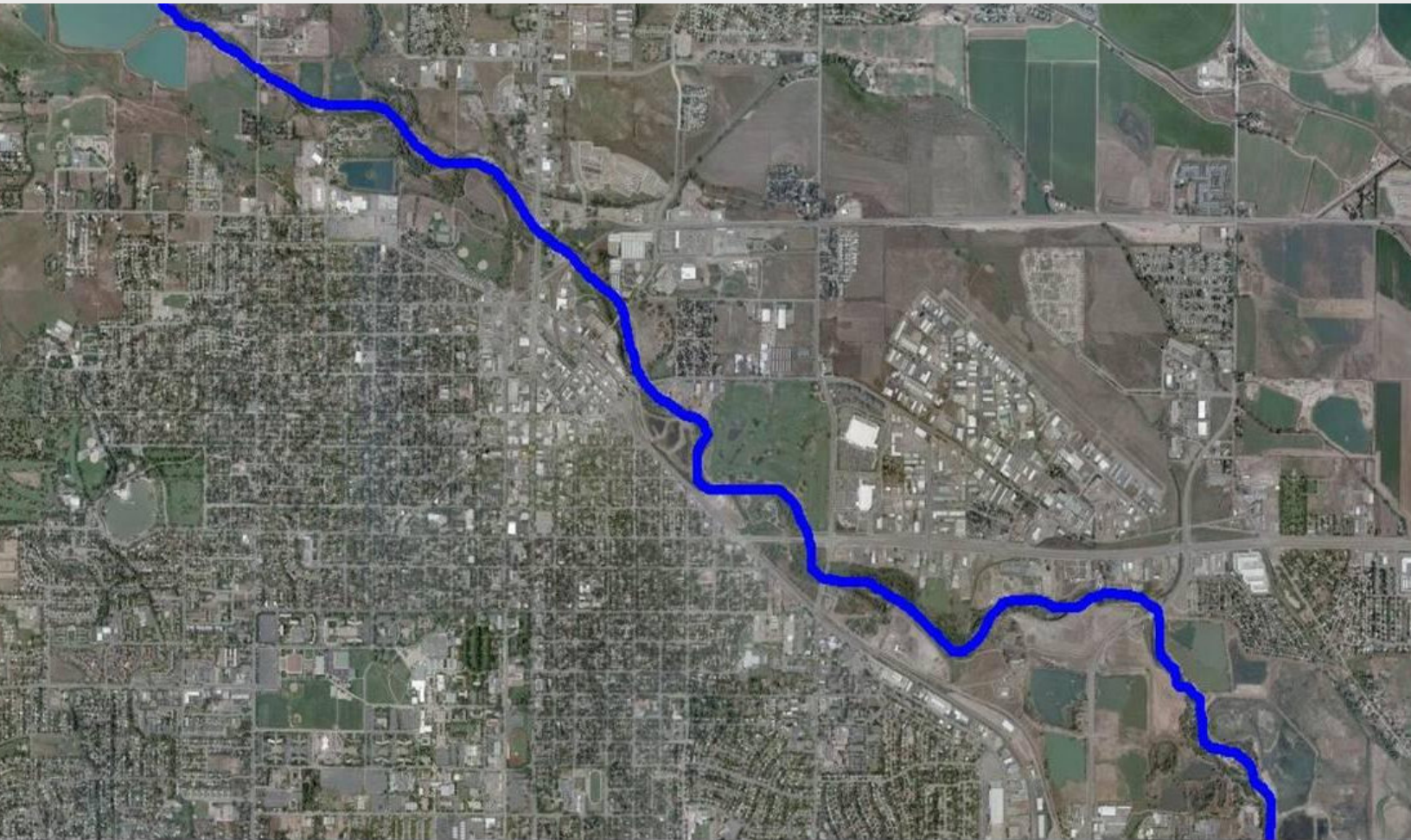


Estimating the Economic Benefits of Maintaining Peak Instream Flows in the Poudre River through Fort Collins, Colorado



**Dr. John Loomis, Economist
Department of Agricultural and Resource Economics
Colorado State University, Fort Collins, CO 80523**

**Final Report
April 2008**

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March 24, 2008

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Executive Summary

The economic benefits to a random sample of Fort Collins residents were estimated using a simulated market method recommended for use by federal agencies including the U.S. Army Corps of Engineers. The mail survey asked households if they would pay to avoid a 50% reduction in peak spring and summer flows. The mail survey had a response rate of 64% of deliverable surveys. Slightly more than two-thirds of respondents thought such a reduction in flows was a very bad change, with an additional 15% stating it was somewhat a bad change. Thus over 80% of residents think the 50% reduction in flows is a bad change.

Following federal benefit-cost procedures, economic benefits were measured as the amount that households would pay to maintain the current flows. Using federally recommended dichotomous choice contingent valuation methodology, the median willingness to pay (WTP) of Fort Collins residents was found to be \$234 per year. This means half the households would pay more than \$234 and half would pay less than \$234 per year. However, the median does not give adequate weight to those with very high willingness to pay, as evidenced by the average or mean WTP being \$352 per year. When the median and mean WTP are generalized to the percentage of households in Fort Collins that responded to the survey, it yields annual benefits of \$8.5 million to \$12.7 million. This represents annual value of water for instream flow of \$171 to \$255 per acre foot during the April to September 6th time period. 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 per acre foot suggests the annual value to Fort Collins residents of maintaining instream flow (\$172-255 per acre foot) exceeds these lease/rental rates of water in Colorado.

The present worth or present value of the median and average benefits in perpetuity is \$282.7 to \$424.5 million at a 3% discount rate. When expressed in terms of per acre foot of water needed to maintain the current spring and summer peak flows, the value per acre foot is approximately \$5,673 to \$8,518 using the median and average WTP values, respectively. The average value is reasonably close to market price of water along the Northern Front Range and what the cost is for developing water in new reservoirs.

Three-fourths of Fort Collins residents surveyed have visited the Poudre River in town at least once, and more than half do so every year, with a median of 6 trips per person. Given a median value of \$15 per visit per survey respondent, this translates into an annual recreation value of \$90 per year. Respondents were asked how their visits to the Poudre River in town would change if peak spring and summer flows were reduced by half. About one-third would visit less with the lower flows, 5% would stop visiting

altogether, and about half would not change their visits (the remainder currently do not visit and the lower flows would not change that). Combining all the responses yields an average reduction of 3.2 visits, with a median reduction of 2 fewer visits with a 50% reduction in flow. Given the reported current median visits is just 6 trips per year, this is a substantial decrease (-33%) in the median number of visits made to the Poudre River if flows were cut in half. Given the economic value of \$15 per visit, average annual recreation losses are between \$30 and \$48 per Fort Collins household with a 50% reduction in flow.

Overall, this analysis indicates a substantial economic value to visiting and non-visiting Fort Collins households to maintain current peak spring and summer flows in the Poudre River. It appears the value of these instream flows to Fort Collins residents is of the same magnitude as the market value of the water in alternative uses.

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INTRODUCTION

Adequate water flows in rivers provide society with many economic benefits. Obviously visitors receive on-site recreation benefits (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. The water flows also support streamside vegetation such as cottonwoods, which have aesthetic values to residents. Further, the river itself and the streamside vegetation provide habitat for numerous native fish and wildlife species. Many people derive enjoyment and satisfaction from viewing wildlife such as birds that depend on this streamside habitat. 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 (Sanders, et al., 1990) or passive use values. These passive use values are recognized by federal agencies when performing natural resource damage assessment. They are also non-market benefits and public good values.

