An Economic Approach to Giving "Equal Consideration" to Environmental Values in FERC Hydropower Relicensing

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ABSTRACT: The economic value of water that flows over a scenic waterfall was measured using the contingent valuation method. Allowing both the value per day and trips to vary with flow resulted in values per cubic feet per second (cfs) of flow ranging from $1,000 for the first 100 cfs to $300 for additional flow at 550 cfs. Accounting for the value of foregone hydropower, the economically optimum flow just considering aesthetics of the falls was about 235–240 cfs during the main recreation season. Monthly analysis during the recreation season suggested that optimum flows varied from 165–175 cfs during the early and late recreation season to 500–600 cfs during the four prime recreation months. These flows were three to ten times greater than current minimum flows. Recommendations are made that the Federal Energy Regulatory Commission should use nonmarket valuation techniques such as contingent valuation surveys to ensure that environmental values are given equal consideration with power values in dam licensing and relicensing decisions.

KEY WORDS: Aesthetics, contingent valuation, falls, willingness to pay.

STATEMENT OF THE PROBLEM

There are thousands of privately owned hydroelectric facilities in the United States. Although these facilities provide electricity using the renewable hydrologic cycle rather than nonrenewable fossil fuels, and produce no air pollution, these facilities are not without environmental impacts. Hydropower facilities often change the flow regime of the river, frequently to the detriment of native fisheries. In addition, hydropower facilities that divert water into penstocks reduce the flow of the river between the point of diversion and point of return, often altering the aesthetics of the riverine environment.

Concern over the environmental impacts of hydropower was a factor addressed by Congress when it passed the Electric Consumers' Protection Act of 1986 (16 U.S.C. 791a-825r). In this Act, Congress required the Federal Energy Regulatory Commission (FERC) to give "equal consideration" to nonpower or environmental values in its licensing or relicensing decisions that relate to the quantity of water to be left in a stream for fish and recreation. Often times the more water that is left in the stream, the less that goes through the turbines. This results in a significant opportunity cost to the utility and, ultimately, to electricity users.

There has usually been a strong difference of opinion between natural resource agencies and dam owners over what amount of streamflow represents equal consideration and balancing. Without commensurate units to compare kilowatts and visitor days, the FERC is faced with trying to balance "apples and oranges." Benefit-cost analysis (BCA) provides a framework in which nearly all the relevant power and environmental values can be put in equivalent terms. Although FERC recognizes this advantage, some senior FERC staff have over-emphasized the difficulty of estimating the economic value of nonmarket resources, such as aesthetics (Fargo 1991). In part, this appears to arise from the out-of-date view that, somehow, analysts must assign values to these nonpower resources. Rather, analysts estimate the visitors' value through surveys and statistical analysis. As illustrated below, this does not require divine inspiration but careful survey design and appropriate statistical analysis. The reluctance of the FERC to adopt BCA is inconsistent with analysis requirements of other federal agencies such as the U.S. Bureau of Reclamation and U.S. Army Corps of Engineers. If these federal agencies were proposing to build the hydropower project, they would be required to perform a benefit-cost analysis and quantify the economic effects for recreation and aesthetics (U.S. Water Resources Council 1983).

The purpose of this paper is twofold: (1) to illustrate the application of nonmarket valuation surveys and analysis to a FERC relicensing decision involving determination of economically optimum flows over a scenic falls on a major western river (the location of which is not revealed since the instream flow determination is still before the FERC); and (2) to measure the error from ignoring the change in visitor use with changes in flow when calculating total recreation benefits. Although economic approaches should not be the sole criterion for making licensing or relicensing decisions, at present little comparable information on benefits and costs is provided to FERC decision makers or to the public. The result has been a preoccupation with setting minimum instream flows rather than optimum instream flows.

DETERMINING THE ECONOMIC BENEFITS OF GREATER FLOWS

Benefit-cost analysis puts the benefits of increased flow and the opportunity costs of hydropower into commensurate units (i.e., dollars). More than merely financial returns or revenues, dollars represent the economic value of private consumption goods (e.g., electricity) and public goods such as instream flow. Federal BCA guidelines (U.S. Water Resources Council 1983) require that economic value be measured as net willingness to pay (WTP). The net WTP for hydropower is often approximated by the replacement cost of the next least expensive source or the costs avoided by reliance on hydropower (Gibbons 1986).

For viewing the falls, the net WTP is measured by a visitor's consumer surplus. Consumer surplus is the amount visitors would pay over and above their trip costs to visit the site at different flow levels. Because entrance fees do not reflect market clearing prices for visiting the falls, and the fees do not vary with flow, there is really no direct market evidence of WTP for the falls at different flow levels. However, the techniques we used allowed us to establish a simulated market for flow and use this simulated market to estimate how benefits to visitors change with the flow. Duffield (1984) was one of the first to apply economic efficiency analyses to instream flow issues related to FERC licensing of a hydro project on the Kootenai River in Montana.

