Testing Construct Validity of River Recreation Use Values: 
A Comparison of Direct Elicitation of Use Values to Use Values Inferred Indirectly 
from WTP for Total Economic Value

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Testing Construct Validity of River Recreation Use Values: A Comparison of Direct Elicitation of Use Values to Use Values Inferred Indirectly from WTP for Total Economic Value

Abstract

The Total Economic Value (TEV of on-site use and passive use values) of avoiding a 50% reduction in current early summer high flows is estimated for a western urban river in Colorado. Using a contingent valuation method (CVM) survey of households we found that willingness to pay (WTP) for TEV of city households was $234 per year, with most of this value, $207, being use value. Using a second CVM question specifically about recreation use value of visitors yielded an estimated annual WTP of $156 per year. Given the large variances in estimated WTP, the two estimates of recreation use value are not significantly different. Summing up the TEV’s per household in the city yields an annual value of $171 to $255 per acre foot, several times larger than annual water lease rates in Northern Colorado.

Keywords: contingent valuation, instream flow, recreation benefits, total economic value.

INTRODUCTION

As development has proceeded in the western U.S., the vast majority of natural flows have been diverted for irrigated agriculture. This dominance continues today, although some of this irrigation water has shifted from agricultural to municipal and industrial use. Instream flows are recognized in many western states as a beneficial use, but it is last in time under western water law. Thus, in fully appropriated watersheds, instream flows are negligible. Even when unappropriated water is available for instream flows, these flows are now junior to nearly all others. In droughts when instream flows are most critically
needed, the junior water rights provide little or no water due to calls by senior water right holders.

Another frequent result of water development in the west has been to “flatten” the historic natural hydrograph of rising spring flows with a peak in early summer, and then a decrease in flows in late summer and early fall. The high spring and early summer flows are often important to maintain stream channel structure and maintain riparian vegetation such as cottonwoods and willows. Development of high mountain reservoirs to capture and store high spring flows and then release them in mid and late summer for irrigation results flattens the hydrograph to the detriment of riparian vegetation (and the bird species that depend on them), and some native fish species whose life cycle is keyed to the historic rising spring hydrograph they evolved with.

These two patterns in western water development have affected our study area, the Poudre River in northern Colorado. The Poudre River has its headwaters in Rocky Mountain National Park, and flows down the Poudre Canyon and eventually through Fort Collins and Greeley Colorado. However, major water diversions occur prior to the river entering Fort Collins. This has resulted in reductions in the total flows and also diminution of the natural hydrograph. However, as will be illustrated later, there is still some resemblance to the natural hydrograph, although at a greatly reduced level. Specifically, there is still a rise in flows in the Poudre River through Fort Collins in May and early June as snow melt and spring rains fall. After mid-June the flows tend to also fall rapidly, in part due to reduced snowpack, and to increased irrigation diversions upstream. By August and September Poudre River flows are reduced to the level of that the river barely has enough water to wet the rocks in portions of the river bed where there
is a wide channel. As a result, many ecosystem services the river could provide, such as
cwatervowl habitat, rafting, fishing and swimming are lost. These lost ecosystem services
are particularly apparent to the thousands of visitors to the 18 designated Natural Areas
and 5 City parks along the river. Also lost are the aesthetics of the river for the thousands
of people who use the bike paths along the river that the City of Fort Collins has put in at
great expense.

However, despite the already compromised state of the Poudre River through Fort
Collins, there are unexercised senior water rights upstream to capture a portion of the
“excess” high spring and early summer flows. After unsuccessful attempts by local water
districts and the U.S. Bureau of Reclamation to build a major dam on the mainstem of the
Poudre River in the early 1980’s, a new alternative was proposed in 2007 to build a large
off-channel reservoir to store these uncaptured high spring and early summer flows. As
recently noted (Zaffos, 2008), these types of “off-channel” reservoirs are being proposed
through out the west as a feasible and more environmental friendly water storage
projects. The proposed two reservoir system project is commonly referred to by the name
of the very large reservoir, Glade Reservoir, although the technical name for the project
Northern Integrated Supply Project (NISP).