The objective of this study is to apply a federally approved method (used by agencies such as the US Army Corps of Engineers), the contingent valuation method, to estimate these non-market benefits that Fort Collins residents receive from maintaining current peak (spring and summer) flows in the Poudre River through the city of Fort Collins. This non-market valuation information will be useful for comparing to existing market values of water and market values associated with proposals to divert water from the Poudre River upstream of Fort Collins.

STUDY DESIGN

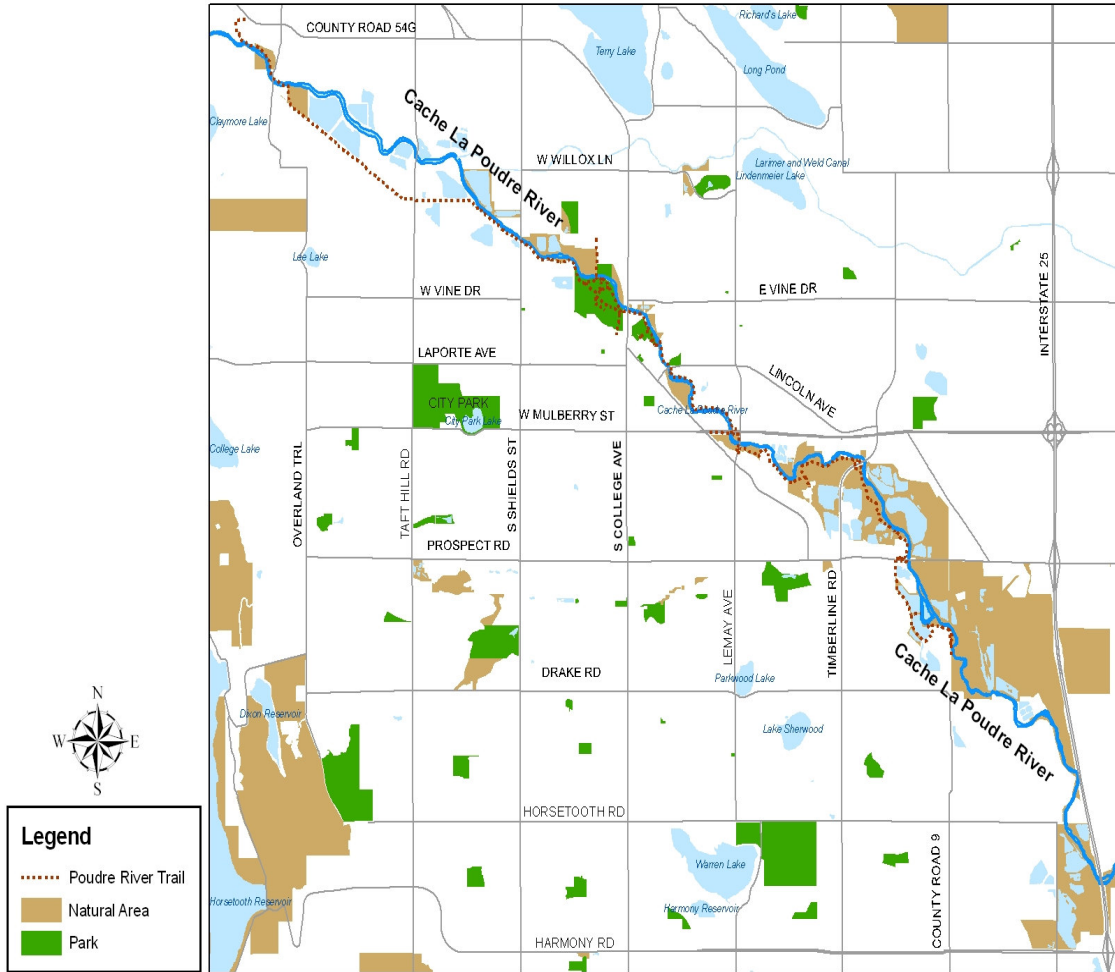
Description of the Poudre River Scenario Being Valued

Our study area is the Poudre River through the City of Fort Collins. This area is illustrated in Figure 1. This map was also included in the survey to focus respondent attention just on this stretch of river. The features of the Poudre River that were described in the survey were as follows:

- The Poudre River flows for 10 miles through Fort Collins.
- Playing a **central role in the region's water supply** by carrying water for cities and agricultural lands in northern Colorado.
- The Poudre River Trail which runs parallel to the river, providing **recreational opportunities** such as walking, bicycling, jogging, dog-walking, bird watching, and in-line skating.
- About 1,400 acres of **publicly accessible land**, including 18 City Natural Areas and 5 Parks along the river.
- Public access to the Poudre River providing **water based recreation** such as fishing, tubing, canoeing and kayaking.
- **Habitat** to many different species, including more than 30 fish species, about 225 bird species, 30 mammal species, 250 native plant species, and 65 species of butterflies. Several of the native fish species are classified as “threatened” with extinction by the State of Colorado, and three bird species are listed as “threatened or species of concern” by the State of Colorado.
- Opportunities for **environmental education** at the CSU Environmental Learning Center and all along the river.

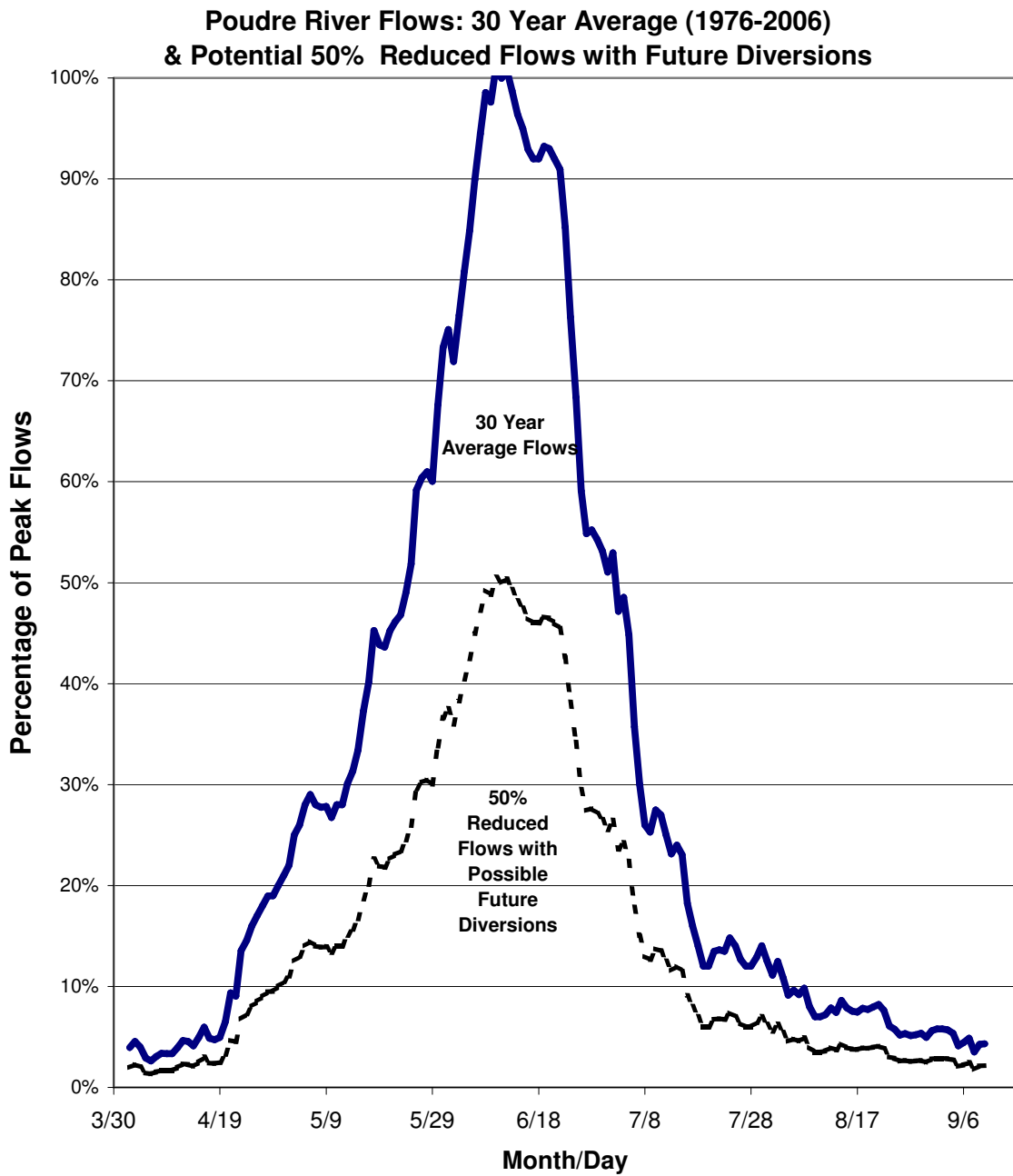
Figure 1. Map of Study Area Provided Respondents

