Final Report

INSTREAM FLOWS IN THE MISSOURI RIVER BASIN:

A RECREATION SURVEY AND ECONOMIC STUDY

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EXECUTIVE SUMMARY

SCOPE AND GENERAL APPROACH

This report provides the results of a recreation survey and economic study of instream flows in the Upper Missouri River Basin. The study was undertaken in co-operation with the Montana Department of Natural Resources and Conservation (DNRC). The authors and DNRC jointly developed the survey instrument. DNRC implemented the survey and developed the data base, while the authors are primarily responsible for the analysis.

This project was designed to provide detailed information on recreation and economics for the on-going water reservation process in the Missouri River Basin above Fort Peck Dam. The reservation process is complex and there are a large number of applicants for reservations. Montana Department of Fish, Wildlife and Parks (DFWP) has submitted an application for reservations on 240 specific streams or stream reaches in the basin. As recognized by DNRC, it was not feasible given the time and budget available for this project to collect information on all of the specific streams or reaches. In our view, the key to this project has been to design a survey that efficiently complements existing data sources and on-going related studies.

The basic scope of this study is to identify recreational use patterns, trip expenditures, current trip values, and a measure of how use and valuation vary with instream flows. Additionally, valuation is required to include nonparticipants in recreation. Because the scope and budget ruled out on-site surveys, we undertook a stratified random mail survey design. The strata included Missouri River Basin communities and out-of-basin Montana residents. This sample was drawn from Montana drivers licenses to avoid the gender bias in phone-based sampling. Additionally, we sampled the major nonresident use group for the Missouri River basin, nonresident anglers, through DFWP license records.

It would require a very large household survey sample to permit disaggregating user-related valuation estimates to the stream reach level. For example, 9000 surveys were mailed for this study and of these only 2058 respondents had taken trips to the basin. Accordingly, the survey was designed to provide key information that can be tied to existing models and data bases. For example, with regard to total use (...)

only existing statewide site-specific data base on recreational use is Montana Department of Fish, Wildlife and Parks (DFWP) angler pressure surveys. This survey has fishing use estimates on a stream specific basis. By using the mail survey to estimate activity proportions (including the proportion of users that are anglers), the mail survey was tied to DFWP's site specific estimates for anglers to derive total use. Similarly, changes in both use and valuation in response to decreased instream flows were identified in terms proportional to current trip values. Following Narayanan (1986), these generic response functions were applied where appropriate to basin and water specific current trip values developed through the mail survey.

To summarize the overall approach, we undertook a large mail survey that was designed to complement existing work. The remainder of this executive summary provides a brief discussion of theory and methods, data, descriptive statistics, and valuation of recreation and flows. Survey instruments and supporting technical information are provided in the appendices and the chapters that follow this summary.

THEORY AND METHODS

The basic approach taken to valuing recreational trips was the contingent valuation method. This approach amounts to directly surveying individuals as to their willingness to pay for a given activity or commodity. Contingent valuation is one of two general methods that have been approved for valuing recreational activity by the U.S. Water Resources Council. The question format utilized was dichotomous choice; in this approach a respondent is faced with a given dollar amount and provides a simple yes or no answer. A sample of these responses is used to derive the relationship between the probability of a yes response and the dollar bid amount. From this relationship (usually modeled as a logistic function), a measure of mean willingness to pay for the population is derived. Recently developed methods for optimally designing the set of offer bids were employed (Appendix C). A limitation of previous dichotomous choice contingent valuation studies is the absence of a measure of precision for the willingness to pay values. In this study a statistical technique, bootstrapping, was employed to estimate standard errors and associated confidence intervals.

study. One series of questions asked the respondent to identify a Missouri River Basin water (river or reservoir) recently visited. The respondent was then asked his/her total trip expenses and a followup question of the form: "Suppose your trip expenses increased by (dollar amount) would you still have chosen to take the trip?." The dollar amount was randomly varied across respondents. The response is used to identify the value of a given recreational trip (or experience) and has been widely applied.

The second type of question was designed to measure preservation values. Three types of preservation values, existence value, option value and bequest value, have been examined in the economics literature. Existence value is the value one places on knowing a resource exists even if he/she has no plans to ever visit or use the resource. Option value is that value one places on preserving the option of using a resource in the future. Finally, bequest value is that value placed on knowing a resource will be available for future generations to use. Previous studies have shown that some resources may have considerable value not associated with direct use. For example, people who have no expectation of ever seeing the Grand Canyon may place a high value on knowing it is protected for future generations. We asked the respondents' willingness to pay to contribute to a trust fund to improve instream flows in Missouri River Basin streams. This format has been widely used to measure the value for given recreational or wildlife resources held by nonparticipants.

The relationship between instream flows and recreational use was determined through a contingent behavior question first used by Narayanan (1986). Respondents were asked (for a recent recreational trip they took to a Missouri River Basin stream) at what level of flow they would discontinue use. Alternative flow levels were presented as varying percentages of the flow they experienced (such as 50 percent or 75 percent of current flow). These responses were used to estimate the cumulative proportion of current use that would be observed at alternative flow levels for a given water.

DATA

A stratified mail sample was used. A total of 9000 questionnaires were mailed; 2000 to residents of each of three subbasins of the Missouri River system (upper, middle and lower), 2000 to out of basin Montana residents and 1000 to holders of nonresident conservation licenses. Dillman's Total Design Method was used with and 3845 of these responded for an overall response rate of 54 percent. A phone survey of 150 nonrespondents was also conducted. The previously mentioned DFWP angler use survey included a mailing of 36,000 surveys in 1985. A total of 19,271 surveys were returned. An examination of DFWP angler license sales indicated only a 1.3 percent increase between 1985 and 1989. This suggests that 1989 angler use may be slightly under-estimated based on the use of 1985 data.

RECREATIONAL USE AND EXPENDITURE

In addition to the valuation questions mentioned previously, the survey included questions related to user characteristics, attitudes, use and expenditures. Responses to several questions indicated that water for recreational use is very important to Montanans.

Recreational use in the Missouri River Basin of Montana totaled over 2 million recreation days in 1989. Approximately 86 percent was resident use and 14 percent nonresident. The use was divided with 61 percent occurring on rivers and streams and 39 percent on reservoirs. The dominant activity is fishing, accounting for about 50 percent of total use. Use estimates and confidence intervals are provided separately in the report at the subbasin level and for major drainages and reservoirs. The aggregate estimates are relatively precise; for example the 95 percent confidence interval for resident use of rivers and streams is only plus or minus 11 percent of the mean estimate. (This confidence interval includes both the statistical precision of the DFWP angler use estimates as well as the statistical precision of parameters used from the current study such as estimated proportion of total use that is due to anglers.)

Average expenditures per trip for residents recreating in the basin were $113, compared to $640 for nonresidents. There was considerable difference for nonresident expenditures by water type, with an average of $797 per trip for visits to rivers versus $366 for visits to reservoirs. Total trip-related expenditures in the basin were $70 million for residents and $45 million for nonresidents. This indicates a significant state level economic benefit from to water-based recreation in the basin. It is interesting to note that nonresident expenditures were concentrated in the Upper Basin (above Three Forks) with 85 percent of all out-of-state expenditures being in this area. Similarly, nonresident expenditure was concentrated on streams and rivers (87 percent) as opposed to reservoirs. This indicates that from in the Upper Basin region including the Madison, Gallatin, Jefferson, Beaverhead and Big Hole. These waters are destination fisheries.

CURRENT TRIP VALUES

From the standpoint of recreationists (and society as a whole) expenditures are a cost, not a benefit. The net benefits of recreation are measured as net willingness to pay over and above costs. These benefits are in part captured by the river owner in a fee fishery setting such as is common in the British Isles or Norway. In this country, these benefits usually are retained by the recreationist who enjoys open public access to recreational resources.

The dichotomous choice contingent valuation models provided current trip estimates of $134 to $175 per trip for residents and from $507 to $793 per trip for nonresidents. On a per day basis the resident values are $40 to $66 across subbasins and water types. These values are similar to estimates reported in a recent review of 120 outdoor recreation studies by Walsh, Johnson and McKean (1988). The estimates are also consistent with previous Montana specific studies. It may be noted that prices observed in Montana fee fisheries are in the same range. Currently the daily fee at Nelson Spring Creek is $40 and the fee on Red Rock River is $45. The average values per day for nonresidents are $193 for rivers and $128 for reservoirs. These values reflect the higher income levels of nonresidents and the high quality of the Upper Basin fisheries compared to other sites in the U.S.

The total net economic value of water-based recreational use in the Missouri River Basin of Montana is $144 million. This estimate is derived from estimated total use and estimated value per day. Assuming a four percent real discount rate into perpetuity, the net present asset value of these recreational resources is $3.6 billion.

INSTREAM FLOW VALUES

Survey respondents were asked how the 1988 drought-induced low flows affected their recreation. A substantial share of respondents (52 percent of residents and 34 percent of nonresidents) indicated that they took fewer trips because of the low flows in 1988. Less than two percent of all respondents indicated that they took more trips due to low flows. A substantial share of respondents also indicated that the quality of their recreational experience was lower because of inadequate stream flows. Thus potentially significant economic impacts may be associated with low stream flows.

Logistic models were estimated that related total recreational use to alternative flow levels at the subbasin and water type level. Models were estimated separately for July-August and rest of year to match relatively homogenous use and flow level periods. These models fit the observed data very well, generally explaining over 90 percent of the variation in the various subsamples. The estimated models generally indicate that use is most sensitive to changes in flow at a level around 65 to 70 percent of the flows experienced in 1989. Use is least sensitive to flow levels for small changes from the levels experienced and also at very low flows. These results have a practical appeal in that they suggest a threshold range where some activities such as boating become impossible, at some flow level.

The estimated values per acre-foot of changing flow levels varied considerably across sites and time periods. For example, July-August flow changes at around 75 percent of 1989 experienced flows in the Upper Basin rivers were valued at $68 per acre foot while changes in Lower Basin (below Fort Benton) river flows were valued at $11. In general, the summer season values were much higher than the rest of year averages. At 75 percent flow levels, changes in Upper Basin river levels for June-September were valued at $23 and Lower Basin river level changes were valued at $4. These value differences reflect when and where people tend to recreate in the Missouri River Basin. In general, the marginal values of instream flows in Missouri River Basin streams appear to be comparable to or in excess of the value of typical competing water uses.

Values were also estimated for changes in the water content of major basin reservoirs. The July-August estimates varied from $1.41 per acre foot-month in the Middle Basin to $.06 in the Lower Basin. Values for the rest of year were from $1.14 in the Upper Basin to $.02 in the lower. The Lower Basin values are less because fewer people recreate in the lower basin relative to the size of the Lower Basin reservoirs. Standard errors for all estimates are reported in the paper.

The estimated values per acre foot for instream flows were compared to other Montana specific instream flow valuation studies. Despite considerable differences in methodology and data, the estimates from the current study were similar to the results of previous research in this area.

TRUST FUND RESPONSE

The benefits of instream flow extend beyond the provision of habitat for fish, wildlife and recreation. Keeping adequate amounts of water in rivers and streams also has intrinsic or indirect values to many people. Individuals may value simply knowing that there are large and free-flowing rivers flowing through natural areas, even if they never see it for themselves. They also may benefit from knowing that a given river is protected for future generations.

Survey respondents were asked if they would donate to a hypothetical trust fund to maintain summertime flows in Missouri Basin streams. Following the usual approach taken in the economics literature,the responses to the dichotomous choice contingent valuation question were used to estimate a logistic relationship. The estimated model fit the data well and estimated parameters were consistent with economic theory. For example, individuals with higher income levels were more likely to donate. The estimated mean donation varied from $14 for out of basin Montana residents to was estimated to be $13.6 million annually. These results indicate that there may be substantial indirect or preservation values associated with Missouri Basin streams.

The estimated trust fund value was similar to other studies of indirect values associated with river preservation. For example, the value of protecting water quality in Flathead River and Lake estimated a trust fund value of $18 million for Montana residents. This study also estimated a regional value (including adjacent states and provinces) for protecting the Flathead of $111 million. Our estimate for a Missouri Basin trust fund is probably very conservative since only nonresident anglers were sampled. It is likely that other nonresidents besides anglers may place a preservation value on Montana's rivers.

CONCLUSION

This study shows very significant recreation and preservation values associated with Missouri River Basin waters. These values vary considerably from one site to another and are highest in the Upper Basin.

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INTRODUCTION

Scope of Study

This report provides the results of a recreation survey and economic study of instream flows in the Upper Missouri River Basin. The study was undertaken in cooperation with the Montana Department of Natural Resources and Conservation (DNRC). The authors and DNRC jointly developed the survey instrument. DNRC implemented the survey and developed the data base, while the authors are primarily responsible for the analysis.

This project was designed to provide detailed information on recreation and economics for the on-going instream flow reservation process in the Missouri River Basin. The reservation process is complex and the scope is very broad. For example, Montana Department of Fish, Wildlife and Parks (DFWP) has submitted reservations on 240 specific streams or stream reaches in the basin. As recognized by DNRC, it was not feasible given the time and budget available for this project to collect information on all of the specific streams or reaches. In our view, the key to this project has been to design a survey that efficiently complements existing data sources and on-going related studies.

The basic scope of this study is to identify use patterns, trip expenditures, current trip values, and measure how use and valuation vary with flow. Additionally valuation is required to include nonparticipants in water-based recreation. Because the scope and budget ruled out on-site surveys, we undertook a stratified random mail survey design. The strata included Missouri River Basin communities and out-of-basin Montana residents. This sample was drawn from Montana drivers licenses to avoid the gender bias in phone-based sampling. Additionally, we sampled the major nonresident use group for the Missouri River basin, nonresident anglers, through DFWP license records. For example, use on the Big Hole in 1988 was over 90 percent fishing and approximately half of these users were nonresidents. As detailed below, the mail survey was designed to address all elements of the scope including current trip valuation and indirect values. The nonmarket valuation method chosen was dichotomous choice contingent valuation.

Even a fairly large household survey sample will not permit disaggregating user-related valuation estimates to the stream reach level. Accordingly, the survey was designed to provide key information that can be tied to existing models and data bases. For example, with regard to total use (number of visits), the only existing statewide site-specific data base on recreational use is Montana Department of Fish, Wildlife and Parks (DFWP) angler pressure surveys. This survey has fishing use estimates on a stream specific basis. By using the mail survey to estimate activity proportions (including the proportion of users that are anglers), the mail survey was tied to DFWP's site specific estimates for anglers to derive total use. Similarly, changes in both use and valuation in response to decreased instream flows were identified in proportional terms to current trip values. Following Narayanan (1986), these generic response functions were applied where appropriate to basin and water specific current trip values developed through the mail survey. The study was also designed to complement and utilize where possible previous research in Montana on trip values (eg. Duffield, Brooks and Loomis, 1987; Duffield and Allen, 1988) and instream flows (Neher, 1989; Duffield, Butkay, and Allen, 1990).

To summarize the overall approach, we undertook a large mail survey that was designed to complement existing work. The remainder of this report provides a detailed discussion of theory and methods, data, descriptive statistics, and valuation of recreation and flows. Survey instruments and supporting technical information are provided in the appendices.

THEORY AND METHODS

This chapter begins with a literature review of contingent valuation methods (CVM) and follows with a description of the specific valuation technique employed in this study: dichotomous choice contingent valuation. The remainder of this section describes the extension of this basic method to address the major study objectives.

Literature Review of Contingent Valuation Methods

The two most widely used methods for estimating net willingness to pay for outdoor recreation are CVM and the travel cost model (TCM). These are also the two general methods recommended by the U.S. Water Resources Council for valuing recreation in federal cost benefit analysis. The travel cost approach estimates demand functions for a given site from observed visit rates corresponding to the supply prices (travel costs) from origins surrounding the site. A regional TCM application to Montana fisheries is described in Duffield, Loomis and Brooks (1987). A regional TCM model is not appropriate for this study because of budget limitations and its inability to measure indirect values.

In the CVM approach individuals are directly surveyed on their willingness to pay for the services of a given resource contingent on the existence of a hypothetical market situation. This is a very flexible technique and has been applied to a wide range of environmental and resource issues including air and water quality changes, scenic beauty, and wildlife (Cummings, Brookshire and Schulze, 1986), and instream flows (Loomis, 1987). The only limitation of the method is the ability of the researcher to frame understandable questions and the willingness and ability of the respondent to accurately value the good or service.

Bishop and Heberlein (1985) have described six key methodological choices in a CVM application: 1) target population, 2) product definition, 3) payment vehicle, 4) question format, 5) method of analysis, and 6) supplemental data. With respect to population, the choice generally hinges on what types of values are being addressed. TCM studies, by necessity, and most CVM studies focus on the values associated with direct use; accordingly, the target population is direct users (such as boaters and anglers). However, there is a considerable literature on indirect or nonuser values such as option, existence and bequest values (Fisher and Raucher, 1984). Estimating the latter typically implies a regional population addressed through a household survey. Product definition and payment vehicle are two key features of the hypothetical market. The resource or service at issue must be clearly described to the individual. This may be difficult for valuing changed conditions, such as the specific physical characteristics of a proposed hydropower installation (Duffield, 1984). Visual aids such as photos and charts have been used (Daubert, Young, and Gray, 1979; Desvousges, Smith and McGivney, 1983). A problem is that the specific information given the individual can bias the response. A general approach is to vary the level of information and test for benefit sensitivity.

Just as for the product definition, it is generally agreed that a payment vehicle must be specified for the respondent. Mitchell and Carson (1981) suggest two criteria for an appropriate vehicle: realism and neutrality. Taxes or site fees may be means of payment that could be realistically employed for public resource use. However, responses to such vehicles may be more influenced by dissatisfaction with high taxes or aversion to fee fishing (for example) than by the value placed on the resource.

A vehicle that has been used successfully for hunting studies is an increase in trip expenses. Hammack and Brown (1974) used this approach in an innovative study of waterfowl hunting. As Bishop and Heberlein (1985) note, this is an appealing vehicle for such studies since respondents are familiar with paying expenses and expenses appear relatively neutral compared with other vehicles such as hunting fees. Past instream flow studies have used trip cost, entrance fee, and sales tax payment vehicles, while studies of water quality benefits have added willingness to drive and the cost of waterfront property (Walsh et al., 1978).

Based on previous studies (Duffield, Butkay and Allen, 1990), this study utilizes a trust fund payment vehicle to identify total willingness to pay for the protection of instream flows and a trip expense vehicle for valuation of direct use alone.

question format or value elicitation procedure. The latter also usually implies the type of analysis that will be undertaken. There are numerous variations, but four general approaches for asking CVM questions can be identified: open-ended questions, bidding games, dichotomous-choice questions, and contingent-ranking techniques. It is beyond the scope of this paper to review these methods in detail (for a recent review see Cummings, Brookshire and Schulze, 1986); however, the key features of each will be briefly described.

The open-ended is the simplest approach: respondents are asked their maximum willingness to pay for use of the given resource. This approach can be utilized in a mail survey and is therefore low cost. Interpretation is also fairly straightforward, requiring only the calculation of the mean offer amount. One difficulty can be in interpreting extreme values. For example, responses of "zero" may indicate a protest response against the payment vehicle or even against the idea that a given resource has a finite value. Generally, follow-up questions are included that attempt to identify the reasons for a zero response. Similarly, it is often not clear what credibility can be attached to extremely high values. In general, the limitation of this approach is that respondents may not have sufficient information or stimulation to fully consider the value they place on the resource.

The most widely used alternative to the open-ended format is a bidding game, where interviewers ask the respondent for a yes or no response to a specific bid amount. If the respondent is willing to pay, for example, $10, the bid is raised in increments until the maximum willingness to pay is determined. Stoll (1983) argues that such an iterative approach is necessary to force individuals to engage themselves in the hypothetical market and continuously reconsider their willingness to pay.

There is some disagreement in the literature on whether the two approaches in fact yield consistently different results. Cummings, Brookshire and Schulze (1986) conclude that open-ended results are generally lower. However, Bishop et al (1984) compared open-ended questions and bidding games and found no significant difference. There are two major limitations to the bidding game approach. It is costly in that it requires face to face or telephone interviews. Second, many studies have shown a positive correlation between the initial (and arbitrary) bid and the final maximum bid. Empirical evidence of this starting point bias has been presented by Duffield (1984) and many others.

the better features of both open-ended and bidding. In dichotomous choice, the individual is faced with a single specific dollar bid and (like bidding games) the response is a simple market-like yes or no. The dollar bid amount is systematically varied across respondents. Since the format is non-iterative (like the open-ended), it is amenable to mail survey and is therefore relatively low cost. This approach is relatively new, but has been successfully applied to valuation of hunting permits (Bishop and Heberlein, 1980), boating and scenic beauty (Boyle and Bishop, 1984), reservoir recreation (Sellar, Stoll and Chavas, 1985) and beach recreation (Bishop and Boyle, 1985).

The major disadvantage of dichotomous choice is that analysis is more complex. This method exploits some of the considerable advancement in methods for modeling discrete choice over the previous decade (Amemiya, 1981). Econometric models such as the logit model are used to predict the probability of accepting an offer as a function of the stated bid and other socio-economic variables, as detailed below. There is some debate over the appropriate welfare estimate for such studies (Hanneman, 1984 and 1989) and issues regarding truncation and functional form are still being resolved.

A related method is contingent-ranking. Here the respondent ranks alternative combinations of environmental resources and monetary outlay. This method also requires the application of econometric techniques (Desvousges, Smith and McGivney, 1983).

As for any model of economic demand, the CVM estimates are generally improved by including at least the conventional demand shifter variables such as income, price and availability of substitutes, and measures of tastes and preference. This is most critical for the dichotomous choice case, where incomplete specification could lead to omitted variable bias. For the open-ended and bidding game methods, analysis amounts to taking the mean of the maximum willingness to pay bids. However, for these two methods it is conventional practice to estimate "bid equations" that relate willingness to pay to demand shifter variables to help establish the credibility of responses.

As is obvious from this review of the CVM literature, there are advantages and disadvantages to each method. The dichotomous choice method was selected for this study. Major considerations were high interview cost and starting point bias associated with the bidding game format.

In dichotomous choice, individuals respond "yes" or "no" as to their willingness to pay a specific cash amount for a specified commodity or service. If it is assumed that each individual has a true willingness-to-pay (WTP), then the individual will respond positively to a given bid only if his WTP is greater than the bid. As Hanneman notes, this can be made explicit in a simple indirect utility difference specification (Boyle and Bishop (1988) provide an application). Accordingly WTP has a straightforward welfare interpretation as an equivalent or compensating variation measure, depending on the question context.

The probability P that an individual will respond positively to a bid of amount x is then

$$1)\ P = \Pr(WTP > x) = 1 - F(x)$$

where F is the cumulative distribution function (c.d.f.) of WTP values in the population.

The standard analysis of dichotomous choice data assumes in equation 1) that the distribution of WTP values is logistic, a two-parameter distribution similar in shape to the normal. This leads to the logit model

$$2)\ L = \log(P/(1-P)) = a + bx.$$

where L is the *logit* or the log of the odds of paying the bid amount x, and a and b are parameters to be estimated from the data. For the time being, we assume that there are no covariates, such as income, but we show shortly how those can be incorporated. Equation 2) can be rewritten explicitly in terms of P, the probability of paying the bid amount x:

$$3)\ P = (1 + e^{-a-bx})^{-1}.$$

Hanemann (1984) has shown that the logit model in 2) and 3) is consistent with the hypothesis of utility maximization. Unfortunately, it has generally been found not to fit contingent valuation data very well. The logistic distribution is symmetric and allows for negative values; observed WTP distributions appear to be skewed to the right and are, of course, always greater than zero. If the bid value x is replaced by *ln*(x), then the model is

$$4)\ L = \log(P/(1-P)) = a + b\log(x).$$

This model implies that the distribution of the *ln*(WTP) values is logistic and so that the distribution of WTP values is log-logistic. This latter distribution is bounded generally been found to give a much better fit to dichotomous choice data. Hanemann (1984) has shown that this model is inconsistent with a standard utility maximization model, but Cameron (1988) has suggested that it simply be viewed, like any statistical model, as an approximation to an unknown, and perhaps very complex, utility maximization model.

