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Toward Empirical Estimation of the Total Value of Protecting Rivers

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The purpose of this paper is to develop and apply a procedure to estimate a statistical demand function for the protection of rivers in the Rocky Mountains of Colorado. Other states and nations around the world face a similar problem of estimating how much they can afford to pay for the protection of rivers. The results suggest that in addition to the direct consumption benefits of onsite recreation, total value includes offsite consumption of the flow of information about these activities and resources consumed as preservation benefits. A sample of the general population of the state reports a willingness to pay rather than forego both types of utility. We recommended that offsite values be added to the value of onsite recreation use to determine the total value of rivers to society.

INTRODUCTION

Water is of increasing concern, how to conserve what we have, plan for the needs of expanding population and industrial base, provide for agriculture, and achieve a balance between development and environmental quality. As the economy grows, increasing demands are made on rivers. In the past, most western communities welcomed new dams and water diversions as a source of income and economic growth. Large reduction in flows or pollution threaten the ecology of unique river systems [*Loomis*, 1987*a*]. Almost one-third of the 20,114 km of river in Colorado, for example, have been adversely affected. More than 10% have been diverted or inundated by reservoirs and 20% polluted, according to studies by the state. More recently, observers have begun to question whether sections of some rivers should be protected from further water development. In a balanced approach, some sections of rivers would be best suited for development and others for protection.

At the time of this study (1985), no rivers in Colorado were protected either by the state or by federal designation as recreational, wild, or scenic rivers. Sections of 11 rivers have been studies by public agencies and found to be suitable for protection. These rivers represent only about 4.5% of the total kilometers of river in the state, and include sections of the Cache la Poudre, Colorado, Conejos, Dolores, Elk, Encampment, Green, Gunnison, Los Pinos, Piedra, and Yampa rivers. Since this study, bills have been introduced in the U.S. Congress to protect several of these rivers under the Wild and Scenic Rivers Act (PL 90-542) of 1968. So far, only one river has been protected, 121 km of the Cache la Poudre in 1986. There is a need to develop information on the economic benefit of river protection to help the people involved at the local, state, regional, and national levels make decisions about their future use. Nations throughout the world face similar problems of how much they can afford to pay for river protection.

The Act provides that selected rivers or sections of rivers may be protected in their natural free-flowing condition. Protection under the act would mean no further construction of dams, reservoirs, water diversions, and other development incompatible with free-flowing rivers. Existing multiple uses would continue so long as the rivers are protected essentially in their natural condition. These include recreation activities such as fishing, boating, hunting, hiking, camping, sightseeing, and staying at resorts; livestock grazing and ranching; living in mountain homes; watershed protection; and timber harvesting.

The Act allows for protection under three categories: wild, scenic, and recreational. Of the 893 km recommended in the environmental impact statements as suitable for protection in Colorado, 521 km are qualified as wild rivers, 163 km scenic, and 209 km recreational. The Act defines the characteristics of each as follows:

1. Wild river areas: those rivers or sections of rivers that are free of impoundments and generally inaccessible except by trail, with watersheds or shorelines essentially primitive and waters unpolluted. These represent vestiges of primitive America.

2. Scenic river areas: those rivers or sections of rivers that are free of impoundments, with shorelines or watersheds still largely primitive and shorelines largely undeveloped but accessible in places by roads.

3. Recreational river areas: those rivers or sections of rivers that are readily accessible by road or railroad, that may have some development along their shorelines, and that may have undergone some impoundment or diversion in the past.

The economic evaluation of rivers has traditionally focused on the demand for onsite recreation use. Several studies have estimated aspects of the demand for fishing,

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boating, (rafting, kayaking, and tubing), and related shoreline uses (primarily sightseeing, camping, and hiking). These include studies of the recreation use value of instream flow in the Poudre River [*Daubert and Young*, 1981] in the Colorado, Yampa, Crystal, Roaring Fork, Frying Pan, and Homestake rivers in western Colorado [*Walsh et al.*, 1980], the Blaksmith, Little Bear and Logan rivers in Utah [*Narayanan et al.*, 1983; *Amirfathi et al.*, 1984], the Rio Chama River in New Mexico [*Ward*, 1987], the John Day River in Oregon [*Johnson and Adams*, 1988], and most recently, the Grand Canyon of the Colorado River in Arizona [*Boyle et al.*, 1988].

Other studies have estimated the recreation use value of the Colorado River at Westwater Canyon in Utah [*Bowes and Loomis*, 1980], the White, Black, Salt, and other rivers in Arizona [*Gum and Martin*, 1975; *King and Walka*, 1980; *Keith et al.*, 1982], the Middle Fork of the Salmon River in Idaho, the first river designated as Wild and Scenic [*Michaelson*, 1977; *Brooks*, 1979; *Rosenthal and Cordell*, 1984], the lower Wisconsin River [*Boyle and Bishop*, 1984], the upper Delaware River in New York [*Rosenthal and Cordell*, 1984], the Chattooga River in Georgia and South Carolina [*Klemperer et al.*, 1984], and rivers throughout the United States [*Vaughan and Russell*, 1982].

While the present study is concerned with the demand for onsite recreation use, it differs from earlier work by introducing offsite demands by the general public. The purpose is to develop and apply a contingent valuation (CVM) procedure to estimate a statistical demand function for rivers which more nearly approaches the goal of including total value. The objective is to contribute to the development of the best practicable methodology for application of economics to the valuation of rivers by society. Special attention is given to empirical measurement of some basic motivations which may help explain willingness to pay for the protection of rivers, particularly the effect of taste and preference, information, and uncertainty of supply and demand.

THEORETICAL APPROACH

In the past, demand for rivers was usually modeled as derived from the demand for recreational visits [*Ward and Loomis*, 1986; *Bockstael et al.*, 1987]. Suppose that for each river, a measurable environmental quality index can be assigned that is constant over individual users. Assume a simple utility function of the following form (1):

$$U = U(X, R, Q) \tag{1}$$

where utility (U) depends on the consumption of private goods (X), recreation participation rates (R) and river qualities (Q). Maximizing utility subject to the budget constraint leads to an ordinary demand function for recreation trips to a river of given quality. Integrating under recreation demand curves for a river with and without desired quality characteristics provides an estimate of the recreation benefits of a river protection program.

An alternative formulation starts with the objective of measuring the total contribution of rivers to national economic development and expands the model to include several possible motivations in addition to recreation access. We will designate the bundle of offsite satisfactions as preservation benefit and assume that it may include option, existence, and bequest demands. Therefore a more general form of the utility function becomes

$$U = U[f_1(X, R, Q) + f_2(O, E, B)] \tag{2}$$

where individuals derive benefit from consumption (f_1) of private goods (X) and onsite recreation use (R) of river quality (Q). Individuals may also benefit from offsite consumption (f_2) of option value (O) to guarantee the opportunity for future recreation use of rivers under conditions of uncertain supply and/or demand [*Bishop*, 1982; *Freeman*, 1985; *Brookshire and Smith*, 1987], existence value (E) of the satisfaction they personally derive from knowledge that rivers exist as a natural habitat for fish, plants and wildlife [*Madariaga and McConnell*, 1987], and bequest value (B) from the knowledge that other individuals will benefit from the protection of river quality [*Brookshire et al.*, 1986; *Loomis*, 1988*a*]. This would seem to be more a general formulation in which (1) is a special case of (2) when offsite benefits approach zero for rivers lacking the necessary characteristics of quality.