Cache la Poudre River in Fort Collins



The next section of the survey described the current pattern of river flows and how that would change with possible diversion. Figure 2 shows the hydrograph insert that was developed with City of Fort Collins and USGS gauging station data over a 30 year average from 1976-2006 to reflect a wide range of dry, normal and wet year flows. Based on input from City staff, reduced flows were represented as a 50% reduction that represents the potentially significant reductions of flows that are possible in the future. Future flow reductions, however, will likely vary considerably over time and are dependent on available flows in the river, water rights that are in priority and operational requirements. The graph was subject to several focus groups and pretests to improve the clarity to the respondent.

Figure 2



This graph shows the 30 Year Average Flows from 1976 to 2006, and includes drought years and wet years as well as typical flow years.

The focus of the study was to find the residents' willingness to pay to maintain the current peak river flows. The survey asked whether a household would pay an annual share of the estimated cost to maintain the current peak flows. The exact wording of the question 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 \$XX 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*

The \$XX was filled in with one of ten different dollar amounts. These dollar amounts ranged from a low of \$2 to a high of \$950. Most of the dollar amounts were centered around what people in the focus groups and pretests indicated they would pay when they were asked an open ended question about the maximum amount they would pay. Thus, most of the dollar amounts were \$10, 20, \$30, \$50 and \$90 per household each year.

The next section of the survey asked households about their recreation visitation to the Poudre River, Natural Areas along the Poudre River and the Poudre River bike paths. Those indicating they did not visit, were instructed to skip to the demographic section. Questions about recreation use included annual number of trips and recreation activities. Individuals were also asked a dichotomous choice contingent valuation willingness to pay question about their recreation use. The text of that question is:

As you know, costs of gasoline, rental rates for equipment, and other recreation expenses typically increase over time. If your cost of a visit to the Poudre River in town had been \$RR higher, would you have still made your most recent visit?

Yes *No* *Not Sure*

The \$RR dollar was replaced with one of ten different dollar amounts ranging from \$2 to \$90.

The majority of the dollar amounts were in the range of \$5 to \$15. These amounts were selected based on responses in the focus groups and pretests.

Respondents were also asked if the changes in flows as shown in Figure 2 would change the number of visits they would make to the Poudre River. Responses included “*I would visit more often, less often and no change.*”

The final section of the survey included demographic questions about zip code, gender, age, education and income on the inside of the back cover. The back cover was blank to allow respondents to write any thoughts or comments on the Poudre River or the survey. The survey made an eight page booklet.

Non Market Valuation and the Contingent Valuation Method

The structure of the willingness to pay (WTP) questions and statistical analysis of responses utilizes the Contingent Valuation Method or CVM. The method derives its name from the fact that responses are contingent upon a simulated market situation presented in the survey. CVM is a commonly used method in which a direct interview or survey is administered to elicit the households' willingness to pay for **non-market** benefits that are not traded in markets (Loomis and Walsh, 1997). It is used to estimate values of public or quasi-public goods, as well as counterfactual scenarios that do not presently exist, but might with different future management actions or policies.

The CVM survey approach has been widely used to value natural resources where other valuation methods are difficult to apply (Brookshire et. al 1982). CVM is a recommended approach by the U.S. Water Resources Council under two different Federal administrations (U.S. WRC, 1979, 1983) and is used today by the U.S. Bureau of Reclamation, U.S. Army Corps of Engineers, and U.S. Environmental Protection Agency in their benefit-cost analyses. 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, is 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.

WTP Question Format and Data Analysis Techniques

To realistically simulate a market for maintaining existing instream flows, a dichotomous choice WTP question format is used. In this question format, an individual answers either "yes" if they would pay (\$X) to maintain the current peak flows in the Poudre River or "no" if they would not. The specific amount of the cost (\$X) varies across the sample. In essence we trace out a demand curve like relationship between the amount residents are asked to pay and the percentage or probability they would pay.

As is commonly done in dichotomous choice CVM studies, we use a logistic regression model also known as a logit model to analyze the discrete yes/no responses.

Our general specification of the logit willingness to pay model is:

$$(1) \quad L_i = \text{Ln} \left(\frac{P_i}{1 - P_i} \right) = \beta_0 + \beta_1(\text{Bid}) + \beta_2 \text{Income} + \beta_3 X_3 + \dots \beta_n X_n$$

Where P_i is the probability of a Yes response, β '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).

From the coefficients in equation (1) the mean and median WTP can be calculated using formulas from Hanemann (1984). If we are interested in determining the dollar amount that a majority of residents would pay we would calculate the median using equation:

$$(2) \text{ Median WTP} = (\beta_0 + \beta_2 X_2 + \beta_3 X_3 \dots \beta_n X_n) / -\beta_1$$

In this equation, β_0 is the intercept, $\beta_2 \dots \beta_n$ represent the non-bid independent variables, and β_1 is the bid coefficient. To compute median WTP, the mean of the all the non-bid independent variables are multiplied by their respective coefficients and added to the constant term. This product is divided by the absolute value of the coefficient on the bid amount.

Defining the Empirical Logit WTP Model

There are several variables that could explain whether Fort Collins households would pay to maintain the current peak flows. Of course we expect the magnitude of the dollar amount of the cost or the **bid amount** to matter, with the higher the cost proposed to households, the fewer people would agree to pay. Demographic characteristics of the respondents may be indicative of differences in tastes and preferences, and therefore utility and ultimately, their willingness to pay for maintaining flows. For example, **Gender** has been shown in past studies to influence environmental attitudes (McStay and Dunlap, 1983; Mohai, 1999), especially about local issues (Blocker and Eckberg, 1989) and thus may influence willingness to pay for flows in a local river. The number of years of education (**edyears**) that the respondent has may also influence their response, as people with higher education levels are often more concerned with the environment.