The change in recreation benefits resulting from a change in flow is composed of two parts (Duffield et al. 1992:2171). The first part is the change in visitation associated with the change in flow. When flows are low the falls are less attractive and fewer people will visit, and, conversely so, when flows are high. The gains or losses in trips (T) are then valued using the WTP function. The second part is the change in value per day of those people continuing to visit the falls at different flow levels. As shown by Duffield et al. (1992), the change in total recreation values (RV) equals:

$$\partial RV/\partial Flow = [(\partial T/\partial Flow) \cdot WTP(flow)] + [\partial WTP/\partial Flow \cdot T(Flow)] \quad (1)$$

One contribution of our paper is to show the size and pattern of error when only the second term is evaluated, as was done in earlier studies (Daubert and Young 1981) rather than both terms. The other contribution is to illustrate the determination of economically optimum flows; that is, the flows that balance the benefits to recreationists with the costs to electricity consumers. This determination is performed for two scenarios: (1) setting of one optimum for the entire recreation season, and (2) setting monthly optimums over the course of the recreation season.

METHODOLOGY

The U.S. Water Resources Council (1983), recommends two approaches for measuring recreationists' WTP: (1) travel cost method (TCM), and (2) contingent valuation method (CVM). The TCM traces out a recreation demand curve by using variation in visitors' travel costs as prices, and number of trips taken as quantities. From this demand curve, net WTP or consumer surplus can be calculated. The TCM was not applicable for valuing the flow at our case study site for two reasons. First, the TCM requires that visitors be on single-destination trips to be able to interpret their travel cost as a price to visit the site. Because nearly 50% of the visitors stop at the falls on their drive enroute to other destinations, it would be incorrect to interpret their travel cost from their residence to the falls as the price of viewing the falls. Ignoring the multi-destination nature of the trip would erroneously overestimate the recreational value of the falls. Second, for TCM to be accurate, visitors must know the flow at the falls before making their trip decision. This is difficult for out-of-state visitors to know.

Therefore, CVM was deemed appropriate because it suffers from neither of these problems. The CVM involves surveying the visitors about their willingness to pay a higher amount (e.g., trip costs) to view the falls at higher water levels. In essence, the CVM involves development of a hypothetical or simulated market for flow or scenery at the falls. Great care was taken to ensure that survey wording and photos clearly communicated the essence of the trade-off to the respondent. The fact that WTP answers are statements of intended WTP and not actual WTP is of concern (Neill et al. 1994). However, CVM responses have been shown to be reliable using a test-retest method for visitors and the general public (Loomis 1989; 1990) and valid measures of actual WTP for use values (Brookshire et al. 1982; Welsh 1986).

With the application of CVM to measure nonuse values of the nonvisiting general public in the Exxon Valdez oil spill in Alaska, the debate over the validity of these nonuse values became quite visible. As a result, the National Oceanic and Atmospheric Administration (NOAA) appointed a blue ribbon committee chaired by two Nobel laureats in economics to hear the arguments over the use of CVM to measure nonuse values. The NOAA panel report (Arrow et al. 1993) discussed the many criticisms leveled by the economists hired by Exxon. However, the Panel was "unpersuaded" by many of their extreme arguments and stated "Thus, the Panel concludes that CV studies can produce estimates reliable enough to be the starting point of a judicial process of damage assessment . . . ." (Arrow et al. 1993). Although we recognize that instream flow over the falls may have nonuse values for households that do not visit the area, we have chosen to measure just use values. This partial estimate of WTP will most likely understate total societal benefits from instream flow, but will avoid many of the concerns about using CVM with people unfamiliar with the resource.

A variant of CVM, called contingent behavior, is useful to obtain how visitors' trip frequency would change with flow conditions. This type of information is also useful for calculating local economic impact analyses. Loomis (1993) found that contingent visitation behavior was both reliable and valid in analyses of visitation to Mono Lake in California. Validity was determined by comparing the actual visitation at the middle lake level to what individuals stated they would visit if the middle lake level was the long term lake level.

SAMPLE FRAME FOR CASE STUDY

The relevant population is the 57,000 annual visitors to the falls, which is located in a designated recreational area. The falls are a well-known attraction in the region and easily accessible from an interstate highway. The falls are over 200-feet high and 800-feet wide at maximum flows. At high flows the falls provide an impressive sight and sound. The names and addresses of visitors to the falls were collected via an on-site survey in 1993. This sample was stratified into three mutually exclusive groups: (1) local area residents (within a 50-mi radius of the falls), (2) remaining state residents, and (3) remaining U.S. residents. In June 1994, five hundred surveys were sent to each group to ensure a large enough sample to allow separate estimation of WTP and changes in visitation for each group. This stratification was performed because we expected visitors from these geographic regions to have different WTP and trip regression coefficients. We used a short on-site visitor survey conducted by the local utility company to weight our sample values (i.e., visits/trips and WTP) and expand to the population level of total visits. Selecting the sample names from on-site visitors increased the likelihood that more frequent visitors would be sampled. More avid visitors may have a higher WTP per visit, but their frequent visits did not bias our estimate of total visits, because the sample visits were only expanded to a known total visits.

Each mailed survey included an individually addressed cover letter. The survey package included a postage paid return envelope. A follow-up postcard was sent two weeks following the initial mailing.

SURVEY DESIGN

The survey format, visual aids, and initial questions were designed jointly with a social science consulting firm to elicit not only WTP and changes in trip taking but also visitor preferences for different flows. Portions of the survey were pretested with focus groups in Idaho and Washington. The focus group subjects were drawn from the recreation site visitor mailing list. The survey format, question order, and question wording were extensively revised following these sessions. Next, a complete draft of the revised survey was mailed to another group of individuals, also drawn from the on-site sample. Using a telephone interview, these individuals were then guided through the survey to uncover problems in interpreting questions that might diminish face validity of the survey.

