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ANALYZING THE EFFECTS OF GLEN CANYON DAM RELEASES ON COLORADO RIVER RECREATION USING SCENARIOS OF UNEXPERIENCED FLOW CONDITIONS[1]

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INTRODUCTION

The validity of the contingent-valuation method has been evaluated from a number of different perspectives. Comparisons have been made across contingent-valuation (CV) questioning formats, with estimates of value derived from hedonic-price and travel-cost models, and with values estimated in experiments employing actual cash transactions (Bishop, Heberlein and Kealy, 1983; Boyle and Bishop, 1988; Brookshire et al., 1982; Dickie, Gerking and Fisher, 1987; Heberlein and Bishop, 1986; Sellar, Stoll and Chavas, 1985; Smith, Desvousges and Fisher, 1986; and Welsh, 1986). A question that has not been addressed by these comparison studies is whether scenarios of unexperienced environmental conditions are useful in eliciting statements of Hicksian surplus for either an enhancement or a degredation of a natural environment. The comparison studies only tell us that two valuation procedures either do or do not, as the case may be, provide comparable estimates of value in a movement from an experienced existing condition to an unexperienced future condition. For example, Boyle and Bishop (1988) estimated the loss in Hicksian surplus that would occur if an existing level of scenic beauty was degraded, and Smith, Desvousges and Fisher (1986) valued an enhancement in water quality. In both of these cases, respondents had experienced the status quo but would not have experienced the proposed degraded or enhanced levels for the resources in question.

The research reported here asks whether CV estimates derived using scenarios of unexperienced environmental conditions are comparable to CV estimates based on actual experience with these conditions. The application is an evaluation of the effects of varying Glen Canyon Dam releases on downstream recreation on the Colorado River. In the paper we summarize the procedures used to evaluate recreationists preferences for a variety of Colorado River flows. After discussing procedures, important relationships

between river flows and Hicksian surplus per trip will be highlighted. We will close with conclusions regarding the use of scenarios in CV studies to evaluate unexperienced environmental conditions.

RESEARCH SETTING

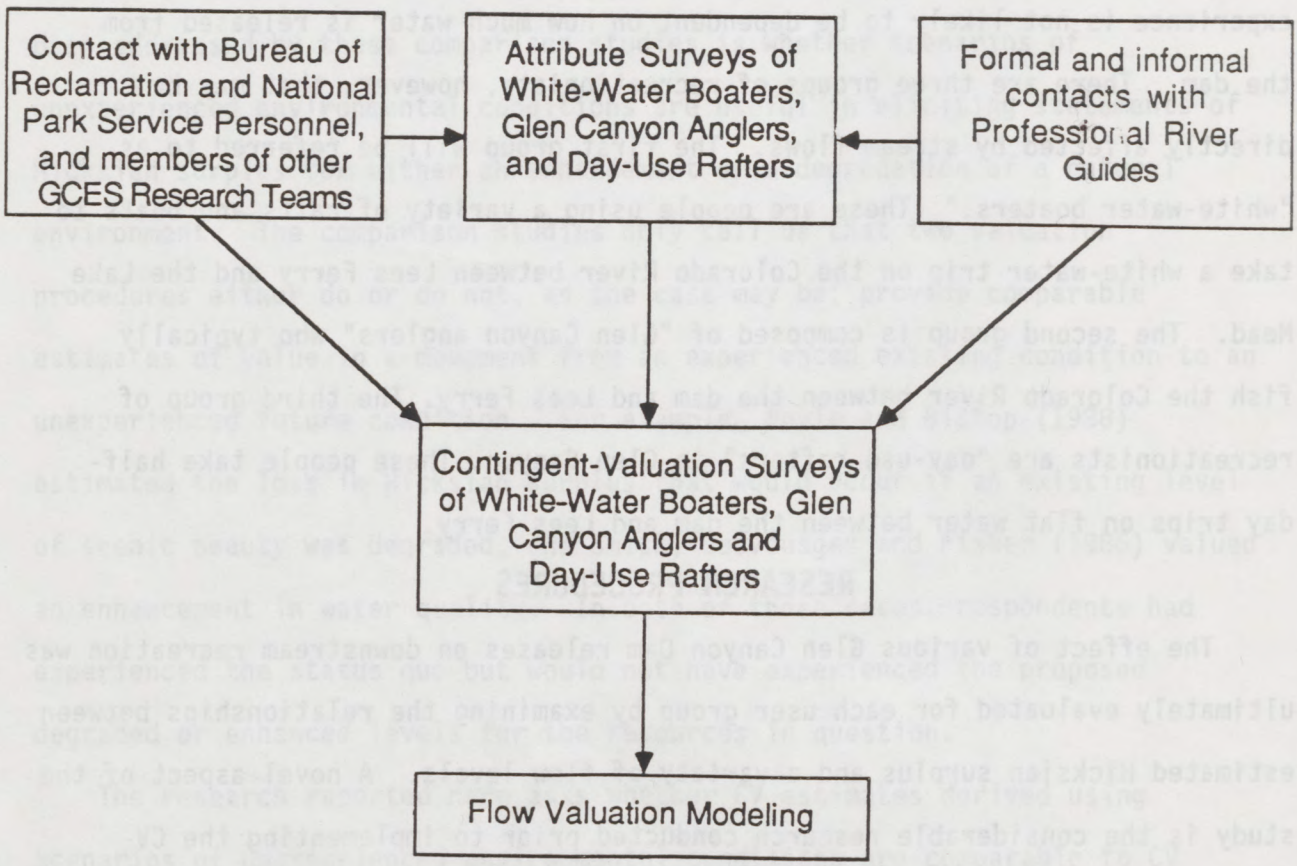
The research focused on the relationships between stream flows and river based recreation along the nearly 300 miles of the Colorado River below Glen Canyon Dam and above Lake Mead. Although the casual visitor viewing the Grand Canyon from the South Rim may enjoy seeing the river, the quality of this experience is not likely to be dependent on how much water is released from the dam. There are three groups of recreationists, however, that may be directly affected by stream flows. The first group will be referred to as "white-water boaters." These are people using a variety of rafts and boats to take a white-water trip on the Colorado River between Lees Ferry and the Lake Mead. The second group is composed of "Glen Canyon anglers" who typically fish the Colorado River between the dam and Lees Ferry. The third group of recreationists are "day-use rafters" in Glen Canyon. These people take half-day trips on flat water between the dam and Lees Ferry.