Attitudes regarding the importance of maintaining the river as wildlife habitat (**habimp**) or for waterbased recreation (**waterecimp**) may influence whether or not the

resident would pay. If an individual thought the reduction in Poudre River flows was a good change (coded positive), the less likely they would pay (**prchange**). An individual's use value toward the Poudre River would be influenced by whether or not they have visited the river, parks or natural areas along the river this year (**Visit**). Thus the following logit model reflects these candidate variables:

$$(3) \quad \text{Vote} = \beta_0 - \beta_1(\text{bidamt}) + \beta_2(\text{educ}) - \beta_3(\text{prchange}) + \beta_4(\text{edyears}) + \beta_5(\text{habimp}) + \beta_6(\text{gender}) + \beta_7(\text{waterecimp}) + \beta_8(\text{visit})$$

DATA COLLECTION

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 Resources 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 each, were held in Fort Collins to evaluate the clarity of information presented, graphs, maps, and questions being asked. Numerous suggestions were received that led to revising the cover, layout of some questions, rewording of several questions, and rewording of information presented in the survey. In addition, we asked respondents open-ended willingness to pay questions for the program in order to determine the range of dollar amounts to ask in the closed-ended dichotomous choice 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 Resources 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 by the main non-CSU zip codes (i.e., 80523 was purposefully omitted) in Fort Collins follows the population distribution in each of the zip codes.

Following the Dillman (2000) Total Design Method, the survey was a booklet with an interesting color cover (see Appendix for black and white version), that showed four different views of the river through Fort Collins, one of which had river visitors, one with a bridge crossing and one with a powerpole. The eight page booklet had a blank back cover where respondents could write comments. Inserted into the survey booklet was a color map of the study area and Figure 2, showing current peak and reduced flows. These were inserts so that respondents could refer to them as they answered questions in various sections of the survey. (A copy of the survey is included in the Appendix).

Following Dillman (2000), there was a personalized cover letter with original signature in blue ink, a \$1 bill enclosed as a token of appreciation, and a stamped return envelope. The outgoing envelope also had original stamps affixed. The survey was mailed out at the end of the first week of October.

To ensure that the response rate would be as high as possible, reminder postcards were sent to each household one-week after they received a copy of the survey. This postcard reminded the household to return the finished survey if they have not already done so, and thank those that did. A phone and email were provided so that those who had misplaced their questionnaire could be mailed another copy.

If a survey was not returned by the end of October, then the household received a more emphatic personalized cover letter stressing the importance of the study, along with another copy of the questionnaire and another stamped return envelope. The new cover letter repeated what was mentioned in the previous mailing, but it will also remind them that their completed survey was not returned.

RESULTS

Survey Sample Returns and Demographics

Of the 550 surveys mailed out, there were 22 undeliverable, and 7 respondents who 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 most election turnouts.

Table 1 presents the distribution of returned surveys by zip code versus the population by zip code. As can be seen there is a very close correspondence. Thus the decision to return the survey was not significantly influenced by where one lives in the city. This suggests that all Fort Collins residents have an equivalent interest in the Poudre River.

Table 1 Comparison of Returned Surveys and City Population by Zip Code

<u>Zip Code</u>	<u>Returned</u>	<u>Population</u>
80521	13%	14%
80524	20%	21%
80525	37%	36%
80526	28%	29%
No Zip Given	2%	
	100%	100%

The sample of returned surveys has a slightly (+11%) higher household income (\$78,721) than the population (\$70,391). The sample is somewhat older at 55 years of age versus 45 years in the population. This pattern is common in mail surveys where older households are more likely to return questionnaires than younger households.

Relative Importance of the Different Characteristics of the Poudre River

Figure 3 presents the overall distribution of responses regarding the relative importance of different features of the Poudre River and different reasons for valuing the Poudre River. The scale of these questions was 3=Very Important, 2=Important, 1=Slightly Important, 0=Not Important, and -1 was No Opinion. Only 7 respondents out of 332, or 2% had No Opinion. The most important characteristic of the Poudre River is providing habitat for fish, birds and other wildlife populations with an average of slightly more than 2.5 on the 3 point scale (i.e., about half the respondents rated habitat as very important and half rating it as important). With a score of 1.8, water based recreation opportunities such as tubing or canoeing, were considered between slightly important and important. Respondents ascribed equally important roles to the Poudre River as water supply for city and agriculture, and as a place to view scenery and as providing water for trees.

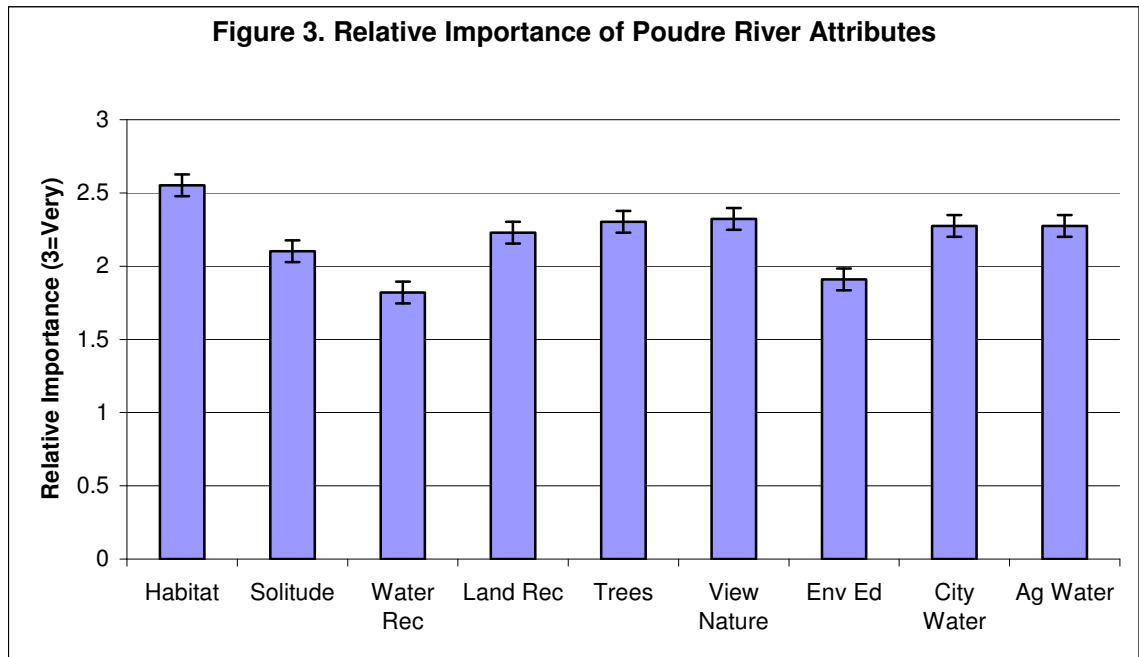


Table 2 presents the distribution of average scores on these questions by zip code. Habitat is ranked most important by respondents in all zip codes. Water based recreation and environmental education is rated relatively lower, although rated as important by residents living in zip code 80521 (the northwest part of the City).