The final survey was short (4 pages long) and consisted of two main sections: (1) questions regarding visitors most recent trip; and (2) visitor preference ratings, WTP, and trips associated with four color photos that depicted the falls at 50 cfs (photo C), 250 cfs (photo B), 790 cfs (photo A) and 2,000 cfs (photo D). The range of flows was meant to include the current minimum, possible flows that could be adopted by the FERC and a large enough range that a statistical WTP and trip function could be estimated to allow analysis of any flows within this range. Effort was made to neutrally present the views of the falls at the four different flows and not to influence the respondent's own assessment of the desirability of one particular flow over another. To facilitate comparison of what the falls looked like at each flow level, all four photos were presented on one page.

The wording of the question that asked how visitors would change the number of trips taken in response to different flows over the falls was: "The appearance of the Falls might influence your decision to make the trip to the Falls. If you could be certain that the Falls looked like photos A, B, C, or D, how would it affect the additional number of trips to the Falls you would make each year?" The categories for each photo were: More Trips, Same Number of Trips, Fewer Trips, and Wouldn't Go. For the categories, More Trips and Less Trips the respondent was requested to write in the number of additional trips or the number of fewer trips.

The wording of the WTP question was: "The appearance of the Falls might also influence how much you would spend to get the opportunity to view the Falls. If you could spend money to be certain that the Falls would look like photos A, B, C, or D, how would it affect the additional amount your party would have spent to make the trip to the Falls on your last visit?" The categories for each photo were patterned after a simplified payment card (Mitchell and Carson 1989) with options of +\$15, +\$10, +\$5, 0, −\$5, −\$10, −\$15, as well as a fill-in-the-blank option for more dollars or fewer dollars. The range from positive to negative was needed because some of the photos reflected flows lower than what the visitors had experienced on their most recent trip; subsequently, they might only be willing to visit the site if it costs less. Because the WTP question asked for "... the additional amount your party would have spent ...", we also asked party size to calculate per person WTP. However, a protest question was not asked for the four flow level WTP questions. Inclusion of protest zero WTP responses in our sample will reduce WTP and may contribute to the low explanatory power of our WTP equations. A few demographic questions such as age and income were also asked. A copy of the survey booklet is available upon request.

SURVEY RESULTS

The response rate was 63% after deleting undeliverable surveys. This response rate is quite reasonable given that no second mailing of the survey was conducted (to keep costs to a minimum) and that most respondents were on multi-destination or multi-purpose trips. This response rate resulted in 886 usable surveys. In-state residents spent about \$4 per person to visit the falls, and out-of-state residents spent nearly \$18 per person. The average party size was 4 persons.

STATISTICAL ANALYSIS

The most general form of the WTP relation is given in equation (2):

$$\text{WTP per person} = f(\text{Flow, Demographics}) \quad (2)$$

The general form of the visitation function is similar:

$$\text{Change in trips} = f(\text{Flow, Demographics}) \quad (3)$$

Economic theory is not very restrictive on the particular functional form or variable specification. If increased flow over the falls has a positive benefit, economic theory suggests that diminishing marginal value would result. That is, each additional 100 cfs of flow would most likely have a smaller and smaller additional value, other things remaining equal. Of course, this is a testable hypothesis. For example, if flow is modeled as CFS and CFS^2, then diminishing marginal value would be indicated by a negative and statistically significant coefficient on CFS^2. In our initial regressions, CFS^2 was statistically significantly negative at the 10% level. Another nonlinear functional form is the natural log of CFS. This functional form appears more consistent with a plot of WTP as a function of flow on the most recent trip. In addition, log flow had much higher statistical significance indicating it was estimated more precisely (i.e., smaller standard error on the coefficient). Log flow was also a consistently significant predictor not only in explaining per visitor WTP, but in predicting how much farther they would drive and how the number of trips would change with flows. Therefore, the natural log of flows will be used throughout this analysis.

To construct the dependent variable, WTP per visitor, we divided the WTP of the group by the number in the party. This was done observation by observation and resulting observations were then regressed on several explanatory demographic variables. Because each person answered four WTP questions (one for each photo depicting flow level), the values of the independent variables were replicated for each individual and then the data set stacked so that we had four observations for each person. This is a common procedure in CVM surveys (Hoehn 1991), and survey sampling efficiency is gained by asking the same person multiple changes rather than obtaining one response to one

TABLE 1
WTP per day function.

	Locals only		Rest of state		Rest of USA	
	Coefficient	Mean	Coefficient	Mean	Coefficient	Mean
Dependent		$.95		$.52		$1.54
Std. error of dependent		($.13)		($.09)		($ .24)
Independent variables						
CONSTANT	−6.855		−3.4894		−6.438	
(*t*-statistic)	(9.45)		(7.68)		(4.98)	
LN (FLOW)	1.136	5.979	0.65774	5.937	1.3418	5.9819
(*t*-statistic)	(12.19)		(10.64)		(8.06)	
INCOME	0.020347	14.492	−0.0494	10.72	−.00403	17.803
(*t*-statistic)	(1.485)		(.043)		(.18)	
TOTSPEND	0.0094644	28.28	0.001932	16.72	.00158	47.53
(*t*-statistic)	(2.202)		(.444)		(.389)	
AGE	0.009427	47.97	0.001787	41.61	−.00097	48.97
(*t*-statistic)	(1.084)		(.327)		(.066)	
Adj R^2	0.154		0.135		0.081	
Sample *n*	840		702		695	
where:						
LN (FLOW) = natural log of flow						
INCOME = per capital income ($1,000's)						
TOTSPEND = expenditures to visit the Falls						

TABLE 2
Change in number of trips per person at the falls as a function of flows.