Covariates can also be incorporated into the logit model by using the equation

$$5)\ L = a + b'x$$

where b is a vector of parameters and x is a vector of explanatory variables, including bid amount (or *ln*(bid)), measures of taste, income and other standard demand shifter variables. The equivalent equation for P is then

$$6)\ P = (1 + e^{-a-b'x})^{-1}.$$

This model implies that the conditional distribution of WTP values, or *ln*(WTP) values if *ln*(bid) is used, given the values of the covariates, is logistic with a constant variance and a mean which depends linearly on the covariates. Again, using *ln*(bid) instead of bid gives WTP distributions which are more consistent with what has been observed.

Model 4) and model 6) with *ln*(bid) are used in the analyses here for the reasons given above. In estimating welfare values, covariates are of interest only if they significantly improve the fit of the model to the data. Therefore, model 4), which provided a good fit in most cases, is used for this purpose.

The logit model can be fit by maximum likelihood to yield maximum likelihood estimates (MLE's) of a and b. Maximum likelihood fitting for the logit model requires iterative numerical methods. We used the logit routine in SAS (SAS, 1988) to fit the models used in this report. MLE's of functions of the parameters a and b can be obtained by simply substituting the MLE's of a and b into the function.

Once the estimated distribution of WTP values is obtained from model 4), we wish to calculate a measure of the welfare surplus for an "average" or "typical" individual. Three measures have been suggested in the literature (Hanemann 1984): the median, the mean, and the truncated mean. When the WTP distribution is skewed, these measures can differ considerably. The median is probably the best measure of a "typical" individual's WTP, but it cannot be aggregated over the source for the population. The mean is the measure of choice on purely theoretical grounds if one wishes to be able to aggregate the values. That is, the total value of the resource can be estimated by multiplying the estimated mean value per individual by the number of individuals in the population of interest. However, in the logit model 4), the WTP distribution is skewed to the right and the mean can be far out in the tail of the distribution (in fact, the mean can be infinite in some cases). This tail is unobserved beyond the maximum bid amount. The estimate of the mean is therefore heavily dependent on extrapolation of the fitted model into the tail of the WTP distribution and we have no way of knowing if the extrapolation is accurate. The truncated mean represents a compromise between the median and mean. It is computed by first determining a truncation point T, then replacing all estimated WTP values greater than T by T, and computing a mean in the usual way. Thus, the influence of the tail of the distribution is reduced. The truncated mean does not rely on extrapolation of the fitted model beyond T because the actual distribution of WTP values above T doesn't matter. In addition, the truncated mean can be aggregated over the population — when the estimate is multiplied by the population size, it gives an estimate of the population total WTP after values above T have been replaced by T.

There are two ways to view the truncated mean as an estimator of welfare. One is that it is an underestimate of the true mean — that it represents an estimated minimum value of the true mean — but that the true mean cannot be reliably estimated because it is not valid to extrapolate beyond the range of the data. The second is that, on distributive grounds, it may be desirable to limit the contribution of any individual to total WTP. In this case, even if the tail of the WTP distribution were known, we would truncate at T. The determination of the truncation point T is a judgement, just as the choice of the median, mean or truncated mean is a judgement.

Many applications have used the truncated mean as the welfare measure (for example, Bishop and Heberlein 1980 and Sellar, Stoll and Chavas 1985). In this study, we report both the median and truncated mean WTP. The truncation value is equal to the maximum bid. The truncated mean is used in all aggregations. It should be realized that this represents a conservative estimate of the true mean (hypothetical) WTP because all individuals having WTP greater than T are included at the value T. Also, different truncation points were used for residents and nonresidents which means that the truncated means for these two groups are not directly comparable described above for the model in 4) are:

$$7)\ \text{Median} = \exp(-a/b)$$

$$8)\ \text{Mean} = E(\text{WTP}) = \int_0^\infty x f(x)\,dx = \int_0^\infty (1 - F(x))\,dx$$

$$9)\ \text{Truncated mean} = \int_0^T \min(x,T) f(x)\,d = \int_0^T (1 - F(x))\,dx$$

where $f(x) = dF(x)/dx$ is the probability density function of the WTP distribution. Numerical integration is necessary to calculate the mean and truncated mean. MLE's of a and b were substituted into the above formulas to obtain sample estimates.

Two specific dichotomous choice valuation questions were utilized in this study: current trip valuation and trust fund contribution for protection of instream flows.(See Appendix A for specific wording of each question.) All of these valuation questions were estimated in the form of equation (4).

Standard Errors

Standard errors for truncated means, quantities like expenditures per day and other combinations of variables were estimated with a combination of methods. Exact formulas for standard errors are not available for the logit model and for ratios and products of correlated quantities, such as total expenditures on a trip and number of days in the trip. Bootstrapping (Efron 1982) was used where possible. Bootstrapping in the logit model is described in Duffield and Patterson (1990). Where bootstrapping was not possible, the delta method (Bishop, Fienberg and Holland 1975) was used to derive approximate asymptotic expressions. The primary two were:

$$10)\ \text{Var}(X/Y) = [1/(EX)^2]\,[(EX/EY)^2\,\text{Var}(X) + \text{Var}(Y) - 2(EX/EY)\text{Cov}(X,Y)]$$

$$11)\ \text{Var}(XY) = (EX)^2\,\text{Var}(Y) + (EY)^2\,\text{Var}(X) + 2(EX)(EY)\text{Cov}(X,Y)$$

If X and Y are independent, then an exact formula for Var(XY) is:

$$12)\ (X,Y\ \text{indep.})\ \text{Var}(XY) = \text{Var}(X)\text{Var}(Y) + (EX)^2\,\text{Var}(X) + (EY)^2\,\text{Var}(Y)$$

To date there have only been a few economic studies of instream flows. It is useful to recognize that changing flows will affect both the quality of recreational use and the amount of use. Both of these influences may be represented by flow as a "shift" variable in a demand function specification. In general, existing studies have focused on either the quality or quantity change. For example, Daubert and Young (1981) and Bishop, Brown, Welsh and Boyle (1989) used the CVM technique and faced respondents (on site interviews) with alternative flow scenarios. The former study used photos of 8 flow conditions in the Poudre River in Colorado, and the latter developed descriptions of 6 flow scenarios for white water rafters in the Grand Canyon and for Glen Canyon anglers. This approach provides a measure of quality changes. Additionally, Bishop et al (1989) used a current trip valuation question and included actual flows as an independent variable in a logistic equation. This approach also does not correct for possible changes in amount of use (i.e. number of visitors). However, this may well be appropriate for the Grand Canyon where use is constrained by a permit quota and there is considerable excess demand. Both the Poudre and Colorado River studies derived relationships between average consumer surplus and flow levels.

An alternative model has been developed by Narayanan (1986) in a study of the Blacksmith Fork River in Northern Utah. Narayanan combined a travel cost model estimate of current valuation with a direct survey based logistic model of participation as a function of flows. Specifically, recreationists were asked on site how much flows would have to decline (as a percent of current flows for 8 specific percentiles) before the individual would discontinue use. The logistic estimate and the current valuation were used to estimate a total and marginal benefit function for alternative flow levels. This approach is appealing in that it provides a fairly robust framework for the valuation-flow relationship. The logistic function is of course constrained between 0 and 1.0; when combined with current trip valuation the result is 0 total value at near zero flow levels and a current (maximum) value at some higher flow. This has a certain practical appeal in that in fact river recreation use (and hence valuation) does go to zero below a certain level of flows. This approach, by contrast with the other referenced studies, focuses on quantity alone. The general method could be improved by combining it with CVM valuation of quality change.

Of the general procedures developed to date for instream flow valuation, the general Narayanan framework is best suited to the needs of this study. Given over time, variation in flows (and the consequent effects on use) can not be directly observed. Even if use was observed over the course of a given year, the range of possible flows which are of greatest interest for the reservation process (those below the DFWP instream flow request) may not be observed on many streams. Following Narayanan's general approach, a logistic relationship between flow and use can be derived from a mail survey.

A brief description of the Narayanan (1986) approach is as follows. Visitors were asked to indicate at what percentage of current instream flows they would cease to visit the site for the entire season. The percentages given as options were 0, 10, 25, 33, 60, 67, 75, and 100; these 8 flow levels can be designated as F_i. The 100 percent option corresponded to the average streamflow for the sample season (summer of 1982, in this case). Based on survey responses, the proportion of visitors at each flow level (or $P(F_i)$) was computed. The logistic function was used to model the relationship of participation and flow:

$$13) \quad P(F_i) = \frac{1}{1 + \exp -(a + b F_i)}$$

For estimation purposes, this can be transformed to a linear function of flow:

$$14) \quad \log(P/(1-P)) = a + b F_i$$

Narayanan apparently used ordinary least squares (OLS) to estimate this equation. Maximum likelihood procedures or weighted least squares are an alternative. The former is inappropriate because the observations are not entirely independent; the latter is the usual correction for heteroscedasticity, which occurs in cases where a proportion is included in the specification. Heteroscedasicity means that the variance of the disturbance term is not constant. Given the nature of the data, we also chose to use OLS.

Given a measure of total recreational benefits B at current (100 percent) flow levels, total benefits as a function of flow are simply:

$$15) \quad B(F_i) = P(F_i)\, B$$

Narayanan used a travel cost model to derive current recreational benefits, but these could just as well come from a CVM model. Given equation (15), a schedule of total benefits as a function of flow levels can be coma unit (one percent) change in flow. The marginal value can be converted to dollars per acre foot by multiplying the first derivative by 100 over current discharge or (100/D). The marginal value is then given by:

$$16)\quad MV(F_i) = \frac{(100/D)\, B\, b\, (\exp -(a + b F_i))}{[1 + \exp - (a + b F_i)]^2}$$

A limitation of this approach is that only the relationship between decrements to flow and use can be derived. This would be a problem in a low water year. Given that the policy issue at hand concerns the valuation of decreases rather than increases in flow, the method is appropriate. As Narayanan notes, the success of this approach depends on how accurately respondents perceive the options in flow levels and are able to evaluate the impact on their recreational experience. To address this potential problem, respondents were asked to rate themselves on how knowledgeable they were about the effect of flow on a given river.

The application at hand is somewhat more complex than the Narayanan case in that valuation is for an entire year and for subbasins, individual waters or groups of waters within an entire river basin. The model can be extended to multiple sites and time periods by indexing the discharge, valuation, and flow variables to specify site, time period and flow or $D_{jt}(F..)$, $MV_{jt}(F..)$ and F_{ijt} where there are i discrete flow levels, j sites and t discrete time periods per year. This raises the additional complication of selecting the level of site and time period aggregation.

Choice of site aggregation is necessary when estimating the participation-flow response function (equation (15)). This choice is in part determined by sample size; one would want to group waters and respondents that might have homogeneous responses - for example rivers versus reservoirs and residents versus nonresidents. Given sample limitations, it may be necessary to develop generic response functions for water types and large site groups.

Choice of time period aggregation is also very important. Narayanan estimated the value of summer recreation and compared this to the change in summer flows. By comparison, using our year total values and year total discharges could be misleading in that average values over the year would certainly understate summer values (when recreation use is concentrated) and overstate winter values. There are three considerations that relate to the appropriate time period choice: opportunity cost, potential demand, and discharge levels.

situation holds when no other uses are competing with instream flows (for example during typical June high flows). The periods when instream flows potentially compete with other uses are during low flow periods when both recreational use and consumptive uses such as irrigation are high - for example during July and August. July and August are also months that are fairly homogeneous with regard to potential use levels - many individuals take vacation during this period, the weather might be nice, and school is out. One wouldn't want to group January and August in that the relationship of potential use and flow are likely to be very different during those months. Finally, the estimated participation-flow relationships are most meaningful if the "current flow" corresponding to the trip surveyed is at about the same level for all respondents. This provides some validity for using the 0 to 100 percent flow index with a given discharge level. In general, most Montana streams change from high to moderate or low flows between June and July.

These considerations suggest modeling (to the extent data permits) the July-August time period separately from the rest of the year.

Use of a mail survey and basin or subbasin level sites introduces some problems for estimating the recreational value of instream flows in that actual variation in use at a given site is not directly observed and sites that are grouped may not be similar. We used a modified Narayanan approach that disaggregates by July-August and rest-of-year time periods. We also dissaggregated by site and water type (reservoirs versus streams) and subbasin level to have more homogeneous site groupings.

Existence Values of Instream Flows

The preceding discussion of the value of instream flows is limited to direct recreational use. However, as first suggested by Krutilla (1967), individuals may place value on the existence of natural environments or wildlife species independent of their own personal use. For example a person may value knowing that a unique environment like the Grand Canyon or an endangered species such as the whooping crane exists, even though they have no hope or desire to visit or see these resources. The fact that people will donate to trust funds (such as the World Wildlife Fund or The Nature Conservancy) for protecting rare species and environments is evidence of existence values. Existence values may be als use. Existence values are also sometimes called intrinsic, nonuse or preservation values.

The combination of direct use and existence value is referred to as the total value of a given wildlife resource (Randall and Stoll, 1983). The estimation of existence values for river environments is fairly new, though there have been applications by Sutherland and Walsh (1985) for valuing the Flathead River and Lake, by Walsh, Sanders and Loomis (1985) for valuing wild and scenic rivers in Colorado, and by Duffield, Butkay and Allen (1990) for valuing instream flow improvements on five Montana rivers. To date there have also been several estimates of the total value of specific wildlife resources or habitats including a study of whooping cranes (Bowker and Stoll (1988), bighorn sheep and grizzly bears in Wyoming (Brookshire, Eubanks and Randall, 1983), bald eagles and striped shiners in Wisconsin (Boyle and Bishop, 1987), desert bighorn sheep (King, Flynn and Shaw 1988) and elk winter range for the Northern Yellowstone elk herd (Duffield, 1989). However, by comparison with the large number (120) of direct recreational value studies identified by Walsh, Johnson and McKean (1988), to date relatively little effort has been directed toward existence values for wildlife or unique environments.

valuation with a hypothetical trust fund payment vehicle. This approach is also used here, with an application of the dichotomous choice contingent valuation model described above. Unlike surveys limited to recreational valuation (which can be conducted on-site), a household mail sample is needed to estimate existence values. This is because both users and nonusers may place existence values on a given resource. The application here is somewhat unique in that no studies directed specifically at the existence or total values of instream flows have been published to date. A description of the detailed approach and discussion of the trust fund survey question is in Chapter VI below.

A complication associated with this study, again because of multiple sites, is that it is difficult to describe for the respondent the increment to instream flows that would be associated with a given trust fund donation. Because of this, the hypothetical situation described is necessarily vague and generic. This limits the possibility of comparing the total and existence valuation estimates from the trust fund section with the recreational value of a given flow increment using the Narayanan method.

DATA SOURCES

The data used in this study came from three sources. All net willingness to pay figures, descriptive statistics and flow valuation statistics were drawn from a mail survey administered by the Department of Natural Resources and Conservation during the summer and fall of 1989. A phone survey of nonrespondents was also conducted in the fall of 1989. The extensive data collected by this DNRC survey was supplemented with estimates of statewide fishing pressure provided by the Department of Fish, Wildlife and Parks from it's 1985 statewide angler pressure survey. (Survey questionnaires are displayed in Appendix A).

In order to sample more efficiently the DNRC survey used a stratified sample. A total of 9000 questionnaires were mailed; 2000 to residents of each of three subbasins of the Missouri River system (upper, middle and lower), 2000 to Montana residents living outside the Missouri River basin and 1000 to holders of nonresident conservation licenses. The pool of nonresident license holders is representative of those nonresidents coming to the waters of the Missouri River basin to fish.

An adaption of Dillman's (1978) Total Design Method was used to conduct the mail survey. A questionnaire booklet, cover letter, and an addressed, stamped return envelope was mailed to the sample. A postcard reminder was sent one week later.(Appendix A) Two weeks after that, a follow-up letter and a second copy of the booklet were sent to those people not yet responding. Previous experience indicated that a 30 to 40 percent response rate could be expected from a general household mailing such as this. The actual response rate for this study was slightly better than expected with 3845 of the 7061 delivered surveys being returned for a 54% response rate. The response rate was the same for residents and nonresidents. The completed surveys were coded and entered into data files under the direction of DNRC.

In order to estimate recreational use on the streams and reservoirs of the Missouri Basin the information collected by the DNRC survey was supplemented with estimates of statewide angler use compiled by DFWP.

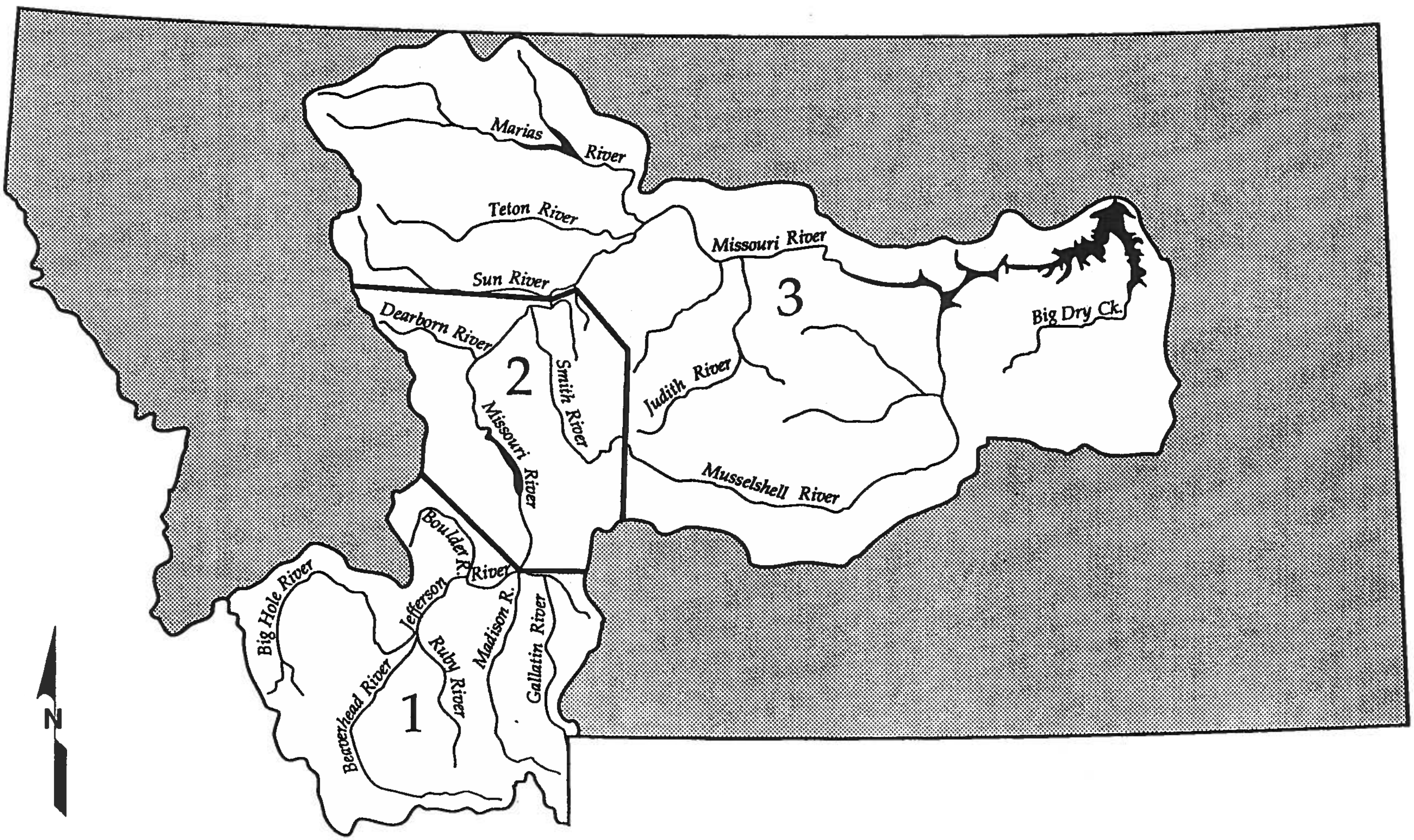
In 1985 the Montana Department of Fish Wildlife and Parks conducted an extensive mail survey to estimate sure survey begun in 1982 and scheduled to end in 1986. For 1985, however, the sampling rate was doubled over the preceding three years in order to provide a more accurate data base for the Montana Bioeconomic Project's study of Montana fishing values. In 1985approximately 36,000 surveys were mailed to anglers. Of the 19,271 surveys returned 5,984 said they had fished during the time period in question and provided information on when and where they fished. The data from this survey was used to estimate total fishing pressure on the streams and reservoirs in the Upper Missouri Basin. When combined with DNRC data on the percentage of recreationists who were anglers a comprehensive picture of recreational use in the Missouri Basin emerges.

Nonresponse Analysis

A phone survey of 150 resident nonrespondents was conducted after the completion of the mail survey in order to examine nonresponse bias. The phone survey script is provided in Appendix A. While the nonrespondent data was not used to make adjustments in use and valuation estimates in this study, it is instructive to examine the nonresponse data for indications of possible bias in the respondent survey data. Table 1 shows a comparison of respondent to nonrespondent mean values for selected attributes. Both participation in water-based recreation and number of days engaged in water-based recreation are lower for the nonrespondent sample. This indicates the original survey respondents are more active in water recreation and thus their responses might bias the estimates herein upward. Since, however, use days as estimated in the following chapter are based on DFWP estimates of angler days rather than on this survey the bias should be a small one. Indicative of a much lower interest in outdoor recreation in general is the mean participation rate in sportsmans organizations for the nonrespondents. This rate of 3.4% compared to 18.5% for respondents is sizable. Again this could indicate an upward bias in the estimates to follow. Estimates for age and education (an index of discrete educational levels) are similar for both respondents and nonrespondents. Finally, Females made up a much larger percentage of nonrespondents

Figure 1.

MISSOURI BASIN WATERWAYS



1 = Upper Subbasin   2 = Middle Subbasin   3 = Lower Subbasin

Comparison of Respondent and Nonrespondent Means

Attribute	Respondents (Std.Dev.)	Non-respondents (Std.Dev.)
% Participating in Water-Based Rec.	85.5 (32.5)	72.8 (44.6)
Number days per year of Water Recreation	20.4 (26.3)	12.9 (15.5)
% who are Member of a Sportsmans Organization	18.5 (38.8)	3.4 (18.2)
Average Age	46.3 (16.4)	45.8 (16.8)
Average Education**	5.06 (1.43)	4.89 (1.41)
% Female	41.0	58.8

** Average education was coded as a continuous variable ranging from 1 to 8 according to the following scheme: some grade school=1, finished grade school=2, finished junior high=3, finished high school=4, some college=5, finished college=6, some postgraduate=7 and finished postgraduate=8.

DESCRIPTIVE STATISTICS AND USE LEVELS

This chapter provides a summary of responses to survey questions dealing with characteristics of respondents, the trips they took and overall levels of use and expenditures on those trips. All major statistics are presented both for the Montana resident population and the nonresident angler population.