Table 2. Distribution of Relative Importance Scores for Features of the Poudre River by Zip Code (3=Very Important, 2=Important, 1=Slightly Important, 0=Not Important)

<u>Reason</u>	<u>Total Avg</u>	<u>80521</u>	<u>80524</u>	<u>80525</u>	<u>80526</u>
Habitat	2.55	2.70	2.60	2.45	2.57
Solitude	2.10	2.33	1.93	2.02	2.22
Water Rec	1.82	2.07	1.88	1.68	1.82
Land Rec	2.23	2.30	2.22	2.21	2.24
Trees	2.30	2.56	2.37	2.18	2.27
View Nature	2.32	2.49	2.33	2.26	2.31
Env Ed	1.91	2.07	2.10	1.82	1.79
City Water	2.27	2.24	2.14	2.34	2.29
Ag Water	2.27	2.16	2.27	2.28	2.31

Recreation Visitation to the Poudre River

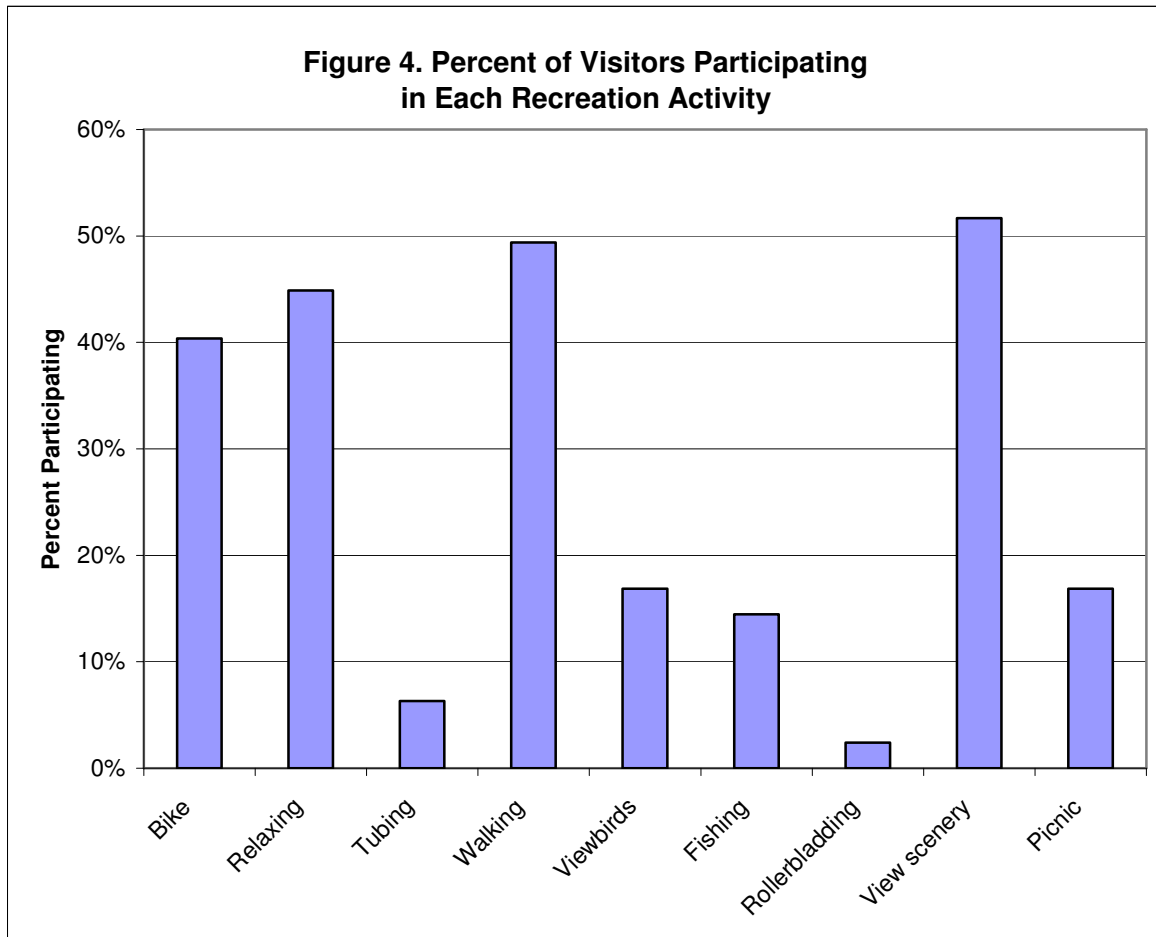
Table 3 presents visitation results. Specifically, the table presents the percentage of the sample that has ever visited the Poudre River trail paths versus visited them this year, as well as whether they ever visited Parks/Natural Areas versus visited them this year. About three-fourths of Fort Collins residents have visited the Poudre River Trail paths and Parks/Natural Areas. About 54% to 63% have visited this year. Roughly equivalent percentages of residents from all four zip codes have visited the Poudre River paths and Natural Areas at least once.

Table 3. Percent of Respondents Having Ever Visited and Visited the Poudre River in Town this Year

	<u>Total</u>	<u>80521</u>	<u>80524</u>	<u>80525</u>	<u>80526</u>
Ever Visit Paths	74%	77%	78%	77%	68%
Visit Paths This Year	54%	58%	55%	56%	51%
Ever Visit Parks/Nat Areas	76%	81%	75%	78%	74%
Visit Parks/Nat Areas This Year	59%	63%	54%	63%	57%
Never Visited	10%	9%	7%	11%	13%
Not Visited This Year	19%	21%	24%	18%	17%

The median number of visits is 6 per year to the Poudre River in town. However, the average number of visits per year is 20 visits as about a dozen people in our sample indicated they make one hundred or more visits per year. The average length of stay along the Poudre River is 90 minutes, with the median of one hour.

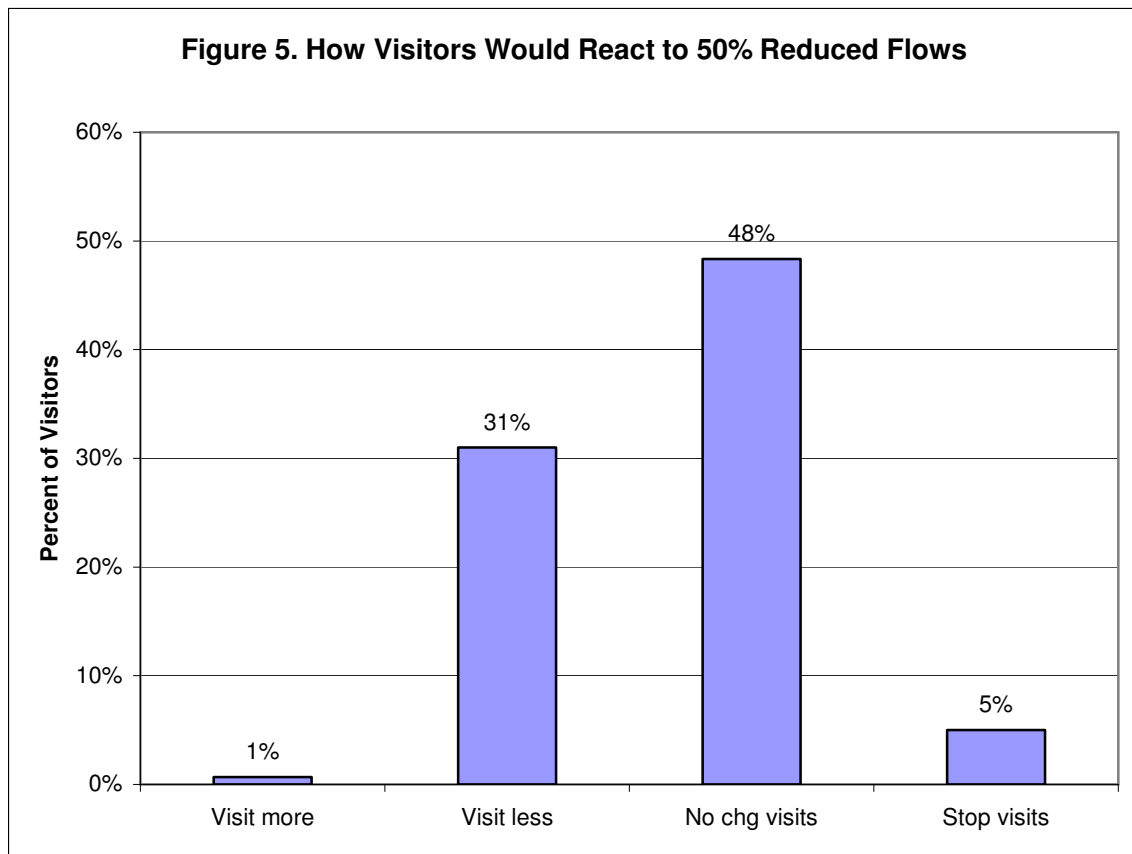
Figure 4 presents the percentage of visitors participating in each type of recreation activity on the Poudre River through town. Viewing scenery and walking are most common activities with about half the visitors participating in them.