	Locals Only		Rest of State		Rest of USA	
	Coefficient	Mean	Coefficient	Mean	Coefficient	Mean
Dependent variable		.531		.807		.238
Std error of dependent variable		.105		.107		.04
Independent variables						
CONSTANT	−1.8712		−3.3839		0.11423	
(*t*-statistic)	(−2.35)		(−4.54)		(.31)	
LN (FLOW)	0.4022	6.285	0.67513	6.095	0.18247	6.223
(*t*-statistic)	(4.77)		(8.60)		(5.30)	
LN (ACTIVS)	0.06554	.66	0.15485	.85	−.039362	.57
(*t*-statistic)	(.455)		(.98)		(−.484)	
LN (INCOME)	0.047072	3.45	−0.01728	3.31	−0.27015	3.66
(*t*-statistic)	(−.282)		(−.11)		(−3.43)	
Adj. R^2	0.025		0.072		0.050	
Sample *n*	768		923		737	
where						
LN (ACTIVS) is natural log of the number of recreation activities						

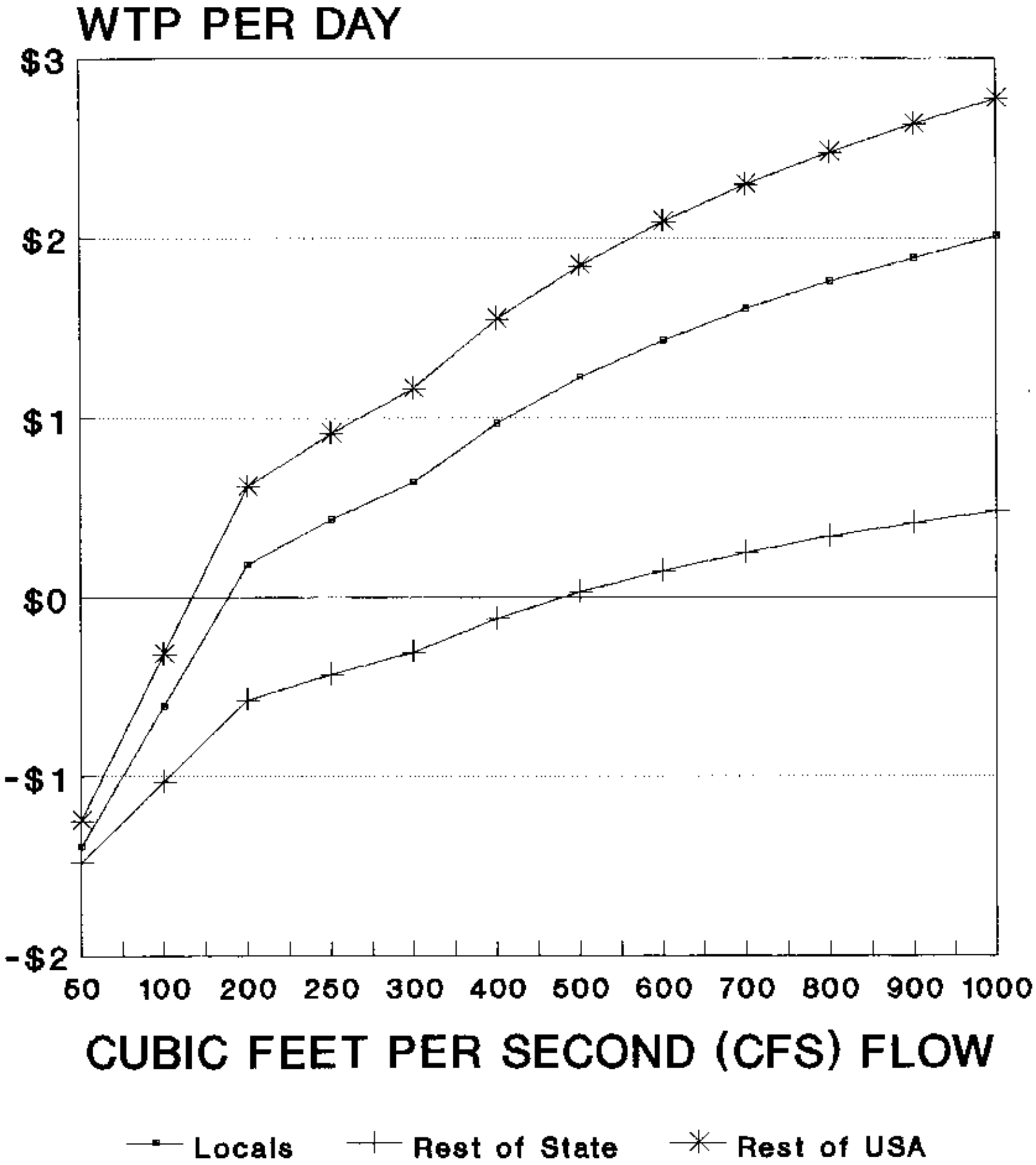

FIGURE 1. *Change in per visitor WTP with change in flows over the falls.*

of the four flows and then estimating the flow function solely by relying on variation across individuals.