Characteristics of Recreationists

A large percentage of Montana residents participate in water- based recreational activities such as fishing, boating, or shoreline activities like picnicking, swimming, sightseeing or camping. Of the resident respondents to the Missouri River survey 83.5% said they participated in one or more of these activities. Since the nonresident subsample was limited to anglers 100% of this group by definition participated in water-based recreation. The high percentage of resident use indicates the importance of Montana streams and reservoirs to the recreational experiences of those living in the state.

Three questions were posed to survey respondents regarding their attitudes about water, its quality and uses. The questions asked respondents to indicate whether they strongly agreed, agreed, disagreed, strongly disagreed with or had no opinion about statements regarding water. The responses of those who either strongly agreed with or agreed with the statements are presented in Table 2.

A clear trend emerges from the reactions to these statements. Water, and the role it plays in recreation is very important to both Montanans and nonresidents as well. It is also interesting that the dominant consumptive water use in Montana (irrigation) is perceived as the most important use of that water by only 44% of residents and only 20.6% of nonresident anglers.

A number of demographic questions were asked of people receiving the surveys. The responses to these demographic questions were analyzed as covariates in the multivariate logistic regression models in order to better explain the economic behavior of respondents. These responses are also interesting in that they paint a composite picture of the respondents. Table 3 presents the statistics from these demographic variables.

Table 2
Percentages of Respondents Either Strongly Agreeing or Agreeing With Statements on Water Use

	Residents	Nonresidents
A. I enjoy knowing that my friends and family can visit rivers for recreation if they want to.	97.4%	99.2%
B. Water quality in rivers and streams in this area of Montana should be improved.	79.7%	65.8%
C. I think irrigation is the most important use of Montana's water.	44.0%	20.6%

Table 3
Demographic Variables for Residents and Nonresidents

	Residents	Nonresidents
% who belong to a conservation, fishing or boating organization.	15.4%	38.6%
% who live in rural areas	28.5%	25.5%
% of respondents who are female	41.0%	17.6%
% with at least a high school education	92.1%	95.0%
% with at least an undergraduate degree	60.9%	74.5%
Average number of days per year spent in water-related recreation	20.3	21.1
Average number of years spent in water-related recreation	28.7	23.7
Average age of respondents	46.6	44.3
Average yearly family income	$ 28,725	$ 49,120

Characteristics of Recreational Trips

In addition to questions about the individuals completing the surveys, several questions were asked about recent recreational trips which they had taken. The questionnaire focused on trips made in 1989, and specifically on one trip made during the year. Table 4 summarizes the responses to a series of questions on 1989 trips.

Table 4
Trip Characteristics for Residents and Nonresidents Who had Taken a Recent Trip

	Residents (Std.Dev.)	Nonresidents (Std. Dev.)
Average number of days of current trip	3.09 (11.1)	4.36 (7.69)
Trips so far this year to this area	6.68 (14.1)	2.02 (2.63)
Years visiting this area	16.29 (13.4)	6.70 (7.83)
% who were either knowledgeable or very knowledgeable of water level effects	52.2%	36.2%
% who either knew exactly or had a general idea of water level before trip.	72.8%	58.6%
% who preferred a <u>higher</u> level	31.9%	24.5%
% who preferred a <u>lower</u> level	2.1%	7.3%

Recreational Use Statistics

One of the major objectives of this study was the estimation of total recreational use on the streams and reservoirs of the Missouri River basin. Two components were used in order to arrive at these estimates; DNRC estimates of the percentage of recreationists who were anglers, and DFWP estimates of total angler use on individual streams and reservoirs. Since the two studies were performed in different years (DFWP 1985, DNRC 1989) sales of resident and nonresident fishing licenses for 1985 and 1989 were examined to determine if the 1985 DFWP fishing pressure estimates could still be considered valid for 1989. It was found that total resident and nonresident fishing license sales increased by

slightly conservative estimate of 1989 angler use. This conservative approach is consistent with the desired goal of determining a defensible lower bound for use and valuation estimates.

The DFWP pressure data classifies waters into major drainages. These major drainages may contain several large rivers or streams. Table 5 details which major rivers and streams are included in the DFWP drainage classifications. It should be noted that estimated angler use includes not only use on the rivers and streams listed but on all tributaries of those waters as well.

Table 5
Major Rivers and Creeks Included in DFWP Drainage Classifications

Subbasin	DFWP Drainage	Included Waters
Upper	Beaverhead	Mainstem Beaverhead R. Ruby River Red Rocks River
	Bighole	Bighole River Wise River
	Gallatin	Gallatin River
	Jefferson	Jefferson River Boulder River
	Madison	Madison River
Middle	Upper Missouri	Mainstem Missouri River from Three Forks to Marias River Dearborn River Smith River Belt Creek
Lower	Marias	Marias River Teton River
	Lower Missouri	Mainstem Missouri River from Marias River to Fort Peck Dam Judith River
	Musselshell	Musselshell River

clude estimates of the standard errors associated with the pressure estimates.

Table 6 shows total number of angler use days for rivers and streams in the Missouri River Basin. The estimates of angler use are presented for residents, nonresidents and for all anglers combined. Table 7 presents the same statistic, but this time for use on all reservoirs within the basin. The estimates are again presented for both residency classes. Table 8 presents a breakdown of angler reservoir use into individual major reservoirs.

Table 9 was aggregated from Tables 6 and 7. Table 9 presents the level of detail in which expenditure, trip valuation and flow valuation estimates will be presented. Statistics are presented for four types of use (resident rivers and streams, nonresident rivers and streams, resident reservoirs and nonresident reservoirs), and for three areas of use (Upper Missouri Subbasin, Middle Missouri Subbasin and Lower Missouri Subbasin). The Upper Missouri Subbasin includes all reservoirs and tributaries of the Missouri River upstream of Three Forks Montana. The Middle Subbasin includes waters and tributaries between Three Forks and the mouth of the Marias River. The Lower Subbasin includes waters between the Marias River and Fort Peck Dam.

In order to compute total recreational use on the streams and reservoirs of the Missouri River Basin the angler use statistics presented thus far needed to be expanded to include user groups besides anglers. The DNRC survey asked respondents several questions about one recent trip. Among those questions was one asking recreationists to indicate what the main activity was that they engaged in on this trip. Choices included fishing from shore, fishing from a boat, boating or floating and shoreline recreation (picnicking, sightseeing, camping or swimming). The first two categories (both fishing) were summed in order to determine the proportion of respondents who were engaged in fishing as a main activity. Tables 10, 11, 12 and 13 present these angler proportions for several levels of aggregation. Also presented in these tables are standard errors and sample sizes for the estimated proportions.

Table 10 is the parallel angler proportion table to angler use Table 9. Table 11 provides angler proportions compatible with Table 6's use statistics. Table 12 is the proportion counterpart to Table 8's angler use days. Table 13 is presented to provide information on how types of recreational use vary across subbasins, residency classes and water types. In some cases where samples are small the standard errors are large relative to the estimate, indi-

Angler Use Days 1985
River and Stream Subsample

Subbasin	Drainage	Residents (Std.Err)	Nonresidents (Std.Err)	Total (Std.Err)
Upper	Beaverhead	28,739 (3405)	21,859 (1823)	50,593 (3863)
	Big Hole	50,990 (6086)	16,638 (2522)	67,628 (6588)
	Gallatin	52,993 (6640)	31,936 (11552)	84,929 (13324)
	Jefferson	26,788 (3624)	3,261 (807)	30,049 (3714)
	Madison	39,506 (6149)	82,349 (13476)	121,855 (14813)
Middle	Upper Missouri*	179,756 (11942)	14,850 (1768)	194,606 (12072)
Lower	Marias	9,026 (1893)	561 (250)	9,587 (1909)
	Lower Missouri	33,339 (5185)	3,668 (788)	37,007 (5244)
	Musselshell	14,547 (3102)	1,684 (459)	16,231 (3136)
	Sun	10,191 (2210)	946 (406)	11,137 (2247)
	Total	**445,875** **(18201)**	**177,753** **(18154)**	**623,628** **(25,706)**

Source: Montana Dept. of Fish Wildlife and Parks 1985 Fishing pressure data.

*Includes mainstem Dearborn, (1246 total days), mainstem Smith, (11,824), Mainstem Belt Creek, (8645), the Missouri River from Three Forks to Marias River, (132,715), and Hound Creek, (1446).

Angler Use Days 1985
Reservoirs

Subbasin	Drainage	Residents (Std.Err)	Nonresidents (Std.Err)	Total (Std.Err)
Upper	Beaverhead	23,836	17,087	40,923
		(4158)	(1908)	(4575)
	Big Hole	0	0	0
	Gallatin	3,570	68	2,638
		(878)	(68)	(881)
	Jefferson	9,055	0	9,055
		(1843)		(1843)
	Madison	13,353	34,119	47,472
		(3372)	(9382)	(9969)
Middle	Upper Missouri	184,942	9,969	194,911
		(21305)	(1965)	(21396)
Lower	Marias	38,769	273	39,042
		(10612)	(136)	(10613)
	Lower Missouri	41,315	1530	42,845
		(5452)	(643)	(5490)
	Musselshell	22,769	685	22,959
		(3520)	(274)	(3531)
	Sun	30,337	733	31,070
		(13754)	(285)	(13758)
	Total	**366,451**	**64,464**	**430,915**
		(28821)	**(9804)**	**(30443)**

Source: Montana Dept. of Fish Wildlife and Parks 1985 Fishing pressure data.

Angler Use Days 1985
Selected Major Reservoirs

Subbasin	Drainage	Residents (Std.Err)	Nonresidents (Std.Err)	Total (Std.Err)
Upper				
	Beaverhead			
	Clark Canyon Res.	20,812	15,088	35,900
		(4022)	(1758)	(4389)
	Ruby River Res.	1,700	828	2,528
		(710)	(514)	(876)
	Madison			
	Ennis Lake	1,198	1,644	2,842
		(510)	(820)	(966)
	Hebgen Lake	12,155	32,475	44,630
		(3333)	(9346)	(9922)
Middle				
	Upper Missouri			
	Hauser Res.	22,637	543	23,186
		(4068)	(250)	(4076)
	Holter Res.	72,342	3356	75,699
		(18408)	(842)	(18427)
	Lake Helena	3,416	0	3,416
		(1394)		(1394)
	Canyon Ferry Res.	70,657	5378	76,035
		(9500)	(1738)	(9657)
Lower				
	Lower Missouri			
	Fort Peck Res.	36,155	1256	37,411
		(5161)	(582)	(5194)
	Marias			
	Lake Elwell	15,947	205	16,152
		(3510)	(118)	(3512)
	Sun			
	Gibson Res.	1,582	137	1,719
		(1422)	(137)	(1428)
	Musselshell			
	Deadmans Basin	11,404	548	11,952
		(2615)	(256)	(2628)
	Martinsdale Res.	10,528	137	10,665
		(2342)	(97)	(2344)

Source: Montana Dept. of Fish Wildlife and Parks 1985 Fishing Pressure data.

Total Angler Use Days 1985
By Subbasin

Subbasin	Rivers and Streams		Reservoirs		All	
	Res.	Nonres.	Res.	Nonres.	Res.	Nonres.
Upper	199,016	156,043	49,814	51,274	248,830	207,317
	(11986)	(18038)	(5729)	(9574)	(13,285)	(20,421)
Middle	179,756	14,850	184,942	9,969	364,698	24,819
	(11,942)	(1768)	(21305)	(1965)	(24,423)	(2643)
Lower	67,103	6,859	133,190	3,221	200,293	10,080
	(6706)	(1029)	(18545)	(767)	(19,720)	(1283)
TOTAL	**445,875**	**177,753**	**367,946**	**64,464**	**813,821**	**242,217**
	(18201)	**(18154)**	**(28821)**	**(9804)**	**(34,087)**	**(20,632)**

Source: Montana Dept. of Fish Wildlife and Parks 1985 Fishing pressure data.

Angler Proportion of Total Use 1989

Subbasin	Rivers and Streams		Reservoirs		All	
	Res.	Nonres.	Res.	Nonres.	Res.	Nonres.
Upper						
Proportion	.481	.876	.605	1.00	.488	.901
(S.E.)	.025	.031	.104	.00	.024	.025
[N]	397	110	22	28	419	138
Middle						
Proportion	.438	.923	.504	.872	.494	.885
(S.E.)	.053	.074	.023	.054	.021	.045
[N]	86	13	468	38	554	51
Lower						
Proportion	.281	.700	.476	.645	.384	.666
(S.E.)	.034	.205	.035	.169	.025	.131
[N]	176	5	199	8	375	13
All						
Proportion	.417	.859	.499	.896	.455	.859
(S.E.)	.017	.028	.019	.035	.014	.024
[N]	659	128	689	74	1348	202

Note: *Proportions may not be an even fraction of sample size, due to the problem of respondents marking multiple activities as their main activity.*

Angler Proportion of Total Use 1989
By Drainage
River and Stream Subsample

Subbasin/Drainage		Residents Result (Std.Err) [N]	Nonresidents Result (Std.Err) [N]	Total Result (Std.Err) [N]
Upper	Beaverhead	.622 (.110) [49]	.955 (.047) [19]	.731 (.082) [72]
	Big Hole	.495 (.057) [107]	.782 (.107) [23]	.546 (.053) [130]
	Gallatin	.537 (.051) [94]	.832 (.167) [21]	.552 (.049) [99]
	Jefferson	.314 (.109) [35]	1.00 (0.00) [2]	.351 (.109) [37]
	Madison	.412 (.047) [112]	.877 (.043) [57]	.569 (.032) [169]
Middle	Upper Missouri*	.411 (.048) [305]	.832 (.079) [38]	.457 (.045) [345]
Lower	Marias	.154 (.057) [64]	—	.154 (.057) [64]
	Lower Missouri	.385 (.039) [253]	.786 (.082) [25]	.421 (.037) [278]
	Musselshell	.475 (.096) [27]	1.00 (.000) [1]	.494 (.094) [28]
	Sun	.359 (.077) [39]	.500 (.354) [2]	.366 (.075) [41]

Note: Missing cells indicate no nonresident use was observed in the sample population

*Includes mainstem Dearborn, mainstem Smith, mainstem Belt Creek, the Missouri River from Three Forks to Marias

Angler Proportion 1989
Selected Major Reservoirs

Subbasin/Drainage	Residents Result (Std.Err) [N]	Nonresidents Result (Std.Err) [N]	Total Result (Std.Err) [N]
Upper			
Beaverhead			
Clark Canyon Res.	.721 (.129) [12]	1.00 (.000) [18]	.889 (.057) [30]
Madison			
Hebgen Lake	.466 (.158) [10]	1.00 (.000) [10]	.733 (.099) [20]
Middle			
Upper Missouri			
Hauser Res./Holter Res.	.599 (.035) [195]	.896 (.076) [16]	.621 (.033) [211]
Canyon Ferry Res.	.429 (.030) [268]	.855 (.075) [22]	.461 (.029) [290]
Lower			
Lower Missouri			
Fort Peck Res.	.431 (.045) [121]	.645 (.169) [8]	.444 (.044) [129]
Marias			
Lake Elwell	.523 (.226) [65]	—	.523 (.226) [65]
Musselshell			
Deadmans Basin	.583 (.201) [6]	—	.583 (.201) [6]

Note: Missing cells indicate no nonresident use was observed in the sample population.

By Activity and Subbasin

Subbasin	Rivers and Streams Res.	Rivers and Streams Nonres.	Reservoirs Res.	Reservoirs Nonres.
Upper Subbasin				
[N]	397	110	22	28
Anglers				
Proportion	.481	.876	.605	1.00
(S.E.)	.025	.031	.104	.00
Float/Boat				
Proportion	.147	.035	.106	.00
(S.E.)	.018	.017	.066	.00
Shoreline				
Proportion	.372	.089	.288	.00
(S.E.)	.024	.027	.097	.00
Middle Subbasin				
[N]	86	13	468	38
Anglers				
Proportion	.438	.923	.504	.872
(S.E.)	.053	.074	.023	.054
Float/Boat				
Proportion	.165	.077	.184	.024
(S.E.)	.400	.074	.018	.025
Shoreline				
Proportion	.397	.000	.311	.103
(S.E.)	.053	.000	.021	.051
Lower Subbasin				
[N]	176	5	199	8
Anglers				
Proportion	.281	.700	.476	.645
(S.E.)	.034	.205	.035	.169
Float/Boat				
Proportion	.132	.000	.154	.166
(S.E.)	.026	.000	.026	.132
Shoreline				
Proportion	.587	.300	.370	.188
(S.E.)	.037	.205	.034	.138

Proportion of Total Use 1989
Entire Basin

	Rivers and Streams Res.	Rivers and Streams Nonres.	Reservoirs Res.	Reservoirs Nonres.
Anglers				
Proportion	.417	.859	.499	.896
(S.E.)	.016	.028	.019	.035
Float/Boat				
Proportion	.166	.041	.173	.030
(S.E.)	.012	.016	.014	.020
Shoreline				
Proportion	.417	.099	.327	.073
(S.E.)	.016	.024	.018	.030

The estimates for total angler use days from DFWP and angler proportion of total use from this survey were combined to arrive at estimates of total recreational use days. This was done by simply dividing total angler use days by total angler proportion These total use estimates are presented in Tables 15, 16, and 17. Again, standard errors for the estimates are presented along with the estimated totals. The specific equations used in the calculation of all estimates and standard errors are presented in Appendix B.

Table 15 shows that a total of over 2 million recreational use days occurred on waters of the Missouri basin in 1989. Of this total approximately 86% was resident use and 14% nonresident. The use was divided with 61% occurring on rivers and streams and 39% on reservoirs. Table 16 presents the total use statistics for rivers and streams in a more disaggregated manner. Likewise, Table 17 shows total recreational use for specific reservoirs in the Missouri basin.

A final set of tables on recreational use in the Missouri River Basin makes explicit the standard errors presented along with the use estimates. Tables 18 and 19 show the 95% confidence intervals for the DFWP angler use days estimates shown in Tables 6 and 7. That is, these tables present the range of possible angler use for the DFWP estimates + or - 1.96 times their standard errors. Tables 20 and 21 present these confidence intervals for the total recreational use estimates of Table 14.

Estimated Total Recreational Use Days 1989
By Subbasin

Subbasin	Rivers and Streams Res. (S.E.)	Rivers and Streams Nonres. (S.E.)	Reservoirs Res. (S.E.)	Reservoirs Nonres. (S.E.)	Total Res. (S.E.)	Total Nonres. (S.E.)
Upper	413,755	178,131	82,337	51,274	509,898	230,097
	(32,915)	(21,535)	(16,794)	(9574)	(36,944)	(23,547)
Middle	410,402	16,089	366,948	11,432	738,255	28,044
	(56,653)	(2309)	(45,468)	(2362)	(58,559)	(3309)
Lower	238,801	9,799	279,811	4,994	521,596	15,135
	(37,475)	(3224)	(44,023)	(1768)	(61,520)	(3546)
Total	**1,069,732**	**206,846**	**737,366**	**71,940**	**1,788,617**	**277,987**
	(61,689)	**(22,184)**	**(64,170)**	**(11,297)**	**(92,898)**	**(25,278)**

Table 16
Estimated Total Recreational Use in Days 1989
By Drainage
River and Stream Subsample

Subbasin	Drainage	Residents (Std.Err)	Nonresidents (Std.Err)	Total (Std.Err)
Upper	Beaverhead	46,204	22,889	69,210
		(9835)	(2216)	(9391)
	Big Hole	103,010	21,276	123,860
		(17,084)	(4344)	(17,033)
	Gallatin	98,683	38,385	153,857
		(15,515)	(15,879)	(27,733)
	Jefferson	85,312	3261	85,609
		(31,784)	(807)	(28,613)
	Madison	95,888	93,899	214,156
		(18,504)	(16,040)	(28,684)
Middle	Upper Missouri*	437,362	17,849	425,834
		(58,764)	(2714)	(49,558)
Lower	Marias	58,610	—	62,253
		(24,934)		(26,164)
	Lower Missouri	86,595	4,667	87,903
		(16,072)	(1114)	(14,657)
	Musselshell	30,625	1,684	32,856
		(8998)	(459)	(8910)
	Sun	28,387	1,892	30,429
		(8658)	(1566)	(8751)

*Includes mainstem Dearborn, mainstem Smith, mainstem Belt Creek, the Missouri river from Three Forks to Marias River, and Hound Creek.

Estimated Total Recreational Use in Days 1989
Selected Major Reservoirs

Subbasin/Drainage	Residents (Std.Err)	Nonresidents (Std.Err)	Total (Std.Err)
Upper			
Beaverhead			
Clark Canyon Res.	28,865	15,088	40,382
	(7602)	(1758)	(5574)
Madison			
Hebgen Lake	26,084	32,475	60,887
	(11,374)	(9346)	(15,838)
Middle			
Upper Missouri			
Hauser Res./ Holter Res.	158,563	4,352	159,235
	(32,808)	(1047)	(31,545)
Canyon Ferry Res.	164,702	6,290	164,935
	(24,961)	(2106)	(23,377)
Lower			
Lower Missouri			
Fort Peck Res.	83,886	1,947	84,259
	(14,835)	(1037)	(14,373)
Marias			
Lake Elwell	30,491	—	30,491
	(14,835)		(14,835)
Musselshell			
Deadmans Basin	19,560	—	20,501
	(8099)		(8383)

Note: Missing cells were not calculated due to a lack of observed visitation in the sample population.

Angler Use Days
95% Confidence Intervals Derived from Table 6
River and Stream Subsample

Drainage	Residents Lower	Residents Upper	Nonresidents Lower	Nonresidents Upper
Upper				
Beaverhead	22,065 —	35,413	18,286 —	25,432
Big Hole	39,061 —	62,919	11,695 —	21,581
Gallatin	39,979 —	66,007	9,297 —	54,578
Jefferson	19,685 —	33,891	1,679 —	4,843
Madison	27,454 —	51,558	55,936 —	108,762
Middle				
Upper Missouri	156,350 —	203,162	11,385 —	18,315
Lower				
Marias	5,316 —	12,736	71 —	1,051
Lower Missouri	23,176 —	43,502	2,124 —	5,212
Musselshell	8,467 —	20,627	784 —	2,584
Sun	5,859 —	14,523	150 —	1,742
TOTALS				
Upper Basin	175,523 —	222,509	120,689 —	191,397
Middle Basin	156,350 —	203,162	11,385 —	18,315
Lower Basin	53,959 —	80,247	4,842 —	8,876

Source: DFWP 1985 fishing pressure survey.

Angler Use Days
95% Confidence Intervals Derived from Table 7
Reservoir Subsample

Drainage	Residents Lower	Residents Upper	Nonresidents Lower	Nonresidents Upper
Upper				
Beaverhead	15,686 —	31,986	13,347 —	20,827
Big Hole	-0-		-0-	
Gallatin	1,849 —	5,291	0 —	201
Jefferson	5,443 —	12,667	-0-	
Madison	6,744 —	19,962	15,730 —	52,508
Middle				
Upper Missouri	143,184 —	226,700	6,118 —	13,820
Lower				
Marias	17,969 —	59,569	6 —	540
Lower Missouri	30,629 —	52,001	270 —	2,370
Musselshell	15,870 —	29,668	148 —	1,222
Sun	3,379 —	57,295	174 —	1,292
TOTALS				
Upper Basin	37,585 —	60,043	32,509 —	70,039
Middle Basin	143,184 —	226,700	6,118 —	13,820
Lower Basin	96,347 —	169,043	1,718 —	4,724

Source: DFWP 1985 fishing pressure survey.