RESEARCH PROCEDURES

The effect of various Glen Canyon Dam releases on downstream recreation was ultimately evaluated for each user group by examining the relationships between estimated Hicksian surplus and a variety of flow levels. A novel aspect of the study is the considerable research conducted prior to implementing the CV surveys which was designed to identify important attributes of the recreational experiences and to learn about user preferences and qualitative terms. The results of this step were subsequently used in the design of the CV surveys and to interpret value estimates. The interrelationships of the study components are shown in Figure 1 (for a more complete discussion see Bishop et al., 1987).

FIGURE 1

DIAGRAM OF THE RELATIONSHIPS AMONG STUDY COMPONENTS



The first stage of the research incorporated the knowledge of resource managers concerned with the recreational use of this section of the Colorado River and input of other researchers who were studying the physical and biological effects of varying Glen Canyon Dam releases on the natural environment. Second, river guide's practical knowledge of the recreational experiences was incorporated in the research design. The people who serve as guides for white-water trips, for anglers, and for day-use raft trips constitute an important group of experts on the relationship between flows and recreation. River guides have first-hand knowledge of the recreationists, the recreational experience, and the river itself. A formal mail survey of white-water guides was conducted and, because of the small number of people involved, fishing and day-use rafting guides were contacted informally.

The third stage involved "attribute surveys" of recreationists. The effects of varying flow release patterns are transmitted to recreationists largely through changes in the quality of the experiences. The attribute surveys were designed to learn more about the characteristics or attributes of the recreational experience that influence recreational quality.

The fourth, and final, step in the research involved the CV surveys of recreationists to estimate their Hicksian surplus for a variety of flow release patterns.[3] As shown in Figure 1, the design of the CV surveys drew heavily on the findings from each of the three previous steps in the research process. In the remainder of this paper, however, we will focus only on the results of the CV exercises.

