c) = v(g_1)$; this might be called "pure" embedding. However, when the sample that values the composite is asked to allocate a portion of $v(c)$ to g_1 the distinction between c and its components is clear, leading to $v(c) > v(g_1)'$. In case 6 the goods are imperfect substitutes, and the respondent interprets g_1 as some larger portion of c than the survey designer intends, but not as all of c (thus "partial" embedding). Again, when the sample that values the composite is asked to allocate a portion of $v(c)$ to g_1, the distinction between c and its components is clear, leading to $v(g_1) > v(g_1)'$. In case 7 the goods are indeed perfect substitutes, but upon being asked what portion of $v(c)$ should be allocated to g_1 the respondent allocates a portion of $v(c)$ to g_1, leaving a portion for g_2, rather than insisting that g_1 and g_2 are perfect substitutes which could each be allocated the full $v(c)$. This tendency, the result of an unspecified valuation path, might be called "value allocation bias." Case 8 is similar to case 7, but the goods are imperfect substitutes; upon being asked to allocate part of $v(c)$ to g_1 the respondent allocates less of $v(c)$ to g_1 than g_1 would garner by itself, leaving the rest for g_2. Note that embedding affects $v(g_1)$, and value allocation bias affects $v(g_1)'$.

Table 2 summarizes 12 of the CV studies that have tested for part-whole valuation effects. Each study asked one sample of respondents to value a relatively small good (g_1) and another sample to value a more inclusive or composite good (c) or to value its components (g_1 and g_2). Several procedures were used with the latter sample of respondents (Table 2, fourth column from the left). In four studies, respondents valued only the composite good; in five they valued the composite good and then allocated part of that WTP to g_1 (called the "allocation" procedure in Table 2); in two studies respondents were made aware that they would be valuing g_2 or c as well as g_1 before valuations began (called the "aware of c" procedure); and in one study respondents first valued g_2 and then valued the composite, allowing $v(g_1)'$ to be computed as $v(c) - v(g_2)$ (called the "residual" procedure).

Five of the 12 studies surveyed three or more samples instead of just two; for these studies, Table 2 compares WTP of only two samples unless additional comparisons indicate different conclusions. Because two of the studies found different results for different comparisons, a total of 14 comparisons are listed in Table 2.

The results of these 14 comparisons, as summarized in Table 2, suggest possible relations among goods and the possible presence of bias. These possibilities, expressed in terms of the eight cases of Table 1, are listed in the right-hand column of Table 2. For example, the results of the *Bergstrom and Stoll* [1987] study (that $v(c)$ is not greater than $v(g_1)$, but $v(g_1)$ is greater than $v(g_1)'$) suggest that case 5 or case 7, or some combination of both, applies. Five of the 14 comparisons suggest imperfect substitution with pure embedding (case 5) or perfect substitution with value allocation bias (case 7); three comparisons suggest perfect substitution (case 3) or case 5; one comparison suggests imperfect substitution (case 4) or imperfect substitution with partial embedding (case 6); two comparisons suggest independence in valuation (case 1), complements (case 2), or case 4; two comparisons suggest four possible cases (1, 2, 4, or 6); and the final comparison suggests case 6 or 8. Thus part-whole bias may have contributed to the results of 12 of the 14 comparisons, but in only six of the 12 comparisons is bias unambiguously indicated, and value allocation bias rather than embedding may be the culprit in each case. Embedding (case 5 or 6) is a possibility, but not a certainty, in each of the 12 comparisons where bias is indicated.

Table 2 is not meant to be the last word on part-whole bias in CV. Other kinds of bias, not considered here, may have been present in some of the studies summarized in Table 2. Further, some of the individual studies may have presented evidence or reasoning that would shed doubt on the applicability of some of the suggested relations between goods listed in the right-hand column of Table 2. The main point we wish to make with Table 2 is that the possible relations among assessed values depend first of all on the nature of the goods in light of respondents' preferences; without a good understanding of those relations, we will have a difficult time distinguishing between the effects of preference and the effects of bias on the values estimated using CV. In particular, we need a better understanding of how information about substitutes affects expressed values.

Information about substitutes that is available to CV respondents may be separated into the information that respondents bring to the survey situation and the information provided in the CV scenario. Few of the studies listed in Table 2 provide insight about the effect of scenario information about substitutes on the results, and none attempts to determine the effect of different levels of prior information among the respondents. Some of the studies, such as *Desvousges et al.* [1992], reminded respondents in general of "other possible uses of your household income," but only two studies [*Loomis et al.*, 1993; *Rowe*

Table 2. Contingent Valuation Studies Testing for Part-Whole Valuation Effect

Author	Good: Whole ($c = g_1 + g_2$)	Good: Part (g_1)	Procedure for Estimating $v(g_1)'$[a]	Mean Annual WTP,[b] $: $v(c)$	$v(g_1)$	$v(g_1)'$	Significantly Different?: $v(c) > v(g_1)$	$v(g_1) > v(g_1)'$	Suggested Relations Between Goods (Case Numbers From Table 1)
Bergstrom and Stoll [1987]	farmland protection program[c]	environmental amenities protection	allocation	nr	nr	nr	no	yes	5 or 7
Brown et al. [1995]	enhance environmental services[d]	preserve natural areas	allocation	55	59	17	no	yes	5 or 7
Desvousges et al. [1992]	avoid death of 20,000 waterfowl	avoid death of 2000 waterfowl	none	59	59	nr	no	nr	3 or 5
Diamond et al. [1992]	protect three wilderness areas	protect one wilderness area	none	45	30–50[e]	nr	no	nr	3 or 5
Diamond et al. [1992]	protect 57 wilderness areas	protect one wilderness area	none	79	29	nr	yes	nr	1, 2, 4, or 6
Gilbert et al. [1991]	protect all wilderness areas east of the Mississippi[f]	protect Lye Brook Wilderness Area in Vermont	none	7	7	nr	nr	nr	3 or 5
Hoehn [1991]	protect air quality in Chicago and Grand Canyon	protect air quality in Grand Canyon	residual	190	83	11	nr	yes	4 or 6
Kahneman and Knetsch [1992]	environmental services[g]	preparedness for disasters	allocation	136	152	29	no	nr	5 or 7
Loomis et al. [1993]	protect 122,000 ha of forest	protect 70,000 ha of forest	allocation	100	103	72	no	nr	5 or 7
Loomis et al. [1993]	protect 70,000 ha of forest	protect 6000 ha of forest	allocation	103	57	55	yes	no	1, 2, or 4
Rahmatian [1986]	maintain air quality at Grand Canyon and other parks[h]	maintain air quality at Grand Canyon	aware of *c*	129	68	63	nr	no	1, 2, or 4
Rowe et al. [1992]	prevent all oil spills over next 5 years	prevent one moderate size oil spill over next 5 years	allocation	122[i]	64	35	nr	nr	6 or 8
Walsh et al. [1990]	protect forest quality in Colorado	protect forest quality in northern Front Range of Colorado	aware of *c*	nr	61	33	no	yes	5 or 7
Whitehead [1993]	protect all nine threatened and endangered species in coastal North Carolina	protect loggerhead sea turtle in coastal North Carolina	none	9	6	nr	nr	nr	1, 2, 4, or 6