Total Recreational Use Days
95% Confidence Intervals Derived from Table 15
River and Stream Subsample

Subbasin	Residents Lower	Residents Upper	Nonresidents Lower	Nonresidents Upper
Upper	349,242 —	478,268	135,922 —	220,340
Middle	299,362 —	521,442	11,563 —	20,615
Lower	165,350 —	312,252	3,480 —	16,118
All	948,822 —	1,190,642	163,365 —	250,327

Table 21
Total Recreational Use Days
95% Confidence Interval Derived from Table 15
Reservoir Subsample

Subbasin	Residents Lower	Residents Upper	Nonresidents Lower	Nonresidents Upper
Upper	49,421 —	115,253	32,509 —	70,039
Middle	277,831 —	456,065	6,802 —	16,062
Lower	193,526 —	366,096	1,529 —	8,459
All	608,039 —	859,585	49,798 —	94,082

One measure of the economic significance of water based recreation in the Missouri Basin is the expenditures made by people engaged in that recreation. These expenditures have a distributive impact upon the areas and communities where they are made. Unlike net economic values, expenditures do not represent a societal gain, since they would be spent somewhere else if not in the Missouri Basin. Rather, they represent a transfer of expenditures from one area to another or from one type of purchase to another (in the case of nonresidents the transfer is from out of state, for residents living outside the Missouri Basin the transfer is from one area of the state to another). The average expenditure per recreational trip in the Missouri Basin is $113.49 for residents and $640.14 for nonresidents. There is some variation in average expenditures between streams and reservoirs. Residents spent $100.95 per trip for stream recreation and $125.06 for reservoir recreation. Nonresidents showed significant variation between expenditures on the two types of recreation. They spent $796.88 for stream recreation and $365.58 for reservoir recreation.

Tables 24, 25 and 26 present per trip and per day expenditure statistics. Table 24 shows per trip expenditures for the three subbasins and four classes of use. Table 25 details the average number of days per trip for the same aggregation levels shown in Table 24. Table 26 has been calculated from the previous two tables and shows average expenditures per day. For the entire sample average expenditures per day were $39.13 for residents and $158.43 for nonresidents. Again, there was some difference between expenditures on stream and reservoir recreation. Residents spent $38.09 per day for stream recreation and $39.93 for reservoir recreation. Nonresidents spent $194.36 per day on stream recreation and $92.68 on reservoirs.

It is instructive to look at the expenditure estimates of this study in comparison to other recent recreational surveys. While there is always some difficulty in comparing estimates across studies due to differing study years, populations and questions, comparison still remains a useful test of "ball park" validation.

Two recent studies, the 1985 National Survey of Fishing, Hunting and Wildlife-Associated Recreation (U.S.F.W.S.,1989) and the Net Economic Value of Fishing in Montana (Duffield, Loomis, and Brooks, 1987) provide comparable expenditure statistics to the current study. In order to be comparable, however, only angler expenses were selected out of the current study. The estimates of per day angler expenditures for all fishermen current study for a river and stream subsample for both residents and nonresidents. These results are presented in Tables 22 and 23.

When corrected for inflation, differences in the estimates remain. The current estimates are for the Missouri Basin only, while the other estimates are for all Montana waters. Differences in their estimates may also be due to differences in study years and angler population sampled.

Another source of the differences between these estimates may be memory bias. In the current study respondents were asked to answer questions about their trip most proximate to a certain date. It may be that people tend to remember longer trips which entail more planning and greater expense when faced with this type of situation. The use of a mail survey makes it impossible to tell if this type of bias is affecting the responses.

One final potential source of bias arises from the fact that each trip in the current study is given equal weight in determining average expenditures. While this equal weighting does give an accurate average of the expenditures made on these trips, it does not allow consideration of the fact that different people take varying numbers of trips per year. The possible effect of this potential weighting bias is not clear. Determination of the existence or extent of this bias would require more detailed questions on visitation patterns than were asked in the current study.

Table 22
Comparison of Expenditure Estimates Across Studies
Aggregated Sample; All Waters / All Anglers

Study	Year	Per Day Expenditure Current $	Const. 1989 $**
National Survey of Fishing (Montana subsample)	1985	$ 33.40*	$ 38.60
Duffield et al.	1985	$ 42.21	$ 48.79
Current Study	1989	$ 69.21	$ 69.21

* Computed from total trip related fishing expenditures of $81,618,000 (National Survey) and total fishing days of 2,443,438 (DFWP, McFarland, 1989)

** Based on Consumer Price Index of 373.1 August 1989 and 322.8 July 1985

Comparison of Per Day Angler Expenditure Estimates
River and Stream Subsample

Study	Year	Per Day Expenditures Residents	Nonresidents
Duffield et al.	1985	$ 22.31 ($ 25.79)	$ 116.37 ($ 134.50)
Current Study	1989	$ 36.15	$ 188.06

Constant 1989 dollars in parentheses.

Table 24
Per Trip Expenditures 1989
By Subbasin

Subbasin	Rivers and Streams Res. (SE)	Nonres. (SE)	Reservoirs Res. (SE)	Nonres. (SE)	All Res. (SE)	Nonres. (SE)
Upper	97.24 (8.07)	772.80 (66.46)	150.82 (36.99)	258.79 (14.74)	100.31 (7.91)	666.98 (57.59)
Middle	162.05 (40.85)	1011.31 (262.35)	104.75 (7.08)	445.33 (77.62)	113.49 (8.67)	595.48 (95.36)
Lower	78.52 (8.33)	763.00 (341.28)	169.97 (19.55)	380.50 (165.34)	128.40 (11.57)	527.61 (166.22)
All	100.95 (7.66)	796.88 (64.14)	125.06 (7.58)	365.58 (51.69)	113.49 (5.39)	640.14 (47.22)

Average Number of Days Per Trip 1989
By Subbasin

Subbasin	Rivers and Streams Res. (SE)	Rivers and Streams Nonres. (SE)	Reservoirs Res. (SE)	Reservoirs Nonres. (SE)	All Res. (SE)	All Nonres. (SE)
Upper	2.79 (.45)	4.05 (.28)	3.59 (.89)	3.96 (.79)	2.84 (.42)	4.02 (.27)
Middle	2.91 (.51)	4.53 (.31)	2.71 (.25)	3.75 (.81)	2.73 (.23)	3.96 (.60)
Lower	2.17 (.20)	4.00 (1.34)	4.07 (.64)	4.75 (1.69)	3.21 (.36)	4.46 (1.13)
All	2.65 (.28)	4.10 (.24)	3.13 (.25)	3.94 (.54)	2.90 (.19)	4.04 (.25)

Table 26
Average Expenditures Per Day 1989
By Subbasin

Subbasin	Rivers and Streams Res. (SE)	Rivers and Streams Nonres. (SE)	Reservoirs Res. (SE)	Reservoirs Nonres. (SE)	All Res. (SE)	All Nonres. (SE)
Upper	34.77 (5.71)	190.99 (16.60)	42.00 (10.18)	65.27 (7.88)	35.29 (4.95)	165.53 (15.02)
Middle	55.66 (16.63)	222.83 (55.84)	38.67 (3.97)	118.76 (26.27)	41.43 (4.17)	150.40 (28.65)
Lower	36.11 (4.69)	190.75 (78.07)	41.70 (6.32)	80.10 (26.09)	39.99 (4.45)	118.25 (33.38)
All	38.09 (4.31)	194.62 (15.73)	39.93 (3.70)	92.68 (12.29)	39.13 (2.66)	158.43 (13.49)

Note: Estimates in this table may not exactly equal Table 23 estimates divided by Table 24 estimates due to rounding.

subbasins and across residency classes and water types it is interesting to look at differences between levels of expenditure on different types of recreational activities. Tables 27 and 28 present expenditure estimates for these different activities. Table 27 examines average expenditure per trip by residence and by activity type. Residents spend the most per trip on fishing from boats ($143.16) and the least on fishing from shore ($103.93). Nonresident expenditures are highest for boating or floating ($814.24) and lowest for shoreline activities ($597.83).

Table 28 looks at expenditures per day for residents only. These estimates are broken down by activity type, subbasin, and water type.

Estimates of total water based expenditures in the Missouri River Basin can be estimated by multiplying total recreational use days from Table 15 by average expenditure per day from Table 26. Tables 29, 30 and 31 present these total recreational expenditures. In total approximately 113 million dollars per year is spent on Missouri Basin recreation. About 61% of this amount is spent by residents and 39% by nonresidents. Nearly 77% of the total is spent on recreation on rivers and streams. The remaining 23% is spent on reservoir recreation.

Three additional tables, 32,33 and 34 show 95% confidence intervals for the total expenditure estimates presented in Tables 29,30 and 31.

Table 27
Average Expenditure Per Trip 1989
By Activity Type

Activity	Residents (SE)	Nonresidents (SE)
Boating / Floating	120.26 (11.16)	814.24 (142.69)
Fishing From Boat	143.16 (10.09)	636.60 (70.42)
Fishing From Shore	103.93 (7.97)	613.33 (45.33)
Shoreline Activities	106.96 (4.99)	597.83 (67.54)

Resident Subsample

Subbasin/Activity	Rivers and Streams Mean	N	Reservoirs Mean	N
Upper				
Fish from Shore	25.13	172	38.55	11
Fish from Boat	43.06	57	44.84	7
Boating/Floating	42.36	72	82.50	3
Shoreline Act.	32.17	173	27.57	9
Middle				
Fish from Shore	75.49	39	33.64	109
Fish from Boat	85.34	8	38.68	190
Boating/Floating	44.45	16	55.02	117
Shoreline Act.	37.44	42	30.67	198
Lower				
Fish from Shore	41.76	54	57.26	48
Fish from Boat	27.44	11	33.63	77
Boating/Floating	41.55	29	41.28	44
Shoreline Act.	29.66	117	48.48	100

Table 29
Total Recreational Expenditures
River and Stream Subsample
By Subbasin

Subbasin	Rivers and Streams: Residents (SE)	Nonresidents (SE)
Upper	14,386,261 (2,422,650)	34,021,240 (5,163,781)
Middle	22,842,975 (7,659,837)	3,584,443 (923,345)
Lower	8,623,104 (1,773,885)	1,869,159 (575,952)
All	45,852,340 (8,227,333)	39,474,842 (5,277,208)

Reservoir Subsample
By Subbasin

Subbasin	Reservoirs: Residents (SE)	Nonresidents (SE)
Upper	3,458,154 (988,436)	3,346,654 (747,953)
Middle	14,189,879 (2,231,617)	1,357,664 (451,843)
Lower	11,668,119 (2,488,553)	400,019 (186,202)
All	29,316,152 (3,485,687)	5,104,337 (893,458)

Table 31
Total Recreational Expenditures
All Waters Combined
By Subbasin

Subbasin	Residents (SE)	Nonresidents (SE)
Upper	17,994,300 (3,003,293)	38,087,956 (5,175,318)
Middle	30,585,905 (3,855,689)	4,217,818 (917,271)
Lower	20,858,624 (3,309,635)	1,789,714 (595,088)
All	69,438,829 (5,902,524)	44,095,488 (5,289,559)

Total Recreational Expenditures
95% Confidence Intervals Derived from Table 29
River and Stream Subsample
By Subbasin

Subbasin	Rivers and Streams			
	Residents		Nonresidents	
	Lower	Upper	Lower	Upper
Upper	9,637,867 —	19,134,655	23,900,229 —	44,142,251
Middle	7,829,694 —	37,856,256	1,774,687 —	5,394,199
Lower	5,146,289 —	12,099,919	740,293 —	2,998,025
All	29,726,767 —	61,977,913	29,131,514 —	49,818,170

Table 33
Total Recreational Expenditures
95% Confidence Intervals Derived from Table 30
Reservoir Subsample
By Subbasin

Subbasin	Reservoirs			
	Residents		Nonresidents	
	Lower	Upper	Lower	Upper
Upper	1,520,819 —	5,395,489	1,880,666 —	4,812,642
Middle	9,815,910 —	18,563,848	472,052 —	2,243,276
Lower	6,790,555 —	16,545,683	35,063 —	764,975
All	22,484,205 —	36,148,099	3,353,159 —	6,855,515

Total Recreational Expenditures
95% Confidence Intervals Derived from Table 31
All Waters Combined
By Subbasin

Subbasin	Residents		Nonresidents	
	Lower	Upper	Lower	Upper
Upper	12,107,846 —	23,880,754	27,944,333 —	48,231,579
Middle	23,028,755 —	38,143,055	2,419,967 —	6,015,669
Lower	14,371,739 —	27,345,509	623,341 —	2,956,087
All	57,869,882 —	81,007,776	33,727,952 —	54,463,024

CURRENT TRIP VALUATION ANALYSIS

The total, or gross economic value of a recreational trip is made up of two components. The first, which was discussed in the preceding chapter, is the actual out-of-pocket expenditures made during the trip. The second component is the net economic value of the trip, or the extra amount a person would be willing to spend for the trip over and above what they actually must spend. This chapter describes the methodology and results of net economic valuation as it was applied to the Missouri River data.

Valuation of the Current Recreational Trip

Individuals who received the Missouri River survey were asked a number of questions about a recent trip they took to the streams or reservoirs of the basin. Questions on types of activities engaged in, preferences about water flows and expenditures made on the trip were asked. Additionally, a question designed to allow the calculation of the average net willingness to pay for the trip was asked. Before asking any of these questions however it was necessary to identify one specific trip on which to focus the questions. To achieve this the respondent was asked to identify the Missouri River Basin river or reservoir which they visited closest to a specific date. There were three possible dates asked: June 15th, July 15th or simply their most recent trip. All remaining questions in this section of the questionnaire referred to this trip.

The question designed to elicit net willingness to pay asked the recreationist to place a value on their recreational experience. This question asked:

> Suppose that your share of the expenses to visit this area increased; would you still have made the trip if your cost had been $<u>X</u> more?

The survey respondent could answer yes or no to this dichotomous choice CVM question. The dollar amount $ X was one of several predetermined bid levels ranging from $5 to $500 for residents and from $5 to $2000 for nonresidents. The bid amount was varied randomly across questionnaires. For a complete discussion of the determination of bid levels, ranges, and distribution across ranges see Appendix C,"Bid Distribution Analy-

Outlier and Protest Responses

In the analysis of CVM responses there are two groups of respondents who should be excluded from the sample before any analysis occurs. The first is that group whose willingness to pay is inconsistent with their income. The standard economic definition of demand requires both a willingness and an ability to pay. Therefore those respondents who indicate a willingness but lack the ability to pay the bid amount must be excluded as their responses do not meet the constraints of economic theory. Ability to pay was determined by first isolating those respondents answering yes to the CVM question and calculating the percentage of their income which respondents were willing to spend on Missouri Basin recreation. This was calculated as follows:

17) PERCENT = ((TOTAL + BID) * TRIPS) / INCOME

Where:

TOTAL = The amount they reported spending on their most recent trip.
BID = The dollar bid level asked.
TRIPS = The number of separate Missouri Basin trips they reported taking this year.
INCOME= Their reported annual Family income.

This percentage statistic was calculated for each individual who responded yes to the bid amount asked. As an initial screening measure all cases with PERCENT > 1.0 were dropped from the sample. These individuals most obviously lack the ability to pay the stated amount. The percentages for the remaining respondents were then tabulated giving the following results.

	Mean	Std.Dev.	Mean + 3 S.D.	Skewness	Kurtosis
PERCENT	.065	.128	.4429	4.134	19.78

Since the distribution of the calculated variable PERCENT was somewhat skewed rather than normally distributed a three standard deviation interval was placed around the calculated mean in order to determine the cutoff limit for outlier exclusion. In total 26 of the 2058 responses to this question were excluded from the following economic analysis due to a reported willingness from the analysis were those whose responses reflected a "protest" to some aspect of the simulated market. The U.S. Water Resources Council has suggested that a follow-up question be asked to each CVM question. In this survey that question was: "If no, would you have made the trip if your share of the trip expenses had been only $ 1 more?" If the respondent answered "No" to this question they were asked to explain why they wouldn't. Those respondents who indicated a valid reason for their zero willingness to pay were left in the sample. These valid reasons included:

- Respondents who could not afford a higher trip cost.
- Respondents who said they would have gone elsewhere if faced with increased trip costs.
- Respondents who indicated that the trip would just not be w orth any more money.

A second group of respondents was excluded from the sample because their responses indicated they were protesting the market setup rather than legitimately considering the question which was asked. These "protest" responses included:

- Respondents who said they already paid taxes to use public resources.
- Respondents who said they were opposed to fee recreation.
- Respondents who claimed that the costs could not possibly b e that high.

In total 389 of the 2038 respondents were excluded from the sample because their responses were deemed to be protest responses.

Current Trip Sample Aggregation

As has been mentioned previously, the Missouri River Survey was administered in a stratified manner consisting of 4 resident strata and 1 nonresident stratum. The standard statistical method for analyzing a stratified sample such as this is to examine each strata individually and calculate a weighted mean for the entire sample with the strata weights being the percentage of the total population which each strata represents. The ideal aggregation level for the analysis of the Missouri River Basin data would be the identification of values for the three subbasins for two water types (rivers and reservoirs), for each of the five strata. This level of analysis however would require the estimation of 30 separate models. In order to accurately interpret the of a certain minimum size. It was found that in the case of this study that minimum was approximately 100 observations. With a total sample size of only approximately 1400 observations an alternative to the 30 ideal models had to be found.

An examination of differences across the means of estimable in-state strata showed that current trip values were not significantly different from one another. It was therefore decided to estimate six resident models for the two water types and the three subbasins. Only two nonresident models were estimated due to the limited number of nonresident observations (212). Of the eight final models (6 resident and 2 nonresident) only one, residents visiting upper subbasin reservoirs, had an insufficient sample size for the logistic regression modeling. It is felt that this final aggregation scheme provides the most useful and detailed breakdown of the data possible given the constraints of the sample size.

Functional Form

The net economic value for recreation in the Missouri Basin was determined by analyzing the respondents' yes or no answers to the CVM question. These responses were analyzed using logistic regression.

Economic theory suggests that certain variables should influence the response of an individual to a CVM question. In this study, these variables include the bid amount asked, variables measuring the quality of the trip such as length of trip, and socioeconomic variables such as income and club affiliation. For some variables, the relationship with the response should be in a certain direction. For example, it is expected that as bid increases, the probability of a "yes" response will decrease and that as income increases, the probability of a "yes" response will increase.

The following multivariate logit model was used for the current trip CVM question (see equation 6), chapter II):

$$18)\ \log(P/(1-P)) = b_0 + b_1\log(BID) + b_2\log(INCOME) + b_3\log(TRIPL) + b_4CLUB$$

where:

P = Probability of a "yes" response
BID = Dollar amount of increased trip costs the respondent was asked to pay
INCOME = Annual household income
TRIPL = Length in days of the current trip
CLUB = Dummy variable indicating whether the respondent belongs to a sportsmen's organization: 1 = belongs, 0 = doesn't belong

model in equation 18) are shown in Table 36. In all cases, the coefficients for the independent variables had the expected sign and all variables added significantly to the model at the .05 level. These results indicate the responses are logical and consistent with economic theory.

Benefit Estimation

For benefit estimation, the bivariate logit model in equation 4) of Chapter II was used:

$$\log(P/(1-P)) = b_0 + b_1 \log(BID).$$

Summary statistics for this model are reported in Table 35. This model was used instead of the multivariate model of equation 18) because inclusion of covariates is useful only if the WTP distribution cannot be adequately modeled with the bivariate specification. As indicated in Table 35, the bivariate models fit the data quite well. This indicates that the WTP distribution can be well-approximated without covariates which substantially simplifies computation and interpretation of benefit estimates.

Two measures of benefit per trip were calculated from the bivariate logit models and are presented in Table 37. They are the median and the truncated mean (Chapter II). The truncation point used for the truncated mean was the maximum bid — $500 for residents and $2000 for nonresidents. The truncated mean was calculated by numerical evaluation of the integral in equation 9), since this integral cannot be evaluated analytically for the model of equation 4) with log(bid) as the independent variable. The truncated means for residents and nonresidents are not directly comparable because of the differing truncation points, but both represent conservative estimates of the true mean benefit per trip. The median is the point at which the estimated probability of responding "yes" equals .5; the median values for residents and nonresidents can be compared, but cannot be aggregated (Chapter II).

the multivariate models in Table 36 by substituting the sample mean values for INCOME and TRIPL into equation 18). These represent the estimated benefit for an average individual, which is not necessarily the same as the average benefit over all individuals. These were, in general, very close to the truncated means from the bivariate models lending credence to the hypothesis that exclusion of covariates was not biasing the truncated mean benefit estimates.

Standard errors for the medians and truncated means were estimated by bootstrapping (see chapter II) with 200 replications. Bootstrapping was used because there is no analytic formula for a standard error of the truncated mean. Although an approximate asymptotic formula exists for the standard error for the median, bootstrapping will probably give a more reliable estimate,particularly for small samples.

It can be seen from Table 37 that there is relatively little variation across basins for the resident net economic values for as measured by the truncated mean. There is slightly more variation as measured by the median, but the values are still relatively stable. There is not a large difference between rivers and reservoirs. For nonresidents there is a much larger difference between rivers and reservoirs. In addition, the median nonresident value per trip is much higher than for residents.

Calculation of Total Net Economic Values

Having the net economic value estimates for the seven models it is now possible to combine these with the total recreational use days from chapter III in order to arrive at total net economic value figures for the Missouri Basin waters. The truncated means were used in all these calculations. This means that the resulting estimates of total economic value can be viewed as conservative estimates of the true total or as estimates of the total after limiting the contribution of any individual. Table 38 shows the net economic value per day statistics for the 8 logit models and Table 39 presents the products of the total use and average value per day tables. Also shown are the standard errors associated with these estimates.

Estimated Bivariate Equations
Current Trip Regression

Model	Intercept (Std.Err.)	log(BID) (Std.Err.)	P**
RESIDENTS			
Upper Subbasin			
Rivers	3.455 (.529)	-.845 (.112)	.610
Reservoirs	2.907 (.367)	-.745 (.079)	.25
Middle Subbasin			
Rivers	3.704 (1.14)	-.835 (.243)	.727
Reservoirs	2.822 (.431)	-.747 (.094)	.549
Lower Subbasin			
Rivers	4.137 (.779)	-.988 (.171)	.89
Reservoirs	3.171 (.749)	-.754 (.158)	.006
NONRESIDENTS			
Rivers	6.841 (1.43)	-1.099 (.221)	.093
Reservoirs	4.338 (1.23)	-.836 (.213)	.49

** If P > .05 we accept the null hypothesis that the estimated model fits the hypothetical logistic model.

Estimated Multivariate Equations
Current Trip Estimation

Model	Const.	ln (BID)	ln (INCOME)	ln (TRIPL)	CLUB
RESIDENTS					
Upper Subbasin					
Rivers N=336	-3.418 (2.08)	-0.944 (.129)	.672 (.21)	.936 (.20)	—
Reservoirs	(insufficient sample size to estimate)				
Middle Subbasin					
Rivers N=77	3.884 (1.24)	-1.071 (.284)	—	1.176 (.449)	—
Reservoirs N=404	-1.659 (1.86)	-0.806 (.104)	.428 (.18)	.524 (.18)	—
Lower Subbasin					
Rivers N=155	3.739 (.802)	-1.016 (.179)	—	.878 (.32)	—
Reservoirs N=174	-2.399 (2.82)	-0.820 (.178)	.5289 (.278)	.758 (.258)	—
NONRESIDENTS					
Rivers N=143	-0.6202 (3.79)	-1.224 (.256)	.766 (.77)	—	—
Reservoirs N=69	4.758 (1.41)	-0.990 (.256)	—	—	1.647 (.738)

Note: Numbers in parentheses are standard errors of the estimates.