Included in the total value concept [*Peterson and Sorg*, 1987] are the (1) onsite consumption benefits of recreation activity, and (2) offsite consumption of the flow of information about these activities and resources consumed as preservation benefits, i.e., willingness of citizens to pay for the knowledge that rivers are protected (option, existence, and bequest values). This knowledge may be experience based or education based. Individuals either have visited specific rivers (onsite use) or they have learned about them (offsite use). Based on this knowledge, they report total value as a willingness to pay for both types of satisfaction rather than forego it, as demonstrated in the case of visibility [*Schulze et al.*, 1983], grizzly bears and bighorn sheep [*Brookshire et al.*, 1983], endangered species such as the golden eagle and striped shiner [*Boyle and Bishop*, 1987], wildlife habitat [*Loomis*, 1987*b*], water quality [*Smith and Desvousges*, 1986], and the availability of wilderness areas [*Walsh et al.*, 1984].

Preservation values are nonmarket public goods since their consumption is both nonrival and nonexclusive. *Bradford* [1970] developed a theoretical basis for the contingent valuation method of estimating an aggregate benefit function for public goods. *Brookshire et al.* [1980] extended the theory of total value to a general conceptual model for valuation of all natural resource service flows such as increments in river protection. The objective is to estimate a total value function reflecting the representative individual's willingness to pay for alternative levels of river protection. Individual total value functions have a slope representing the marginal rate of substitution between income and river protection. The aggregate total willingness-to-pay curve is the vertical summation of individual values over the relevant population. Its first derivative is the marginal willingness-to-pay function representing a compensated demand price for the protection of rivers.

The upper panel of Figure 1 shows two hypothetical aggregate total benefit curves, both of which increase at a decreasing rate with the protection of additional rivers. The lower curve illustrates the effect of incomplete benefit measures in the past. The four points which plot the lower aggregate total benefit curve include only recreation use values. The points which plot the higher curve represent the maximum amount citizens would be willing to pay for

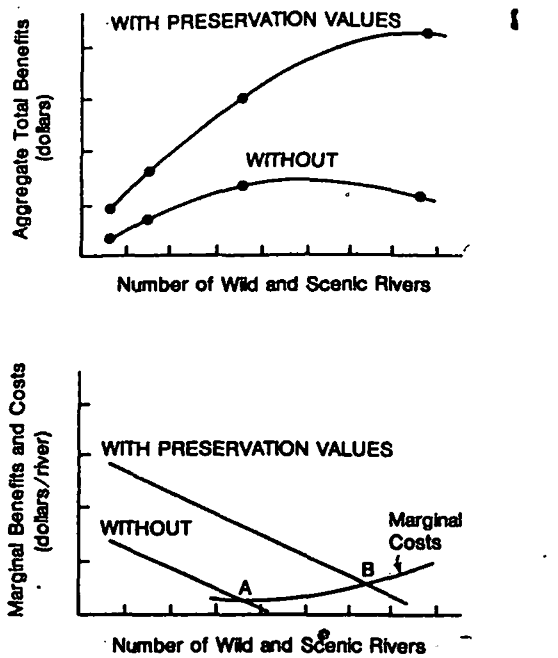

Fig. 1. Hypothetical aggregate total and marginal benefits and costs for wild and scenic rivers with and without preservation values.

The following questions are asked:

People value protection of some rivers more highly than others. Please rank four of the above rivers from most important to least important from your point of view.

What is the maximum amount of money you (your household) would pay per year to guarantee that these rivers are protected?

Your most important choice?	$______
Your top 2 choices?	$______
Your top 3 choices?	$______
Your top 4 choices?	$______
All 11 study rivers (See map)	$______

People value the protection of rivers for several purposes. What proportion (percent of 100) of the highest dollar value you reported above would you assign to each of the following purposes? Read the entire question first, then answer each of four parts; together, they should total 100 percent.

a. Payment to actually visit these rivers for recreation use. ______%

b. In addition to your actual recreation use value, how much of an "insurance premium" would you be willing to pay each year to guarantee your choice of recreation use of these rivers in the future? ______%

c. Payment to protect these rivers for reasons other than your own personal use.

1) The value to you from just knowing these rivers exist as natural habitats for plants, fish, wildlife, etc. ______%

2) The value to you from knowing that these rivers will be protected for future generations. ______%

Fig. 2. Questionnaire about the value of changes in quantity or quality of a resource.

protection of rivers, including both recreation use and preservation values.

The lower panel of Figure 1 illustrates the economic significance of introducing preservation values. Marginal benefit curves represent the change in aggregate total benefit with increments in number of rivers protected. Hypothetical marginal benefit and cost curves are shown with and without preservation values. A perpendicular dropped from the intersection of the marginal cost and marginal benefit function without preservation value at point A to the horizontal axis indicates a substantially lesser efficient number of rivers than the intersection of the marginal cost and marginal benefit function with preservation value at point B. The number of rivers represented by point B with preservation value would be recommended on efficiency grounds because the excess of aggregate total benefit over total cost exceed that resulting from any alternative amount.

RESEARCH METHOD

The demand for rivers is measured using the contingent valuation method recommended by federal guidelines [*U.S. Water Resources Council*, 1979; 1983] as suitable for the valuation of water-based recreation and environmental resources. To apply the method, a sample of the affected population is asked direct questions about the value of changes in quantity or quality of a resource (Figure 2). In this case, individuals are asked to report their maximum willingness to pay annually for the protection of an incremental number of specific rivers. The contingent valuation method is the only known way to value the protection of rivers before changes occur. To wait until after irreversible development may be an unnecessarily costly form of experimentation [*Brookshire and Crocker*, 1979].

Respondents are asked to make a series of five budget allocation decisions based on total annual benefits received from increments in river protection, i.e., to write down the maximum amount of money they would be willing to pay annually for increases in the number of specific rivers protected as depicted on a map of the state. Once this budget allocation question is completed, they are asked to allocate the total value reported for the 11 study rivers among the four categories of value. The procedure is designed to identify the consumer surplus of current recreation use as distinct from the option, existence, and bequest values of both onsite and offsite users of the resource.