Results of the Reduced Flow Scenario on Recreation Visitation

Respondents were asked how their visitation to the Poudre River in town would change if peak spring and summer flows were reduced by half. As shown in Figure 5, about one-third would visit less with the lower flows, 5% would stop visiting altogether, and about half would not change their visits (the remainder currently do not visit and the lower flows would not change that). Combining all the responses to number of visits more or less (and the percentage of no change) with the reduced flows yields a weighted

average reduction of 3.2 visits across the entire sample, with a median reduction of 2 fewer visits. Given the reported current median visits are 6 trips per year, this is a substantial (-33%) decrease in the median number of visits made to the Poudre River if flows were cut in half. Given the economic value of \$15 per visit, average annual recreation losses are between \$30 and \$48 per Fort Collins household with a 50% reduction in flow.



Households were asked whether they viewed reducing the peak spring and summer flows in half as a Very Good Change, Somewhat Good Change, Neither Good nor Bad, Somewhat Bad Change, Very Bad Change, No Opinion, or Not Enough Information.

As is evident in Table 4, slightly more than two-thirds of respondents thought such a reduction in flows was a very bad change, with an additional 15% stating it was somewhat a bad change. Thus more than 80% of the survey respondents think a 50% reduction in flows is a bad change.

Table 4. Number and Percentage That Think Reducing Flows in the Poudre River in Half

	<i>Frequency</i>	<u>Percent</u>
Very Bad Change	218	68%
Somewhat Bad	48	15%
Neither	11	3%
Somewhat Good	2	1%
Very Good Change	3	1%
Not enough Info	33	10%
No Opinion	4	1%
	<hr/> 319	<hr/> 100%

Household Economic Benefits of Maintaining Peak Flows in the Poudre River

Households were asked if they would pay an annual cost to avoid the 50% reduction in peak spring and summer flows so as to keep the Poudre River at its current level during that time period. To quantify the maximum willingness to pay, a household was randomly asked to pay one of ten different dollar amounts. These dollar amounts ranged from a low of \$2 to a high of \$950.

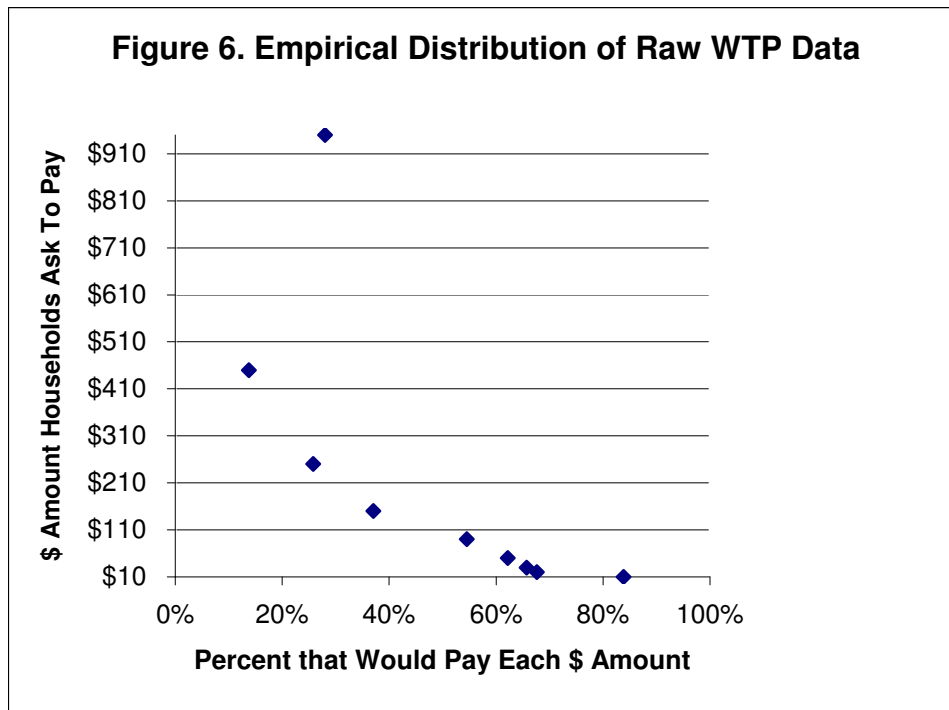
Fifty-five percent of respondents stated they would pay the annual cost to maintain flows in the Poudre River through town. Of the remaining 45%, 23% said they would not pay, and 22% were unsure. Of those respondents that answered either Yes or No to the

willingness to pay question, most were fairly certain of their responses, with an average score of 7.24 on a ten point scale (where 1 is Not Certain, 5 being Somewhat Certain and 10 being Very Certain).

Of the 71 indicating they would not pay anything to maintain the Poudre River, six indicated it was due to not receiving any benefits from maintaining flows in the Poudre River. Twenty-six percent indicated they could not afford to pay at this time. In some respects, this “could not afford” response indicates that households took the dollar amount they were asked to pay seriously, and recognized their limited household budgets when answering the willingness to pay question. Only 39 individuals or 12% of respondents gave what would be considered a “protest” response, rejecting the premise that they had to pay to maintain Poudre River flows. These included 12 who checked that only households living close to the river or those that visit should pay, or gave a response of “Other”. Since these individual’s votes would still count in a real election and to be conservative, we have included the protest responses in our analysis of willingness to pay.

To be consistent with the literature on polling and contingent valuation, we have recoded the unsure responses to No responses as well. The literature suggests those that are uncertain of their responses typically vote No when an actual election is held. That is, the polling literature suggests these uncertain voters stick to the status quo when they are unsure about the change. This recoding also improves the validity of the willingness to pay results, as comparisons with between actual cash willingness to pay and stated

willingness to pay in CVM surveys show those uncertain of their response, tend to vote No when faced with the actual cash costs (Champ, et al., 1996). Figure 6 provides a plot of the raw data percentage of Yes and No (where the unsure responses are coded as No), at each dollar amount the sample of respondents were asked to pay.



As can be seen there is generally a continuous (monotonic) reduction in the percentage of households that would pay as the dollar amount asked to pay increases. The only exception is at the highest dollar amount, where there is an increase in the percentage that would pay. Thus, the overall pattern of the data at nine of the ten data points indicates internal validity of the responses, in the sense that the higher the dollar amount asked to pay, the fewer percentage of the sample that would pay this amount.