CONTINGENT-VALUATION SURVEY DESIGN

The dichotomous-choice technique was used to ask the valuation questions. This technique involves asking respondents if they would pay a prespecified amount, an amount over and above their actual trip expenses, to take a white-water trip, a fishing trip or a day-use raft trip.[4] The yes/no responses, along with the corresponding offers and other explanatory variables were analyzed by estimating logit models which are used to calculate expected consumer surplus for fixed flow levels. For a complete discussion of the procedures used to implement this questionning format and to analyze responses see Bishop et al., (1987), Boyle and Bishop (1988), and Hanemann (1984). Other applications of the dichotomous-choice questionning technique have been conducted by Cameron and James (1987), and Sellar, Stoll and Chavas (1985).

Two types of dichotomous-choice questions were used to estimate values. First, all three groups valued an actual trip (see Figure 2). Trip expenditures were chosen as a payment vehicle to meet the key criteria of being both realistic and neutral (Mitchell and Carson, 1987). Since day-use rafters and white-water boaters would not, in all probability, have taken more than one trip in any given year, they were simply asked to value the trip taken in 1985. Many Glen-Canyon anglers, however, take more than one trip per year. This problem was solved by implementing an on-site sample selection procedure so that anglers could be asked to value the trip taken on that date of the on-site interview. To help anglers recall this trip when they later received the CV survey in the mail, information from the on-site interview was incorporated in the introduction to the survey and in the CV section of this survey.

A wide variety of flow levels are generally experienced by recreationists throughout the year. A random sample of individuals from an entire year would hopefully select a group of individuals who would have collectively

FIGURE 2

GLEN CANYON ANGLER EXPENDITURE AND ACTUAL TRIP CV QUESTION

As near as you can recall for the trip when you filled out our short survey, about how much was your share of <u>total</u> trip expenses for the following items? (Include only money <u>you</u> personally spent. If you didn't spend money on a certain item, please put $0). [PLEASE CALCULATE AND FILL IN THE TOTAL ON THE LAST LINE].

Gas and Oil for vehicle	$_____
Food and Beverages	$_____
Lodging, Camping	$_____
Fishing equipment/bait/license	$_____
Guide fees	$_____
Boat/equipment rental	$_____
Airfare	$_____
Car rental	$_____
Other _____	$_____
_____	
TOTAL YOU SPENT ON THIS TRIP	$_____

Would you still have gone on that particular trip to Lee's Ferry if your expenses had been $_____ more than the total you just calculated? (CIRCLE ONE NUMBER)

1 YES, the trip would still be worthwhile

2 NO, it would not be worthwhile

experienced all, or at least most, of the flow levels during the year under consideration. Thus, respondents from each group would collectively experience a wide variety of river flows and responses to this first valuation question (actual trip) could be used to develop relationships between river flows and estimated Hicksian surplus per trip, a flow-value function.

We were concerned that individuals in each group may not have collectively experienced a wide range of river flows since 1985, the year from which the samples were drawn, was a year of unusually, high flows. Thus, after white-water boaters and Glen Canyon anglers had answered a CV question for their actual trips, they were asked to value trips at several alternative flow levels as described by flow scenarios.[5] The flow scenarios described trips under different flow conditions, primarily in terms of the changes that would occur in important, flow-sensitive attributes identified in the attribute surveys. Descriptions were supplemented with the information gained from contacts with guides and resource managers. A great deal of effort was exerted to insure that the scenario descriptions were based on documented facts and that they were worded in matter-of-fact language (see Figure 3). Scenario values could be used as an alternative source of data to develop flow-value functions in the absence of collective experience with a variety of flows.

These two types of valuation questions, actual trip and scenarios, provide the basis for determining whether scenarios of unexperienced environmental conditions are appropriate to use in CV surveys. The unexperienced conditions here are the flow levels described in the scenarios and their resulting impact on the recreational environments. If the scenarios work well, then the resulting value estimates should correspond with the appropriate value from the flow-value functions based on actual experiences.

FIGURE 3

WHITE-WATER BOATER CONSTANT FLOW SCENARIO (5,000 cfs)

AND ASSOCIATED VALUATION QUESTION

At a constant flow of 5,000 cfs, the speed of the river is relatively slow, reducing time for side canyon visits and other attractions. Boaters must break camp early to stay on schedule. Although rapids are present at this low water level, the waves are smaller and do not produce the big "roller coaster" ride created by higher flows. Due to exposed rocks, some rapids may be so difficult that it is likely passengers would have to walk around them. However, camping opportunities are abundant with many large sandy beaches exposed.