The basic data are from a 1983 mail survey designed to represent the resident population of the state. A sample of 214 households replied which represents a 51% response rate. The demographic characteristics of the sample are very close to those of the population. Income level and income distribution, age of household head, household size, occupation, and education are similar to the population of the state as reported by the U.S. Census. Statistical tests show no significant difference between values reported by early and late responses to four mailings. A random sample of 10% of the nonrespondents were contacted by phone. Average incomes are slightly higher than respondents while age and education are slightly lower. They are somewhat less active in river-based recreation, reflecting some self-selection bias. Still, it is apparent that a substantial majority of nonrespondents value river protection. The sample is adjusted to be consistent with the geographic distribution of the state population [*Sanders*, 1985]. Although the household survey has the limitation of excluding tourists from out of state, the resident population appears to be reasonably well represented by the sample for most comparisons. The mail survey method used in this study has been successfully applied in previous contingent value studies of wilderness recreation

[*Cicchetti and Smith*, 1973] and waterfowl hunting [*Hammock and Brown*, 1974].

A procedure for mail surveys developed by *Dillman* [1978] is followed insofar as possible. The questionnaire is pretested and designed for clarity and ease of answering. The legitimate scientific purpose of the survey is established by use of university letterhead and self-addressed return envelopes. Cover letters are individually addressed and signed by the project leader. The cover letters explains the usefulness of the study and the importance of participation. The survey is introduced as a scientific experiment administered to a sample of citizens whose answers may affect government decisions as to use of the rivers. Participants are assured their answers are confidential and reported as part of sample averages.

Public interest is stimulated by reports in local newspapers about Congressional consideration of proposed recreational, wild, and scenic management of several study rivers. The questionnaire is designed to be completed in less than 30 min. It includes a total of 36 questions to obtain information on willingness to pay for protection of the rivers, reasons why rivers are valued, importance of various types of river recreation experience, and social economic characteristics of the sample. It is professionally printed on good quality paper and bound in booklet form. A copy of the questionnaire is reproduced by *Walsh et al.* [1985].

An assessment by *Cummings et al.* [1986] concludes that several conditions should be met if willingness to pay questions are to provide reasonably accurate measures of the value of environmental resources. Respondents should understand the resource to be valued, have prior experience valuing it and choosing how much to consume under conditions of little uncertainty. There is reason to believe that these conditions are present in this study.

Respondents are provided an attractive map showing the location of the study rivers along with a brief description of each. They are introduced to the concepts of value and the quality of rivers by the placement of preference questions prior to the economic valuation questions. This is designed to help them clarify motivations. Replies indicate considerable accuracy in valuing choices with respect to the quality of rivers. Their valuations are not significantly different from a technical index of the quality of study rivers developed for the environmental impact statements by study teams from government agencies [*Walsh et al.*, 1985]. It is apparent that nearly everyone sampled had prior knowledge of the major rivers in the state.

The economic value questions are designed to be as realistic and credible as possible. Respondents are asked to report their willingness to pay into a special fund to be used exclusively for the purpose of protecting the study rivers. It is recommended by the federal guidelines to avoid emotional reaction or protest against methods of payment such as a user fee or tax. Respondents are asked to assume it is the only possible way to finance river protection. If a respondent reports that he is not willing to pay anything for rivers, he is asked to respond to a series of questions designed to find out why. About 12% of the sample object to payment into a trust fund but would not oppose some other method of paying for river protection and 11% believed they have a right to rivers and considered it unfair to expect them to pay for river protection. Thus, 23% of the sample is recorded as protesting against the structure of the experiment and are omitted from the economic analysis. This is somewhat more than the 15% recommended by the federal guidelines.

Individuals are asked to write down their maximum willingness to pay as an open-ended direct question. The approach is recommended by the federal guidelines for small projects such as river protection programs. Open-ended questions in mail surveys may have several advantages. The question can be answered at home and at a time convenient to the respondent. Household members can engage in extensive discussion before giving a dollar value. There is no possibility that an interviewer may influence the answers, nor that a bias might be introduced by alternative procedures. However, the experience with open-ended value questions indicates that the results may be somewhat conservative, particularly as compared to the dichotomous choice format which is now the preferred approach [*Loomis*, 1988*b*].

RIVER PREFERENCES

Nearly all of the households surveyed favor protection of rivers. Table 1 summarizes responses to the question: "Do you favor or oppose protecting each of the following rivers from water diversions and dams?" Survey households rated the importance of each river on a 5-point scale, with (1) strongly oppose, (2) oppose, (3) indifferent, (4) favor, and (5) strongly favor. The average scores are shown for each river along with the standard deviation. The most important study river is the Cache la Poudre, with 78.5% reporting that they favor or strongly favor its protection as a wild and scenic river. The preference for protection of other study rivers is not significantly lower. The second most important river is the Gunnison, preferred by 75.6% of the households. This is followed, in declining order of preference, by the Colorado (75.0%), Green (74.7%), Yampa (73.1%), Elk (72.0%), Dolores (72.1%), Piedra (71.5%), Los Pinos (69.4%), Encampment (69.3%), and Conejos (65.1%).

A substantial majority favor the study of additional rivers for possible protection. The most important is the Arkansas, with 61.1% reporting that they favor or strongly favor its study. The second most important is the Roaring Fork, preferred by 59.5% of the households. This is followed, in declining order of preference, by an additional 193 km of the Yampa (58.6%), South Platte (56.9%), Rio Grande (54.9%), an additional 153 km of the Dolores (54.8%), and the Crystal (43.9%). Several respondents suggest that St. Vrain, Eagle, and White rivers also should be studied for possible protection.

Very few households report that they oppose protection of rivers. Opposition represents less than 10.0% of households in every case. However, 21.6% of the households report that they have no opinion or do not care whether the 11 study rivers are protected. Indifference is higher for the less well-known Conejos (29.1%), Encampment (26.4%), and Los Pinos (27.1%) than the popular Colorado (16.2%) and Poudre (14.8%). More of the households are indifferent whether additional rivers are studied for possible protection. Indifference is higher for the Crystal (50.6%), an additional 193 km of the Yampa (34.9%), South Platte (34.4%), Roaring Fork (34.0%), and Arkansas (32.1%).