Glade Reservoir would be larger than the current largest off-channel reservoir
(Horsetooth Reservoir) in northern Colorado, and would store 170,000 acre feet in its five
mile length and 260 foot depth. The project has an overall price tag of $405 million
(www.ncwd.org). In order to provide this much water, the late spring and early summer
flows would be reduced by between 50% and 75%. Even a 50% reduction would cut the
peak of the hydrograph in half, putting at risk the remaining riparian vegetation (and its
associated bird population) as well as greatly shortening the waterbased river recreation season, and the reducing aesthetics of the natural areas to bike path users.

While the project is proposed and financed by Northern Water Conservancy District and several small towns, the U.S. Army Corps of Engineers must develop an EIS prior to issuing the needed permits. As part of the EIS process the stakeholders, including the City of Fort Collins, would be providing comments on the EIS. The City Council of Fort Collins decided that in order to provide factual and objective comments it would commission a series of studies of the effect of these diversions on the Poudre River through town. These studies included hydrology and ecology. However, the City Council also asked for an economic study on the effects of reduced flows on recreation and the citizens of Fort Collins. The City Council and its Natural Areas staff commissioned the author to perform such a study, that the City Council used in its official comments on the EIS, and to justify their request that the COE perform a Supplemental EIS.

This article reports the result of a survey of Fort Collins household regarding their values of instream flows through the city, along with a methodological comparison of two different ways of developing estimates of the recreation use values. This consistency check provides some confidence that the recreation use values are reliable estimates of the benefits received by urban residents for maintaining the current instream flows.

ECONOMIC VALUES TO BE MEASURED

Adequate water flows in rivers provide society with many economic benefits. Obviously, visitors receive on-site recreation benefits from the water based recreation, such as bird watching along the riparian forests and enjoying the aesthetics of river
(Loomis, 1987). Recreation values from visiting the Poudre River are not traded in markets, but nonetheless have economic values to visitors. Federal benefit-cost procedures used by the U.S. Army Corps of Engineers (U.S. Water Resources Council, 1983), recognizes these values. Further, some residents receive enjoyment from just knowing that adequate flows support native fish and wildlife species even if they do not visit the river (Krutilla, 1967, Sanders, et al., 1990, Loomis, 1987). These off-site benefits are sometimes known as existence values (Sanders, et al., 1990) or passive use values. These passive use values are recognized by federal agencies when performing natural resource damage assessment. These passive use values are also non-market benefits and public good values. Taken together the recreation use values and passive use values are known at Total Economic Value (TEV).

The monetary values of these recreation use and passive use values are measured by economists and federal agencies (U.S. Water Resources Council, 1983) as the maximum amount a visitor or household would pay for the opportunity to visit or have the river at its current flows. While the benefit measure is called willingness to pay (WTP), this is merely short hand for willingness and ability to pay.

METHODS

Since many western states have stream access laws, and in the case of the Poudre River, 1,400 acres of public land along the river, there is no formal market to purchase access to the river. As such, economists utilize a constructed market approach to estimate visitors and household’s willingness to pay (Carson, 1991). This constructed market approach is known as the Contingent Valuation Method (CVM) and is a recommended
method for federal agencies to use in order to measure the WTP for recreation (U.S. Water Resources Council, 1983). While the method uses survey respondents’ statements regarding their WTP, this intended behavior is needed to provide the ex ante policy relevant estimate of benefits since the dam has not yet been built and the water diversion has not yet occurred. The whole point of an EIS is to assess the potential effects so as to inform the decision about whether to build a project and at what scale or location. Thus, actual behavior is not available at the time the decision must be made. Therefore, CVM is a useful tool since it provides answers to what would be the reduction in visitor benefits with a reduction in peak flows in the river if the dam were to be built.