Here "nr" indicates not reported.

[a]This refers to the procedure used with the respondent sample that did not value only g_1 by itself: Here "allocation" indicates that respondents estimated $v(c)$ and then allocated a portion of $v(c)$ to g_1; "aware of c" indicates that respondents were aware that they would be valuing more than just g_1 (either c or g_2) when they valued g_1; and "residual" indicates that respondents first estimated $v(g_2)$ and then estimated $v(c)$, so that $v(g_1)'$ was later computed as $v(c) - v(g_2)$.

[b]For each row, the $v(g_1)$ column is based on responses from one respondent sample, and the $v(c)$ and $v(g_1)'$ columns are based on responses from another sample.

[c]The farmland protection program was described as having four major components: protection of local and national food supplies, protection of local agricultural jobs, more orderly urban development, and protection of environmental amenities.

[d]Environmental services were described as including natural resources, recycling, and recreation; natural resources were described as including environmental education, street tree maintenance, and preservation of natural areas.

[e]The three wilderness areas were valued by three separate samples at $30, $37, and $50. Clearly, computing a residual value $v(g_1)'$ by subtracting from $v(c)$ the separate estimates of $v(g_2)$ would leave a negative value.

[f]The two samples were drawn from different geographical areas (for Lye Brook from within 25 miles (40.2 km) of Lye Brook; for all eastern wilderness areas from within 25–75 miles (40.2–120.7 km) of Lye Brook).

[g]Environmental services were described as including preserving wilderness areas, protecting wildlife, providing parks, preparing for disasters, controlling air pollution, insuring water quality, and routine treatment and disposal of industrial wastes. The authors also compared ensuring availability of equipment and personnel with a composite good of improved preparedness for disasters, but the conclusion was the same.

[h]The other parklands consisted of Zion, Bryce, Mesa Verde, Glen Canyon and Canyonlands, plus a specified number of unnamed other national parks.

[i]Original responses were for a 5-year period. For this table those responses were converted to annual WTP based on the finding, from another sample, that annual payments over 5 years were 0.36 of the 5-year payment.

et al., 1992] carefully alerted subjects valuing only g_1 to the existence of alternative but related goods that were part of the composite good valued by the other samples. Unfortunately, the results of these two studies are not consistent.

In the *Loomis et al.* [1993] study, survey participants were sent a map showing the total 122,000 ha of protectable forest area in southeastern Australia and highlighting the specific portion of that total forest area at issue for the bidding. This approach resulted in a separately assigned mean value of $57 for protecting 6000 ha that was nearly identical to the $55 value of the 6000 ha of protection obtained from the sample that first valued protecting 70,000 ha and then allocated a portion of the larger value to protection of the 6000 ha (Table 2). Apparently, the map sent to the sample valuing only g_1, highlighting only 6000 ha, or 5%, of the protectable forest area, alerted the respondents to the ample substitutes in southeastern Australia. Loomis et al. did not compare valuations with and without such maps, so we cannot be sure of their effect. Further, in the other comparison achieved by Loomis et al., using similar procedures, protection of 70,000 ha was as valuable as protection of the full 122,000 ha, suggesting that in this case the map had no effect (perhaps because respondents placed little value on the increase from 70,000 to 122,000 ha protected).

In the other study that carefully alerted respondents to the presence of substitutes, *Rowe et al.* [1992] explained to a sample asked to value prevention of only one moderate size oil spill in the next 5 years (a sample not reported in Table 2) that there were many other potential spills that would not be affected by their payment. This information was presented through the use of maps and verbal descriptions. However, the extra information had no effect on mean or median WTP. If the additional information removed any part-whole bias, one must conclude that respondents considered one moderate size spill in 5 years to be a perfect substitute for all spills, which is unlikely. Thus the evidence about the degree to which similar goods are considered substitutes, or the degree to which part-whole bias afflicts CV, and the evidence about the effect of information about substitutes in CV, are inconsistent, suggesting that we need to learn much more about how substitutes and information about them affect CV responses.

We present below a study that provides evidence on the importance of information about substitutes to the resulting contingent values. In this study we attempted to control for information about substitutes indirectly. On the basis of respondents' past experience, we classified respondents into two groups, one that had recently visited the rivers to be protected and the other that had not. We expected that recent visitation would be associated with increased information about the rivers and their flow patterns and that this information would lead user respondents to be less likely to view alternative rivers as being close substitutes. Similarly, we expected that nonusers would be more likely to view separate rivers as members of a more homogeneous class of goods. Thus we hypothesized that recent users would be less likely to allocate all their WTP to only one river, even if only presented with an opportunity to protect flow in one river.