Table 2 summarizes the reasons rivers are valued by residents of the state. Survey households rate the relative importance of each reason on a 5-point scale, with (1)

TABLE 1. Preferences for the Protection of Rivers, Colorado, 1983

River	Percent Responding: Strongly Opose (1)	Oppose (2)	Indifferent (3)	Favor (4)	Strongly Favor (5)	Average*	Standard Deviation
			Study Rivers				
Cache La Poudre	2.4	4.3	14.8	29.8	48.7	4.18	1.00
Colorado	4.0	4.8	16.2	26.6	48.4	4.11	1.09
Conejos	2.2	3.5	29.1	31.7	33.4	3.91	0.98
Dolores	2.2	4.5	21.2	32.3	39.8	4.03	1.00
Elk	3.2	1.4	23.4	29.3	42.7	4.07	1.00
Encampment	2.1	2.2	26.4	31.2	38.1	4.01	0.96
Green	3.2	4.3	17.8	29.3	45.4	4.09	1.04
Gunnison	4.0	3.5	16.9	22.3	53.3	4.18	1.08
Los Pinos	2.1	1.4	27.1	31.8	37.6	4.01	0.94
Piedra	2.1	1.4	25.0	33.8	37.7	4.04	0.93
Yampa	3.2	4.3	19.3	26.0	47.1	4.10	1.06
Average	2.8	3.2	21.6	31.0	42.9	4.07	1.01
			Other Rivers to Study				
Arkansas†	2.2	4.6	32.1	35.9	25.2	3.77	0.95
Crystal†	2.2	3.3	50.6	26.2	17.7	3.54	0.90
Dolores‡	2.4	3.3	39.4	33.3	21.5	3.68	0.93
Rio Grande†	2.4	3.5	39.2	38.8	16.1	3.63	0.88
Roaring Fork†	2.2	4.3	34.0	31.1	28.4	3.79	0.98
South Platte†	2.4	6.2	34.4	24.4	32.5	3.79	1.04
Yampa§	2.2	4.3	34.9	32.4	26.2	3.76	0.96
Average	2.3	4.2	37.8	31.7	23.9	3.71	0.95

*Scale is 1 to 5, where 5 is strongly favor and 1 is strongly oppose. Sample size is 214.
†Various segments.
‡Additional 153-km segment.
§Additional 193-km segment.

definitely not important, (2) not important, (3) somewhat important, (4) important, and (5) very important. The average scores are shown along with the standard deviation. The most important reason for valuing rivers is to protect the quality of water, air and scenery. The next most important reason is the protection of fish and wildlife habitat. Third in importance is the satisfaction from knowing that future generations will have rivers (a bequest value). Satisfaction from knowing they have the option of possible recreation visits to rivers in the future (option value) is the fourth most important reason.

These two preservation values (option and bequest) rank higher than current recreation use of rivers for fishing, boating, camping, hunting, sightseeing, etc., which ranks

TABLE 2. Response to "Reasons Why You Value the Protection of Rivers," Colorado, 1983

Reasons	Percent Responding: Definitely Not Important (1)	Not Important (2)	Somewhat Important (3)	Important (4)	Very Important (5)	Average*	Standard Deviation
Protect the quality of water, air, and scenery	1.0	0.0	5.1	18.6	75.3	4.67	0.66
Protecting fish and wildlife habitat	1.0	1.9	6.7	19.7	70.7	4.57	0.78
Providing you with actual river recreation (fishing, camping, hunting, sightseeing, etc.)	3.2	3.7	20.5	32.6	40.0	4.03	1.02
Knowing that in the future you have the option to go there if you choose	3.0	2.4	14.3	35.4	44.9	4.17	0.97
Just knowing rivers exist and are protected	3.2	7.5	19.1	31.2	39.3	3.96	1.08
Knowing that future generations will have rivers	1.1	0.5	9.7	30.7	58.0	4.44	0.78
Average	2.1	3.2	12.6	28.0	54.7	4.31	0.88

*Scale is 1 to 5, where 1 is definitely not important, and 5 is very important. Sample size is 214.

TABLE 3. Willingness to Pay per Household for Increments in River Protection, Colorado, 1983

Annual Household Values	Potential Wild and Scenic Rivers: Three Most Valuable Rivers (Poudre, Elk, and Colorado)	Seven Most Valuable Rivers (Add Gunnison, Green, Yampa, and Piedra)	Eleven Study Rivers (Add Los Pinos, Conejos, Dolores, and Encampment)	Fifteen Most Valuable Rivers* (Add Arkansas, Roaring Fork, South Platte, and Rio Grande)
Recreation use value	$ 7.54	$14.08	$18.00	$ 19.16
Preservation value	$32.26	$60.24	$77.00	$ 81.96
Option value	$ 6.28	$11.73	$15.00	$ 15.97
Existence value	$11.31	$21.12	$27.00	$ 27.67
Bequest value	$14.66	$27.38	$35.00	$ 36.19
Total value	$39.00	$74.32	$95.00	$101.12

*Included are the 11 rivers studied and found qualified for designation. In addition, this study asks respondents if sections of other rivers should be studied for possible designation. The four rivers shown are among those rivers most respondents agreed should be studied. Since willingness to pay is not obtained for these specific rivers, the estimated values in this column are forecasts based on the quadratic function: WTP = $4.67 + 13.03(Q) - 0.44(Q)^2$, where Q = number of rivers.

fifth in importance. The final reason is another preservation value: the satisfaction from knowing that rivers exist and are protected. Still, a substantial 70.5% of the households rate knowing that rivers are protected as important or very important. These results suggest that rivers provide many preservation benefits to the people of the state in addition to actual recreation use benefits. In fact, preservation motives appear to be more important than recreation use. The interested reader is referred to the growing literature discussing the importance of these and related motivations [*Weisbrod*, 1964; *Krutilla*, 1967; *Brookshire et al.*, 1986; *Madariaga and McConnell*, 1987; *Boyle and Bishop*, 1987; *Brookshire and Smith*, 1987; *Loomis*, 1988*a*].

Demand for Rivers

Table 3 shows the average total value of annual recreation use and preservation demands of potential wild and scenic rivers reported by resident households of the state. Also shown is the willingness to pay for each of the four basic motivations for protection: recreation use, option, existence, and bequest demands. Aggregate benefit would be equal to the average annual willingness to pay reported per household multiplied by the 1,185,000 households in the state at the time of the study.

Annual benefits of the three most valuable rivers in the state (Cache la Poudre, Elk, and Colorado at Westwater Canyon) are estimated as $40 per household, including about $8 onsite recreation use value and $32 offsite preservation value. This illustrates the importance of adding preservation values to benefits from recreation use. When preservation values are included, the benefit estimate is more than 5 times the estimate for recreation use values alone.

With designation of additional rivers, benefits increase at a decreasing rate. Benefits rise to approximately $74 per household with designation of the seven most valuable rivers, and to $95 with designation of all 11 study rivers. Total annual benefits would rise to a maximum of about $101 with designation of 15 rivers, including four rivers not yet studied. The most preferred additional study rivers are the Arkansas, Roaring Fork, South Platte, and Rio Grande rivers.

The upper panel of Figure 3 illustrates this total benefit function and the lower panel the marginal benefit derived from the total. It is an approximation of the representative household's demand curve for rivers in the state. For the first river protected, households are willing to pay a great deal because of its scarcity value. However, as more rivers are designated, the benefit generated by each additional river becomes smaller, indicating diminishing marginal benefits. As individual demands for rivers are fully satisfied, the total benefit function flattens out.