Although not without controversy, (Portney, 1994), CVM has been used to simulate other local voter referendum and has been shown to be reasonably accurate (Vossler and Kerkvliet, 2003), and yield values comparable to actual behavior valuation methods (Brookshire, et al., 1982; Carson et al., 1996). Nonetheless, hypothetical bias has been a found in several CVM studies (Neil, et al, 1994; Cummings, et al., 1995; Brown, et al., 1996). Our case study has more similarities to the situations studied by Vossler and Kervliet (2003), Brookshire et al., and Carson, et al. Similar to these three studies, the public good being valued, the Poudre River, is well known to the local residents we are surveying. The familiarity is due to the average time lived in Fort Collins, roughly 20 years, and the fact that about three-fourths of Fort Collins residents have visited the Poudre River or used adjacent Natural Areas or bike paths along the river at least once during that time. Thus several of the conditions that Cumming, Brookshire and Schulze’s (1986) suggest are necessary for obtaining a valid estimate of WTP are met in our study.
Nonetheless, there are several ways economists can evaluate the consistency of a specific CVM estimates of WTP. One way, is to conduct test-retest reliability studies. Loomis, (1989; 1990) and Reiling, et al., (1990) found their estimates of WTP to be reliable in test-retest studies. Another test of consistency involves a form of construct validity, called convergent validity (Mitchell and Carson, 1989: 191). One way to test convergent validity involves assessing whether two different empirical measures of the same theoretical construct (here WTP for recreation use), yield estimates that are not significantly different. A methodological contribution of this paper is to test whether two estimates of annual WTP for recreation use, developed using two different dichotomous choice CVM questions, are statistically different.

DATA

Survey Development, Focus Groups and Pre-testing

The final survey was the result of initial interaction between the author and City of Fort Collins Natural Areas staff, with input from the City Utilities staff. Once the basic survey design and information was agreed upon, two focus groups of 14-15 city residents were held in Fort Collins to evaluate the clarity of information presented, graphs, maps, and questions being asked. In addition, we asked respondents open-ended willingness to pay questions for the instream flow program in order to determine the range of dollar amounts to ask in the closed-ended WTP questions. The survey was revised after each focus group. Then a pre-test of the entire survey booklet was conducted on another group of 14 Fort Collins residents. Final revisions and final review by City Natural Areas staff, resulted in the survey that was printed and mailed to residents.
Sample Design and Data Collection Procedures

A random sample of 550 Fort Collins residents was purchased from Survey Sampling Inc., a company specializing in providing survey samples. The distribution of the sample of the non-university zip codes followed the population distribution in each of the zip codes.

The actual survey booklet followed Dillman’s (2000) Tailored Design Method. Inserted into the survey booklet was a color map of the study area and Figure 1, showing the difference in the hydrograph with and without diversions. These were inserts so that respondents could refer to them as they answered questions in various sections of the survey.

Following Dillman (2000), there was a personalized cover letter, a $1 bill enclosed as a token incentive, and a stamped return envelope. Reminder postcards were sent to each household one-week after they received a copy of the survey. If a survey was not returned, then the household received another copy of the questionnaire.

Wording of the Two Willingness to Pay Questions

In order to conduct our test of convergent validity, we asked two different dichotomous choice willingness to pay questions: (1) one question directly about WTP for recreation use; (2) one for Total Economic Value—TEV. Given that the study section of the river runs through town, and has several city owned natural areas and a bike path along much of the river, we expected a substantial amount of TEV to represent use value. This allows us to test for consistency in our two estimates of recreation use value.
The wording of the recreation use value question is:

As you know, costs of gasoline, rental rates for equipment, and other recreation expenses typically increase over time. If the cost to visit the Poudre River in town had been $_____ higher, would you have still made this visit?     ___ Yes     ___ No     ___ Not Sure

The wording of the Total Economic Value question to maintain the same current flows presently being experienced by visitors was:

If the costs of keeping the current peak flows were spread among all Fort Collins households and businesses, your share of the cost is estimated to be $_______ per year.

Would you pay this amount each year to be used solely to keep Poudre River flows at the current 30 Year Average Flows shown in Figure 1 rather than have 50% Reduced Flows?

     ___ Yes ___ No ___ Unsure

To be conservative and increase the likelihood of validity of our WTP estimates, we follow Champ, et al. and others and recoded the Not Sure and Unsure responses as No responses.