We would now like you to imagine that you are presently deciding whether or not to go on a Grand Canyon white-water trip. Imagine that the trip would be the same as your last trip (e.g., the same people, same food, etc.) with <u>two exceptions</u>:

The water level would be constant at 5,000 cfs

AND

<u>Your individual</u> costs for the trip increased by $_____ (over the total cost you calculated on page 8, question A26)

Would you go on this trip? (CIRCLE ONE NUMBER)

1 YES, I WOULD PAY THIS AMOUNT TO TAKE THE TRIP

2 NO, I WOULD NOT PAY THIS AMOUNT TO TAKE THE TRIP

SUMMARY OF CONTINGENT-VALUATION RESULTS

White-Water Boaters

Subsamples of individuals taking commercial white-water trips and privately sponsored trips, each collectively experienced a wide range of river flows. Hicksian surplus per trip varies with the average flow experienced as well as the type of trip, commercial or private. For commercial passengers, values rise from $47 per trip at a flow of 1,000 cubic feet per second (cfs) to a maximum of $898 at 33,000 cfs, and then declines to $732 at 45,000 cfs (see Figure 4). Private boaters' surplus follows a similar pattern, rising from $21 per trip at a flow of 1,000 cfs to a maximum of $688 at 29,000 cfs, and then declining to $376 at 45,000 cfs (see Figure 5). Respondents experienced flows ranging from 10,000 to 44,000 cfs and flow-value functions are extrapolated down to 1,000 cfs to cover a somewhat wider range of flows for policy analyses. The scenarios evaluated generate point estimates of Hicksian surplus for flows of 5,000, 13,000, 22,000 and 40,000 cfs (see Figures 4 and 5).

Glen-Canyon Anglers

Sampled Glen Canyon anglers did not collectively experience a wide variety of flows and it was impossible to develop a flow-value function. This condition occurred because nearly all of the respondents experienced relatively high flow levels in 1985. The valuation question for their actual trip only generated a point estimate of $130 per trip. This being the case, the scenario values become very important in determining the relationship between flows and Hicksian surplus per trip for anglers.

Scenarios anchored at 3,000, 10,000, 25,000 and 40,000 cfs were evaluated. The flow-value function developed from the resulting value estimates, using linear interpolation between the point estimates, reveals that values rise from $60 at 3,000 cfs to a maximum of $126 at 10,000 cfs and then decline to $94 at

FIGURE 4

COMMERCIAL BOATER HICKSIAN SURPLUS FOR CONSTANT FLOW SCENARIOS AND ACTUAL TRIP

($ PER TRIP)