Tables 1 and 2 present the regression equations for changes in WTP and changes in number of trips with flow for the three geographic samples. Figures 1 and 2 display the relation between the flow and value per visitor day and the change in number of trips with alternate flows.

The natural log of flow is statistically significant in all equations at well beyond the 0.01 level. The flow variable is important because it is the key policy variable in this analysis. The other shifter variables from the survey include income, age, the sum of the number of recreational activities participated in while visiting the falls, and total spending on the trip. These variables had expected signs but were not always significant at the 10% level or greater in every regional sample. These variables

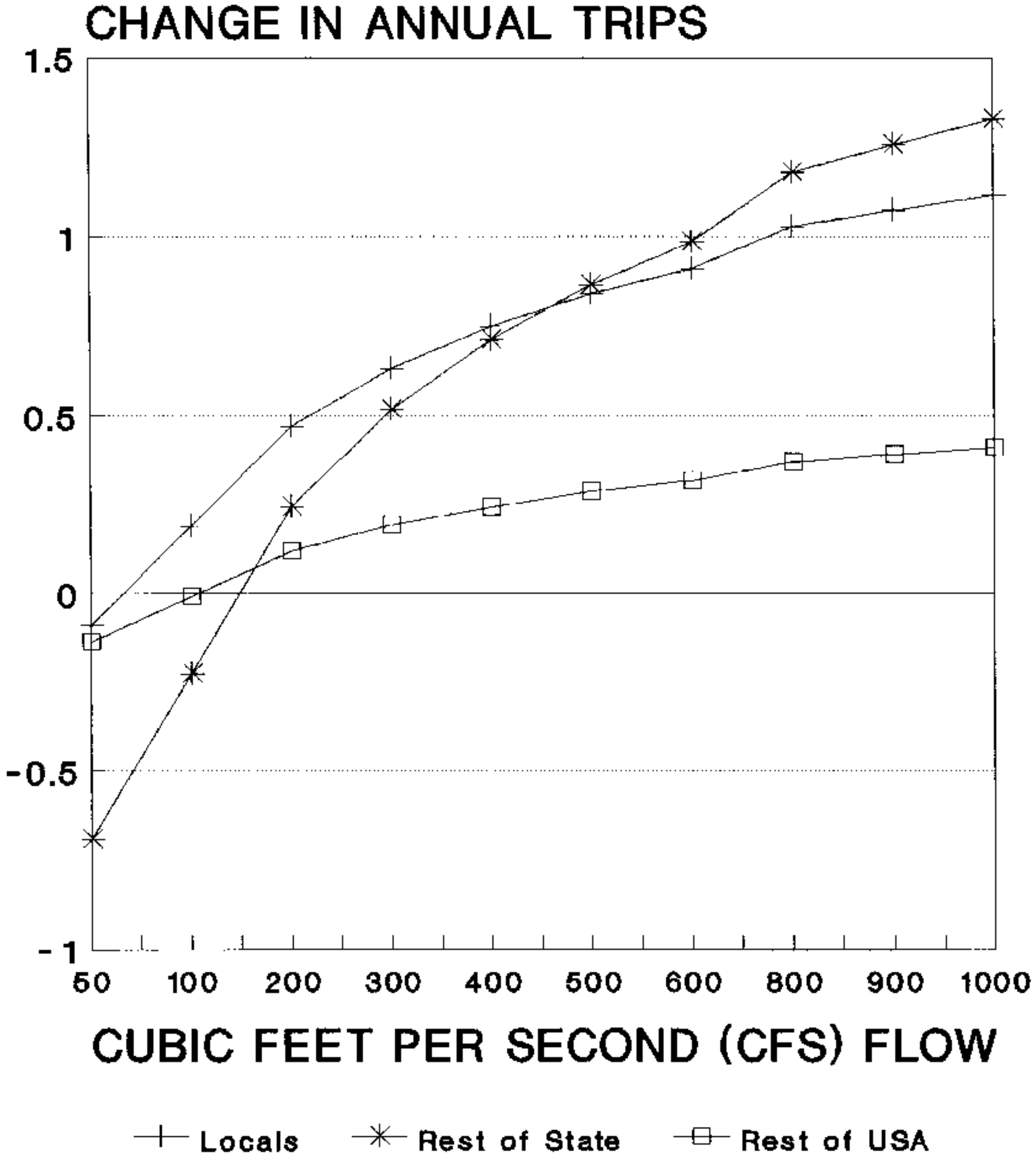

FIGURE 2. *Change in per visitor number of trips with change in flows over the falls.*

were retained due to their conceptual importance, concern about the possible effects of omission on the magnitude of the flow coefficient (i.e., omitted variable bias), and their contribution to increasing the goodness of fit, as measured by the adjusted R^2 of the regression equation. Income is negative in the trip making equation, a finding consistent with a negative sign on income in many travel cost model demand equations (Duffield 1984; Creel and Loomis 1990). The negative sign often reflects the higher opportunity cost of time for taking trips as income rises.