Another Test of Part-Whole Valuation Effects

We asked separate samples about their WTP to protect instream flow in either one or five Montana rivers. The group of five rivers included the river valued by the single-river sample. After obtaining the five-river bid, we asked those respondents to allocate their bid by percentage among the five rivers (we did not specify a valuation path). Thus, in the context of the taxonomy provided in Table 2, the current study is of the "allocation" type.

We expected that instream flow preservation on an individual river was neither independent nor a perfect substitute of instream flow preservation on another river. Rather, we hypothesized that the five rivers would be considered imperfect substitutes in flow preservation. Specifically, our null hypothesis H_1 was that $v(c) > v(g_1) > v(g_1)'$, where g_1 is the individual river, c is the five-river composite good, and $v(g_1)'$ is the value of g_1 assigned as a percentage of the composite value. In terms of the Table 1 categorization, we hypothesized that case 8 applies, but we would be unable to distinguish case 8 from case 6.

To develop a functional equivalent of H_1, suppose that a total WTP (w) function can be estimated for the given change across a set of homogeneous rivers as

$$w = f(n, \bar{x}) \tag{1}$$

where n is quantity demanded (rivers protected) and $\bar{x}$ is a vector of explanatory variables. By the nonsatiation axiom of consumption theory and the judgment that different rivers are not perfect substitutes, we expected the first derivative, $\partial w/\partial n$, to be greater than zero (that total WTP was a positive function of quantity demanded). By the law of demand and the usual convexity assumptions, plus the judgment that the rivers are not complements or independent in valuation, we expected the second derivative, $\partial^2 w/\partial^2 n$, to be negative (that marginal WTP is an inverse function of quantity demanded).

Given a double-log specification of the total WTP function, these two hypotheses ($\partial w/\partial n > 0$ and $\partial^2 w/\partial^2 n < 0$) can be made explicit in terms of function parameters. Using a dichotomous choice ("yes" or "no" to the posited payment amount) CV, the variables could be made explicit as

$$\ln (p/(1-p)) = b_0 + b_1 \ln (t) + b_2 \ln (n) + \sum_i b_i \ln (x_i) \tag{2}$$

where p are observed proportions of respondents who say "yes" to the posited payment amount t, b_i are estimated parameters, n is number of rivers protected, and x_i are other explanatory variables. It can be shown that $\partial w/\partial n > 0$ if $-b_2/b_1 > 0$ (this is found by solving (2) for t, which becomes w, and then taking $\partial w/\partial n$). And it can be shown that $\partial^2 w/\partial^2 n < 0$ when $0 < -b_2/b_1 < 1$. Thus the functional equivalent of our first hypothesis, which we label H'_1, is that the parameters of the total WTP response function (as in (2)) would satisfy $0 < -b_2/b_1 < 1$.

In addition to H_1 and H'_1 about the entire sample of respondents, we examined the difference in substitution among rivers between recent users and nonusers. We hypothesized that WTP would be more sensitive to number of rivers being valued for respondents who had recently visited the rivers than for respondents who had not recently visited the rivers. Specifically, our null hypothesis H_2 was that $d = [v(c) - v(g_1)]/v(g_1)$ would be greater for users than for nonusers. The difference $v(c) - v(g_1)$ was divided by $v(g_1)$ to adjust for the effect of magnitude, based on the expectation (as found by *Whitehead and Blomquist* [1991]) that past users' WTP would exceed nonusers' WTP.

Of course, a greater difference d for users than for nonusers could occur because users placed more use value, but not more nonuse value, on streamflow enhancement in five rivers than on flow enhancement in only one river. Only if the difference in d between users and nonusers is attributable to the difference in nonuse value between the two groups do we have any evidence that knowledge about substitutes affects nonuse value. Fortunately, our data help to sort this out, because we asked respondents to allocate their bids between use and nonuse value. Our hypothesis (H_2) was that the greater d for users than for nonusers would be largely attributable to nonuse value.

Methods

A regional household mail survey was designed to measure the level and extent of indirect or preservation values associated with instream flows. Because of the need to ask some respondents to value protection of a group of rivers, the definition of precise site-specific flow increments at each river would have been quite confusing and was not attempted. Instead, the flow increments were more generally specified. The degree of detail in the specification of the goods was designed to simulate a workable trust fund mailing and thereby provide an estimate of effective demand for a trust fund.

The Survey

The sampling goal was to obtain responses from a wide range of people in the region where the target rivers were located, rather than obtain a probability sample representing the views of a specifically defined regional population. Six populations at varying distances from the study rivers were sampled: people listed in the current telephone directories for five Montana areas (Billings, the Bitterroot Valley, Butte, Helena, and Missoula) and one nearby area in Washington (Spokane).

Three different mail survey instruments were administered to each population. The three versions differed primarily in which river(s) were to be protected in the trust fund question. In addition to a Bitterroot River version and a Big Hole River version, a five-river (Bitterroot, Big Hole, Clark Fork, Gallatin, and Smith) version was used. In terms of the above hypotheses, g_1 is either the Bitterroot or the Big Hole, depending on which single-river version is used, and c is the five-river composite.

A phone pretest of the mail survey was administered to 100 Missoula area residents in September 1988 using the Big Hole survey version. The pretest was fashioned to establish the feasibility of the survey and to obtain preliminary estimates of the trust fund response, which were used to establish the range and distribution of the dichotomous choice dollar bid levels.

A total of 1850 questionnaires were mailed out. The mailing procedure was based on *Dillman*'s [1978] total design method and included the standard initial mailout with cover letter, questionnaire, and stamped return envelope. A postcard reminder was sent 10 days after the initial mailout, and a second mailing was made to nonrespondents about 1 month later.

Of the 1850 questionnaires mailed out, 140 were not deliverable and 582 were completed and returned, providing a 34% response rate. A scheduling problem with the mail survey, which may have contributed to the low response rate, was that the second mailing was delayed several weeks so as to not arrive just before Christmas.