Figure 1 illustrated the 50% reduction in flow. The final figure represented the input of the two focus groups and the pre-tests. Ideally pictures of the river at alternative flows would have been used, as the city of Fort Collins had such pictures of the same stretches of river ad different flows. However, City Natural Areas staff repeatedly rejected using the pictures, despite suggestions from the focus group. Having viewed the matched pictures, the author believes our WTP values would have been higher had the pictures been used in addition to the graph.
Figure 1. Poudre River Flows: 30 Year Average (1976-2006) & Potential 50% Reduced Flows with Future Diversions
Statistical Models

Since the dependent variable is simply a Yes (=1) and No (=0), we analyze the responses using a logistic regression model also known as a logit model. Our general specification of the logit willingness to pay model is:

\[ L_i = \ln \left( \frac{P_i}{1 - P_i} \right) = \beta_0 + \beta_1(Bid) + \beta_2X_2 + \beta_3X_3 + .. \beta_nX_n + u_i \]

Where \( P_i \) is the probability of a Yes response, \( \beta \)'s are slope coefficients and \( X \)'s are independent variables. To estimate equation (1) using maximum likelihood requires that equation be rewritten as a log likelihood function (see Kmenta (1986: 551) or Haab and McConnell (2002: 29) for the details). \( X_2...X_n \) are explanatory variables specific to visitors in the visitor WTP logit model, and to households in the resident TEV WTP model. In the recreation WTP question, the bid amounts ranged from ___ to ___, while in the TEV WTP question, the bid amounts ranged from a low of $2 a year to a high of $950. The selection of the bid amounts for both questions were based on results from the focus groups and pretests.

From the coefficients in equation (1), the median WTP can be calculated using formulas from Hanemann (1984). We are interested in determining the dollar amount that visitors would pay. We chose to calculate the median WTP for two reasons. First, median WTP is less sensitive to the tails of the distribution. Second, in order to carry out our construct validity test we need the same statistical measure for both the visitor use and TEV. In order to most directly calculate the portion of TEV due to recreation, we use Cameron’s reparameterization of the logit model, which yields median WTP.
We calculate the median WTP using equation (2), where $\beta_1$ the coefficient on the bid amount visitors were asked to pay.

(2) \( \text{Per trip Median } WTP = (\beta_0 + \beta_2 X_2 + \beta_3 X_3 \ldots \beta_n X_n) / \beta_1 \) 

As noted above, to calculate how much of TEV WTP is related to recreation use, we adopt Cameron’s reparameterization of the logit model that is quite similar to equation (2). This reparameterization of the logit model in equation (1) is given in equation (3):

(3) \( \text{Median } WTP_i = (\beta_0 / \beta_1) + \left( (\beta_2 / \beta_1) \times X_2 \right) + \left( (\beta_3 / \beta_1) \times X_3 \right) + \ldots \left( (\beta_n / \beta_1) \times X_n \right) \) 

By dividing through the other non-bid coefficients by the coefficient on the bid amount we are able to calculate the portion of resident WTP that is due to recreation. This will be compared to the annual value of recreation, which is calculated by multiplying the median value per trip (Equation 2) times the annual number of trips a visitor takes each year. This is our relatively simple test of convergent validity or consistency of WTP as estimated from the two different WTP questions.

RESULTS

Survey Response Rate

Of the 550 surveys mailed out, there were 22 undeliverable, and 7 respondents were deceased. This yields a net eligible sample of 521. We received 332 surveys back. Given the undeliverable surveys and deceased addressees, this represents a response rate of 64% of deliverable/eligible surveys. This survey response rate is reasonably good and higher than many city election turnouts. The distribution of responses also matches the population distribution by zip codes.
Statistical Results

The survey indicated that in the last 12 months, about 60% of the sample had visited one of the City Parks or City Natural Areas along the Poudre River for recreation. The median number of visits was 6 per year.

Table 1 presents the logit model results for respondents that visited a Park or Natural Area along the Poudre River in the last 12 months.