It should be noted that our use of ordinary least squares (OLS) regression when each person answered four WTP and trip questions involves a loss in statistical estimation efficiency that results in standard errors of coefficients being larger and hence t-statistics being lower than they would be otherwise. Based on Hoehn (1991) it appears that a generalized least squares (GLS) implementation of an "error component model" would improve efficiency and raise our t-statistic. Hoehn (1991:296–297) compared the GLS error component model and the OLS approach we adopted and concluded, "It is notable that the two sets of coefficients (OLS & GLS) are very similar."

A single equation pooled across the three geographic residences of visitors was estimated and compared with separate regression estimates for each geographic subsample. A test of the equality of coefficients across the three regions (Kmenta 1971) is rejected for both the per person WTP (calculated $F = 6.59$, critical $F_{0.01} = 3.02$) and the Trip regressions (calculated $F = 12.77$, critical $F_{0.01} = 3.32$). Therefore, Tables 1 and 2 present just the individual subsample equations that will be used in the benefit-cost analysis.

AGGREGATE ANNUAL AND MONTHLY BENEFIT ESTIMATES

The annual benefits relation with flow was calculated using the formula in equation (1) for each of the three geographic regions as follows: To estimate just the change in recreation value with a change in flow, not allowing for any change in visitation, we used only the second term in equation (1). The WTP regression coefficient of CFS in Table 1 provides our empirical estimate of $\partial WTP/\partial Flow$ in equation (1) for each level of flow in each region. The region's value per day at each level of flow is multiplied by the current visitor days from that respective region. These three regional estimates were then summed. To calculate the "No Change in Trips" marginal benefit curve in Figure 3, the change in aggregate benefits was divided by the change in CFS.

To calculate the more complete or correct measure of marginal benefits that allows a change in trips, both terms of equation (1) are used as follows: To incorporate the first term of equation (1), the three regional regression equations in Table 2 were used to predict the change in number of trips per visitor resulting from each flow level. In particular, the regression coefficient on flow provides our estimate of ($\partial T/\partial Flow$). This change in number of trips per visitor was applied to the base visitation for each geographic area to estimate the level of aggregate visitation at each flow level. This level of visitation was valued at the WTP per visit associated with that specific flow. Reductions in number of trips below current use (i.e., lost trips due to low flows) were valued at the average value per trip during the base or survey season. These two sources of the change in benefits were then summed as required by equation (1). To calculate the "Change in trips" marginal benefits curve in Figure 3, we calculated the change in aggregate benefits summed across all three regions, divided by the change in CFS. Figure 3 presents the change in annual WTP for alternative flows over the falls summed over the three different geographic samples and with and without allowing a change in visitation in response to flows. Nearly half of the visitors are from the local area and slightly more than one-third from the rest of the United States. Therefore, the bulk of the benefits are for visitors from these two geographic areas.

Figure 4 presents the marginal benefit curves for each month of the main recreation season. These were calculated using monthly, instead of annual visitation in the calculations described above. As can be seen, there are basically two clusters. The lower cluster of marginal benefit curves reflects the low visitation in early season months (March and April) and late season (September). The main summer months of June, July, and August are also clustered together. As seen below, this graph allows for determination of optimum flows that vary over the recreation season.

OPPORTUNITY COSTS OF HYDROPOWER FOREGONE

The benefits of increased flows over the Falls is sizeable but the benefit-cost test requires that the change in benefits be compared to the change in the opportunity cost of hydropower foregone. In essence, the marginal benefit of water over the falls must be compared to the marginal opportunity costs. Although the exact opportunity costs will vary from utility to utility depending on their replacement power