A phone survey of 251 nonrespondents to the mailout, conducted in April 1989, used an abbreviated version of the mail survey. The main purpose of the nonresponse survey was to identify any significant differences between respondents and nonrespondents. Few differences between the mail respondents and nonrespondents were found. The primary difference was that users were more likely to respond to the mail questionnaire than nonusers. Because users have a larger WTP for flow protection than do nonusers, a mail survey would therefore overestimate the population's WTP. However, this difference is not of concern for the present paper, where our purpose is to examine an individual measurement issue, and not to extrapolate a value to the larger population.

The first section of the mail questionnaire asked about respondents' recreational use of rivers, including how frequently they and members of their household participated in river-related recreation, what activities they did on or along rivers, the types of experiences people desired, and the importance they placed on recreation compared to other uses of river water such as irrigation or hydropower. The second section asked about their past river recreation in general and their use of the target river(s), including number of visits in the past three years, activity participation, and encounters with low-flow conditions.

The next section contained the CV questions. They were prefaced by a series of four questions designed to measure respondents' familiarity and experience with the general objective of increasing instream flows (e.g., "Did you know that the Montana Department of Fish, Wildlife, and Parks has purchased water from reservoirs during recent drought years to maintain adequate flow levels on Montana rivers?") and with the trust fund payment vehicle (e.g., "Have you ever donated money or time to a trust fund like this, or to other efforts to help conserve natural resources such as rivers or wildlife habitat?"). Problems associated with low flows, and the possible benefits if flows were increased, were described. The benefits included those related to recreational use ("people would be able to float the river later in the summer") and those not necessarily related to recreational use ("many species of birds, wildlife and plants would benefit; for example, better habitat would exist for osprey and river otters"). The statements also included a direct appeal to nonusers ("Even if you don't use the ____ River for recreation, you would know you were helping to keep an important Montana river clean and healthy"). Mechanisms for providing additional flow were described. For example, in the Bitterroot River version, respondents were informed: "Water available in Painted Rocks Reservoir could be used to increase summertime flows in the Bitterroot. This water could be purchased when needed to avoid damaging low flows in the river. A trust fund could be developed specifically to purchase water when needed."

The initial CV question was posed in a dichotomous choice format; respondents were asked if they would purchase, at a specific dollar amount (which varied from $5 to $300), an annual membership in a trust fund to buy water when needed. If the respondents said "no," they were asked if they would pay at least $1 per year. If they said "yes" to either the initial or $1 payment, they were asked to specify, in an open-ended format, the maximum amount they would pay for such a membership. Respondents to the five-river survey were then asked to apportion their total WTP among the five rivers. All respondents with positive WTP were asked to apportion their bid between "payment to guarantee high enough flows for boating and fishing when I actually visit the ____ River for recreation, either now or in the future" and "payment for reasons other than my own use, such as just knowing that the ____ River has sufficient flows . . . or knowing that future generations will benefit."

The questionnaire then asked (1) about opinions regarding who, if anyone, should be responsible for maintaining adequate flow levels, (2) about motives for preserving natural environments, and (3) about respondents' gender, employment status, education, income, and membership in organizations. The complete questionnaire is reproduced by *Duffield et al.* [1994].

Several payment vehicles were considered for this study. Entrance fee and recreation cost payment vehicles were rejected because we wanted to survey nonusers. The choice between a tax and a trust fund payment vehicle was based on the judgment that the trust fund vehicle had the greatest chance of actually being used. In fact, subsequent to this study, an instream flow trust fund was created by the Montana Legislature and another was tested for the Nature Conservancy [*Duffield and Patterson*, 1992]. Although it is feasible that a different payment vehicle would have yielded different WTP estimates, we doubt that a different payment vehicle would have yielded significantly different results vis à vis part-whole bias.

CV Data Analysis

We place primary emphasis on the dichotomous choice responses, because the dichotomous choice question preceded the open-ended question, received a better response rate than the open-ended question, and is assumed to require less of the respondent. In any case, analysis showed that this single-bounded dichotomous choice model yielded the same conclusions as a more involved procedure that also utilized responses to the follow-up WTP questions.

Our primary strategy was to develop a model with quantity (number of protected rivers) as a covariate and to identify the quantity-WTP relation analytically. Briefly, the WTP values were assumed to have a logistic distribution in the population of interest, conditional on the value of covariates. For the dichotomous choice response a statistical model was developed that relates the probability of a "yes" response to explanatory variables including the posited bid amount. The specific model is

$$\pi(t; \bar{x}) = [1 + \exp(-\alpha t - \bar{\gamma}'\bar{x})]^{-1} \quad (3)$$

where $\pi(t; \bar{x})$ is the probability that an individual with covariate vector $\bar{x}$ is willing to pay the bid amount t. The parameters to be estimated are α and $\bar{\gamma}'$ (the constant term is included in $\bar{x}$). The equation to be estimated can be derived as

$$L = \ln [p/(1 - p)] = \alpha t + \bar{\gamma}'\bar{x} \quad (4)$$

where L is the "logit" or log of the odds of a "yes" and p are observed response proportions.

To obtain maximum likelihood estimates (MLEs) of the parameters in (4), we employed *Cameron*'s [1988] alternative parameterization, which emphasizes the threshold motivation and the dependence of individual WTP on covariates and assumes the distribution of WTP conditional on $\bar{x}$ is logistic. An advantage of the reparameterized model is that the coefficients are more easily interpreted. For example, in a double-log specification, the coefficients are elasticity point estimates of the relation of WTP to a given covariate. A more thorough exposition of the methods we followed for estimating the dichotomous choice model is presented by *Duffield et al.* [1992] in a paper based on on-site interviews at the Big Hole and Bitterroot Rivers. Standard errors for the MLEs in Cameron's parameterization were calculated using the bootstrapping procedure described by *Duffield and Patterson* [1991].

Our model assumes a constant elasticity of WTP with respect to number of rivers protected. There is perhaps some risk in treating the quantity variable as continuous because we have data for only two points, at one and five rivers. It is feasible that the elasticity of WTP with respect to number of rivers protected would not be constant between these two points.