Table 5 presents the statistical logistic regression results of the main valuation question on whether Fort Collins households would pay an annual cost to maintain the current flows in the Poudre River through town and avoid a 50% reduction in peak spring and summer flows shown in Figure 2. The logistic regression results have higher internal validity, as indicated by the negative sign on the **Bid Amount(\$)** variable. The negative and statistically significant (at the 1% level) coefficient indicates that those asked to pay a higher cost were less likely to vote yes (coded as 1, and no is coded as zero). This conforms with both common sense and downward sloping demand curves. It also suggests respondents took the dollar amount they were asked to pay seriously. If they did not, then there would not be a statistically significant and negative relationship between the magnitude of the dollar cost and the percentage that would pay each dollar amount.

The other variables are statistically significant at the 10% level or better and also have an intuitive relationship between the voting Yes. In particular, residents that have **visited** a river, park or natural area along the river the year of the survey are more likely to pay. The more important waterbased recreation was (**Water Rec Imp**), the more likely they are to pay for maintaining flows in the Poudre River. Thus, recreation use values have a significant influence on willingness to pay. Gender also plays a role with males more willing to pay than females. Individuals with additional years of education are also more willing to pay. Those that view a reduction in Poudre River flows as a good change are less likely to pay (coded as positive for good change), and those that indicate it is a bad change are more likely to pay (coded as negative for a bad change). Below we examine how much each of these variables contributes to annual willingness to pay.

Table 5. Logistic Regression Results for Total Economic Value of Maintaining Poudre River Flows

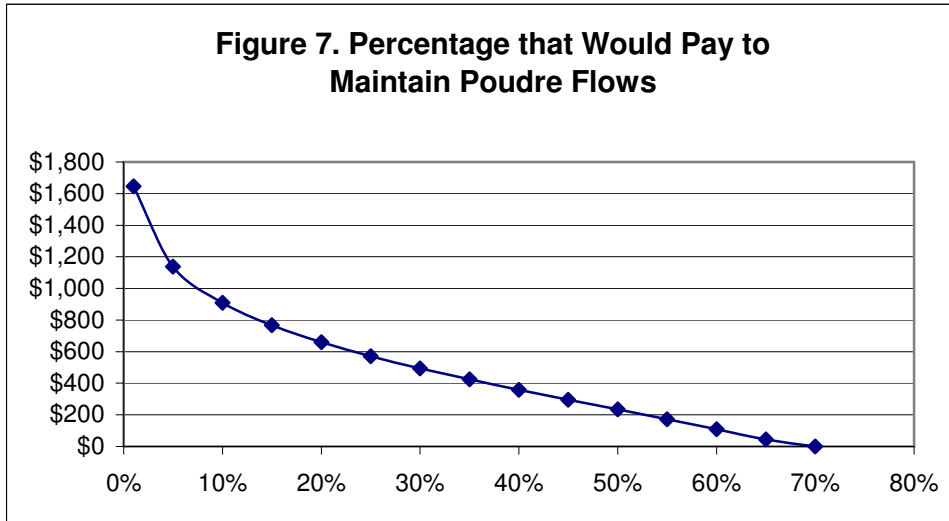
Dependent Variable: Yes or No to Pay Annual Cost				
Method: ML - Binary Logit				
Observations: 300				
Variable	Coefficient	z-Statistic	Probability	Mean
Constant	-4.827273	-4.4879	0.0000	1.00
Bid Amount(\$)	-0.003256	-5.1793	0.0000	180.10
Poudre River Change	-0.860144	-4.5251	0.0000	-1.5167
Visit Park/Nat Area Year	0.675515	2.2553	0.0241	0.6234
Gender	0.693383	2.3723	0.0177	0.6233
Years of Education	0.194652	3.0723	0.0021	15.23
Water Rec Imp	0.253041	1.7513	0.0799	1.85
Mean dependent variable	0.5466	McFadden R-squared		0.248934
Log likelihood	-155.19	LR statistic (6 df)		102.8771
Restr. log likelihood	-206.63	Probability(LR stat)		0.000000
Obs Dependent =0 (No)	136	Total observations		300
Obs Dependent =1 (Yes)	164			

Hanemann (1989) presents the formula used to calculate median WTP:

$$WTP = ((\beta_0 + \beta_2 X_2 + \beta_3 X_3 + \dots + \beta_n X_n) / -\beta_1)$$

where β_1 is the coefficient on the BidAmount(\$), and the other β 's are the constant and the coefficients on the other variables times their means (X). The median willingness to pay for Fort Collins residents is \$234.40 per year to avoid a 50% reduction in peak spring and summer flows in the Poudre River. This is interpreted as half the residents in Fort Collins would pay less than this and half would pay more than this amount.

The fitted logistic relationship between the amount Fort Collins residents were asked to pay and the percentage of them that would pay each amount is illustrated in Figure 7.



As can be seen in the figure, this curve has an intuitive negative slope, with the higher the annual dollar amount a household is asked to pay, the lower the percentage of Fort Collins households are estimated to pay that amount. The median of \$234 per year corresponds to the amount that 50% of households would pay. However, the median WTP does not give adequate weight to high values that some residents reported. As shown in Figure 7, 20% of Fort Collins respondents would pay nearly three times the median value or slightly more than \$600 per household annually. The average WTP reflects this high intensity and is more appropriate for benefit-cost analysis comparisons, than the median (which is more useful for judging the dollar amount that would pass in a voter referendum). The average or mean annual WTP is \$352 per household (calculated using the formula in Hanemann, 1989), substantially above the median WTP.

The Krinsky-Robb technique is used to construct a confidence interval around median and mean WTP (Park, Loomis, and Creel, 1991). The 90% confidence interval around the median is \$107 to \$380 per household, per year. The 90% confidence interval around the average or mean WTP is \$259 to \$505 per household per year.

To provide a more intuitive understanding of the relationship between the independent variables and annual household willingness to pay, the logit coefficients in Table 5 are “reparameterized” by dividing slope coefficient on the independent variable by the absolute value of the coefficient on the bid amount. Doing this converts the logistic regression coefficients into slope coefficients that can be interpreted as how a one unit change in the independent variable affects annual household willingness to pay.

$$\begin{aligned} \text{Annual Household Willingness to Pay (\$)} = & \\ -1482 & -\$264.17 * (\text{Poudre River Change}) + \$207.17 * (\text{Visit Park/Nat Area This Year}) \\ & + \$212.96 * (\text{Gender}) + \$59.78 * (\text{Years of Education}) + \$77.72 * (\text{Water Rec Importance}) \end{aligned}$$

In the above equation each additional year of household education raises annual willingness to pay by \$59.78. A household that visited Poudre River parks or natural areas this year has an annual willingness to pay \$207.17 higher than households that did not visit this year. Males (Gender =1) willingness to pay is \$212.96 higher than females (Gender=0). A one unit increase in the importance of the Poudre River for water based recreation (e.g., from important (2) to very important (3)) raises annual household willingness to pay by \$77.72. If a household feels the 50% reduction in flows in the Poudre River is a somewhat bad change (-1) then annual household willingness to pay increases by \$264.17 (-1*-264.17).

Economic Analysis of Recreation Benefits of the Poudre River

The same type of dichotomous choice contingent valuation question was asked of visitors to the Poudre River in the survey. Table 6 presents the results of the logistic regression analysis.

Table 6. Logistic Regression Results for Recreation Economic Value of a Visit to the Poudre River in Town.