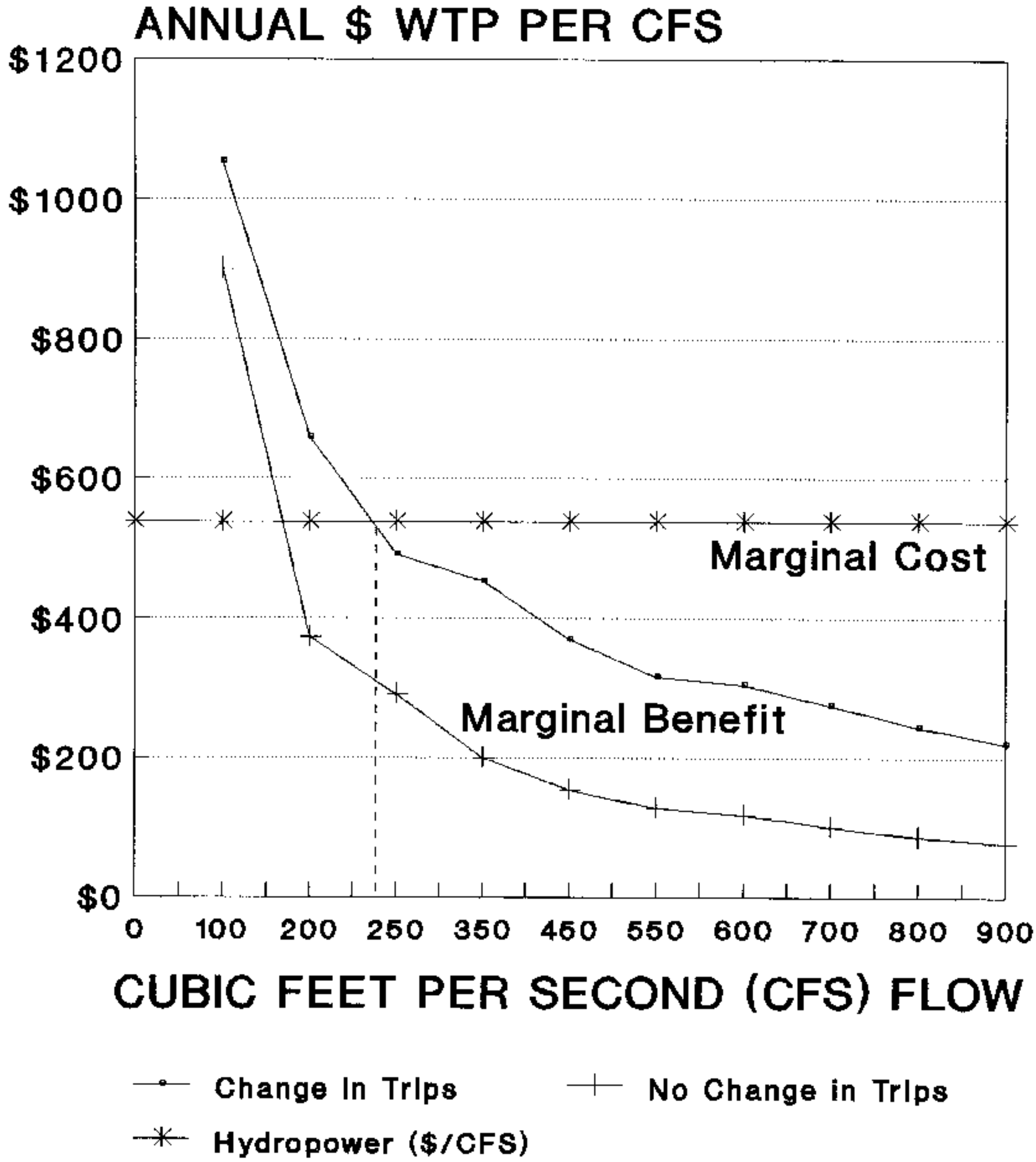

FIGURE 3. ***Annual marginal benefits of flows over the falls with and without change in trips.***

opportunities, estimation of approximate hydropower values is relatively straightforward because standard factors are available. Each cfs of water passing a fixed point for 1 day amounts to 1.9835 acre-feet of water. Therefore, 100 cfs of flow per day represents 198 acre-feet of water. An acre-foot of water generates 0.87 kilowatt hours (kwh) per foot of head (Gibbons 1986:89). Because the study site's hydroelectric plant has 207 feet of head, this translates into 180 kwh per acre-foot of water. If we require 100 cfs during the 12 daylight hours per day for the 6-month recreation season, this requires 18,068 acre-feet of water and would sacrifice 3,252,240 kwh of electricity.

The value of hydropower is the cost avoided by the utility over the next least expensive source. This varies from a national average of $0.017 per kwh using coal fired steam electric plant (Gibbons 1986: 92) to $0.0192 per kwh in the Pacific Northwest (Hamilton and Whittlesey, unpub-