Because the dichotomous choice contingent valuation approach yields a distribution of WTP values, the question remains as to which parameter of the distribution to use as a welfare measure. A variety of welfare measures for dichotomous choice models have been proposed in the literature, including a truncated mean [*Bishop and Heberlein*, 1980], the overall mean [*Johansson et al.*, 1989], and percentiles of the distribution, including the median [*Hanemann*, 1984, 1989]. For the case where WTP values are skewed, the median and the mean may differ considerably, as demonstrated, for example, by *Bowker and Stoll* [1988]. The median is generally much smaller than the mean for these types of models. We provide two estimates, the 75th percentile (which was similar to the truncated mean) and the median. We emphasize the 75th percentile in the presentation of hypothesis tests, but the median tells essentially the same story.

Results

About 70% of the mail survey respondents were men, compared to about 50% of the Montana population, according to the 1980 census. The higher proportion of men in our sample likely resulted partly from the sampling method (more telephones are listed in names of males) and the nature of the study (women were less likely to participate in river recreation). *Frost and McCool* [1986], for example, found in their statewide survey that 70% of the men sampled had fished in the last 12 months, compared to 42% of the women.

Results showed that visitation was strongly linked to distance from the rivers; one or more visits to the target river(s) were made in the last three years by 85% of the respondents from the Bitterroot valley, 74% of the Butte residents, 65% of the Missoula residents, 37% of the Helena residents, 34% of the Billings residents, and 20% of the Spokane residents. The same patterns held for number of visits; 35% of the Bitterroot valley residents and 29% of the Butte residents had visited the river(s) 21 times or more, while none of the Spokane and Billings residents had visited so frequently.

In general, people were somewhat familiar with the trust fund concept; 57% said they had heard of such funds, and 21% said they knew a fair amount about them. Thirty percent had donated money or time to natural resource conservation efforts, and about half knew of other people who had done so. However, 60% said they had never known about the state's past efforts to purchase flows when needed.

Of the 555 respondents participating in the initial dichotomous choice WTP question, 7% indicated that they would pay the bid level for an annual membership in the trust fund, 50% said they would pay $1, and the remaining 43% were not willing to pay anything. Those unwilling to pay anything were asked in an open-ended question to explain why, and respondents identified as valuing instream flow but protesting the trust fund method of protecting flows were removed before WTP was estimated.

Table 3. Logit Model Variables

Variable	Definition	Sample Means
BID	dollar bid (posited payment amount) for trust fund donation	
QUANT	number of rivers protected by trust	2.350
DIST	distance (one-way miles) of respondent home from river(s) to be protected	159.342
SEX	dummy variable for gender with value of 1 for males	0.695
USER	dummy variable with value of 1 if visited this (any of these) river(s) in last three years	0.518

1 mile equals 1.609 km.

Value of Preserving Instream Flow

For model specification the single-river (Bitterroot or Big Hole only) responses were combined with the multiple-river responses, and a "quantity of rivers protected" (QUANT) variable was included that took a value of one or five. This combination of Bitterroot and Big Hole surveys was supported by the finding that when a dummy variable for Bitterroot River surveys was included in the logit equations, the estimated coefficient on this variable was not statistically significant. Explanatory variables included in the final model are listed in Table 3 and include posited bid and variables describing respondent characteristics and recreation behavior.

The following logit model is based on information from the 461 respondents who provided sufficiently complete answers to the dichotomous choice and other pertinent questions (t values in parentheses):

$$L = \underset{(1.643)}{2.5183} - \underset{(-6.234)}{1.2140}[\ln(\text{BID})] + \underset{(2.496)}{0.8130}[\ln(\text{QUANT})] - \underset{(-2.109)}{0.5435}[\ln(\text{DIST})] + \underset{(1.963)}{1.0115}(\text{USER}) + \underset{(0.941)}{0.4381}(\text{SEX}) \quad (5)$$

The maximum likelihood test of this model has a chi-square of 131, which is significant at the 0.01 level. All independent variables but SEX were significant at the 0.05 level. The variables of this equation have the expected signs: WTP increases with quantity of rivers protected and past use, and decreases with distance from the respondent's home to the river(s) protected and with posited payment amount.

Additional variables were also considered in modeling, including variables representing motives for preservation of natural environments, income, and a variable for planned use in the next three years. The motive variables were correlated with past use variables and did not enter the same model as the use variables. Other variables were either insignificant or correlated with included variables (equations that utilize these additional variables are available in the work by *Duffield et al.* [1994]). Numerous interactive variables were also constructed as products of Table 3 variables as well as other explored variables. The estimated parameters on these interactive variables were not significant.

The influence of quantity of rivers protected (QUANT) on estimated trust fund donation is displayed in Table 4, based on a reparameterization [*Cameron*, 1988] of (5) with variables other than QUANT held at their mean levels. The 75th percentile individual donations were $4.02 for protection of one river, $6.40 for two rivers, and $11.82 for five rivers. Results for the logit median are also shown in Table 4. The corresponding marginal individual donations for the 75th percentile measure were $2.69 at one river protected, $2.14 at two, and $1.58 at five rivers protected.

Part-Whole Valuation Effects

Our first hypothesis requires point estimates of WTP for (1) a single river from the single-river subsample, $v(g_1)$, (2) the five-river composite from the five-river subsample, $v(c)$, and (3) the portion of that composite WTP that was allocated to the single rivers of interest, $v(g_1)'$. We hypothesized (H_1) that $v(c) > v(g_1) > v(g_1)'$. As seen in Table 5, five-river WTP ($12.43) was significantly greater than single-river WTP ($6.70) when user and nonuser responses were combined. This holds true for the combined (Big Hole + Bitterroot) sample, as displayed in Table 5, and for the individual Big Hole and Bitterroot samples (not presented in Table 5). The five-river respondents were asked to allocate their WTP among the five rivers. Forty-five percent of these respondents allocated 20% of their payment to each of the five rivers, whereas the remaining respondents showed some discrimination among the rivers, allocating unequal portions of their payment to individual rivers. Average percentage allocations were 23% for the Big Hole, 28% for the Bitterroot, and from 13% to 20% for each of the three other rivers. Using the average allocation of the composite (five-river) WTP to the Big Hole or Bitterroot River, of 25%, yields an estimate for $v(g_1)'$ of $3.12. Thus the three values of our hypothesized relation are as expected: $12.43 > $6.70 > $3.12. These results suggest that for the respondents as a whole the individual rivers are partial substitutes in flow protection. Further, the allocation of the five-river bid to individual rivers is subject to value allocation bias (case 8, Table 1), and the single-river value may be subject to partial embedding (case 6).