Calculated From Bivariate Logit Models in Table 31

Model	Truncated Mean* (Std. Error)	Median (Std. Error)
RESIDENTS		
Upper Subbasin		
Rivers	$ 146.55 (13.55)	$ 59.58 (9.72)
Reservoirs **	$ 143.23 (9.46)	$ 49.48 (6.83)
Middle Subbasin		
Rivers	$ 175.19 (27.45)	$ 84.58 (26.42)
Reservoirs	$ 134.62 (10.30)	$ 43.62 (7.49)
Lower Subbasin		
Rivers	$ 142.65 (18.88)	$ 65.92 (12.95)
Reservoirs	$ 163.78 (19.56)	$ 67.03 (16.66)
NONRESIDENTS		
Rivers	$ 792.52 (85.39)	$ 506.19 (103.98)
Reservoirs	$ 507.14 (111.59)	$ 178.89 (69.25)

* Truncation point is $500 for residents and $ 2000 for nonresidents.

** Upper subbasin reservoir estimates for residents are the pooled estimates for all resident reservoir use. This was done due to an insufficient sample size for more disaggregated estimation.

Current Trip Question

Model	Based on Truncated Mean*	Std. Err.
RESIDENTS		
Upper Subbasin		
Rivers	$ 52.53	$ 9.77
Reservoirs **	$ 39.90	$ 10.23
Middle Subbasin		
Rivers	$ 60.20	$ 14.15
Reservoirs	$ 49.68	$ 5.95
Lower Subbasin		
Rivers	$ 65.73	$ 10.60
Reservoirs	$ 40.24	$ 7.95
NONRESIDENTS		
Rivers	$ 193.30	$ 23.70
Reservoirs	$ 128.72	$ 33.37

* Truncation point is $500 for residents, $2000 for nonresidents.

** Upper subbasin reservoir estimates for residents are the pooled estimates for all resident reservoir use. This was done due to an insufficient sample size for more disaggregated estimation.

Total Net Economic Value
Current Trip Question

Model	Total Values Based on Truncated Mean	Std. Err.
RESIDENTS		
Upper Subbasin		
Rivers	$ 21,734,550	$ 4,408,382
Reservoirs **	$ 3,219,291	$ 1,077,587
Middle Subbasin		
Rivers	$ 24,706,200	$ 6,782,156
Reservoirs	$ 18,206,776	$ 3,151,261
Lower Subbasin		
Rivers	$ 15,698,777	$ 3,554,516
Reservoirs	$ 11,217,745	$ 2,858,727
Resident Total	**$ 94,780,952**	**$ 9,865,598**
NONRESIDENTS		
Rivers	$ 39,983,332	$ 6,534,283
Reservoirs	$ 9,260,117	$ 2,831,912
Nonresident Total	**$ 49,243,449**	**$ 7,121,557**

** Upper subbasin reservoir estimates for residents are the pooled estimates for all resident reservoir use. This was done due to an insufficient sample size for more disaggregated estimation.

Total Net Economic Value
95% Confidence Intervals Based on Table 39
Current Trip Question

Model	Total Values Based on Truncated Mean Lower		Upper
RESIDENTS			
Upper Subbasin			
Rivers	$ 13,094,121	—	$ 30,374,979
Reservoirs **	$ 1,107,221	—	$ 5,331,362
Middle Subbasin			
Rivers	$ 11,413,174	—	$ 37,999,226
Reservoirs	$ 12,030,304	—	$ 24,383,248
Lower Subbasin			
Rivers	$ 8,731,926	—	$ 22,665,628
Reservoirs	$ 5,614,640	—	$ 16,820,850
Resident Total	**$ 75,444,380**	—	**$ 114,117,522**
NONRESIDENTS			
Rivers	$ 27,176,137	—	$ 52,790,527
Reservoirs	$ 3,709,570	—	$ 14,810,665
Nonresident Total	**$ 35,285,197**	—	**$ 63,201,709**

** Upper subbasin reservoir estimates for residents are the pooled estimates for all resident reservoir use. This was done due to an insufficient sample size for more disaggregated estimation.

The estimated net economic values per day provided in Table 38 can be compared to previous estimates of the values associated with river recreation. Walsh, Johnson and McKean (1988) reviewed 120 studies of outdoor recreation demand completed between 1968 and 1988 for various U.S. sites. The mean value they report for coldwater fishing is $30.62 based on 39 estimates with a range of $10 to $118 dollars across studies (1987 dollars). The mean value for nonmotorized boating they report is $48.68 based on 11 estimates and with a range of $10 to $183 per day. A mean value of $20.14 is reported for camping, picnicking and swimming based on 36 estimates with a range of $7 to $47 per day.

The estimates in Table 38 are of course for a combination of river activities. The estimates for residents are close to the mean and well within the reported range for fishing and nonmotorized boating value estimates at other U.S. reported ranges. It is likely that the Missouri River Basin rivers and reservoirs are on average higher quality than the average U.S. water-based recreation site.

The estimates in Table 34 can also be compared to previous recreation value estimates in Montana. Previous studies have largely addressed the value of fishing. Duffield, Brooks and Loomis (1987) estimated the value per day of lake and reservoir fishing in Montana at $37 to $80 and stream fishing at $55 to $118 per day using a travel cost model (updated to 1989 dollars). Duffield and Allen (1988) used a dichotomous choice CVM model to estimate the value of fishing on 19 of the better trout streams in the state. The estimate was $125 (1989 dollars) per day. These estimates combine both resident and nonresident use. In general the estimates in the current study for all river and reservoir related recreation are similar to previous estimates for angler use only.

VALUATION OF INSTREAM FLOWS

A major goal of this study was the estimation of recreational values for instream flows within the Missouri River Basin. In order to do this it was necessary to examine the role which water levels play in recreational decision making, and the satisfaction people receive from that recreation.

Before asking about trips taken during the summer of 1989, survey respondents were asked a series of questions about trips which they took during the drought summer of 1988. Respondents were presented with a list of specific streams and reservoirs and asked about their 1988 trips to these waters. The questions and results are summarized below.

(1) As you may recall, 1988 was a year of severe drought in Montana. How did the low water levels in 1988 affect the number of trips you took to these areas last year? (Please check one)

	fewer trips	more trips	no change
Residents	51.8%	1.5%	46.7%
Nonresidents	34.3%	0.8%	64.8%

(2) How did low water levels on these rivers or their tributaries affect the overall quality of your trips in 1988?

	quality was raised	quality was unchanged	quality was lowered
Residents	1.1%	34.0%	64.8%
Nonresidents	1.8%	40.1%	57.6%

The responses to these two questions suggest that both the number of recreational trips and the quality of those trips suffer in times of severely low water flows. This chapter details the methodology used and the results obtained in determining the marginal value of instream flows in the Missouri River Basin.

In order to model the sensitivity of water based recreation to flow levels this study used an adaptation of a in detail in Chapter II, this model involved asking respondents who had indicated they recreated at a Missouri Basin river or reservoir a hypothetical question regarding how low the water would have to get before they would not visit the site. The presentation of this question was as follows:

What is the lowest water level at which you would visit this river or reservoir? (please check one)

___ at the ACTUAL LEVEL I experienced
___ at 90 PERCENT of what I experienced
___ at 75 PERCENT of what I experienced
___ at 50 PERCENT of what I experienced
___ at 25 PERCENT of what I experienced
___ at 10 PERCENT of what I experienced
___ I would visit the area NO MATTER WHAT the water level was.
___ Other ____________________

As is discussed in the following section, responses to this question were analyzed in order to determine the relationship of water flow levels to visitation rates.

The Flow / Visitation Model

Before fitting the responses to the flow / visitation question to a model some interpretation of the data was necessary. Three answers in the flow/visitation question capture the responses of those who for one reason or another felt that the 90%, 75%, 50%, 25% and 10% choices did not apply to them. These are the ACTUAL LEVEL, NO MATTER WHAT and OTHER responses. An examination of the frequencies for each of the responses for the entire sample showed that fully 40% of the respondents said they would have made the trip no matter what the water level. Given the other possible flow levels, an interpretation of the NO MATTER WHAT response should include zero water flows as a possible level. However, it was not clear what flow level was being considered with this response since a relatively equal proportion of anglers, boaters, and shoreline users chose this response, (it seems obvious they were not realistically considering zero flows as a possible level.) Probably the majority of these responses are individuals who were not able to answer a specific from the sample before further analysis was begun.

Just as there was difficulty in interpreting the NO MATTER WHAT flow level responses, it was also not entirely clear what was intended by those marking "at the ACTUAL LEVEL I experienced" in response to the question. Without making use of the "other" response there was no way for people who went on the trip and found the water unacceptably low to say that with this new information they would NOT EVEN make the trip again at the actualflow. Since the possibility existed that the number of responses to this top category was being artificially inflated, these responses were also dropped from the following analysis. These responses accounted for 12.8% of the sample.

Finally, 2.6% of the respondents marked other when answering this question. No attempt was made to code these responses to other percentage levels, and thus they were also dropped from the analysis.

A plot of visitation to hypothetical flow levels is shown in Figure 2. The sigmoid shape of this relationship with increasing rates initially and decreasing rates at higher flow levels suggested that two functional forms might provide a good fit to the data. A cubic function of the form shown in equation 19) and a logistic function shown in equation 20) were the possible choices.

19) $P = B_1 \text{FLOW} + B_2 \text{FLOW}^2 + B_3 \text{FLOW}^3$

20) $\text{Ln}\,[P/1\text{-}P] = B_1 + B_2 \text{FLOW}$

Where:
P = percentage of actual Visitation
FLOW = percentage of actual flows

Because of the limited number of data points in the model to be estimated, the logistic form of equation 20) was chosen to conserve degrees of freedom. As was mentioned in Chapter II, this logistic model was estimated using Ordinary Least Squares regression.

Estimated Equations

Several aggregation levels were chosen for the model estimation. Twelve models of resident use (11 successful) were constructed. These models broke resident use down by water type (river or reservoir), Missouri River Subbasin, and time of year. Regarding time of year, July and August use was modeled separately from the remaining years use for reasons outlined in Chapter II. Two generic models of nonresident use were estimated for all rivers in the basin. These models were for July

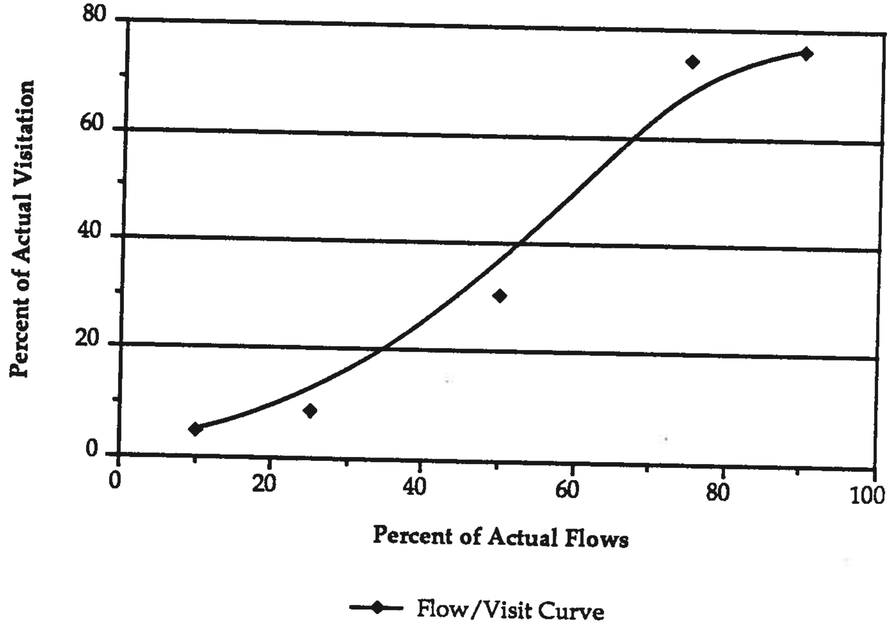
shows them to be both well fitting and very stable across models. The R square statistics which range upwards from .90 show the models to match the data closely, and the high T-statistics on the coefficients suggest good predictive powers for the models.

A plot of actual visitation response rates to predicted rates is shown in Figure 3. It can be seen that the predicted model for this upper subbasin river sample fits the actual responses quite well.

Table 41
Estimated Flow / Visitation Equations

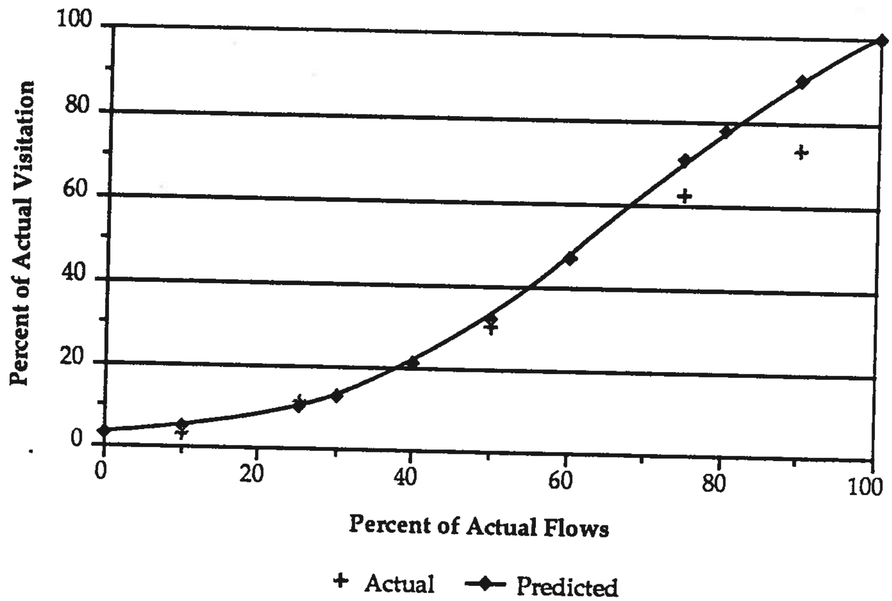
Model	Intercept (Std.Err)	Flow (Std.Err)	R^2
RESIDENTS			
Upper Subbasin Rivers			
July and August	-3.7493	.05567	.968
	(.2894)	(.0049)	
Rest of Year	-4.0741	.06546	.986
	(.2572)	(.0044)	
Upper Subbasin Reservoirs			
July and August	insufficient data to estimate		
Rest of Year	-4.4807	.05826	.986
	(.3542)	(.0048)	
Middle Subbasin Rivers			
July and August	-3.5887	.05957	.986
	(.2028)	(.0034)	
Rest of Year	-4.2184	.05736	.984
	(.2735)	(.0042)	
Middle Subbasin Reservoirs			
July and August	-3.9426	.05952	.992
	(.1493)	(.0025)	
Rest of Year	-4.9303	.06810	.973
	(.3254)	(.0055)	
Lower Subbasin Rivers			
July and August	-3.2104	.04919	.995
	(.0946)	(.0016)	
Rest of Year	-4.1412	.06368	.964
	(.3563)	(.0061)	
Lower Subbasin Reservoirs			
July and August	-3.4558	.05291	.974
	(.2475)	(.0043)	
Rest of Year	-4.0557	.05977	.990
	(.1749)	(.0030)	
NONRESIDENTS			
Rivers			
July and August	-4.2639	.05956	.994
	(.1679)	(.0026)	
Rest of Year	-5.0289	.07255	.978

Figure 2
Visitation vs. Instream Flows



Lower Subbasin Rivers

Figure 3
Predicted vs. Actual Resident Responses



Upper Subbasin Rivers

Having estimated the flow / visitation equations it was then possible to calculate the marginal values per acre foot of water for each of the estimated models. It was hypothesized that this marginal value would be quite low near zero and would increase to some maximum point and then decrease as flows approached 100%. These a priori expectations were born out by the results of the marginal value calculations. Figure 4 shows a plot of the per acre foot marginal values for upper subbasin resident use of rivers during July and August. It would be expected that the marginal value shown in Figure 4 would continue to decline as flows rise above 100% and would indeed become negative at some point of high flows. The fact that 1989 was a below average flow year and that the questionnaire was not designed to measure decreased participation at flows above 100% of actual flows precluded the observation of these negative marginal values.

The calculation of the marginal values of flows began with the estimated flow/visitation equations. As was shown in Chapter II, the logistic specification of equation 21) can be rewritten as equation 22). The derivative of this equation with respect to

21) $\log[P/(1-P)] = B_1 + B_2\,FLOW$

22) $P = 1/(1+\exp-(B_1 + B_2\,FLOW))$

this derivative has been calculated the marginal value of flows can be found through the straightforward application of equation 24)

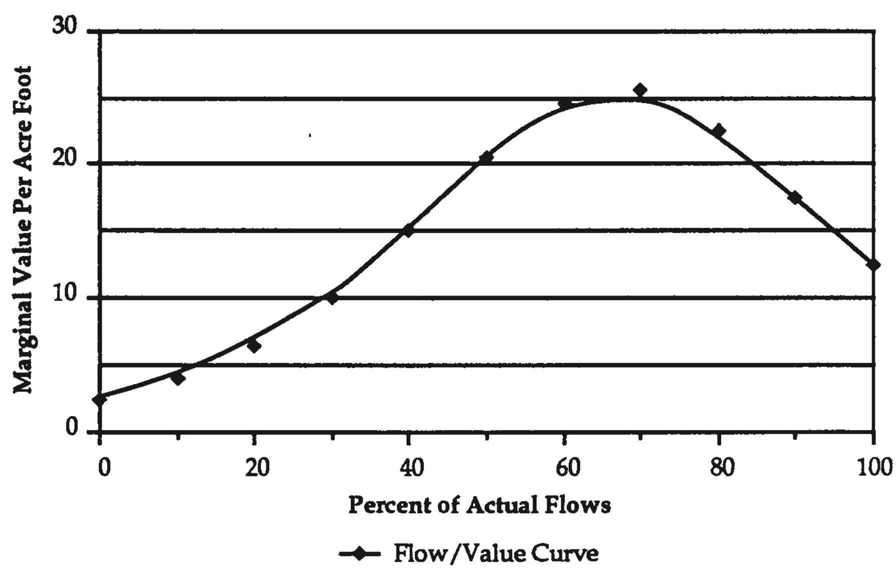
23) $$\frac{dP}{dF} = \frac{B_2 * \exp-(B_1 + B_2\,FLOW)}{(1+\exp-(B_1 + B_2\,FLOW))^2}$$

24) $$\text{Marginal Value} = \frac{\text{Total Value} * dP/dF}{\text{Total Discharge}/100}$$

In order to estimate the marginal values for July and August and for the rest of the year the numerator of equation 24 was multiplied by the percentage of total year angler use which occurred on a 19 river sample of Montana waters in 1985 (Neher, 1989) during the months being estimated.

The final element necessary for equation 24 was total discharge. Total discharge should correspond to instream flows at the point where the recreational use reflected in the total value term occurs. Since recreation use in this application is over fairly large subbasin areas, it is necessary to use average instream flows through these same areas. The calculation of total discharge was constrained by two factors: (1) measurement of flow could only be determined for locations which had a U.S. Geological Service gauging station and (2) The flow of water within rivers and streams is

Figure 4
Marginal Instream Flow Valuation



and ground water charges and discharges) thus a measurement of flow at the mouth of a river will not necessarily equal the sum of flows of all rivers and streams entering that river.

Where possible, water gauge readings from all major component streams within a subbasin were summed in order to arrive at total discharge. This is a conservative method which accounts for more flow than would be measured by a gauge at the bottom of the subbasin. A dramatic example of this comes from the Upper Missouri Subbasin. Records from the Toston gauge (several miles downstream from the lower boundary for the Upper Subbasin) show a combined July and August discharge of 230,700 acre feet. If, however, the discharge readings from upstream guages on the Missouri's major tributaries (Big Hole, Jefferson, Madison, Gallatin, Beaverhead, Boulder, Ruby, and Red Rock) are summed the resulting July-August discharge is 432,130 acre feet. It was this larger figure which was used in the following analysis, thus diluting the weight (and value) given to each acre foot.

The total discharge for reservoirs was a stock variable rather than a flow. Thus the month end contents of the reservoirs were used to calculate a per month marginal value.

Tables 42 through 45 show the marginal flow values calculated for the resident and nonresident models. The tables for river use report marginal values per acre foot for the entire time period being examined. The table for reservoirs, however, reports per month marginal values for the time period being examined.

Table 42
Marginal Values Per Acre Foot of Flow
Rivers and Streams
Resident Use

Model	July and August 50% (SE)	75% (SE)	100% (SE)	Rest of Year 50% (SE)	75% (SE)	100% (SE)
Upper Subbasin	20.44	24.46	12.31	7.71	7.61	2.59
	(4.14)	(4.96)	(2.49)	(1.56)	(1.54)	(.52)
Middle Subbasin	25.62	23.28	8.79	4.82	7.37	4.35
	(7.03)	(6.39)	(2.41)	(1.32)	(2.02)	(1.19)
Lower Subbasin	8.49	9.21	5.06	3.25	3.67	1.43
	(1.92)	(2.08)	(1.14)	(.74)	(.83)	(.32)

Marginal Values Per Acre Foot of Flow
Rivers and Streams
Nonresident Subsample

Model	July and August 50% (SE)	75% (SE)	100% (SE)	Rest of Year 50% (SE)	75% (SE)	100% (SE)
Upper Subbasin	29.84	43.52	23.09	10.17	15.37	5.64
	(4.87)	(7.11)	(3.77)	(1.66)	(2.51)	(.92)
Middle Subbasin	2.43	3.55	1.88	.76	1.14	.41
	(.40)	(.58)	(.30)	(.12)	(.19)	(.07)
Lower Subbasin	.97	1.42	.75	.35	.54	.20
	(.16)	(.23)	(.12)	(.06)	(.09)	(.03)

Table 44
Marginal Values Per Acre Foot of Flow
Rivers and Streams
Total For Resident and Nonresident Use

Model	July and August 50% (SE)	75% (SE)	100% (SE)	Rest of Year 50% (SE)	75% (SE)	100% (SE)
Upper Subbasin	50.28	67.98	35.40	17.88	22.98	8.23
	(6.39)	(8.67)	(4.52)	(2.28)	(2.94)	(1.05)
Middle Subbasin	28.05	26.83	19.46	5.58	8.50	4.76
	(7.04)	(6.41)	(2.43)	(1.33)	(2.03)	(1.19)
Lower Subbasin	9.46	10.63	5.81	3.60	4.21	1.63
	(1.92)	(2.09)	(1.15)	(.74)	(.83)	(.32)

Table 45
Per Month Marginal Values Per Acre Foot of Flow
Reservoirs*
Resident Subsample

Model	July and August 50% (SE)	75% (SE)	100% (SE)	Rest of Year 50% (SE)	75% (SE)	100% (SE)
Upper Subbasin	Unable to estimate			.65	1.14	.75
				(.69)	(1.21)	(.79)
Middle Subbasin	1.20	1.41	.62	.36	.62	.29
	(.29)	(.34)	(.15)	(.20)	(.34)	(.15)
Lower Subbasin	.05	.06	.03	.02	.02	.01
	(.02)	(.02)	(.01)	(.02)	(.02)	(.01)

* The subbasin level reservoir models have been estimated using one representative reservoir from each subbasin. Clark Canyon Reservoir was used for the Upper subbasin, Canyon Ferry for the Middle and F...

the total value figures for the subbasins. Since the calculation of a standard error on the derivative of the flow/visitation equations is very problematic this value was treated as a constant, as was the observed flow for the year. The resulting standard error calculation is discussed in Appendix B. These estimated standard errors should be considered rough estimates of the actual ones, and caution should be exercised in their use or interpretation. Complete tables of marginal values and estimated standard errors for all flows from 0% to 100% can be found in Appendix D.