Benefit cost analysis instructs the decision maker to continue increasing the number of rivers protected until the excess of benefit over cost is as large as possible. Total benefit is maximized when 15 rivers are designated for protection. Total benefit would diminish with further designation. This is the point where the marginal benefit of additional rivers becomes zero. If there were no opportunity cost, the economically efficient number of wild and scenic

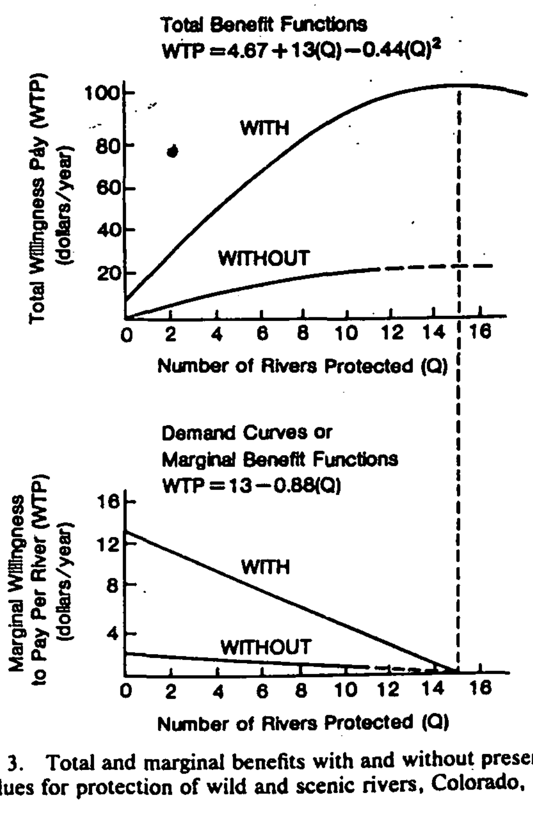

Fig. 3. Total and marginal benefits with and without preservation values for protection of wild and scenic rivers, Colorado, 1983.

rivers would be 15, where total benefit is maximized and marginal benefit is zero.

It should be acknowledged that these results are not extremely precise. The 95% confidence interval is approximately 26.6% plus or minus mean willingness to pay (2 times the standard error). This reflects the wide variation among respondent value for specific rivers. Another problem is that respondents differ with respect to the order in which rivers are valued, whereas the representative household's benefit function is the average value of each river reported by all respondents, with the rivers arrayed from most to least average value of the entire sample. Some values for specific rivers may change when the order of protection changes since the value of any given river depends, in part, on which other rivers are already protected. As a result the benefit function must be treated as an approximation for illustrative purposes. However, the total value of the study rivers would not change so long as all 11 rivers are protected.

Statistical Analysis

Table 4 shows the variables that are significant predictors of total willingness to pay for recreational and preservation demands including option, existence, and bequest values of all 11 study rivers. The ordinary least squares statistical method is used to estimate the relationship of total annual benefit to the characteristics of households and the resource. Alternative functional forms are evaluated including natural logarithm of the dependent variable with the linear independent variables. This semilog model results in a much better fit to the data as measured by the Box-Cox procedure. The semilog form also results in residual plots more in line with the classical assumptions concerning error terms.

The adjusted R^2 indicates that 36–45% of the total variation in willingness to pay is explained by the variables included in the functions. This is considered a satisfactory level of explanation for data from a cross-sectional survey of households. The number of observations, 163, is sufficient for statistically significant analysis. The overall equations are significant at the 0.01 level, as indicated by F values of 26.0–35.5. Regression coefficients included in the equations are significantly different from zero at the 0.01–0.10 level, with the exceptions noted. Omission of a variable indicates that it is not related to benefit.

Several tentative conclusions can be reached based on the statistical benefit functions. Willingness to pay for rivers is significantly related to taste and preference in all cases. For example, in the equation for existence value, importance of the knowledge that rivers exist and are protected as a natural habitat for fish and wildlife is strongly positive. Uncertainty of demand apparently is important since the variable, probability of future recreation use of the study rivers, is positive and significant in four of the five equations, most notably for option value. The income variable is not statistically significant in any of the functions which suggests that the value of rivers to the citizens of the state is not constrained by income levels. Education is positively associated with value in three of the equations. The value of river protection appears to be broad based, crossing most occupational categories. Both men and women are equally willing to pay for the preservation values of rivers. However, men are willing to pay more for the recreation use of study rivers which reflects the fact that they are more likely to participate in most recreation activities at rivers.

A quality index for the study rivers is positively associated with willingness to pay in all cases. Since it is developed from the criteria used by government agencies in environmental impact studies of the rivers, the findings support the consistency of existing criteria. Apparently, household values reflect the valuation criteria used by the study teams. Perhaps the most interesting result is that members of agricultural organizations, often considered the opponents of river protection, are willing to pay more for preservation value (option, existence, and bequest demands) than other citizens of the state.

Discussion of Results

It is important to review results of the CVM study for several possible influences or bias. Discussed below are regional effects and resource uniqueness, ability of individuals to partition recreation use value from total value, comparison with replications of the preservation value estimates, effect of supply and demand uncertainty, attribution of total value to users and nonusers, information provided to respondents, and strategic behavior by respondents.

The literature suggests that there is little or no regional effect on willingness to pay for unique environmental resources such as the Colorado River at the Grand Canyon [*Schulze et al.*, 1981*b*]; however, for less unique resources with regional rather than national significance, willingness to pay appears to be a declining function of the distance households live from the resource [*Sutherland and Walsh*, 1985]. The possibility of regional effects on the value of less unique resources is supported. The most valuable river to residents of each of the regions in the state tends to be located in the same region [*Walsh et al.*, 1985]. Most of the rivers studied are located in the western region, and their familiarity to households living there is reflected in higher willingness to pay for protection ($136).

The results can be challenged on the grounds that what people say they are willing to pay contingent on the availability of rivers represents a behavioral intention rather than a directly observable action. The relationship between recreational intentions and actual behavior is subject to systematic empirical investigation. We tested the ability of respondents to partition recreation use value (equivalent to $21 per day) from total value by asking them to estimate use value per day ($24), both of which are not significantly different at the 0.05 level from the $23 value based on actual behavior measured by the travel cost method [*Walsh et al.*, 1985]. This is consistent with other findings that CVM studies of recreational benefits perform reasonably well when compared to the available empirical evidence from travel behavior, actual cash transactions, and controlled laboratory experiments [*Cummings et al.*, 1986]. Levels of accuracy are reasonable and consistent with levels obtained in other areas of economics and in other disciplines.