Table 1. Logistic Regression Results for Recreation Economic Value of a Visit to the Poudre River in Town.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>z-Statistic</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>-0.56149</td>
<td>-1.3514</td>
<td>0.1765</td>
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<tr>
<td>Recreation Bid Amount</td>
<td>-0.04002</td>
<td>-4.9071</td>
<td>0.0000</td>
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<tr>
<td>Visit Park/Natural Area Year</td>
<td>0.92478</td>
<td>2.5582</td>
<td>0.0105</td>
</tr>
<tr>
<td>Water Rec Importance</td>
<td>0.30134</td>
<td>1.9141</td>
<td>0.0556</td>
</tr>
</tbody>
</table>

Mean dependent variable 0.404 McFadden R-squared=.172
Log likelihood -110.605 LR statistic (3 df)=45.94
Restricted log likelihood -133.574 Probability(LR stat)=0.000

Where Recreation Bid Amount is the dollar amount people were asked to pay. Visit Park/Natural Area Year is whether the respondent visited a Park or Natural Area along the Poudre River this year. Water Rec Imp is an attitude variable measuring how important a respondent thought the Poudre River was for water based recreation.
Table 2 presents the Logistic Regression Results for all residents from the household sample for TEV.

**Table 2. Logistic Regression Results for Total Economic Value of Maintaining Poudre River Flows**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>z-Statistic</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>-4.8272</td>
<td>-4.487</td>
<td>0.0000</td>
</tr>
<tr>
<td>Bid Amount</td>
<td>-0.0032</td>
<td>-5.179</td>
<td>0.0000</td>
</tr>
<tr>
<td>Poudre River Change</td>
<td>-0.8601</td>
<td>-4.525</td>
<td>0.0000</td>
</tr>
<tr>
<td>Visit Park/Natural Area Year</td>
<td>0.6755</td>
<td>2.255</td>
<td>0.0241</td>
</tr>
<tr>
<td>Gender</td>
<td>0.6933</td>
<td>2.372</td>
<td>0.0177</td>
</tr>
<tr>
<td>Years of Education</td>
<td>0.1946</td>
<td>3.072</td>
<td>0.0021</td>
</tr>
<tr>
<td>Water Rec Imp</td>
<td>0.2530</td>
<td>1.751</td>
<td>0.0799</td>
</tr>
<tr>
<td>Mean dependent variable</td>
<td>0.5466</td>
<td></td>
<td>McFadden R-squared=.25</td>
</tr>
<tr>
<td>Log likelihood</td>
<td>-155.19</td>
<td>LR statistic (6 df)=102.88</td>
<td></td>
</tr>
<tr>
<td>Restr. Log likelihood</td>
<td>-206.63</td>
<td>Probability(LR stat)=0.000</td>
<td></td>
</tr>
</tbody>
</table>

The variable Poudre River Change is if an individual thought the reduction in Poudre River flows was a good change (coded positive). Of course, if they thought it was a good change they were less likely to would pay for maintaining the current instream flows. All other variables are as defined above in the recreation model.

**Testing Consistency of CVM Use Value Estimates from Two Different CVM Questions**

In this section we test whether the direct use value component of TEV yields an estimate consistent with the separate dichotomous choice question on WTP for recreation use.

Applying Cameron’s (1990) reparameterization from equation (3) to our statistical results in Table 2, yields equation (4):
(4) Annual Willingness to Pay (TEV) =

-1482 – $264.17*(Poudre River Change) + $207.17*(Visit Park/Natural Area This Year) 
+ $212.96*(Gender) + $59.78*(Years of Education) + $77.72*(Water Rec Importance)

If we set Visit Park/Natural Area This Year equal to one, this represents respondents who visited the Parks or Natural Areas along the Poudre River this year. Since the marginal WTP value is $207, this indicates that households that visited in the year of the survey would pay $207 more than those that did not. The 90% confidence interval on this estimate is $95 to $336.

Applying equation 2 for median WTP to the logit coefficients given in Table 1 yields a day trip value of $26. When multiplied by the number of annual trips taken by visitors yields an annual WTP for on-site use $156, with a 90% confidence interval of $126 to $204.

To test for consistency, we evaluate whether the two confidence intervals overlap. While, the two estimates of annual WTP differ by about 30%, the substantial overlap of confidence intervals suggest the two estimates are not statistically different. Thus there appears to be some consistency between the approaches to estimating annual use values associated with the current flow regime in the Poudre River.