An examination of the marginal values presented in Tables 42 through 45 shows several expected results. The values for the July and August subsamples are higher than for the rest of the year. This makes intuitive sense in that much of the use occurs in these two months and flows are generally low. It is also interesting to note that nonresident angler flow values are much higher for the Upper Missouri Subbasin than for the middle and lower subbasins. This is not entirely unexpected given the widespread reputation of rivers such as the Madison and the Bighole as well as many other productive trout waters in this subbasin.

Calculation of Average Flow Values

An alternative approach to estimating the value per acre foot of flows is to compute the average value per acre foot. The average value is simply total value divided by total discharge and does not require the use of the flow/visitation model. Of course this approach to valuing instream flows obscures any differences in value at different flow levels. Table 46 presents average acre foot values for the same aggregations of resident and nonresident use as in Tables 42 to 45. The values in Table 46 are generally lower than the reported marginal values at flow levels of 50 percent or 75 percent of current flows, but greater than the marginal value at current (100 percent) flows.

Limitations of the Flow Analysis

The marginal flow values derived here are estimates of value and as such are subject to the limitations of the analysis used in this study. These limitations can be discussed best in relation to the four component parts of the marginal value equation: the flow/visitation relationship, the net economic trip values, the observed shares of total use assigned to times of the year and the total discharge.

budget of this study dictated the use of a mail survey. The data, therefore, is based on contingent behavior rather than observed behavior. This contingent behavior is subject to difficulty in interpretation. Questions arise as to whether the respondents accurately describe their actual flow/visitation participation patterns, whether they understand the flow/visitation question as asked, and whether they understand how 10,25 or even 50% of current flows translates into the levels of water which they fish in, swim in, or boat on. One manifestation of the problems in using contingent behavior instead of observed behavior can be seen in the difficulty in interpreting the responses of people saying they would visit a site at any flow level or those responding they would only visit at the current flow level. Data based on observed behavior would show an actual observed flow level and an observed visitation level. No interpretation of responses would be necessary.

In defense of this aspect of the study, the marginal values derived here are consistent with values derived from studies based on observed behavior. This consistency, which is discussed more fully below, lends a degree of validation to the results of the current study.

The second component of the marginal value equation is the total net economic value of water based recreation for the subbasins. These estimates of total recreational value have been derived using established methodologies and are consistent with values estimated by other Montana recreational studies (see discussion in Chapter V).

The observed percentage of total use allocated to different times of the year has the potential to bias the distribution of value between the July-August period and the rest of the year. This percentage is based on only one data base (DFWP 1985 fishing pressure estimates). While this is a high quality data base it should be remembered that it is also highly aggregated and thus could mask local or regional differences in visitation patterns.

Finally, total discharge has an affect on the magnitude of the estimated marginal values. As was discussed previously, the extent of the areas for which values are calculated makes determination of the correct flow figure to use difficult. It would be easiest to have one point on a river where recreation takes place and to measure the flows at that point. The extension of this simple case to the current one where recreation on hundreds of miles of rivers and streams is considered make

This analysis was constrained by the available data on flows as collected by the U.S.Geological Service. While every effort was made to use flow data which would be representative of the areas where most water based recreation took place the limitations of the available flow data and uncertainty as to the exact distribution of recreation within a subbasin introduced possible sources of error into the calculations of total discharge.

Table 46
Average Values Per Acre Foot of Flow

Model	July and August	Rest of Year
RIVERS		
Residents		
Upper Subbasin	18.39	5.51
Middle Subbasin	18.85	5.14
Lower Subbasin	7.92	2.55
Nonresidents		
Upper Subbasin	29.55	8.85
Middle Subbasin	2.41	.66
Lower Subbasin	.97	.31
Total		
Upper Subbasin	47.94	14.36
Middle Subbasin	21.26	5.80
Lower Subbasin	8.89	2.86
RESERVOIRS		
Upper Subbasin	——	7.87
Middle Subbasin	1.01	.37
Lower Subbasin	.048	.016

Note: The subbasin level reservoir models have been estimated using one representative reservoir from each subbasin. Clark Canyon Reservoir was used for the Upper subbasin, Canyon Ferry for the Middle, and Fort Peck for the Lower subbasin.

Flow Valuation Studies

Previous research on instream flow valuation was described in Chapter II. In order to compare values across studies, it is useful to recognize that the total value of recreation at a given site as a function of flow is given by:

$$TV(F) = U(F)\,W(F)$$

or the total recreational value (TV) is equal to total use (U(F) given in days or trips) times the value of a given recreation day or trip (W(F)). The marginal value of a change in flow is then the total derivative of this expression, or:

$$dTV/dF = W\,dU/dF + U\,dW/dF = MV(F)$$

Letting $E_{u,f}$ equal the elasticity of total use with respect to flow and $E_{w,f}$ be the elasticity of unit value with respect to flow, the second expression can be rewritten as:

$$MV(F) = (U\,W/F)\,(E_{u,f} + E_{w,f})$$

This is an interesting result in that it shows that marginal value is simply the average value of flows (the first term in this third equation) times the dimensionless elasticity sum. Certainly the difficult aspect of instream flow valuation is identifying the relationship of flow and either use or value as summarized by the elasticity term. However, even if sites have identical use-flow or value-flow elasticities, there may be considerable differences across sites due to differences in either use, value per day (or trip) and flow levels. Because of this, one needs to be cautious in comparing values across site.

A case in point is comparing Narayanan's (1986) study of the Blacksmith Fork River in Utah with the current study. Although the same basic methodology was used, Narayanan's estimate of the marginal value of an acre foot of water varies from around 1 cent to about 85 cents. This is in 1982 dollars and would be about 2 cents to a $1.10 in 1989 dollars. This contrasts with estimates of from $3 to $48 dollars for streams in the Upper Missouri Basin. The differences are not due particularly to the complex elasticity term, but simply because of differences in the relative total value and total flows in these rivers.

Taking the specific example of the Big Hole to compare to the Blacksmith Fork, use on the Blacksmith Fork was estimated at 1716 trips for July-September in a normal year. This contrasts with 15,419 trips estimated to the lars (or $6.06 in 1989 dollars) compared to this study's estimate of $170.71 for trips to the Big Hole in our survey year (1989). These considerable differences lead to total benefit estimates of $10,399 for the summer on the Blacksmith Fork (1989 dollars) compared to our estimate of $2.63 million for the Big Hole. While the summer flows on the Big Hole in 1989 were over four times the flows in a normal water year on the Blacksmith Fork (463 cfs and 105 cfs respectively), this still leads to great differences in average flow values because of the great difference in estimated total recreation benefits. The average value of an acre-foot on the Blacksmith Fork is 54 cents (1989 dollars) compared to $46.35 on the Big Hole. An examination of the travel cost model data base for the Blacksmith Fork seems to indicate that it primarily attracts visitors from the near vicinity (and not many of those). This contrasts with the Big Hole which is a major destination fishery for anglers from all over the United States.

The point of this simple example is that as one would expect, the marginal value of flows is closely tied to the overall value of a given recreational resource. One should therefore be cautious in attempting to compare (or extrapolate) instream flow values from one site to another without at least correcting for differences in total use, value per trip (or day) and relative average flows. The range in values across sites in the reported literature is, as one would expect, fairly large. One of the first studies, by Daubert and Young (1981) estimated marginal values for the Cache La Poudre river near Fort Collins. The values ranged from $12 per acre foot (1978 dollars) at 100 cfs to near zero at 500 cfs for May to October and from $20 per acre foot at 100 cfs to zero around 500 cfs for July and August. Correcting these values for inflation, their July-August estimate is $38.14 in 1989 dollars at 100 cfs.

A study of the value of flows in the Grand Canyon (Bishop et al 1989) does not report an acre foot value. However, an average value can be derived from the reported data for the 1984 water year of about 56 cents per acre foot. An approximate marginal value for an increase of flows from 5000 to 13000 cfs may be on the order of 70 cents. Although the Grand Canyon trip values were comparatively high (ranging from about $100 to $900 per trip for different flow levels), and total benefits were large ($11.6 million), so is the total annual flow in the Colorado (on the order of 20.8 million acre feet in 1984). Marginal values are also low because they only reflect changing trip values (since total use is constrained by a permit/quota system that is not sensitive to flow levels).

A more appropriate comparison is to examine the results of different instream flow valuation methods applied to estimates for the Big Hole river. This comparison is somewhat complex in that these studies use very different methods and sampled different time periods, activities and river sections.

A flow-value relationship specific to the Big Hole was estimated in the current study. A Big Hole specific average trip value was also estimated (pooling resident and nonresident responses) for a mean truncated at $500 of $170.71. Based on previously described use estimates, this yields marginal values at 1989 average flow levels of $18 and $3 for July-August and Sept-June respectively. When flows are at 25 percent below 1989 levels, these marginal values increase to $43 and $9 respectively.

Neher (1989) used a pooled time series-cross sectional sample of angler use on 19 Montana rivers for 1982, 1983 and 1985 to construct a zonal travel cost model that included annual average flow as an independent variable. Flow was found to be a significant explanatory variable in several specifications. Because he used a double-log model, the elasticity of use with respect to flow is constant and can be easily derived. For the entire 19 river sample the elasticity is +.352 and a sample average value per acre foot is $1.03. Because the model is estimated on annual data, this estimate of $1.03 is likely to be lower than a summer (July-August) estimate and higher than a "rest of the year" estimate, other things equal. The average value per acre foot for all 19 rivers was $2.83. The marginal value of $1.03 is probably appropriate only for small changes from normal flows (which may not have significant impacts on use and benefits). This is because the sample of 19 rivers included a number of dam-controlled rivers that did not show considerable variation over the sample years.

Neher estimated a separate model for his subsample of 8 free flowing rivers including the Big Hole. The elasticity for this model is +.826. Using this parameter with Neher's estimated angler recreation benefits on the Big Hole in 1985 ($11.4 million) and 1985 flows (795 cfs average) yields an estimated marginal value of $16.35. The related average value per acre foot is $19.80. These estimates are conservative in that they exclude non-angler recreation use. If these estimates are inflated by the .546 angler share found in the current study, an estimated marginal value per acre foot for the Big Hole is $30. This estimate falls in the range of values estimated in the current study.

A very different approach to modeling the value of instream flows was taken by Duffield, Butkay and Allen (1990). These authors used an on-site survey in the summer of 1988 to estimate the relationship of observed use

Their study is indexed on average flows at the permanent Melrose gauge and a temporary gauge at Wise River. At 200 cfs for the gauge averages, they estimate a marginal value of $12 per acre foot and at 400 cfs, $9. These estimates are only for their study section of Wise River to Glenn, which accounts for only about 43 percent of total Big Hole use. Inflating estimate yields values of $21 to $28. These estimates are also within the range of those provided by the current study.

To conclude, there is remarkable similarity in estimates of instream flow values for the Big Hole from these different studies. This provides a measure of validation for the current study estimates.

INSTREAM FLOW TRUST FUND VALUATION

The benefits of instream flows extend beyond the provision of habitat for fish, wildlife and increasing numbers of recreation visitors. Keeping adequate amounts of water in rivers and streams also has intrinsic or indirect values to many people. For example, individuals may value simply knowing that there is a large and dramatic river flowing through the Grand Canyon, even if they hadn't seen it themselves. They also may benefit from knowing that they can see the river in the future, or from preserving this opportunity for future generations.

Trust Fund Format

In order to determine the magnitude of the intrinsic values which people place on the preservation of instream flows in the Missouri River Basin a second CVM question was asked of respondents regarding their willingness to support efforts to protect these flows. The actual dichotomous choice CVM trust fund question was preceded by two questions on the respondents familiarity with existing trust fund efforts. Two paragraphs briefly detailing the problem of dewatering in the Missouri Basin and how a trust fund could mitigate the damages directly preceded the CVM question as follows:

> As you may be aware, sections of some Missouri Basin rivers such as the Big Hole, Gallatin, Smith, Sun, Judith and Musselshell typically have had low summertime flows. Low flows can occur in other basin streams, especially in drought years. Often existing flows in streams are not legally protected and could be reduced by new diversions of water.
>
> To help protect existing flows, a private trust fund could be established to purchase or lease water to maintain fish, birds, wildlife and plants, and recreational uses. This would benefit people who use these rivers for recreation as well as those who believe having water in rivers is important. The effectiveness of the trust fund would increase with the amount of money contributed to it.
>
> If you were contacted within the next month, would you pledge to make an annual contribution of $_X to help buy the water to maintain summertime flows on Missouri Basin streams?

As with the current trip CVM question the respondents were asked to answer yes or no to this question. The values placed in the trust fund questions ranged from $5 to $200 for Montana residents and from $5 to $500 for nonresident anglers. A complete discussion of the determination of these bid ranges and their distributions can be found in Appendix C; "Bid Distribution Analysis: DNRC Missouri River Basin Recreational Survey" (Duffield, Patterson and Butkay, 1989).

The answers to the trust fund question were screened in order to eliminate protest responses using the same criteria used for the current trip question.

Functional Form

Since the same question was asked of all respondents, sample sizes were sufficient to allow analysis of the responses in a stratified manner. Therefore, there were five models estimated, one for each of the five sample strata: lower subbasin residents, middle subbasin residents, upper subbasin residents, out-of-basin residents and nonresident anglers. The following multivariate logit model was used.

25) $$\log[P/1\text{-}P] = b_0 + b_1 \log(BID) + b_2 \log(INCOME) + b_3 (CLUB) + b_4 (PARTIC) + b_5 (MEMBER)$$

Where:

P = Probability of a yes response
BID = Trust fund contribution amount asked.
INCOME = Annual household income
CLUB = Dummy variable for membership in a sportsman's organization: 1=belongs to one, 0=doesn't belong.
PARTIC = Dummy variable for participation in water-based r ecreation: 1=participates, 0=doesn't participate.
MEMBER = Dummy variable indicating whether respondent has ever donated to a trust fund before: 1=yes, 0=no

The five estimated trust fund equations are shown in Table 47. The independent variables in these equations are all significant at the .05 level except for one which is significant at the .10 level. As was done with the current trip models, bivariate forms of the trust fund models were estimated. Since these bivariate models provided good fits to the data they were used in the calculation of the truncated means and medians. The estimated bivariate trust fund equations are shown in Table 48.

Table 47
Estimated Logistic Regression Models
Trust Fund Question

Model	Constant	Bid	Income	Club	Memb	Partic
Lower Sub.						
Residents	-3.527	-1.222	0.566	0.912	—	—
N=670	(1.849)	(.131)	(.183)	(.311)		
Middle Sub.						
Residents	-8.608	-1.340	1.030	—	1.060	0.958
N=649	(2.033)	(.135)	(.198)		(.272)	(.473)
Upper Sub.						
Residents	-5.337	-1.006	0.670	1.162	0.968	—
N=615	(1.917)	(.121)	(.192)	(.303)	(.283)	
Out-Of-Basin						
Residents	-6.449	-1.130	0.751	0.684	1.044	—
N=608	(2.432)	(.153)	(.239)	(.409)	(.382)	
Nonresident						
Anglers	-7.964	-0.855	0.888	—	—	—
N=431	(2.981)	(.116)	(.281)			

Note: Number in parentheses are standard errors of the parameter estimates.

Trust Fund Question

Model	Constant (Std.Err)	log(BID) (Std.Err)	P
Lower Subbasin Residents	2.091 (.356)	-1.176 (.118)	.436
Middle Subbasin Residents	2.519 (.358)	-1.181 (.112)	.321
Upper Subbasin Residents	1.571 (.338)	-.847 (.099)	.986
Out-Of-Basin Residents	1.342 (.386)	-1.008 (.125)	.327
Nonresident Anglers	1.358 (.412)	-.836 (.111)	.428

** If P > .05 we accept the null hypothesis that the estimated model fits the hypothetical logistic model.

Trust Fund Benefit Estimates

As with the analysis of the current trip responses, two measures of net willingness to pay for an instream flow trust fund were calculated. These measures were the median and the truncated mean willingness to pay. These welfare measures for the five strata as well as the entire aggregated sample are presented in Table 49. Once again the upper limit of integration for the truncated mean was the maximum bid level: $200 for residents and $500 for nonresidents. The truncated mean annual net economic value of the trust fund ranges from $14.92 among out-of-basin Montana residents to $33.07 for nonresident anglers.

Table 50 presents the calculation of the total value based on truncated means of a Missouri River Basin trust fund for both residents and nonresident anglers. The estimate for the annual value of the trust fund for residents is $ 9,995,598. The nonresident angler estimated value is $ 3,555,422 per year for a total value of $ 13,551,020. The latter estimate may be conservative in that other nonresidents who recreate on or care about Montana rivers were not sampled.

for the trust fund benefit estimates. These standard errors for both the individual model estimates and the aggregate value figures are presented in Table 51. The aggregate trust fund estimate is relatively precise with a 90 percent confidence interval that is only plus or minus 10 percent of the estimate.

It should be noted that the aggregate estimate of 13.5 million per year is based on the assumption that respondents and nonrespondents are identical with respect to river valuation. An alternative assumption is that nonrespondents have zero indirect values. In this case, the trust fund values are the respective response rates (50.5% for nonresidents, etc.) times the values presented in Table 50. It was not possible to address this issue in the nonresponse survey.

Table 49
Truncated Mean and Median Values
Trust Fund Question

Model	Mean Logit	Median
Lower Sub. Residents	$ 16.86	$ 5.92
Middle Sub. Residents	$ 22.26	$ 8.44
Upper Sub. Residents	$ 27.44	$ 6.38
Out-Of-Basin Residents	$ 14.92	$ 3.79
Nonresident Anglers	$ 33.07	$ 5.08

Table 50
Total Value of Missouri River Basin Trust Fund

Strata	Value	Population**	Total
Lower Sub.	$ 16.86	71,953	$ 1,213,128
Middle Sub.	$ 22.26	96,110	$ 2,139,409
Upper Sub.	$ 27.44	69,730	$ 1,913,391
Out-of-Basin	$ 14.92	317,002	$ 4,729,670
Resident annual total			$ 9,995,598
Nonresident Anglers	$ 33.07	107,512	$ 3,555,422
Total annual value of trust fund			$ 13,551,020

** Resident population is 1980 census, resident over 18 years of age. Nonresident population is number of non-

Confidence Intervals on Trust Fund Valuation Figures

Model	Trunc.Mean (Std.Error)	Median (Std.Error)
Lower Sub. Residents	$ 16.86 (1.56)	$ 5.92 (.821)
Middle Sub. Residents	$ 22.26 (1.93)	$ 8.44 (1.07)
Upper Sub. Residents	$ 27.44 (2.41)	$ 6.38 (1.28)
Out-Of-Basin Residents	$ 14.92 (1.76)	$ 3.79 (.913)
Nonresident Anglers	$ 33.07 (5.31)	$ 5.08 (1.44)

Strata	Total	Std. Error
Lower Sub.	$ 1,213,128	$ 112,247
Middle Sub.	$ 2,139,409	$ 185,492
Upper Sub.	$ 1,913,391	$ 168,049
Out-of-Basin	$ 4,729,670	$ 557,924
Resident total	$ 9,995,598	$ 621,712
Nonresident Anglers	$ 3,555,422	$ 570,889
TOTAL VALUE	$ 13,551,020	$ 844,062

Comparison to Previous Estimates of Preservation Values

There have been three previous studies of the preservation values of rivers, as listed in Table 52. Walsh, Sanders and Loomis (1985) conducted a mail survey of Colorado residents to value protection of potential Wild and Scenic Rivers. Respondents were asked to value groups of from three to 17 rivers. Based on 214 responses to an open-ended CVM question, the average household was willing to pay $95 per year to a trust fund to protect 11 of the specific rivers. In 1989 dollars this is equivalent to $118 per household. For purposes of this discussion, all values from all studies have been updated to 1989 dollars as in Table 53. The total trust fund value was $140.2

Montana residents in 1981 to place a value on protecting water quality in the Flathead River and Lake system. Based on 171 responses to an open-ended CVM question, the average household had a value of $87.14 (Table 53). The trust fund total for Montana residents was estimated to be $17.9 million. Based on the relationship of distance to willingness to pay, a regional trust fund total (including adjacent states and provinces) was estimated at $111.1 million. These aggregated estimates exclude the direct recreational use component (which was about 12 percent) of the household valuation response.

The Colorado and Flathead River studies are not directly comparable to the current study in that they are for different river basins and for different levels of protection: "water quality" and protection from "development" through Wild and Scenic River designation. Either of the latter may be more significant improvements to the resource than a given increment to instream flow. Additionally, the responses are on a household basis. On a per person basis, the values would still be $40 to $60 per respondent, which is considerably higher than the average value per Montana resident for the current study of about $16. These differences may be due to differences in the resource being valued or (for the Walsh study) differences between Colorado and Montana residents. One can conclude that other researchers have found trust fund values for protection of river systems that are considerably higher than those found in the current study.

A more recent study by Duffield, Butkay and Allen (1990) provides a somewhat closer comparison to the current study in that instream flow values for Montana rivers were examined. These researchers undertook a household mail survey of valuation of improved instream flows for (varying across respondents) one to five Montana rivers including the Big Hole, Gallatin, Smith, Bitterroot and Upper Clark Fork. The average value for improvements on the group of all five rivers was estimated through dichotomous choice CVM at $12.14 based on a sample of 582 respondents. Improvement on only one river was valued at $5.04 per respondent. The relationship between willingness to pay and the number of rivers was positive and showed diminishing returns (consistent with economic theory). This finding was consistent with the results of Walsh, Sanders and Loomis (1985).

Montana resident average of $16.19 for the current study. However, the current study was for instream flow improvement in any or all Missouri River Basin rivers - 22 specific rivers or river segments were for example listed in the use estimation section of the survey. When the results of the five river survey are extrapolated to a total of around 20 rivers, the estimated willingness to pay is around $16. In any case, one would not expect the results to correspond exactly in that the five river estimate includes several out-of-basin rivers. This simple comparison indicates that the current study's trust fund response appears to be fairly consistent with the results of Duffield, Butkay and Allen (1990).

It is interesting to note that only the Sutherland and Walsh (1985) study of the Flathead attempts to estimate a regional trust fund value. Their basic finding is that the Montana resident share is only about 15 percent of the total valuation for protecting the Flathead. Their estimate is based on extrapolating values to residents of adjacent states and provinces based on a relationship of willingness to pay and distance. For the average weighted distance of Montana residents from the Flathead area (184 miles) Sutherland and Walsh show an elasticity of willingness to pay with respect to distance of -.43 (a ten percent increase in distance leads to a 4.3 percent drop in average willingness to pay). The relationship of distance and willingness to pay was also derived in the Duffield et al. study at -.35. (The functional form of the willingness to pay models in the two studies differed; the latter is an elasticity that holds at all distances in the model.) This indicates some consistency across the models. It is not possible to derive the distance-willingness to pay relationship in the current study because the site extends across the entire state.

To conclude, it appears that there is some consistency across the various studies conducted to date on the preservation value of rivers. Results of other studies indicate that the current study's estimated value of instream flow improvements on Missouri River Basin streams may be very conservative because of excluding most of the value associated with residents of other states in the region. This study only includes the values held by nonresident anglers.