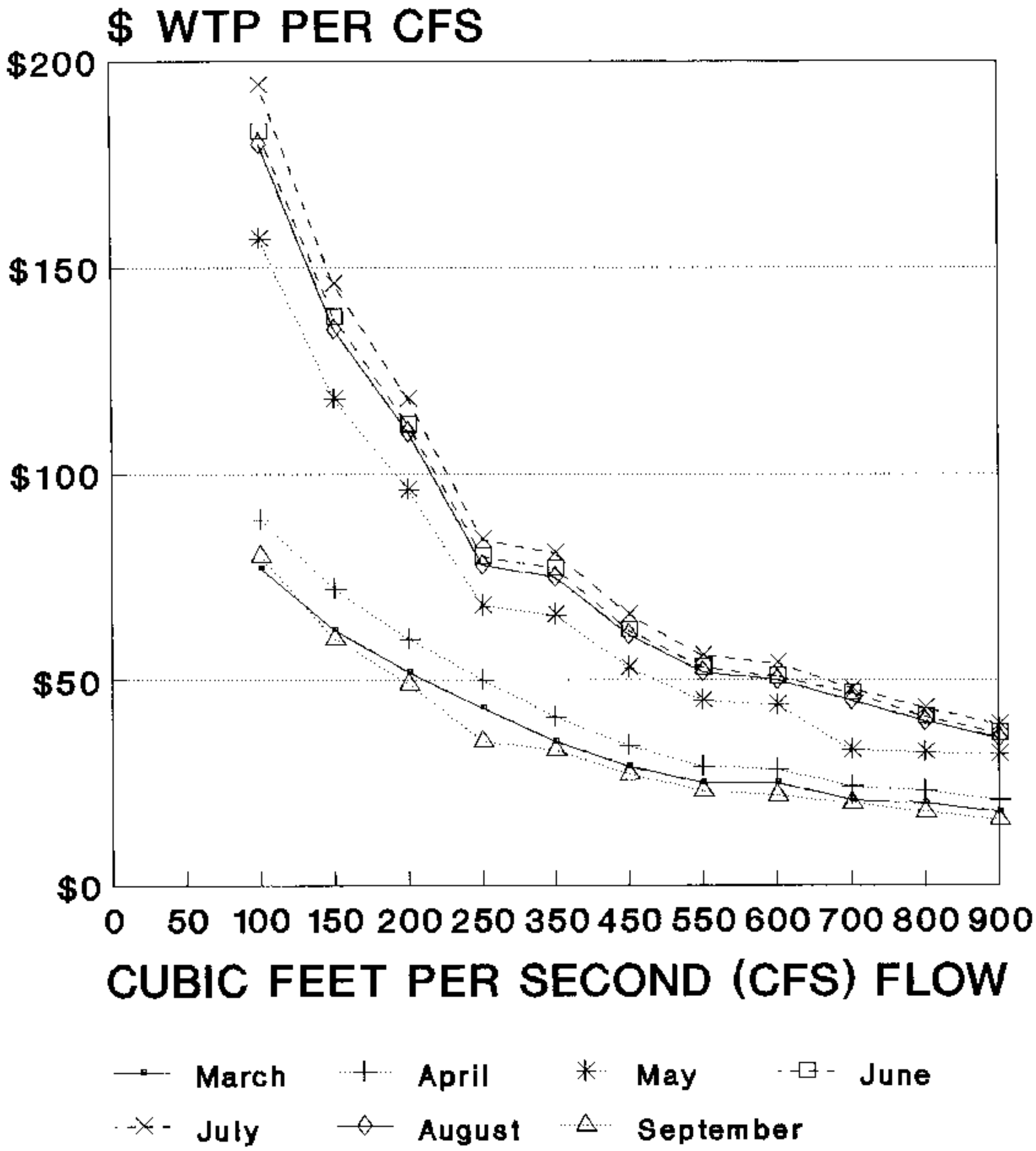

FIGURE 4. ***Monthly marginal benefits of incremental flows over the falls.***

lished report). For the utility under study, the weighted average of six days per week at peak power (during the daytime) and Sunday off-peak is $0.01653 per kwh. Applying this kwh value, the opportunity cost of foregone hydropower is $53,759 for 100 cfs or $538 per cfs. Because the energy production and value of electricity per unit are constant across the range of flow alternatives being considered, the opportunity cost per acre-foot is constant.

DETERMINING ECONOMICALLY OPTIMUM FLOWS

Figure 3 plots the marginal benefit of each additional cfs of flow against the opportunity costs of flows. If just one optimum flow must be selected for the entire recreation season, then Figure 3 indicates that the economic optimum flows to maintain just the aesthetic value of viewing the falls (assuming no other benefits such as fisheries and riparian vegetation) is about 235–240 cfs during the recreation season when both value per day and number of trips are allowed to vary with flow. This is the optimum because the marginal benefit of additional flows just equal the marginal cost at 235 cfs. For flows greater than this level the marginal benefit curve is less than the marginal cost curve, indicating that total net benefits (benefits minus costs) are falling. Review of U.S. Geological Survey gauging station flows for the segment of the river above the turbine intakes and the falls indicates that there are adequate flows in every month—even during drought years–to meet this 235 cfs requirement.

The degree of error from ignoring the change in visitation is evident in Figure 3: The optimum would be underestimated at about 140 cfs, which is 100 cfs less than the real optimum. The error of ignoring changes in trip behavior associated with changes in flow increases as flows increase, resulting in only a 10% underestimate of benefits when flows are very low (100 cfs), but a 70% underestimate when flows rise to 1,000 cfs due to the significant rise in visitation at the higher flows.

As shown in Figure 4, one can fine-tune the economic optimum by month. To do this we rely upon the monthly opportunity cost per cfs. This figure varies by month depending on power demand and replacement costs of power. For the utility under study, the hydropower opportunity costs per month per cfs range from a low of $34 during June to $55 in April, August, and September. During the early and late season months (March and September), the economic optimum is between 165 and 175 cfs. During the main recreation season, which accounts for the vast majority of the visitation, the optimum varies from a high of 1,000 cfs in June (being a peak visitation month and lowest hydropower opportunity cost month) to 500–600 cfs during May, July, and August. The economically optimum flows are also well above the current median flows over the falls of 50 cfs. Nevertheless, this economically optimum flow regime could be met every month of a typical water year except in the worse drought years of record. Only the differences between the marginal WTP functions between the peak season months and between the early/late season months are likely to be meaningfully different. Given the closeness of the within peak season months marginal WTP functions to each other, distinctions between peak months are not meaningful. The same is true of comparisons within the early/late season months.

CONCLUSION

We demonstrated that nonpower values such as the aesthetics of water flowing over a falls can be measured in dollar terms using carefully developed and implemented surveys along with appropriate statistical analysis. This type of analysis can provide a quantitative approach for including environmental values that are commensurate with hydropower values. The approach illustrated in our paper suggests that it would be relatively straightforward for the FERC to balance benefits and costs when attempting to give "equal consideration" to nonpower values as required by the Electric Consumers' Protection Act of 1986. Although nonmarket valuation cannot be reduced to some "cookbook" table of values, a site specific economic analysis would make trade-offs more objective as illustrated in Figure 3 where benefits and costs of alternative flows are graphically compared. At present, fisheries biologists and recreation planners are often at a disadvantage when all they have are narrative statements or measures of weighted usable area of fish habitat and utilities have dollar opportunity costs of power foregone. Although economics should not be the decisive factor in public policy decisions, being able to quantify most of the affected benefits and costs on a comparable basis would contribute to ensuring that nonpower resources really are given equal consideration in FERC licensing and relicensing decisions.

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