Table 4. Individual Donations as a Function of Number of Rivers Protected

Number of Rivers	Welfare Measure: 75th Percentile, dollars	Welfare Measure: Median, dollars
Individual Donation[a]		
1	4.02	1.63
2	6.40	2.59
3	8.39	3.40
4	10.18	4.12
5	11.82	4.78
Marginal Individual Donation[b]		
1	2.69	1.09
2	2.14	0.87
3	1.87	0.76
4	1.70	0.69
5	1.58	0.64

Values are in 1988 dollars. Results are for participants only (no adjustment for nonparticipation or nonresponse).

[a]Values are based on the following equation, which is a reparameterization of (5), with variables other than QUANT set at their sample means: WTP $= 1.6273[p/(1-p)]^{0.8237}$ (QUANT$^{0.6697}$). The reparameterization is accomplished by solving (5) for BID and then replacing "BID" with "WTP." Sample means are given in Table 3. Variable p is set to 0.5 for the median and 0.75 for the 75th percentile measure.

[b]Values are computed using the first derivative of WTP with respect to QUANT of the equation in note a.

An alternative hypothesis (H_1'), consistent with consumption theory and our judgment of the nature of the goods at issue, was that the partial derivative of the total WTP function with respect to quantity would be positive and that the second partial derivative would be negative. For the functional form utilized in the reparameterized logit model (double log), these requirements are satisfied if the estimated parameter on quantity demanded, which is the elasticity of total WTP with respect to the number of rivers protected, is greater than zero and less than one. The hypothesis is accepted. The estimated parameter is $-b_2/b_1 = -(0.813/-1.214) = 0.67$, where b_1 and b_2 are the coefficients on ln (BID) and ln (QUANT), respectively, in (5).

We also hypothesized that users' WTP would be more sensitive than nonusers' WTP to number of rivers protected. Specifically, H_2 was that $d = [v(c) - v(g_1)]/v(g_1)$ would be greater for users than for nonusers, with users defined as those who reported recreating at the river(s) in the past three years. This hypothesis was confirmed: d for users was 0.77, compared with −0.43 for nonusers. Further, users' WTP for protection of five rivers was significantly greater than users' WTP for protection of only one river, but there was no significant difference between the measures for nonusers (Table 5). Note that this conclusion is tentative because of the small sample size for the five-river nonuser WTP estimate, which lowers the power of the significance test. The small sample size is also most likely the reason that the five-river estimate of nonuser WTP is actually smaller than the single-river estimate.

If nonusers' WTP for protecting five rivers is allocated to the Big Hole or Bitterroot River according to the rule mentioned above, a WTP of about $0.50 results, which is considerably below the single-river bid reported in Table 5. On face value these results suggest that for nonusers either the rivers were perfect substitutes and respondents were subject to value allocation bias (case 7, Table 1), or the rivers were imperfect substitutes but respondents were subject to pure embedding (case 5).

Additionally, we hypothesized that the greater d for users than for nonusers would be largely attributable to nonuse value, not to use value. Users in both the single- and five-river samples allocated about two thirds of their bids to nonuse motives. Applying the nonuse percentage to the 75th percentile measures of WTP reported in Table 5 yields estimates of nonuse WTP of users of $12.25 for the five-river subsample and $6.82 for the one-river subsample, yielding a d of 0.80, very similar to the d for total WTP of 0.77.

Table 5. WTP to an Instream Flow Trust Fund by User and Survey Type

	Subsample Results		
	Single River[b]	Five Rivers	t Statistic[a]
	Users[c]		
WTP, dollars	10.18	18.02	−1.40*
N	153	116	
Standard error	2.57	4.97	
	Nonusers		
WTP, dollars	3.55	2.02	0.62
N	197	57	
Standard error	2.04	1.41	
	Users Plus Nonusers		
WTP, dollars	6.70	12.43	−1.64**
N	368	186	
Standard error	1.58	3.11	

Values are individual donations in 1988 dollars based on the 75th percentile welfare measure, computed from logit models developed for the subsamples. The t tests were performed on the basis of standard errors computed using a bootstrapping procedure [*Duffield and Patterson*, 1991].

[a]Results are from a one-tailed t test of the hypothesis that the sample river mean is less than the five-river mean. A single asterisk indicates significance at a probability level of 0.05, a double asterisk at the 0.01 level.

[b]Results are from combined Big Hole and Bitterroot samples.

[c]Users are defined by response to the question, Have you visited this (these) river(s) in the last three years?

Discussion

These results provide evidence that CV of environmental goods, even when using a trust fund (i.e., donation) payment vehicle, produces estimates that are consistent with consumption theory. Similar but distinct goods (separate rivers) were considered by the full sample of respondents as imperfect substitutes for each other. The average respondent would donate more if more rivers were protected, although the amount for each additional river was declining. Because the basic elements of the consumption theory model are derived from the standard constrained maximization formulation, these results provide some insights into characterizing the trust fund phenomenon. It appears that trust fund donations can be modeled like the purchase of most other commodities and that these purchases reflect the presence of a single budget constraint. However, we could not reject the possibility that partial embedding also affected the results.