Study	Object of Preservation
Walsh, Sanders and Loomis (1985)	protect from development 11 Colorado Wild and Scenic River candidates
Sutherland and Walsh (1985)	protect water quality Flathead River and Lake
Duffield, Butkay and Allen (1990)	improve instream flows 5 Montana rivers
Current study (1990)	maintain instream flows Upper Missouri River Basin

Estimated Preservation Values for Rivers

Study/site	Dollars per respondent		Trust fund total (million dollars)	
	person	household	state	region
Walsh/Colorado	—	118.26	140.2	—
Sutherland/MT	—	87.14	17.9	111.1
Duffield/MT	—	12.14	7.5	—
DNRC/MT*	—	16.19	10.0	—

Notes: All estimates are in 1989 dollars (based on the consumer price index). See Table 51 for complete references and description of resource being protected. All estimates include direct use as well as existence motives except the Sutherland and Walsh (1985) trust fund total which excludes direct use values.

CONCLUSIONS

The basic conclusion of this report is that there are significant recreation and preservation values associated with Missouri River Basin waters. The reader is referred to the executive summary for a narrative overview. Specific major findings are as follows:

- 9000 questionnaires were mailed to Montana residents and nonresident anglers with an overall response rate of 54 percent
- recreational use of Missouri River Basin waters in Montana totaled over 2 million recreation days in 1989
- 86 percent of total use was by residents and 14 percent by nonresidents
- 61 percent of use was on rivers and streams and 39 percent on reservoirs
- average expenditures per trip for residents were $113 and for nonresidents $640
- average expenditures per day for residents were $39 and for nonresidents $158
- total trip-related expenditures in the basin in 1989 were $70 million for residents and $45 million for nonresidents
- nonresident expenditures were concentrated (85 percent) in the Upper Missouri Basin (above Three Forks)
- nonresident expenditure was primarily on river related recreation (87 percent) as compared to reservoir use
- from the standpoint of state economic impact, far and away the most important recreational resource in the basin are the streams in the Upper Basin
- the net economic value per day of recreational activity varied from $40 to $66 across subbasins for residents
- resident net economic values are consistent with previous research and actual prices for Montana's fee fisheries
- nonresident net economic values were estimated at
- nonresident values reflect the higher income of these users and the relative quality of Montana fisheries
- the total net economic value of water-based recreational use in the basin is $144 million annually or a present value of $3.6 billion
- survey respondents indicated that 1988 drought-related low flows in the basin substantially reduced the number and quality of their recreational trips
- estimated instream flow values in dollars per acre foot for a change in flows varied considerably across site and time of year
- estimated July-August values varied from $68 in the Upper Basin to $11 in the Lower Basin per acre foot for a change from 75 percent of 1989 flows
- instream flow values for September-June were around $23 in the Upper Basin and $4 in the Lower Basin
- estimated instream flow values for recreation were similar to previous estimates for sites in the basin
- values of changes in reservoir contents were on the order of $1.40 to $.02 per acre foot-month across site and time of year
- respondents placed significant values on maintenance of summertime flows in the basin as evidenced by responses to hypothetical trust fund donations
- the mean trust fund donation ranged from $14 for out of basin Montana residents to $33 for nonresident anglers
- the mean trust fund donation for in-basin Montana residents ranged from $17 to $27
- total trust fund value was estimated at $13.6 million annually, which is in the same range as a previous estimate for preservation of water quality in the Flathead basin
- the trust fund value is quite conservative because of exclusion of all potential nonresident

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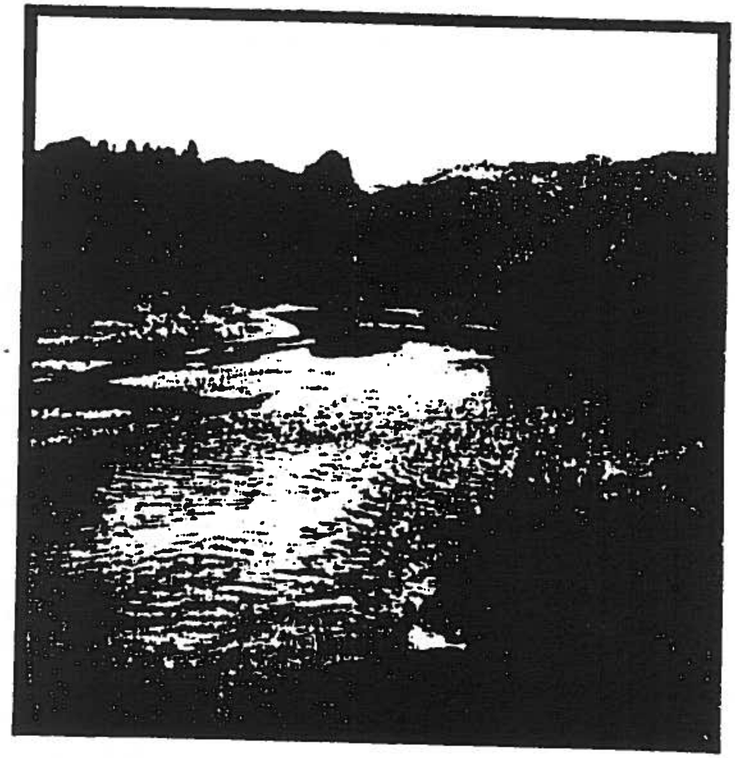
APPENDIX A:
Survey Instruments

ık you for your help. Is there anything else you'd like to tell us ıt flow levels in Montana's rivers or other related issues. We ld appreciate your comments.

again. If you would like to receive a copy of the results of this study, please ›ur name and address on the back of the return envelope (NOT on this nnaire).

Recreation Use and Values
in the

MISSOURI RIVER BASIN



STATE OF MONTANA

Department of Natural Resources and Conservatio

I. First, we have some general questions about your opinions regarding use of Montana rivers and reservoirs. Please answer ever if you rarely or never visit rivers or reservoirs for recreation.

1. Check the box that best represents how you feel about each of the thre statements below.

	Strongly Agree	Agree	Disagree	Strongly Disagree	No Opinion
a. I enjoy knowing that my friends and family can visit rivers for recreation if they want to.	☐	☐	☐	☐	☐
b. Water quality in streams and rivers in this area of Montana should be improved.	☐	☐	☐	☐	☐
c. I think irrigation is the most important use of Montana's water.	☐	☐	☐	☐	☐

2. Do you participate in water-related recreation such as fishing, boating, c shoreline activities like picnicking, swimming, sightseeing or camping?

☐ yes ☐ no (If no, please go to Part IV)

3. About how many days so far this year did you participate in water-relate recreation?

________number of days so far this year

4. How many years have you been going to rivers or reservoirs to fish, boat participate in other water-related activities?

________years

If you haven't visited Missouri Basin rivers or reservoirs this year (see ma on back of cover letter) please go to Part IV.

his Section asks about the trips you have made to eight rivers and ervoirs in the Middle Missouri River Basin of Montana. A trip can part of a day, a full day, or several days long.

/hich of the following rivers or reservoirs or their tributaries have you visited far this year? (Please check each river or drainage you have visited. If you sited none of these rivers or reservoirs or their tributaries please go to #3.)

issouri R. from Three Forks to Canyon Ferry	☐ Smith River
auser and/or Holter Reservoir	☐ Canyon Ferry Reservoir
issouri River from Holter to Great Falls	☐ Belt Creek
issouri River from Great Falls to Fort Benton	☐ Dearborn River

out how many trips did you make to any of these eight rivers and reservoirs their tributaries so far this year for each of the following activities?

___Number of trips where FISHING FROM BOAT was the main activity
___Number of trips where FISHING FROM SHORE was the main activity
___Number of trips where BOATING/FLOATING was the main activity
___Number of trips where shoreline activities like PICNICKING, SWIMMING, SIGHTSEEING OR CAMPING were the main activity

w many more trips do you expect to make to these areas in the remaining nths of 1989?

________number of ADDITIONAL TRIPS in 1989

d you make major equipment expenditures this year for river or reservoir-ated equipment such as a boat, motor, trailer, rod or reel?

☐ no ☐ yes

If yes, about how much did you spend? $________

The next few questions are about trips taken in 1988.

ich of the following rivers and reservoirs or their tributaries did you visit in 88? (Please check each area you visited.)

souri R. from Three Forks to Canyon Ferry	☐ Smith River
user and/or Holter Reservoir	☐ Canyon Ferry Reservoir
souri River from Holter to Great Falls	☐ Belt Creek
souri River from Great Falls to Fort Benton	☐ Dearborn River

you may recall, 1988 was a year of severe drought in Montana. How did the water levels in 1988 affect the number of trips you took to these areas last r? (please check one)

☐ fewer trips ☐ more trips ☐ no change

7. How did low water levels on these rivers and reservoirs or their tributaries a the overall quality of your trips in 1988? (Please check one of the followi

☐ quality was raised ☐ quality was unchanged ☐ quality was lowere

8. How did low flows in 1988 affect the type of activities that you participatec (Please check all that apply)

☐ boated or floated less	☐ participated in less shoreline activity
☐ boated or floated more	☐ participated in more shoreline activity
☐ fished less	☐ no change
☐ fished more	☐ other________

9. In 1988, if you took FEWER TRIPS to any of these eight rivers and reserv or their tributaries, did you visit any other rivers and reservoirs instead?

☐ yes ☐ no

10. If yes, which ones? (please list alternative rivers visited)

____

____

The next few questions ask about trips you took to other areas of t Missouri River Basin in 1989.

11. Did you make any trips so far this year to the following rivers or their tributar in the UPPER Missouri River Basin? (Please check each area visited)

☐ Big Hole	☐ Ruby	☐ Wise
☐ Jefferson	☐ Gallatin	☐ Madison
☐ Beaverhead	☐ Boulder	☐ Red Rocks

12. Did you make any trips so far this year to the following rivers and reservo or their tributaries in the LOWER Missouri River Basin? (Please check ea area visited)

☐ Sun	☐ Teton	☐ Marias
☐ Judith	☐ Musselshell	☐ Big Spring Creek
☐ Missouri River below Fort Benton		☐ Fort Peck Reservoir

The next few questions ask about a specific trip you took to a river reservoir in the Missouri River Basin. If you have not visited one these areas in 1989, please go to Part IV. We are asking different ople about trips taken at different times of the year.

Which Missouri River Basin river or reservoir (see map on back of cover letter) lid you visit CLOSEST TO JULY 15TH OF THIS YEAR? A trip can be anything rom an hour to several or more days(If the trip you took closest to July 15th vas in another month, this is still ok.)

____________________NAME OF RIVER OR RESERVOIR

Nhat was the approximate date of this trip?

______MONTH _____DAY

-low many days did you spend at this river or its tributaries on this trip?

_____NUMBER OF DAYS

Nhat was the MAIN ACTIVITY you participated in on this most recent trip? please check one)

- ☐ fishing from shore
- ☐ fishing from a boat
- ☐ boating/floating
- ☐ shoreline recreation (picnicking, sightseeing, camping, or swimming)

Did you know what the water level in the river or reservoir or their tributaries was going to be before you visited the river? (please check one)

- ☐ knew exactly
- ☐ had a general idea
- ☐ had no idea

Would you have preferred to visit the river or reservoir or their tributaries at a different water level than what you experienced? (please check one)

- ☐ preferred higher water level
- ☐ preferred lower water level
- ☐ water level was good

7. What is the lowest water level at which you would visit this river or reserv (please check one)

- ☐ at the ACTUAL LEVEL I experienced
- ☐ 90 PERCENT of what I experienced
- ☐ 75 PERCENT of what I experienced
- ☐ 50 PERCENT of what I experienced
- ☐ 25 PERCENT of what I experienced
- ☐ 10 PERCENT of what I experienced
- ☐ I would visit the area NO MATTER WHAT the water level was.
- ☐ Other ______________________________

8. How many trips have you made to area so far this year?

_______Number of trips so far this year.

9. How many years have you been visiting this river or reservoir?

_______Number of years visiting this area.

10. How would you rate YOUR KNOWLEDGE of this river or reservoir inclu how different water levels affect your recreational activity? (please check c

- ☐ very knowledgeable
- ☐ knowledgeable
- ☐ only somewhat knowledgeable
- ☐ not knowledgeable

11. About how much money did you personally spend on this trip (if anything each of the following categories? If you can't recall the exact amount, ple give your best estimate:

Transportation expenses (gas, oil, etc.)	$______
Lodging, such as motel or campground fees	$______
Food and beverages bought in stores	$______
Food and beverages bought in restaurants	$______
Equipment (such as tackle) for this trip	$______
Other (list)______________________	$______
Total amount you spent on this trip	$ ______(TOTAL)

Approximately what percent of this total amount did you spend in Montana?

_______PERCENT SPENT IN MONTANA

Suppose that your share of the expenses to visit this area increased; would you still have made the trip if your cost had been $________ more? (please check one)

☐ yes, I would still have made the trip
☐ no

If no, would you have made the trip if your share of the expenses had been only $1.00 more?

☐ yes ☐ no

If no, could you please indicate why not (check one):

☐ I could not afford the additional cost.
☐ I would have gone elsewhere if the cost increased.
☐ I already pay taxes to use public resources.
☐ I am opposed to fee recreation.
☐ I live close by so costs could not be that high.
☐ other_______________________________

IV. This section asks how familiar you are with efforts to conse natural resources — and about your own willingness to becc involved.

1. In various parts of the country, trust funds have been set up to purchase w or land resources to conserve unique natural resources. The Nature Cor vancy, Ducks Unlimited and the Rocky Mountain Elk Foundation are exam of the types of groups that can do this. How familiar are you with these effc (check one)

☐ I have never heard of such trust funds
☐ I have heard of them but don't know much
☐ I know a fair amount about them
☐ I know a great deal about them

2. Have you ever been a member of or donated money or time to a trust func this, or to other efforts to conserve natural resources such as rivers or wil habitat?

☐ yes, I have
☐ no, I have not

As you may be aware, sections of some Missouri Basin rivers such as the Hole, Gallatin, Smith, Sun, Judith and Musselshell typically have had summertime flows. Low flows can often occur in other basin streams, espec in drought years. Often, existing flows in streams are not legally protected could be reduced by new diversions of water.

To help protect existing flows, a private trust fund could be establishe purchase or lease water to maintain fish, birds, wildlife and plants, and rec tional uses. This would benefit people who use these rivers for recreation as as those who believe having water in rivers is important. The effectiveness o trust fund would increase with the amount of money contributed to it.

3. If you were contacted within the next month, would you pledge to mak annual contribution of $_________to help buy the water needed to mair summer flows on Missouri Basin streams?

☐ yes (please go to #6)
☐ no (please go to #4)

/ould you be willing to donate a smaller amount, such as $1.00 per year, to
ılp purchase water when needed for these rivers?

- ☐ yes (please go to #6)
- ☐ no (please go to #5)

ould you please give your reason for not wanting to purchase an annual
ıembership in this trust fund?

____

____

r answering #5, please go to section V.)

e there any of these nineteen Missouri Basin streams that you think should
ceive a higher priority from the trust fund? If so, which ones? (check up to
ee)

☐ Red Rocks	☐ Boulder	☐ Teton
☐ Big Hole	☐ Dearborn	☐ Marias
☐ Ruby	☐ Smith	☐ Judith
☐ Beaverhead	☐ Sun	☐ Musselshell
☐ Jefferson	☐ Belt Creek	☐ Big Spring Creek
☐ Gallatin	☐ Missouri R. from Three Forks to Canyon Ferry	
☐ Madison	☐ Missouri R. below Great Falls	

V. This final section will help us to understand the responses wı receive.

1. Are you a member of any conservation, sport fishing, or boating organizations (please check one)

   ☐ yes ☐ no

2. What kind of area do you live in? (please check one)
   - ☐ in a town or city
   - ☐ on the outskirts of a town or city
   - ☐ in a rural area

3. What is your age? ______Years.

4. Are you: ☐ male ☐ female

5. What is the highest year of formal education you completed?

☐ some grade school	☐ some college
☐ finished grade school	☐ finished college
☐ finished junior high	☐ some postgraduate
☐ finished high school	☐ finished postgraduate

6. Which of the following best describes your occupation? (please check one)

☐ agriculture	☐ retired
☐ service or trades	☐ homemaker
☐ professional	☐ student
☐ other:________________	

7. Please check your household's income before taxes last year.

☐ under $5000	☐ $20,000-24,999	☐ $40,000-49,999
☐ $5,000-9,999	☐ $25,000-29,999	☐ $50,000-74,999
☐ $10,000-14,999	☐ $30,000-34,999	☐ $75,000-100,000
☐ $15,000-19,999	☐ $35,000-39,999	☐ over $100,000

DATE ______________________

NONRESPONDENT # ____________

MONTANA DNRC MISSOURI RIVER BASIN STUDY
NONRESPONSE TELEPHONE SURVEY SCRIPT

Hello. Is ______________________ home? (If NO, call back when?)

I'm __________________ calling from the Montana Department of Natural Resources and Conservation in Helena about a survey we've been conducting on recreation in the Missouri River basin. I'm calling people who didn't respond to our study to just ask a few questions. This is not a request for money. Could I have a few minutes of your time? (If NO, thanks anyway. If YES, proceed.)

1. Do you participate in any of the following recreation activities: fishing, boating, swimming in rivers or lakes, or picnicking, sightseeing, or camping beside rivers or lakes?

   _____YES _____NO (if NO, skip to question #3)

2. About how many days so far this year did you participate in water-related recreation?

   _____ number of days so far this year

3. Are you a member of any conservation, sport fishing, or boating organization?

   _____YES _____NO

4. What kind of area do you live in? Is it a: (CHECK ONE)

   _____ town or city
   _____ on the outskirts of a town or city
   _____ in a rural area

5. What is your age? _____years

6. What is the highest level of formal education you have completed?

   _____ some grade school
   _____ finished grade school
   _____ finished junior high
   _____ finished high school
   _____ some college
   _____ finished college
   _____ some postgraduate
   _____ finished postgraduate

7. Which of the following best describes your occupation?

   _____ agricultural
   _____ service or trades
   _____ professional
   _____ retired
   _____ homemaker
   _____ student
   _____ other ____

Thanks very much for your help. Goodbye.

INTERVIEWER RECORD:

Survey # ______________

Sub-basin area ________________

_____MALE _____FEMALE

CITY/TOWN______________________

Montana Department of Fish, Wildlife & Parks

FISHERIES SURVEY

DID YOU FISH IN MONTANA DURING AUGUST 16-31

☐ YES ☐ NO

PLEASE CHECK THE TYPE OF LICENSE YOU PURCHASED

☐ FISHING OR FISHING/CONSERVATION COMBINATION FOR RESIDENT OR NONRESIDENT
☐ SPORTSMAN
☐ DISABLED RESIDENT CONSERVATION
☐ RESIDENT CONSERVATION ONLY

IF YOU ARE A PIONEER (62 OR OLDER) OR A YOUTH (12 TO 14), DO YOU PLAN ON USING YOUR CONSERVATION LICENSE TO FISH?

☐ YES ☐ NO

PLEASE REFER TO THE MAPS TO HELP US IDENTIFY THE WATERS YOU FISHED

DATE FISHED AUGUST 16-31	NAME OF LAKE OR STREAM FISHED	SECTION NUMBER IF INDICATED ON MAP	NEAREST TOWN AND/OR POINT OF ACCESS OR LANDMARK	TOTAL HOURS FISHED PER DAY	TOTAL NUMBER OF FISH CAUGHT		TOTAL NUMBER OF FISH KEPT		WAS THE MAIN PURPOSE OF YOUR TRIP TO FISH? (Y OR N)	DID YOU STAY OVERNIGHT? (Y OR N)	ROUND TRIP DISTANCE** TRAVELED
					TROUT AND SALMON	OTHER SPORT FISH*	TROUT AND SALMON	OTHER SPORT FISH*			
ENTER EACH DAY AND EACH WATER FISHED ON A SEPARATE LINE. LIST ALL FISHING IN MONTANA, NOT JUST WATERS INDICATED ON THE MAP											
AUGUST											
AUGUST											
AUGUST											
AUGUST											
AUGUST											
AUGUST											
AUGUST											
AUGUST											
AUGUST											

* SUCH AS: THE NUMBEROF WHITEFISH, WALLEYE, PERCH, BASS, ETC.

** IF YOU STAYED OVERNIGHT, PLEASE MAKE A SEPARATE ENTRY FOR EACH FISHING TRIP.

THIS INFORMATION WILL BE HELD IN STRICT CONFIDENCE AND WILL BE USED FOR MANAGEMENT PURPOSES ONLY

APPENDIX B:
Computational Notes

study than was presented in the main report text. The computational notes are presented in the order of the tables with which they are associated.

The DNRC Missouri River Basin survey was administered in a stratified manner. Since this was a general household survey cost considerations dictated that sampling be targeted to specific user groups in order to achieve the desired response sample sizes. The strata included: Upper Missouri Basin residents, Middle Missouri Basin residents, Lower Missouri Basin residents, residents living outside the Missouri Basin and nonresident conservation license holders.

Stratified sampling is commonly employed for several reasons. Often an increase in precision can be gained through the use of sample stratification, and sampling resources can be allocated more efficiently through the use of stratification (Snedecor and Cochran, 1968). One difficulty regarding the analysis of stratified data, however, is that all analysis of the resulting data should also be done in a stratified manner. The major problem this presents is that sample sizes are divided at best by the number of strata (in the case of equal sample sizes for all strata). These smaller sample sizes can present problems for certain types of statistical analysis, especially logistic regression which is used heavily in this study.

In an effort to eliminate the problem of reduced sample sizes an alternative method of stratifying was used for data analysis in this study. As is traditionally done in studies such as this the nonresident strata was examined independent of the resident stratas. Nonresidents are consistently different from residents in their spending levels, lengths of stay and net economic valuations. An analysis of the resident strata was then performed to determine if the strata means for expenditures, length of trips, and net economic values were significantly different, or whether the resident strata could be pooled without significantly biasing the results. For nearly all levels of aggregation it was found that no significant difference between resident means existed. Where differences were found to exist, the pooled estimates provided underestimates of the expenditure levels and net economic values, thus erring on the conservative side.

The results in this study are therefore presented for two strata, residents and nonresident conservation license holders (anglers), rather than for the five strata of the original survey design.

Following is a list of the tables in the text along with any relevant computational notes regarding them.

Statistics are simple sample proportions.

<u>Table 3 and 4</u>

Statistics are simple sample proportions and means. Average family income was reported as one of 12 ranges of income from 5000 to over 100000 dollars. responses were coded to the midpoints of the range indicated, and the over 100,000 responses were coded to 125,000 dollars.

<u>Tables 6,7,8 and 9</u>

Estimates are the sums of individual water, angler use estimates made by DFWP. The assumption of independence between water estimates was made and the standard errors for the aggregate use estimates were calculated as the square root of the sums of the variances.

<u>Tables 10,11,12 and 13</u>

Respondents were asked to select one of four activities as the main activity of their trip. While most marked only one <u>main</u> activity nearly 20% marked more than one activity. These multiple answers were recoded from 1's to 1/2, 1/3, or 1/4 depending on the number of activities marked. The angler proportion was calculated by summing the proportions of use for the two angler activity classes. The standard errors for these estimates were calculated as:

$$\text{Standard Error} = \text{sqrt}\left[\frac{P(1-P)}{n}\right]$$

Though this formula is exact only if all the data is zeros and ones, it will overestimate the standard error slightly when there are some fractional entries.

<u>Tables 14, 15, and 16</u>

Estimates in these tables were calculated as total angler days divided by angler proportion. Since these estimates are from different samples, they are independent. The covariance term is therefore=0 and is dropped from the standard variance of a ratio formula. The standard errors for this estimate of total use days were calculated as:

$$\text{Std.Err.}\left(\frac{D}{P}\right) = \frac{1}{P^2}\left[\text{VAR}(D) + \frac{D^2}{P^2}\,\text{VAR}(P)\right]$$

Where:

P = angler proportion, D = Total angler use days.