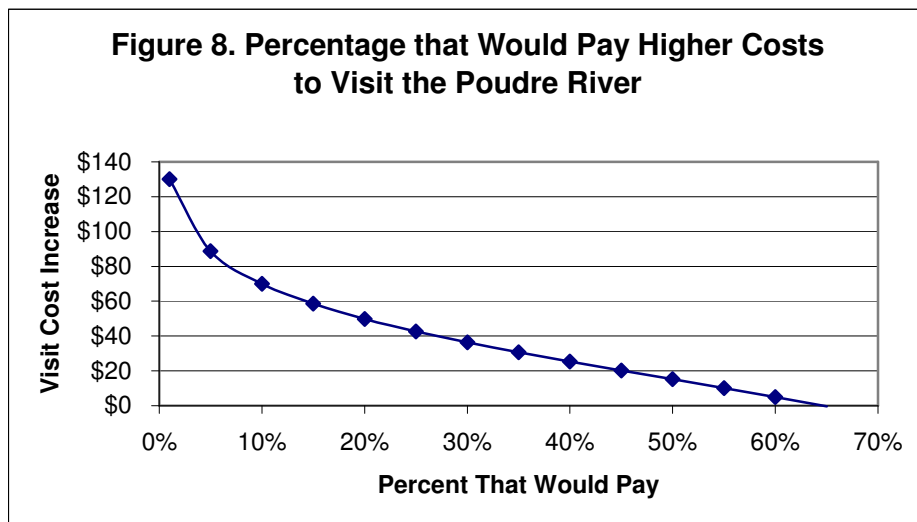
Dependent Variable: Yes-Pay Higher Trip Cost
 Method: ML - Binary Logit
 Observations: 198

Variable	Coefficient	Std. Error	z-Statistic	Probability
Constant	-0.561497	0.4154	-1.3514	0.1765
Recreation Bid Amount	-0.040018	0.0081	-4.9071	0.0000
Visit Park/Natural Area Year	0.924787	0.3614	2.5582	0.0105
Water Rec Importance	0.301341	0.1574	1.9141	0.0556
Mean dependent variable	0.40404	McFadden R-squared		0.171953
Log likelihood	-110.605	LR statistic (3 df)		45.93680
Restr. log likelihood	-133.574	Probability(LR stat)		5.85E-10
Obs Dependent =0 (No)	118	Total observations		198
Obs Dependent =1 (Yes)	80			

The recreation logistic regression results also have higher internal validity, as indicated by the negative sign on the Recreation Bid Amount variable. The negative and statistically significant (at the 1% level) coefficient indicates that visitors asked to pay a higher cost were less likely to state yes (coded as 1, and no is coded as zero). This also suggests that respondents took the cost increase seriously. The other variables are statistically significant at the 5% level or better and also have an intuitive relationship with a Yes response. In particular, residents that have **visited** the river, park or natural area along the river this year are more likely to pay the higher visitation cost. The more

important waterbased recreation was (**Water Rec Imp**), the more likely they are to pay the higher recreation visit cost.

Setting the non-bid amount variables at their means, we calculated the median willingness to pay for a visit to the Poudre River at \$15, with a 90% confidence interval of \$7 to \$22. Thus, half the visitors to the Poudre River would pay \$15 or more, while the other half would pay \$15 or less. Figure 8 presents the graph of the fitted logistic willingness to pay curve. As can be seen, 15% to 20% of visitors receive substantial benefits (\$50-60) from their visits to the Poudre River.



Application of Values to Water Management

Recreation Value to Visitors

The annual recreation loss per Fort Collins resident from a 50% reduction in peak spring and summer flows can be calculated by multiplying the median reduction in trips of the times the value per trip. The median reduction in trips of the 31% of the sample that

stated they would reduce trips plus 5% of the sample that indicated they would stop visiting is -5 trips. Combining this trip reduction with the 48% that would not change their visits, and the others who do not visit, yields an overall sample weighted average trip reduction is 3.2 trips, with a median reduction of two trips. Thus, \$15 per trip times the median -2 trip reduction yields a reduction of \$30 per year and \$15 per trip times the average reduction of 3.2 trips yields an annual loss of \$48 a year in lost recreation benefits due to lower spring and summer flows for those that would take fewer trips.

Total Economic Value to Fort Collins Households

The annual median loss in total economic value associated with a 50% reduction in flow to visiting and non-visiting Fort Collins households would be the median WTP of \$234.40. According to the U.S. Census there were 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 nor had sufficient interest to return the survey after two mailings. If we take a conservative approach of assuming those non-responding 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 median WTP per household of \$234, this yields median annual total benefits of maintaining the current flows in the Poudre River of \$8.5 million. Using the average value per households that reflects the fact that 20% of the respondents have a value triple the median (see Figure 7), the mean or average WTP

is \$352 per year per household. This yields an annual value of \$12.73 million. In other words, Fort Collins households would pay between \$8.5 million to \$12.73 million each year rather than have spring and summer peak flows reduced by 50%.

Using the Lincoln Street Gauge data 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 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 \$171 to \$255 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 per acre foot suggests the annual value to Fort Collins residents of maintaining instream flow (\$171-255 per acre foot) exceeds these lease/rental rates of water in Colorado during non drought years.

Taking the present value or present worth of the annual benefits in perpetuity using the Federal government discount rate of 3% used by agencies such as the Army Corps of Engineers, yields \$282.7 million to \$424.5 million. Thus the \$282.7 million to \$424.5 million to avoid a 50% reduction during the spring and summer peak flows in the Poudre River implies a water right value per acre foot of the flows ranging from \$5,673 to \$8,518 per acre foot.

According to discussion 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 Glade Reservoir project). Using the average WTP, Fort Collins households value maintaining the peak flows during the spring and summer period almost equal to the market value of the water for development. Given the high cost of permanently maintaining instream flow in a city with rising population, there may be merit in the concept of leasing water rather than purchasing water rights. However, water leasing can be difficult and there would be significant legal, administrative, and water rights issues to resolve. As the Fort Collins population increases from its 130,000 to 150,000 over the next couple of decades, this would raise median and mean 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, 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).

CONCLUSION

Eighty-three percent of those surveyed indicated that a 50% reduction in peak spring and summer flows in the Poudre River through town would be a “bad change”, with nearly two-thirds saying it would be a “very bad change”. Thus it is not surprising that median annual willingness to pay to avoid the reduction in flows was substantial, at \$234 per household and the average value of \$352 per household. When these amounts are generalized to the percentage of households in Fort Collins that responded to the survey, it yields annual benefits of \$8.5 million to \$12.73 million. The present worth or present value of these benefits in perpetuity is \$282.7 million to \$424.5 million. When expressed in terms of per acre foot of water needed to maintain the current spring and summer peak flows, the value per acre foot ranges from \$5,673 to \$8,518. The average value is reasonably close to the market price of water along the Northern Front Range and what the cost is for developing water in Glade Reservoir.

Three-fourths of Fort Collins residents have visited the Poudre River in town, and more than half do so every year, with a median of 6 trips per person. The number of trips would fall dramatically among the 36% of visitors who said they would take fewer trips to the Poudre River if flows were cut in half. The economic value of a visit to the Poudre River in town is \$15 per visit. The current annual value of these recreation trips is \$90. The annual loss in recreation value from a 50% reduction in flow is \$30 to \$48 per household based on a median reduction of 2 trips and a mean reduction of 3.2 trips.

Overall, this analysis indicates a substantial economic value to visiting and non-visiting Fort Collins households to maintain current peak spring and summer flows in the Poudre River. It appears the average value of these instream flows to Fort Collins residents in the same range as the market value of the water in alternative uses.

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APPENDIX: COPY OF SURVEY INSTRUMENT