A conference assessing the validity of CVM concludes that the value of the public good characteristics of environmental resources cannot be validated by comparisons with behavior-based studies [*Cummings et al.*, 1986]. The reason is that the general public cannot be excluded for nonpayment nor charged their stated willingness to pay. There is a need to develop alternative procedures to test the validity of CVM studies of the value of public goods such as the preservation value of rivers. Replication of the approach in studies of

TABLE 4. Regression Estimates of Willingness to Pay for Recreation, Option, Existence, and Bequest Demands for 11 Wild and Scenic Rivers, Colorado, 1983

		Regression Coefficients				
Independent Variables	Description of Variable	Preservation Value	Option Value	Existence Value	Bequest Value	Recreation Use Value
Quality index for most preferred river	percent	0.0200	0.0100	0.0143	0.0146	0.0062
		(0.0026)	(0.0020)	(0.0024)	(0.0029)	(0.0020)
Probability of future use of a study river	percent	0.0095	0.0048	0.0042	—	0.0116
		(0.0030)	(0.0026)	(0.0027)	—	(0.0024)
Population density in county where river is located	persons/square mile	0.0183	—	—	0.01683	—
		(0.0030)	—	—	(0.0027)	—
Membership in an agricultural organization	1 = yes	1.6858	0.6395	1.3296	1.6808	—
	0 = no	(0.2041)	(0.1640)	(0.1888)	(0.1850)	—
Consumer surplus from last river trip	dollars	0.0036	0.0011	0.0020	0.0031	0.0015
		(0.0004)	(0.0003)	(0.0004)	(0.0004)	(0.0003)
Number of trips to rivers in other states	trips/year	0.1204	—	—	0.1512	—
		(0.0286)	—	—	(0.0286)	—
Household income	thousand dollars/year	−0.0025	0.0026	−0.0025	0.0003	−0.0018
		(0.0026)	(0.0020)	(0.0024)	(0.0024)	(0.0021)
Nonskilled, skilled, sales or clerical occupation	1 = yes	0.5631	—	0.5249	—	0.4686
	0 = no	(0.1615)	—	(0.1506)	—	(0.1277)
Recreation use is important	1 = yes	−1.7095	—	—	−0.8468	0.1860
	0 = no	(0.3039)	—	—	(0.2755)	(0.2047)
Size of party	number of people	−0.0609	−0.0425	—	—	−0.7887
		(0.0181)	(0.0143)	—	—	(0.0151)
Education	years	0.0918	0.0895	—	—	0.0999
		(0.0224)	(0.0179)	—	—	(0.0174)
Most preferred alternate site was a study river	1 = yes	0.7419	—	0.4689	0.6306	0.4842
	0 = no	(0.1474)	—	(0.1354)	(0.1300)	(0.1216)
Existence value is important	1 = yes	1.2672	—	0.7277	1.0371	—
	0 = no	(0.2394)	—	(0.2105)	(0.2223)	—
Option value is important	1 = yes	1.7245	0.9326	0.7687	1.0604	—
	0 = no	(0.3493)	(0.2341)	(0.3233)	(0.3205)	—
Manager or professional occupation	1 = yes	1.5959	0.7223	1.2842	1.2516	0.8265
	0 = no	(0.1786)	(0.1197)	(0.1580)	(0.1373)	(0.1384)
Willingness to pay to reduce travel time	dollars/hour	—	−0.1044	—	—	—
		—	(0.0257)	—	—	—
Willingness to pay to increase travel time	dollars/hour	—	0.0251	0.0175	—	—
		—	(0.0051)	(0.0059)	—	—
Wildlife and fish habitat is an important reason for river protection	1 = yes	—	1.0103	2.0089	—	1.3531
	0 = no	—	(0.3152)	(0.3716)	—	(0.3131)
Membership in an environmental organization	1 = yes	—	0.5143	—	0.5630	—
	0 = no	—	(0.1679)	—	(0.1860)	—
Visited a study river on last river trip	1 = yes	—	0.4306	—	—	—
	0 = no	—	(0.1228)	—	—	—
Recreation visitor days at most preferred river	thousand days/year	—	—	0.0019	—	—
		—	—	(0.0003)	—	—
River recreation is an important reason for river protection	1 = yes	—	—	−1.5208	—	—
	0 = no	—	—	(0.2743)	—	—
Number of trips to other rivers in Colorado	trips/year	—	—	—	−0.0342	—
		—	—	—	(0.0093)	—
Fishing among three most popular river trip activities	1 = yes	—	—	—	0.5307	—
	0 = no	—	—	—	(0.2175)	—
Probability of a future visit to other Colorado rivers	percent	—	—	—	−0.0060	—
		—	—	—	(0.0015)	—
Bequest value is important	1 = yes	—	—	—	0.0469	—
	0 = no	—	—	—	(0.5330)	—
Year of first visit to river	calendar year	—	—	—	—	0.0057
		—	—	—	—	(0.0020)
Number of trips to study rivers	trips/year	—	—	—	—	0.0146
		—	—	—	—	(0.0031)
Sex of respondent	1 = male	—	—	—	—	0.4928
	0 = female	—	—	—	—	(0.1088)
Recreation visitor days at site	thousand days/year	—	—	—	—	(0.0016)
		—	—	—	—	(0.0002)
Constant		−2.5875	−3.0288	−2.3434	−1.4296	−3.1109
		(0.4476)	(0.4070)	(0.4190)	(0.4736)	(0.4070)
Adjusted R^2		0.45	0.40	0.36	0.40	0.44
F significance		35.49	30.82	26.01	27.02	34.50
Number of cases		163	163	163	163	163

Numbers in parentheses are standard errors. Dashes indicate that the variable did not enter the equations at the 0.01–0.10 significance levels.

these and other rivers would indicate relative stability of estimates. Two studies discussed in the following paragraph use similar procedures and show somewhat lower total values although within the 95% confidence limit.

Preliminary results of a mail survey of 733 households in Alabama indicate a total willingness to pay of $57 per year (1987 dollars) for protection of 15 rivers in the state, including demand for recreation use, $8; option, $9.50; existence, $22.50; and bequest, $17 (H. A. Clonts and J. Malone, Estimating natural resource values: The case of free-flowing rivers, unpublished paper, Department of Agricultural Economics, Auburn University, Auburn, Alabama, 1988). Also, personal interviews with a sample of 198 households in Colorado result in total willingness to pay of $58 per year (1983 dollars) for protection of the same 11 study rivers, including demand for recreation use, $15; option, $12; existence, $13; and bequest, $17 [*Aiken*, 1985]. The recreation use and option values are not significantly different from values reported in this statewide mail study, however, existence and bequest values are significantly lower. In the study, respondents value rivers in a sequence of seven environmental amenities including, in addition, air and water quality, endangered fish and wildlife, wilderness areas, forest quality, and the quality of recreation facilities. Several of these amenities are complements to the protection of rivers. This means that some of the values attributed to the existence and bequest demands for rivers may properly be placed in the other complementary categories for specific amenities which are enhanced by river protection programs.