Importantly, the results also show that the positive relation of number of rivers protected to WTP was attributable to the responses of past users, not past nonusers. Although users' WTP was sensitive to quantity of rivers protected, nonusers' WTP was not. Two possibilities are presented: Either use of the rivers decreased the degree to which similar goods were considered substitutes in valuation, or use of the rivers decreased the propensity for pure embedding. Following the first possibility, perhaps for nonusers the essential notion was that they were helping to protect rivers; the actual number of rivers was not very important, and the individual rivers easily substituted for each other. To us, this seems more plausible than to conclude that the rivers were considered imperfect substitutes by nonusers but that nonusers, unlike users, were subject to pure embedding. However, this interpretation of the nonusers' responses is tentative, because we do not know how the nonusers bidding about only one river would have responded if they had been made aware of the existence of other rivers in the area that experienced low flows.

If we view demand for goods as resulting from human effort to satisfy objectives, following *Hicks* [1956] and *Morishima* [1959], different levels of substitutability for different consumer segments seem reasonable. Possible consumer objectives in donating to an instream flow trust fund include, in order of increasing specificity, contributing to a worthy cause, helping the environment, protecting aquatic environments, enhancing fish populations, and protecting or enhancing the environment of a specific river. In addition, potential users of the sites may also donate to improve the quality of their recreation outings. It seems likely that some people will lack specific objectives that are satisfied by enhanced streamflow; their bids satisfy the general objective of contributing to a worthy cause and perhaps also the objective of helping the environment. For these people, alternative rivers protected, and perhaps many other public goods, may be perfect substitutes. Other people will hold objectives that are specifically satisfied by flow enhancement. Still others will hold objectives that are satisfied by flow enhancement in specific locations. Of course, these latter groups may also hold the more general objective of contributing to a worthy cause. For such people, alternative rivers are more likely to be only partial substitutes.

Our instream flow trust fund results suggest that past use was associated with donation objectives that were sensitive to the number of rivers to be protected, leading past users to consider protection of alternative rivers as only imperfect substitutes, not perfect substitutes. However, as a qualification, we note that our conclusion relies on respondents' own allocations of WTP to use and nonuse motives. Additionally, we surveyed only a small sample of nonusers. But, in combination with the studies listed in Table 2, the results suggest that information about substitutes influences CV estimates of WTP, suggesting in turn that CV surveys should include information about relevant substitutes.

This suggestion, however, begs the question, What are relevant substitutes? Clearly, substitutes that cannot be purchased should not be mentioned to respondents. For example, rivers that lack options for purchasing water that could be used to augment streamflow during dry times should not be mentioned to respondents to an instream flow questionnaire such as the one used for this study. And completely different types of goods should probably not be mentioned. For example, options for donating to a fund to protect rain forests seems a little far afield of options for protecting rivers in Montana. However, there is still likely to be a large number of feasible and reasonably similar substitutes for the respondent's payment, all of which could be mentioned.

A further question is, How should the relevant substitutes be presented? One alternative is to implement the top down disaggregation method (the "allocation" method in Table 2) (*Kemp and Maxwell* [1992] show how this approach can be taken to extremes to produce a very small value). Here the good of interest is valued as a subset of a composite good. Another approach is to describe the good of interest and the substitutes before asking respondents to value the good of interest ("aware of *c*" in Table 2). There are other approaches. Because the approach will likely influence the result, this question as well is important.

In light of the conclusion that CV estimates of WTP are sensitive to information about substitutes, the pessimistic view is that the CV survey itself constructs values, that the survey designer determines the outcome. The more optimistic view is that a good CV offers the respondent the proper information to construct a value. Papers by *Lazo et al.* [1992] and *Gregory et al.* [1993] have taken this more optimistic view. Resolution of this complex issue will depend in part on additional empirical work investigating respondents' sensitivity to alternative presentations of information in CV surveys.

Acknowledgments. This study benefited from the help of Stewart Allen and John Loomis in questionnaire design, Susan Ehlers in data collection, and Chris Neher in data analysis. We are also grateful for the comments of Patricia Champ and the journal's reviewers, which led to significant improvements in the paper. Of course, we remain responsible for any remaining errors or oversights.

References

Bishop, R. C., and T. A. Heberlein, Simulated markets, hypothetical markets and travel cost analysis: Alternative methods of estimating outdoor recreation demand, *Dep. Agric. Econ. Staff Pap. 187*, Univ. of Wis., Madison, 1980.

Bergstrom, J. C., and J. R. Stoll, A test of contingent market bid elicitation procedures for piecewise valuation, *Western J. Agric. Econ.*, *12*, 104–108, 1987.

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.

Brown, T. C., J. G. Taylor, and B. Shelby, Assessing the direct effects of streamflow on recreation: A literature review, *Water Resour. Bull.*, *27*, 979–989, 1991.

Brown, T. C., S. C. Barro, M. J. Manfredo, and G. L. Peterson, Does better information about the good avoid the embedding effect?, *J. Environ. Manage.*, *44*, 1–10, 1995.

Cambridge Economics, Inc., *Contingent Valuation: A Critical Assessment*, Cambridge, Mass., 1992.

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

Desvousges, W. H., F. R. Johnson, R. W. Dunford, K. J. Boyle, S. P. Hudson, and K. N. Wilson, Measuring natural resource damages with contingent valuation: Tests of validity and reliability, in *Contingent Valuation: A Critical Assessment*, Cambridge Econ., Cambridge, Mass., 1992.

Diamond, P. A., J. A. Hausman, G. K. Leonard, and M. A. Denning, Does contingent valuation measure preferences?, in *Contingent Valuation: A Critical Assessment*, Cambridge Econ., Cambridge, Mass., 1992.

Dillman, D. A., Mail and telephone surveys: The total design method, John Wiley, New York, 1978.

Duffield, J. W., and D. A. Patterson, Inference and optimal design for a welfare measure in dichotomous choice contingent valuation, *Land Econ.*, *67*, 225–239, 1991.