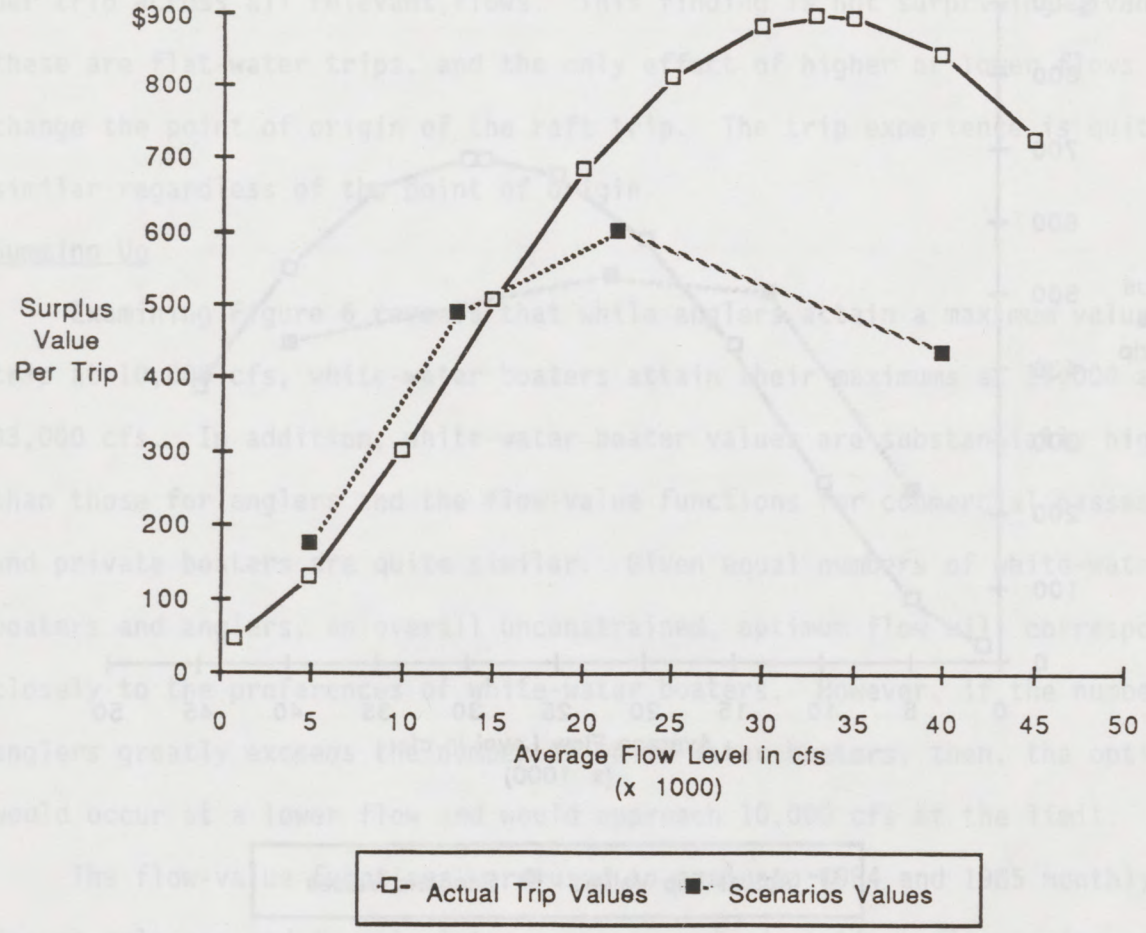
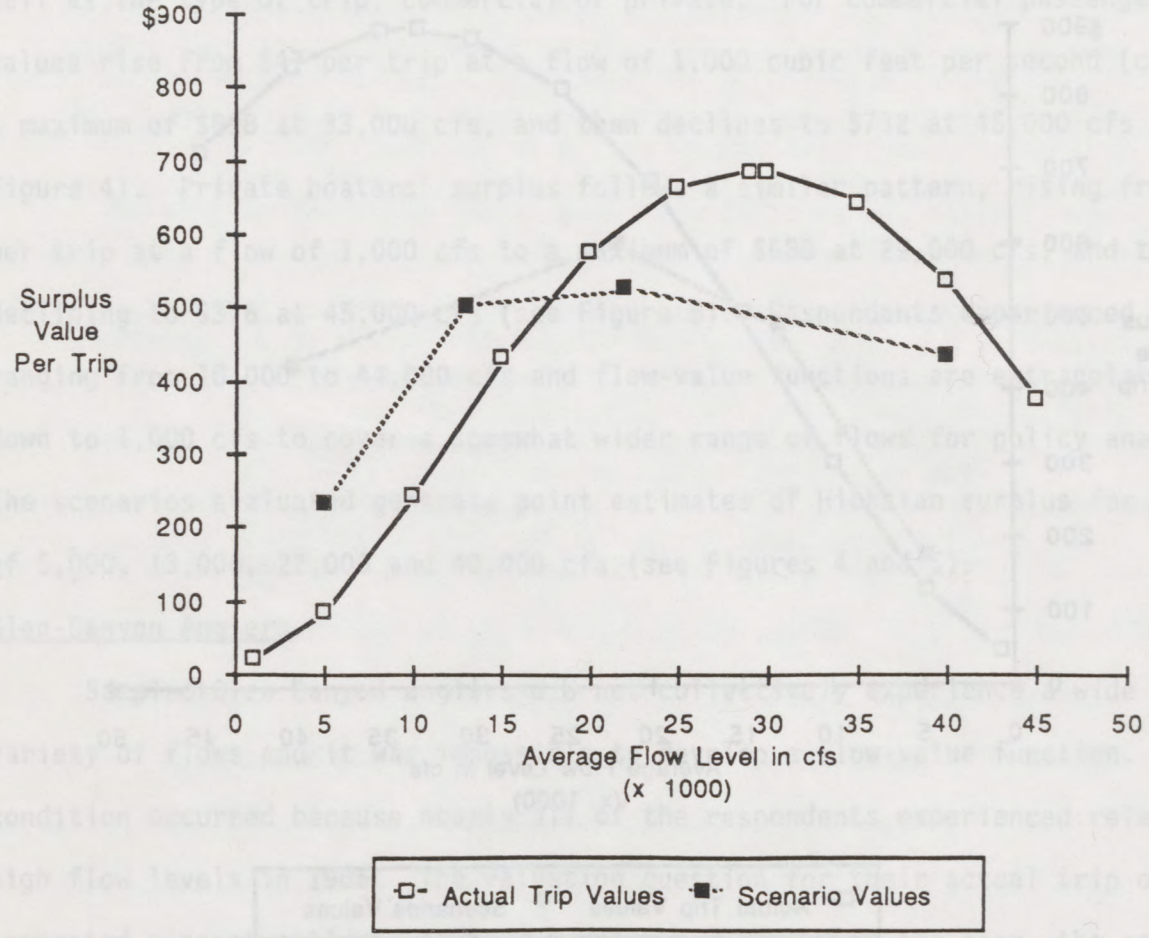