The literature on environmental benefit estimation suggests that individual choices are made either under conditions of approximate certainty or uncertainty as to demand and supply [*Freeman*, 1985; *Brookshire and Smith*, 1987]. To test for the effect of supply uncertainty, approximately one-half of the households are asked to assume that if they do not pay to protect the rivers, there is a 50% chance that the process of water development will begin next year. The other half are asked to assume that water development projects are certain to begin next year if they do not pay (Table 5). The uncertain (50-50 chance) loss of the study rivers results in a 20% decrease in willingness to pay for protection, although the difference is not statistically significant owing to smallness of the sample.

To illustrate the effect of demand uncertainty, households report how likely it is that they will visit any of the study rivers next year (Table 6). Those who report that they are certain to visit a study river are willing to pay 4 times more for protection than those who are certain not to. As demand uncertainty broadly diminishes (probability of use 0.1–0.99), willingness to pay increases for the recreation use value and option value categories as expected. However, existence value and bequest value also increase reflecting the association of increased appreciation with anticipated recreation use.

It is possible to evaluate the proposal that the total value reported by respondents who intend to use a resource in the future should be interpreted as option price (sum of expected consumer surplus of recreation use and option value for future use) while it is existence value (a combination of existence and bequest values) for those who do not intend to use the resource [*Brookshire et al.*, 1983]. According to this approach, individuals can have one or the other value but not both. The results of this study illustrate the expected tendency (Table 6). Households not intending to use the resource next year place most (77%) of total value in the existence and bequest categories as do households with uncertain demand (70%). However, a surprising 50% of total value is included in the existence and bequest categories by households certain to use the resource next year. These results may be affected by the fact that individuals are presented with the opportunity to allocate motivations for payment into as many as four categories [*Loomis*, 1988*a*].

It is likely that information provided in the questions may influence the response. Approximately one-half of the households are provided a minimum of information about the concepts of recreation use and option value. The other half are given detailed information such as (1) payment to actually visit these rivers for recreation use and (2) in

TABLE 5. Effect of Supply Uncertainty on Willingness to Pay for 11 Wild and Scenic Rivers, Colorado, 1983

Source of Value	Probability That Water Development Will Begin Next Year	
	0.5	1.0
Total value	$84	$102
	(9.23)	(9.75)
Option price	$29	$37
	(4.42)	(3.84)
expected consumer surplus	$15	$21
	(2.69)	(1.84)
option value	$14	$16
	(1.73)	(2.00)
Existence and bequest values	$56	$66
	(7.87)	(9.62)
existence value	$32	$22
	(4.13)	(1.94)
bequest value	$24	$44
	(3.74)	(7.68)
Sample size	78	85

Standard errors are shown in parentheses. Group *t* tests show no significant difference at the 0.05 level between the mean values reported with the two levels of supply uncertainty.

TABLE 6. Effect of Demand Uncertainty on Willingness to Pay for 11 Wild and Scenic Rivers, Colorado, 1983

Source of Value	Probability of Visiting Next Year		
	0	0.1–0.99	1.0
Total value	$22	$128	$109
	(4.03)	(12.06)	(13.43)
Option price	$6	$38	$53
	(1.11)	(2.82)	(9.69)
recreation use value	$4	$19	$31
	(0.73)	(1.31)	(5.50)
option value	$2	$38	$22
	(.38)	(2.82)	(4.19)
Existence and bequest values	$22	$90	$56
	(3.89)	(13.76)	(7.03)
existence value	$10	$35	$31
	(1.94)	(4.40)	(3.16)
bequest value	$12	$55	$25
	(1.95)	(9.36)	(3.87)
Sample size	40	64	59

Standard errors are shown in parentheses.

TABLE 7. Frequency Distribution of Willingness to Pay for 11 Wild and Scenic Rivers, Colorado, 1983

Value Categories	Number of Respondents
Zero*	40
$1–9	2
$10–19	11
$20–29	22
$30–99	30
$100–249	36
$250–499	15
$500–999	4
$1000–1250	3
Total sample	163
Mean value†	$95
(standard error)	(13.3)

*An additional 49 zero values were protest bids.

†Evaluation of responses resulted in the rejection of two cases reporting values of $2000, and $5000 as outlyers. If the two largest responses were included, the weighted average annual willingness to pay would increase to $121.

addition to your actual recreation use value, how much of an "insurance premium" would you be willing to pay each year to guarantee your choice of recreation use of these rivers in the future? There is no difference in willingness to pay for recreation use and option demands for designation of the 11 study rivers with the alternative wording of the questions. Since the additional information has no effect on mean response, we tentatively conclude that the respondents with minimum information understand the distinction between actual recreation use value and the option equally well.

Another possibility is that individuals may engage in strategic behavior, overstating willingness to pay in order to encourage management agencies to protect rivers while avoiding actual payment of the stated amount, or understating values to discourage management agencies from levying taxes or user fees. If respondents bias their willingness to pay responses, visual inspection of a frequency distribution may show bimodal clustering of values at abnormally high and/or low levels. Distribution of the values in Table 7 does not indicate bimodal distribution, which suggests there may be little or no strategic bias of the study results. However, without knowledge of the true underlying distribution of values, visual inspection does not constitute a completely satisfactory test of strategic bias [*Rowe and Chestnut*, 1983]. It is noteworthy that the *Schulze et al.* [1981*a*] review of six CVM studies concludes that strategic bias in revealing consumer preferences is not likely to be a major problem.

PRESENT VALUE OF BENEFIT AND COST FUNCTIONS

Present value is the sum of annual benefit or cost each year discounted over a given planning period. The total value per household for increments in river protection (from Table 3) is multiplied by the 1,185,000 households in the state, and discounted over a 50-year planning period at the 7.875% federal rate for fiscal 1982–1983 [*U.S. Water Resources Council*, 1983]. River values are arrayed from most to least and accumulated to estimate the following present value of total benefit function (P_vB):

$$P_vB = 59.68 + 166.55(Q) - 5.62(Q)^2$$

where Q is the number of rivers protected and benefit is in million dollars.

The present value of total cost includes management cost and the opportunity cost of foregone timber, mineral, grazing, and possible water development projects. Management cost includes investment cost of initial construction, planning, and purchase of physical and scenic easements, plus annual operation and maintenance cost. Opportunity cost includes estimates from the wild and scenic river environmental impact statements regarding the loss of timber, minerals and grazing. For example, see *U.S. Department of Agriculture* [1982]. Opportunity cost is augmented with estimated net benefits foregone from two water development projects that could possibly be constructed without designation [*Weaver*, 1983]. They are on the Elk ($16.7 million) and the Gunnison ($12.9 million) rivers. River costs are arrayed in the same order as the benefit function and discounted at the same rate over the same planning period to estimate the following present value of total cost function (P_vC):

$$P_vC = 6.351559 + 1.171000(Q) + 0.067143(Q)^2 + 0.000254(Q)^3$$

The present value of total benefit from protection of the three most valuable rivers in the state (Cache la Poudre, Elk, and Colorado) are estimated as $599 million, including about $113 million recreation use and $486 million preservation value. With designation of additional rivers, the present value of benefit increases at a decreasing rate. Present value of benefit rises to $1119 million with designation of the seven most valued rivers, and to $1430 million with designation of the 11 study rivers. The present value of benefit is forecast to rise to a maximum of about $1521 million with designation of 15 rivers, including 4 rivers not yet studied. The most preferred additional study rivers are the Arkansas, Roaring Fork, South Platte, and Rio Grande rivers.