Duffield, J. W., and D. A. Patterson, Field testing existence values: comparison of hypothetical and cash transaction values, in Western Regional Research Project W-133, 5th interim report, Benefits and Costs in Natural Resource Planning, Dep. of Agric. and Resour. Econ., Oreg. State Univ., Corvallis, 1992.

Duffield, J. W., C. J. Neher, and T. C. Brown, Recreation benefits of instream flow: Application to Montana's Big Hole and Bitterroot Rivers, *Water Resour. Res.*, *28*, 2169–2181, 1992.

Duffield, J. W., T. C. Brown, and S. D. Allen, Economic value of instream flow, *Res. Pap. RM-317*, 64 pp., Rocky Mt. For. and Range Exp. Stn., U.S. Dep. of Agric., Fort Collins, Colo., 1994.

Frost, J., and S. McCool, The Montana outdoor recreation needs survey, prepared for the Montana Department of Fish, Wildlife, and Parks, Helena, 1986.

Gilbert, A., R. Glass, and T. More, Valuation of Eastern wilderness: Extramarket measures of public support, in The Economic Value of Wilderness, *Gen. Tech. Rep. SE-78*, pp. 57–70, Southeast. For. Exp. Stn., Asheville, N. C., 1991.

Gregory, R., S. Lichtenstein, and P. Slovic, Valuing environmental resources: A constructive approach, J. Risk Uncertainty, *7*, 177–197, 1993.

Hanemann, W. M., Welfare evaluations in contingent valuation experiments with discrete responses, *Am. J. Agric. Econ.*, *66*, 332–341, 1984.

Hanemann, W. M., Welfare evaluations in contingent valuation experiments with discrete responses: Reply, *Am. J. Agric. Econ.*, *70*, 1057–1061, 1989.

Harrison, G. W., Valuing public goods with the contingent valuation method: A critique of Kahneman and Knetsch, *J. Environ. Econ. Manage.*, *23*, 248–257, 1992.

Herfindahl, O. C., and A. V. Kneese, *Economic Theory of Natural Resources*, Merrill, Columbus, Ohio, 1974.

Hicks, J. R., *A Revision of Demand Theory*, Oxford Univ. Press, New York, 1956.

Hoehn, J. P., Valuing the multidimensional impacts of environmental policy: Theory and methods, *Am. J. Agric. Econ.*, *73*, 289–299, 1991.

Johansson, P. O., B. Kristrom, and K. G. Maler, Valuation experiments with discrete response data: Comment, *Am. J. Agric. Econ.*, *70*, 1054–1056, 1989.

Kahneman, D., and J. L. Knetsch, Valuing public goods: The purchase of moral satisfaction, *J. Environ. Econ. Manage.*, *22*, 57–70, 1992.
Kemp, M. A., and C. Maxwell, Exploring a budget context for contingent valuation estimates, in *Contingent Valuation: A Critical Assessment*, Cambridge Econ., Cambridge, Mass., 1992.
Kopp, R. J., and V. K. Smith (Eds.), *Valuing Natural Assets: The Economics of Natural Resource Damage Assessment*, Resour. for the Future, Washington, D. C., 1993.
Krutilla, J., Conservation reconsidered, *Am. Econ. Rev.*, *57*, 77–86, 1967.
Lazo, J. K., W. D. Schulze, G. H. McClelland, and J. K. Doyle, Can contingent valuation measure nonuse value?, *Am. J. Agric. Econ.*, *74*, 1126–1132, 1992.
Loomis, J., Balancing public trust resources of Mono Lake and Los Angeles' water right: An economic approach, *Water Resour. Res.*, *23*, 1449–1456, 1987.
Loomis, J., M. Lockwood, and T. DeLacy, Some empirical evidence on embedding effects in contingent valuation for forest protection, *J. Environ. Econ. Manage.*, *24*, 45–55, 1993.
Mitchell, R. C., and R. T. Carson, Using surveys to value public goods: The contingent valuation method, Resour. for the Future, Washington, D. C., 1989.
Morishima, M., The problem of intrinsic complementarity and separability of goods, *Metroeconomica*, *11*, 188–202, 1959.
National Oceanic and Atmospheric Administration (NOAA), Natural resource damage assessments under the Oil Pollution Act of 1990, *Fed. Regist.*, *58*, 4601–4614, 1993.
NOAA, Oil Pollution Act of 1990: Proposed regulations for natural resource damage assessments, *Fed. Regist.*, *59*, 1062–1191, 1994.
Rahmatian, M., Extensions of the disaggregate bid experiment: Variations in framing, *J. Environ. Manage.*, *22*, 191–202, 1986.
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 R. D. Rowe and L. G. Chestnut, pp. 265–274, Westview, Boulder, Colo., 1983.
Rowe, R. D., W. D. Shaw, and W. Schulze, Nestucca oil spill, in *Natural Resource Damages: Law and Economics*, edited by K. M. Ward and J. W. Duffield, chap. 20, pp. 527–554, John Wiley, New York, 1992.
Sanders, L. P., R. G. Walsh, and J. B. Loomis, Toward empirical estimation of the total value of protecting rivers, *Water Resour. Res.*, *26*, 1345–1357, 1990.
Smith, V. K., Arbitrary values, good causes, and premature verdicts, *J. Environ. Econ. Manage.*, *22*, 71–89, 1992.
Walsh, R. G., R. D. Bjonback, R. A. Aiken, and D. R. Rosenthal, Estimating the public benefits of protecting forest quality, *J. Environ. Manage.*, *30*, 175–189, 1990.
Whitehead, J. C., Total economic values for costal and marine wildlife, *Mar. Econ.*, *8*, 119–132, 1993.
Whitehead, J. C., and G. C. Blomquist, A link between behavior, information, and existence value, *Leisure Sci.*, *13*, 97–109, 1991.

T. C. Brown, Rocky Mountain Station, Forest Service Research, 3825 East Mulberry Street, Fort Collins, CO 80524.
J. W. Duffield, Department of Economics, University of Montana, Missoula, MT 59801.

(Received November 28, 1994; revised June 5, 1995; accepted June 8, 1995.)