FIGURE 5

PRIVATE BOATER HICKSIAN SURPLUS FOR CONSTANT FLOW SCENARIOS AND ACTUAL TRIP

($ PER TRIP)



25,000 cfs and $52 at 40,000 cfs (see Figure 6). While the scenario estimates can not be used to define a unique optimum flow due to their discrete nature, the optimum would almost certainly fall in the 8,000 to 15,000 cfs range.

Day-Use Rafters

Estimated consumer surplus for this group was found to be constant at $26 per trip across all relevant flows. This finding is not surprising given that these are flat-water trips, and the only effect of higher or lower flows is to change the point of origin of the raft trip. The trip experience is quite similar regardless of the point of origin.

Summing Up

Examining Figure 6 reveals that while anglers attain a maximum value per trip at 10,000 cfs, white-water boaters attain their maximums at 29,000 and 33,000 cfs. In addition, white-water boater values are substantially higher than those for anglers and the flow-value functions for conmercial passengers and private boaters are quite similar. Given equal numbers of white-water boaters and anglers, an overall unconstrained, optimum flow will correspond closely to the preferences of white-water boaters. However, if the number of anglers greatly exceeds the number of white-water boaters, then, the optimum would occur at a lower flow and would approach 10,000 cfs at the limit.

The flow-value functions were used to evaluate 1984 and 1985 monthly Glen Canyon releases and to calculate an unconstrained, optimum flow regime across all three groups of recreationists. These analyses were conducted using 1985 use rates as a common denominator and summaries of the annual benefits are presented in Table 1. The results show that the high flow years of 1984 and 1985 approach the benefits of an unconstrained optimum. The total water released in 1984 and 1985, respectively, was 20.8 and 16.6 MAF, and the total annual release for the optimum regime would be 18.2 MAF.