The present value of total cost of protecting the three most valuable rivers in the state is estimated as $27.2 million, including $16.7 million for the opportunity cost of foregone water development projects and $10.5 million of management and other opportunity costs. With designation of additional rivers, the present value of cost would increase at an accelerating rate. Present value of costs rise to $47.5 million with designation of the seven most valued rivers, and to $57.3 million with designation of the 11 study rivers. The present value of cost is forecast to rise to a maximum of about $69.5 million with designation of 15 rivers, including four rivers not yet studied.

Present value of net benefit (benefit less cost) would represent the investment value of natural rivers to society. It is the amount that a prudent government could afford to invest in the protection of rivers. Benefit-cost analysis instructs decision makers to continue increasing the number of rivers protected until the excess of benefit over cost is as large as possible. The benefit of river protection will be at a maximum where willingness to pay for an additional river equals its opportunity cost. On this basis, the optimum number of rivers to protect falls from 15 rivers without cost to about 13.7 rivers when present value of cost is introduced.

The optimum number of rivers to protect is not very sensitive to variations in the level of marginal cost. The marginal benefit of designating the eleventh study river is estimated at $42 million, with a 95% confidence interval of $31 to $53 million. We can conclude that the present value of marginal benefit exceeds the $4.8 million present value of marginal cost by more than 6 times. Thus the marginal benefit-cost ratio is not very sensitive to variations in the level of marginal cost. However, including preservation value along with the consumer surplus of recreation use in the total benefit function has a substantial effect on this relationship. Without preservation value, the optimum number of rivers to protect would fall to 11.7. The marginal benefit from recreation use of the eleventh study river would decline to $8 million, with a 95% confidence interval of $6 to $10 million. While the lower bound of this confidence interval is more than the $4.8 million present value of marginal cost, the marginal benefit cost ratio would be very sensitive to variations in the level of marginal cost. A slight underestimation of marginal cost could result in an unfavorable benefit-cost ratio.

POLICY IMPLICATIONS

This study was prompted by an impasse in the controversy over legislation to designate the Cache la Poudre and other rives for protection under the Recreation Wild and Scenic Rivers Act. The Northern Colorado Water Conservancy District and other development groups opposed protection because they would bear the opportunity cost of foregone construction of a series of dams. There are three ways in which society can deal with the problem of opportunity costs: (1) prevent the particular river designation from taking place, thereby the problem becomes moot; (2) make it up to the losers either with monetary payments (compensation) or with offsetting changes that improve their welfare (logrolling); and (3) use a tax and transfer system to ensure that the cumulative effect of river protection proposals is an income distribution that meets society's standards of fairness and equity [*Schultze*, 1977].

Economists have recognized for some time that the transaction costs associated with the payment of compensation to individuals often would be excessively high making actual payment impractical. But there are other ways to provide compensation than direct cash payment to individuals. Sites can be set aside that are nearly as suitable for the alternative uses foregone. For example, when Wayne Aspinall, former congressman from Colorado, released the Recreation Wild and Scenic Rivers bill from committee, he is reported to have acknowledged a need to protect rivers in some states but vowed there would be no rivers designated in his district or state. He did not foresee that the current congressman from the same district, would have the good judgment to appoint an advisory committee composed of representatives of groups who benefit and who would bear the opportunity costs of protecting the Cache la Poudre. Both sides gave a little and unanimously recommended 121 km for protection and a little more than 11 km for future damsites. As a result, in 1986, Congress designated it the first recreational, wild, and scenic river in the state. The lesson here is for groups who benefit to find out what those who bear the costs will settle for and support it just as strongly as their own position. This is perhaps the most difficult strategy to adopt when water lawyers increasingly recommend court litigation. It is equivalent to the defense attorney arguing for the best features of the prosecutor's case.

Beneficiaries of river protection should not overlook the possibility that there may be a loss of tax base to the community. For example, a government entity operating its own natural river corridor forgoes the tax revenue it could have earned if the area were held by private owners who pay taxes. Since a public site consumes governmental services in much the same way as a private one, the costs of services provided result in a higher tax load on the rest of the community. Economists consider the foregone tax an economic cost of the public agency. As a result, a number of states and federal agencies make annual payment to local units of government in lieu of taxes.

The payment of compensation for the opportunity cost of foregone development with increased river designation would represent balanced treatment of developers. Currently, they are often required to pay compensation roughly equivalent to opportunity costs. For example, the Fish and Wildlife Coordination Act (P.L. 85-625) requires payment of mitigation cost such as the purchase of sufficient wildlife habitat to offset that lost in development of a reservoir. In addition, the Preservation of Historic and Archeological Data Act (P.L. 93-291) requires resource developers to undertake salvage operations to reduce the external costs of damage to historic cultural resources.

There is a limit, of course, to how far society can go in identifying opportunity costs and compensating losers [*Schultze*, 1977]. It has to be careful that the compensation devices themselves do not become a subsidy of inefficiency. But society could do far more to neutralize the very strong, and very understandable, political pressures against efficient proposals to increase river designation if economists gave as much analytical attention to the compensation problem as they now do to efficiency. Economic and political analysis need to be joined to develop a combined efficiency and compensation strategy.

CONCLUSIONS

The purpose of this study was to develop and apply a procedure for measuring the willingness to pay for river protection. The study addressed the problem of measuring total value, including preservation benefit in addition to the benefit of recreation use. Specifically, it was shown the addition of preservation value to the guidelines for benefit-cost analysis by state and federal agencies would improve the efficiency of river allocation and thus increase the welfare of society.

The total value estimate should be considered a first approximation to be tested by further research. Not included were possible recreation use and preservation values which may be held by nonresidents of the state. The effect of population growth was not estimated. Moreover, there may be long-run ecological values which are not known at the present time. *Fisher et al.* [1972] and *Smith* [1972] have demonstrated that the benefit from environmental protection would rise over time compared to benefit from alternative uses of these resources. This is due to the fixed supply of natural environments and the effect of technological change which increases productivity and introduces substitutes for goods produced from natural resources.

The estimates are sufficient, nonetheless, to demonstrate that estimating the preservation value of increments in river protection would represent a substantial contribution to the present value of benefit estimated for recreational use. In the absence of information on the willingness to pay for preservation value, few rivers would be protected in states such as

Colorado, where future reservoirs, water diversions, and related development may be irreversible. Thus it is proposed that project evaluation by state and federal water agencies consider the preservation value of rivers.

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