POLICY IMPLICATION OF OUR TEV RESULTS

The median annual loss in total economic value associated with a reduction in flow to visiting and non-visiting Fort Collins household is $234.40. According to the U.S. Census there are 129,467 persons living in Fort Collins in 2006. The U.S. Census also
estimates an average of 2.29 persons per household. Thus there are an estimated 56,536 households in Fort Collins. However, while we do have a relatively high response rate of 64%, this means that 36% of Fort Collins households sent surveys did not either take the time or have sufficient interest to return the survey after two mailings. If we take a conservative approach of assuming those households have no willingness to pay to maintain flows in the Poudre River, we then generalize our sample only to 64% of Fort Collins households that did return the survey. This yields about 36,183 households. With a WTP per household of $234, this yields annual total benefits of maintaining the current flows in the Poudre River of $8.5 million. In other words, Fort Collins households would pay a total of $8.5 million each year rather than have spring and summer peak flows reduced by 50%.

Using data from the Poudre River gauge within Fort Collins for the most recent 30 years at the time of this study (1976-2006), the 50% reduction in flows from April to September 6th illustrated to respondents in survey graph, amounts to a total of 25,124 cfs, or roughly 49,831 acre feet of water. Using the total Fort Collins annual value divided by the 49,381 acre feet represents annual value of water for instream flow of $172 per acre foot.

This annual value compares with an annual lease value of water of $11 per acre foot from 1995 to 1999 in Colorado for environmental purposes (Loomis, et al, 2003) to $18 per acre foot for all lease transactions regardless of purpose from 1990 to 2000 (Czetwertynski, 2002). While water right prices have tripled from these time periods, even tripling the lease rates to $33 to $54, suggests the annual value to Fort Collins
residents of maintaining instream flow ($172 per acre foot) exceeds these lease/rental rates of water in Colorado.

Taking the present value or present worth of the annual benefits using the Federal government discount rate of 3% used by agencies such as the Army Corps of Engineers (the agency overseeing the Glade Reservoir project), yields $282.7 million. Thus the $282.7 million to avoid a 50% reduction during the spring and summer peak flows in the Poudre River implies a value of $5,673 per acre foot.

According to personal communication with Joe O’Brien at WaterColorado.com, water rights can be purchased for about $10,000 an acre foot (which is also about the cost of water being developed with the proposed Glade Reservoir project which would divert water from the Poudre River). Given the high cost of permanently maintaining instream flow in a city with rising population, it may be more economical in the short term to simply lease water each year rather than buy water rights. As the Fort Collins population increases from its 130,000 to 150,000 over the next couple of decades, this would raise total benefits by 15%. This relatively high value of water to Fort Collins residents through town arises in part from the public good nature of instream flows. In particular, that instream flow is a non consumptive use of water that all can enjoy, whereas water withdrawals are rival and consumptive (one household’s use reduces the amount of water available to other households). If the rate of population growth in Fort Collins exceeds the rate of growth in lease values of water, it may be efficient for the city to continue to lease water.
CONCLUSIONS

The Total Economic Value (on-site use and passive use values) of avoiding a 50% reduction in current high late spring and early summer flows is estimated for a western urban river through the city of Fort Collins, Colorado. The study was conducted at the request of the City Council to aid them in preparing comments on an EIS regarding water diversion. Using a single dichotomous choice contingent valuation method (CVM) survey of households we found that WTP for Total Economic Value (TEV) of households in Fort Collins was $234 per year, with most of this value, $207, being use value. A direct CVM question about recreation use value of visitors estimated annual WTP of $156 per year. The confidence intervals on these estimates have substantial overlaps indicating the two estimates of recreation use value are not significantly different. In terms of policy implications of the study, summing up the TEV’s per household across the percentage of responding households (64%) yields an annual value of $171 per acre foot. TEV value is several times larger than annual water lease rates in Northern Colorado. However, the present value of TEV is $5,670, which is below the permanent water right prices of $10,000 an acre foot and the cost of developing new water which has also been estimated at $10,000 an acre foot. With the future growth of Fort Collins population, it may make more economic sense for the city to lease water if the population growth of households exceeds the increase in annual lease rates.
References