FIGURE 6

FLOW VALUE FUNCTIONS FOR CONSTANT FLOWS

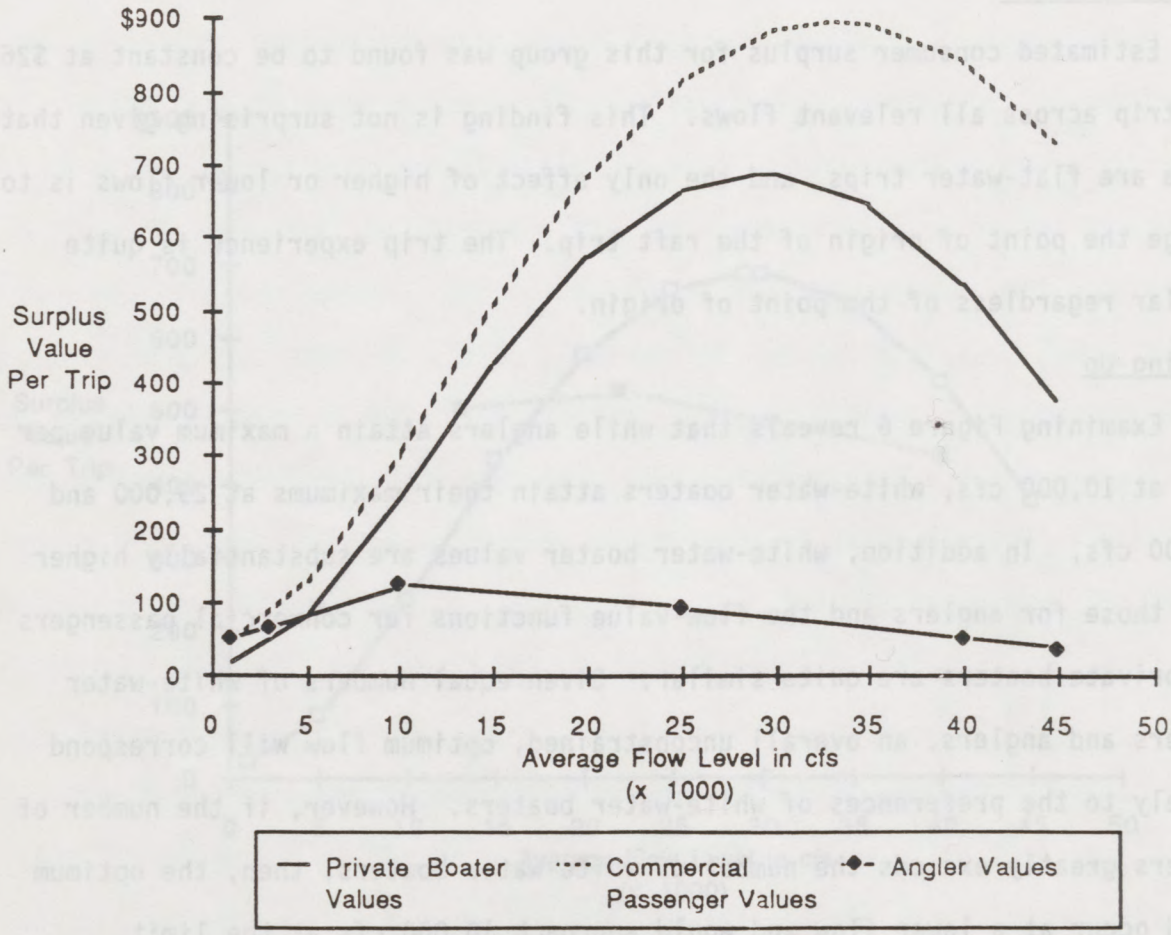


TABLE 1

Evaluation of 1984 and 1985 Flow Regimes and an Unconstrained, Optimum Flow

	White-Water Boaters			
Flow Regime	Commercial	Private	Anglers	All Groups
1984	9,578,038	$1,471,946	$525,591	$11,575,575
1985	9,436,994	$1,359,037	$524,699	$11,320,730
Unconstrained optimum	$10,197,556	$1,590,312	$571,264	$12,359,132

An operational flow regime, however, would need to reflect considerations for fish spawning habitat, beach erosion and other environmental considerations. In effect, managing releases from Glen Canyon Dam involves a complex balancing of many environmental, operational and legal considerations. Recreational use of these flows forms a small, yet still important component of this process.

COMPARISON OF ACTUAL TRIP AND SCENARIO VALUE ESTIMATES

The scenario and actual trip value estimates are only comparable for white-water boaters. A visual inspection of Figures 4 and 5 reveals that the scenario estimates appear to correspond closely to the actual trip estimates at flow levels below 20,000 cfs, but diverge at moderate flows from 25,000 to 35,000 cfs. The scenario and actual trip flow-value functions appear to converge once again at high flow levels above 40,000 cfs. The divergence that occurs at moderate flow levels, approximately the optimum for both commercial passengers and private boaters, may be due to the fact that a scenario was not evaluated for a specific flow within this range. The scenario flow-value functions only present linear interpolations between the point estimates at 22,000 and 40,000 cfs.

This visual comparison indicates that the scenario estimates do maintain ordinal rankings that are consistent with the actual trip flow-value functions. However, if only scenarios were employed, it would be difficult to state that the highest scenario values correspond to an optimum flow due to the discontinuities in the resulting flow-value functions.

A second issue of concern deals with the use of the scenario estimates as cardinal measures. This is due to the absolute differences between the scenario estimates and the corresponding actual trip estimates (Table 2).[6] The largest absolute differences for commercial passengers and private boaters, respectively, are $404 at 40,000 cfs and $149 at 5,000 cfs. These discrepencies may be explainable, in part, by the inate difference in the two types of evaluations. The actual trip question yielded ex ante estimates which are based on actual experience. In contrast, the scenarios generate ex ante evaluations that can be influenced by the information presented to respondents about the proposed environmental conditions.

For example, the difference between the scenario and actual trip estimates at 40,000 cfs for commercial passengers may be due to the safety information presented in the scenario. That is, the safety information may have acted to reduce the scenario estimate. On the other hand, safety considerations may not have entered the actual trip evaluation as strongly since respondents may only recall the large "roller-coaster rides" through the rapids at high flow levels. If nothing bad happened, respondents may only remember the high flow as a very exciting experience.

The divergence between the actual trip and scenario values may not be as dramatic for private boaters at a flow of 40,000 cfs because these respondents were relatively more experienced with the river and with white-water rafting in general. They averaged two trips down the section of the Colorado River

TABLE 2. Comparable Actual Trip and Scenario Estimates of Hicksian Surplus for White-Water Boaters

Flow (cfs)	Commercial Passengers				Private Boaters			
	Actual Trip	Scenario	Absolute Difference*	Absolute Difference As a Percent of Actual Trip Value	Actual Trip	Scenario	Absolute Difference*	Absolute Difference As a Percent of Actual Trip Value
5,000	$130	$176	$ 46	35%	$ 84	$233	$149	177%
13,000	427	488	61	14	358	504	146	41
22,000	744	602	142	19	620	525	95	15
40,000	843	439	404	48	539	434	105	19
Average	---	---	163	29	---	---	124	63

*The absolute differences were calculated by taking the absolute value of the differences between the corresponding actual trip and scenario values at each flow level.

under study. For commercial passengers, a Grand Canyon white-water raft trip is a once in a lifetime experience.

Finally, an additional insight is revealed by examining the differences between the scenario estimates and the corresponding actual trip estimates as percentages of the actual trip estimates. Four of the differences, when expressed as percentages, are less than 20 percent and only one exceeds 50 percent. When this one extreme difference (177 percent) is removed from consideration, the overall average of the differences divided by the corresponding actual trip estimates is 27 percent. A cursory review of previous CV studies reporting standard errors of estimated mean values reveals that it is not unusual for 95 percent confidence intervals to include values within plus or minus 30 percent of the estimated mean (Boyle and Bishop, 1988; Edwards and Anderson, 1987; Samples, Dixon and Gowen, 1986; and Sellar, Stoll and Chavas, 1985). In some instances the confidence intervals include values up to plus or minus 50 percent of the estimated mean.

CONCLUSION

The discussion in the preceding section indicates that the scenario estimates are plausible, but they should not be interpreted as perfect substitutes for values based on actual experience. This is especially true when estimates will be used as cardinal measures of welfare gain or loss in benefit-cost analyses. It is nearly impossible to identify an optimum condition and those who have the most to gain or lose, as the case may be, can be short changed by under or over estimates of Hicksian surplus. On the other hand, scenario values may be the best available estimates. The results presented here indicate that estimates of value based on scenarios would be acceptable to use in this case. However, careful consideration needs to be given to the types of information and level of detail presented in tbe scenarios, and how the resulting estimates will be interpreted and used in policy analyses.

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FOOTNOTES

1. Selected paper, annual meetings of the American Agricultural Economics Association, Michigan State University, August 2-5, 1987. This research was funded by a contract from the U.S. Bureau of Reclamation to HBRS, Madison, WI.
2. Boyle, Welsh and Bishop are also associated with HBRS. We would like to thank Steve Reiling for his helpful comments. Of course, all errors are the responsibility of the authors.
3. Glen Canyon Dam is used for peak power generation, and at such times, downstream flows can vary dramatically during a 24-hour period. Thus, two types of flows were evaluated. The first, constant flows, occur when daily fluctuations are 10,000 cfs or less. Fluctuating flows occur when daily fluctuations exceed 10,000 cfs. We only report the valuation results for constant flows since values for these flows were found to dominate those for fluctuating flows.
4. The prespecified amounts were selected based on the results of pretests of the CV surveys and these dollar amounts were randamly assigned to the final CV surveys.
5. Scenarios were not evaluated by day-use rafters since the attribute and CV-pretest surveys of day-use rafters yielded strong evidence that a relationship did not exist between river flows and consumer surplus for this group. The experts (guides and resource managers) concurred with this finding.
6. No statistical tests for differences were conducted because the actual trip and scenario value estimates are not derived from independent samples.