<u>Tables 17, 18, 19 and 20</u>

These tables present explicit 95% confidence intervals around the estimated use means. The confidence intervals were calculated as:

Current study statistics are sample means for those respondents who indicated that fishing was the main activity of their trip.

Table 23

The per trip expenditure figures are simple means of all non-missing total expense figures for each cell of the table. Standard errors are calculated as:

Standard Error = std. dev. /sqrt(n)

Table 24

Same procedure as above for length of current trip.

Table 25

Estimated average expenditures per day are average expenditures per trip divided by average days per trip. The variance estimates for average expenditures were bootstrapped from the survey data. An approximate variance was also calculated to check the general accuracy of the bootstrapped estimate. These approximate variances were consistently quite close to the bootstrapped variances. The approximate variances were calculated as:

$$VAR\left(\frac{E}{D}\right) = \frac{1}{ND^2}\left[VAR(E_i) + \frac{E^2}{D^2} VAR(D_i) - \frac{2E}{D} COV(E_i,D_i)\right]$$

Where:

E = mean expenditures per trip
D = mean days per trip

Table 26

The average expenditures per trip for specific activity types were calculated as the simple means of total, non-missing expenditures. The Standard Errors were calculated as:

Standard Error = Std.Dev. / sqrt (N)

Table 27

This table provides a more detailed breakout of expenditures per day by activity type. This was calculated as average expenditure per trip divided by average days per trip. Due to the complexity of bootstrapping standard errors for ratios such as this, no measures of variance were calculated for this specific breakout.

Table 28, 29 and 30

Total recreational expenditures were calculated as average expenditures per trip times total recreational use days. The variance for this statistic is calculated as:

E = average expenditures per day
TUD = Total recreational use days

Table 33

Average Net Economic Value per Day was calculated using two methods: 1) The truncated mean was calculated through numerical integration of the estimated bivariate equations shown in Table 31. The upper level of integration for these models was the maximum bid level, or $500 for residents and $2000 for nonresidents. 2) The median was calculated as

$$MEDIAN = \exp(-a/b),$$

with a and b being the coefficients from the bivariate equations of Table 31. The standard errors for this table were bootstrapped following the methodology of Duffield and Patterson (1990).

Table 34

Average net economic value per day was calculated as average net economic value per trip divided by average number of days per trip. In calculating standard errors for this ratio the assumption of independence between value per trip and days per trip was made. While this assumption is not supported by evidence, the variances estimated under it will be overestimates of the true variances, and thus conservative. The formula for calculating these variances was

$$var\left(\frac{x}{y}\right) = \frac{1}{y^2} var(x) + \frac{x^2}{y^4} var(y).$$

where:

x=mean economic value per trip
y=mean days per trip

Table 35

Total net economic value was calculated as average net economic value per day times total recreational user days. The calculation of a variance for this estimate used the following formula:

$$var(NEV * TUD) = var(NEV)\, var(TUD) + NEV^2\, var(TUD) + TUD^2\, var(NEV)$$

where:

NEV=Net economic value per day
TUD=Total recreational user days

Tables 37, 38, 39 and 40

As was discussed in the text, the marginal values for flows were calculated directly from the total value figures of Table 35 and the bivariate flow/visitation equations of Table 36. The derivative of the estimated flow/visitation equations (shown in equation 23) was equation 21) from the text. Standard errors on these values are a direct product of the standard errors on total net economic value. Of the marginal value equation

$$M.V. = \frac{\text{total value} * dP/dF}{\text{Total Discharge}/100}$$

only total value was treated as an estimate with an associated standard error. Hence, the equation for the variance of M.V. can be written as

$$\text{var (M.V.)} = k^2 \text{ var(total value)}$$

where:

$$k^2 = (dP/dF) / (\text{total discharge}/100)$$

As stated in the text, these standard errors are only approximate and care must be taken in their interpretation.

Average value figures were calculated as

$$A.V. = \text{total value} / \text{total discharge}$$

Table 44

The truncated means and medians for the trust fund analysis were calculated using the same methodology as that used for the current trip analysis. Refer to Table 33.

Table 45

The total value figures are the products of the components in the table.

Table 46

The standard errors for the trust fund valuation figures were calculated using bootstrapping of regression coefficients as was done in Table 33. The aggregated standard errors were calculated as

$$\text{Std.Err.(total trust fund value)} = \text{sqrt}(\text{pop.}^2 \text{ var (economic value)}).$$

APPENDIX C:
Bid Distribution Analysis: DNRC Missouri River Basin Recreation Study

BID DISTRIBUTION ANALYSIS
DNRC MISSOURI RIVER BASIN RECREATION SURVEY

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August, 1989

This note describes the design of the bid distribution for the Montana Department of Natural Resources and Conservation (DNRC) Missouri River Basin recreation survey.

The DNRC survey contains two dichotomous choice valuation questions: valuation of instream flows through a trust fund payment vehicle and valuation of recent recreational trips through a trip expense vehicle. Both questions are designed to be analyzed using logistic contingent valuation methods. This method requires that each respondent be faced with specific bid offers, which are randomly varied across respondents. Design of these bid distributions entails the following basic choices:

1. choice of welfare measure
2. sample size
3. bid range
4. bid levels
5. allocation of sample among bid levels

These choices must be evaluated for each question type (trust fund and recent trip) and for two populations: Montana residents and nonresident anglers.

WELFARE MEASURE

Where the purpose of the contingent valuation exercise is to provide estimates of total value associated with a given resource, the appropriate welfare measure is the truncated mean. The basis for that choice will be briefly described.

Previous research indicates that the most successful functional form for logistic regression on recreation and instream flows includes a log transformation of the key independent variable (the bid offer). The normal mean for this functional form is infinite in many cases because the of the large upper tail of the distribution. Accordingly it is necessary to truncate the mean at some level. The usual approach is to truncate the mean at the highest observed bid level. This suggests that the choice of bid range, and particularly the highest bid level, is an important one.

The main alternative to the truncated mean is the median. The median is the bid amount which 50 percent of the sample population are willing to pay. For most applications the median is considerably smaller than the truncated mean because of the large upper tail of the response distribution. In other words, a relatively small The result is that the median may provide a substantial underestimate of the "average" value placed on the given resource. The advantage of the median is that it is more robust. The median is not as sensitive to the design of the bid distribution and does not require information on the upper tail of the distribution. While we advocate designing for the truncated mean, we will of course report the median in all applications.

Our conclusion on this point is that the bid distribution should be designed to provide an efficient estimate of the truncated mean.

SAMPLE SIZE

Target sample sizes for the two questions are 600 for the trust fund question and 300 for the recent trip. These general targets were established based on the precision of logistic contingent valuation estimates in the economics literature. Duffield and Patterson (1989) provide several methods for estimating the variance (and related confidence interval) for the truncated mean. These methods applied to a well-known data base (Bishop and Heberlein, 1980) indicate that 90 percent confidence intervals that are plus or minus 10 to 20 percent of the estimated mean can be estimated with samples of 300 to 600. However, other applications indicate that even larger samples may be needed to achieve these levels of precision. The general characteristics that relate a given estimate to the level of precision are as yet not well understood. Most estimates in the published literature have used samples on the order of 100 to 200 and some estimates are reported for samples of only 25 to 50 observations.

Duffield and Patterson (1989) also provide an equation (p. 19) that relates estimated standard error for the truncated mean to sample size, given the estimated logistic regression equation and the predicted response proportions.

BID RANGE

A major design choice is the bid range. At the lower end, we find it very efficient to use a $1 bid offer following the main bid question to identify protest responses. As no lower offer (the log of $1 is zero) results in positive transformed bid offers, $1 is used as the lowest bid offer.

There are at least two different perspectives to consider in selecting an upper bid level for an experiment designed to produce a truncated mean welfare measure.

ers who are expected to utilize the study results. The basic question is how much should one person's (or a small group of persons) values contribute to the estimated mean value. For example, one individual in the sample population may be willing to contribute $5000 to an instream flow trust fund. If the rest of the sample will contribute an average of $10, including this individual in even a sample of 600 respondents almost doubles the estimated mean to $18. As a practical matter (or from a distributive or equity standpoint), one may decide to not include values above a certain dollar level as "not being representative". Alternatively, given an idea of what the response distribution looks like, one may choose to exclude values held by only a small part of the population (eg. exclude responses where the percent willing to pay that amount is less than 5 percent or less than 1 percent). A related reason for possibly excluding responses where one individual significantly influences the average is that there may be a question about the validity of these responses. The implication of this perspective is that if one has a good idea of the shape of the response distribution, the upper bid level can be set at some selected minimum response proportion, such as 1 percent or 5 percent.

A second perspective on setting the upper bid level is the tradeoff of survey costs (sample size), precision of the estimate and the extent to which the truncated mean provides a conservative estimate. The basic relationships here are that, other things equal, the higher the upper bid (and correspondingly the truncation level for the truncated mean) the more closely the estimated truncated mean will approach the true population mean. On the other hand, given sample size, the higher the truncation level the less precise the estimate. In other words, it can be very costly to precisely estimate the upper end of the response distribution. These tradeoffs can be quantified given a previous estimate of the likely response distribution.

The remainder of this section describes the specific analysis for the upper bid level for each of the bid questions and populations. The sequence of this analysis is to first identify plausible prior estimates of what the actual response distribution will probably look like. Where these prior estimates are actual logistic regression equations, response probabilities at a range of upper bid levels can be calculated. Finally, the methods developed by Duffield and Patterson (1989) are applied to estimate truncated mean and associated standard error for several alternative truncation levels.

Typically bid distributions are designed based on pretests or pilot tests of the actual survey instrument. For example Boyle, Welsh and Bishop (1988) suggest using an open-ended CVM question in the pretest. This approach may be costly in that a fairly large pretest sample may be required to get sufficient responses. Fortunately for the case at hand, results from previous related studies conducted in Montana can be utilized to provide an estimate of the likely shape of the response distribution.

With regard to the current trip question, a very similar question was asked of Montana resident and nonresident anglers for a set of 19 Montana rivers (Duffield and Allen, 1988). The range of values on these rivers based on a multivariate equation was $38 per trip to $228 per trip. One of these rivers was the mainstem Missouri from Holter to Cascade with a value of $60 per trip, making it one of the four lowest-valued waters (along with the Bitterroot, Kootenai and Middle Yellowstone) in this group of rivers. It is our judgement that the response to the Missouri may be typical of the average response for all waters in the Upper Missouri Basin. Some of the highest valued rivers are in this basin (such as the Big Hole and Madison), but so are a number of lesser valued rivers and tributaries. No direct CVM results are available on reservoirs in this basin, however travel cost model results for both streams and reservoirs in Montana (Duffield, Brooks and Allen, 1987) suggest that Missouri Basin reservoir values will be similar to the low end river values. A bivariate logit equation for the Missouri, based on a sample of 157 respondents to a mail survey, is:

(1) $L = 4.35782 \; -1.40332 \ln(\text{Bid})$

(t-statistic): (18.48) (-6.14)

This equation provided an excellent fit to the data and highly significant estimates for the parameters. The highest bid level in the sample was $300 and the probability of a yes response at this level was 3 percent. The use of this river is mainly by residents which comprise 82 percent of respondents in this sample. By comparison, residents are only 33 percent of the respondents on the Madison. Accordingly, the Missouri equation is taken as good prior estimate of resident responses to the current trip question on Missouri Basin waters.

For nonresident responses, the Madison might provide a good estimate, however at the highest bid level in the sample ($500), the probability of a yes response from the fitted equation was 20 percent, indicating that the offer bid levels were not sufficiently high to identify the

Allen (1988) sample. Alternative estimates are available from a study in progress for the Big Hole and Bitterroot Rivers. In this study, which was conducted on-site, a similar current trip valuation question was asked and the upper bid level was set at $2000. The estimated logit equation for the Big Hole is:

(2)	L = 5.2195	- 1.12982 ln(bid)	
(t-statistic)	(30.79)	(-11.9)	

Again the estimated parameters are highly significant. The predicted probability of a yes at $500 is .14 and declines to .03 at $2000. Nonresident use is concentrated on the better waters, so it may be appropriate to use the response to a river like the Big Hole. On the other hand, reservoirs will be less valuable and even among rivers used by nonresidents, the Big Hole is one of the best. These tradeoffs are difficult to predict. We are choosing to temper the influence of using the Big Hole by taking an equation that includes both residents and nonresidents in the sample.

A prior estimate of the response to the trust fund is available from a mail survey of resident and nonresident households undertaken in 1988. The trust fund question in the latter study is very similar to the one considered here, although for a smaller set of rivers. The estimated equation, based on a sample of 554 households is:

(3)	L = 1.3682	- 1.17126 ln(bid)	
(t-statistic)	(22.80)	(-6.82)	

The upper bid in this sample was $300, and the probability of a yes at that bid level was less than 1 percent (.49 percent). The above equation includes responses from about 70 nonresidents (city of Spokane), but the resident-only equation is not significantly different. Accordingly, this equation is an appropriate prior estimate for the resident trust fund question.

No existing studies have been designed specifically to estimate nonresident angler response to a trust fund question. However, an estimate for this type of question can be developed from an on-site survey conducted in the summer of 1988 on the Big Hole and the Bitterroot. Excluding residents from the sample, an equation for nonresident only response to a hypothetical trust fund for instream flow on the Bitterroot is:

(4)	L = 1.27724	- .65054 ln(bid)	
(t-statistic)	(18.9)	(-3.4)	

cent at that bid level. The nonresident only equation for the Big Hole is similar with a probability of a yes at $1000 being 7 percent.

ANALYSIS OF UPPER BID LEVEL

If the preceding four equations are accepted as prior estimates of the likely response distributions to be obtained in the Missouri River Basin survey, the simplest way to pick an upper bid level is to identify a minimum response proportion level and solve for the corresponding bid. For example, suppose that the upper bid level should provide observations for bids to the point where the probability of a "yes" response is 1 percent or 5 percent, then the following approximate upper bid levels would be indicated:

bid level eliciting a response of:		1% yes	5% yes
residents:	trust fund	$200	$40
	recent trip	$500	$200
nonresidents:	trust fund	$8000	$700
	recent trip	$6500	$1500

The estimates for the resident versions seem "reasonable" by comparison with bid levels used in previous research. The nonresident levels seem implausibly high and perhaps mainly reflect the fact that the upper end of the response distribution for this population strata is not well defined by previous estimates. It should be noted that the estimate for nonresident respondents to a trust fund question is based on a very small sample (52).

Another perspective on the upper bid level choice is obtained by looking at the effect of truncation level on mean and standard error (given the estimated equation and holding sample size constant). For example, Table 1 shows this relationship for the prior estimated resident trust fund equation (Equation 3).

Having a lower upper bid level means of course that the upper end of the response distribution is not identified and that the estimated truncated mean is more of an underestimate. For example, at $100 truncation, the mean is about 20 percent lower than at $300 ($8.17 versus $10.07). On the other hand, the estimate at $100 is more precise with a coefficient of variation of .12 as opposed to .17 for the mean truncated at $300. It would appear that in this case $200 might be a good compromise, as the mean is only slightly lower than at $300. Additionally, the lower bound for a 90 percent confidence interval on the mean at $200 is almost identical to teria of having an upper bid that is sufficiently high to take the response down to 1 percent.

Table 1
Effect of Upper Bid Level on Mean and Dispersion for Resident Trust Fund Response

	upper bid level		
	100	200	300
Probability of a yes	.0175	.0079	.0049
Estimated truncated mean	8.17	9.44	10.07
Standard error	.95	1.41	1.73
Coefficient of variation	.12	.15	.17
Lower 90% confidence bound for truncated mean	6.61	7.12	7.22

Notes: Based on equation (3) and a sample of 600. Truncated mean and standard error based on discrete approximation.

A similar analysis supports using $500 for the upper bid level for the resident most recent trip question. A bid of $500 again corresponds to a one percent "yes" response proportion and the level of precision is about the same as for the resident trust fund. Specifically, for the resident recent trip question (based on equation (1), at an upper bid of $500 (and an equal truncation level) the truncated mean is $50.20, the standard error is 6.43 and the coefficient of variation is .13 (all based on a sample of 300). This is slightly more precise than the resident trust fund question with a coefficient of variation of .15 at an upper bid of $200 and for a sample of 600.

One approach to the nonresident bid design, given a lack of specific information, would be to use the same distribution as for the residents. However, it does appear that nonresidents do have higher average values. Somewhat judgementally, we would recommend using an upper bid level of $500 for the nonresident trust fund and an upper bid level of $2000 for the nonresident recent trip. Based on equations (2) and (4) for nonresidents, these correspond to 6 percent and 3 percent positive response proportions at the upper bid levels for the trust fund and recent trip questions respectively.

BID LEVELS

The main consideration in choice of the number and location of bid levels is to have sufficient bids to identify the appropriate functional form for model to be estimated. If one was certain that a linear functional form would be adequate. However, from experience we only know that the best-fitting model in dichotomous choice applications will be nonlinear, but we don't know in advance the specific best functional form.

In order to establish functional form, we have conducted surveys with as many as twenty bid levels. The problem with having many bid levels is that there may be insufficient observations at each point to conduct satisfactory goodness-of-fit tests. Our general recommendation is to have eight to nine bid levels. This provides sufficient points to identify functional form, but is few enough to provide an adequate number of observations at each bid level to do chi-square goodness-of-fit tests.

As to specific bid location, we have generally found the best fit to be with a log transformation of the bid variable. Accordingly, to get bid levels well-spaced for estimation, we generally locate bid levels at approximately equal log intervals. Given the upper bid level (or truncation point) and a lower bid level of $1 (for protest response analysis), the other seven or eight bid levels are then set at approximately equal log intervals.

It may be noted that exactly equal log intervals might imply bids like $13.61 or $73. We generally pick numbers that are close to these but rounded to the nearest $5 or $10 or even $100 in higher bid levels. We have noticed in the past that response proportions to "unrounded" numbers can be significantly different than the response to nearby "rounded" numbers. There is additionally something odd about asking someone to respond to a very large unrounded number like $259. Perhaps it implies a greater precision than the respondent feels is appropriate in the given context.

Given the upper bid levels described above, the specific bid locations for each survey-sample are as follows:

resident trust fund: 5, 10, 15, 25, 40, 50, 100, 200
nonres. trust fund: 5, 10, 25, 50, 100, 200, 300, 500
resident recent trip: 5, 10, 25, 50, 100, 200, 300, 500
nonres. recent trip: 5, 10, 25, 50, 100, 250, 500, 1000, 2000

ALLOCATION OF SAMPLE AMONG BID LEVELS

Based on Duffield and Patterson (1989), we recommend allocating the sample among bid levels to provide the most efficient estimate of the truncated mean. As described below, this basic approach can also be modified to accommodate the requirements of the chi-square goodness of fit test for a minimum number of observaoptimization of the variance of the truncated mean subject to the constraint on minimum shares imposed by goodness-of-fit considerations.

Under the assumption that survey costs are constant across bid levels, it has been shown that the "optimal" sample allocation (in the sense of minimizing the standard error on the estimated truncated mean) is given by:

$$(5) \quad n_i = \frac{N \Delta x_i [p_i (1-p_i)]^{1/2}}{\sum_{i=1}^{m} \Delta x_i [p_i (1-p_i)]^{1/2}} \quad i = 1,.....m$$

where

n_i = number of observations allocated to bid level i
N = total sample size
Δx_i = bid interval associated with bid level i or
$= (x_{i+1} - x_{i-1})/2 \quad i = 2,..., m-1$, and
$\Delta x_1 = x_1 + (x_2 - x_1)/2$, and
$\Delta x_m = (x_m - x_{m-1})/2$
p_i = response proportion at bid level i

Note that the optimal sample proportions n_i /N are independent of N. Accordingly, given a prior estimate of the likely response proportion (p_i) at each i bid level, the optimal sample proportion can be identified and used to distribute any given N sample size among the i bid levels. Compared to an equal distribution of the sample among bid levels, the rule in equation (5) leads to placing a greater proportion of the sample at bid levels that are associated with a large bid interval and/or a response proportion close to 50 percent. Generally the variance of the truncated mean estimate is reduced by about 25 percent by following an optimal as opposed to equal distribution of bids in applications we have examined.

We have calculated optimal shares for each of the four question-sample combinations using predicted response proportions from equations (1) to (4). These results are in Table 2. Calculated optimal shares for some of the lower bid levels are quite low, for example .01 at the $25 bid level for the nonresident current trip. This is because the contribution of the $25 bid level to the mean and variance for this case is trivial (since the bid levels run all the way to $2000).

While the "optimal" allocation will minimize variance of the estimate, it creates a problem for implementing the chi-square test. Accordingly, we also provide a modified cated a minimum of 5 to 7 percent of the sample to each bid level. Given our sample sizes and likely response proportions at the lower bid levels, this strategy is intended to provide a minimum of 5 to 10 responses in each response cell for the goodness-of-fit test.

RANDOM BIDS

Random bids in sets of 1000 are generated using the statistical software package "S". The only inputs required are the bid levels and the sample allocation among bid levels.

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by Question and Sample

Bid Level	Optimal Share	Modified Share
A. Resident Trust Fund		
5	.11	.11
10	.06	.07
15	.08	.08
25	.10	.10
40	.08	.08
50	.17	.17
100	.28	.28
200	.12	.11
B. Resident Recent Trip		
5	.02	.07
10	.04	.07
25	.09	.08
50	.14	.13
100	.21	.20
200	.18	.17
300	.21	.20
500	.10	.08
C. Nonresident Trust Fund		
5	.02	.07
10	.03	.07
25	.06	.07
50	.10	.09
100	.17	.15
200	.20	.18
300	.26	.25
500	.15	.12
D. Nonresident Current Trip		
5	.00	.05
10	.00	.05
25	.01	.05
50	.03	.05
100	.09	.06
250	.15	.12
500	.23	.20
1000	.33	.30
2000	.15	.12

Notes: Optimal share column may not add to 1.00 due to rounding. Optimal share based on predictions from equations (1) to (4).

APPENDIX D:
Detailed Flow / Valuation Tables

ACRE FOOT VALUATION OF INSTREAM FLOWS

RIVERS

OBS	FLOW	PREDICT	DERIV	MARG	SEMARG
1	0	0.02673	0.001250	2.2293	0.46637
2	5	0.03505	0.001628	2.9929	0.60705
3	10	0.04585	0.002109	3.8780	0.78657
4	15	0.05981	0.002717	4.9953	1.01320
5	20	0.07772	0.003473	6.3859	1.29524
6	25	0.10050	0.004397	8.0846	1.63979
7	30	0.12917	0.005498	10.1104	2.05068
8	35	0.16475	0.006771	12.4512	2.52546
9	40	0.20815	0.008183	15.0473	3.05201
10	45	0.26002	0.009666	17.7747	3.60522
11	50	0.32046	0.011115	20.4394	4.14569
12	55	0.38890	0.012393	22.7884	4.62213
13	60	0.46390	0.013350	24.5477	4.97897
14	65	0.54321	0.013857	25.4811	5.16828
15	70	0.62396	0.013842	25.4523	5.16244
16	75	0.70309	0.013305	24.4656	4.96232
17	80	0.77777	0.012326	22.6646	4.59703
18	85	0.84577	0.011034	20.2896	4.11530
19	90	0.90572	0.009579	17.6147	3.57277
20	95	0.95707	0.008098	14.8903	3.02017
21	100	1.00000	0.006693	12.3064	2.49610

ACRE FOOT VALUATION OF INSTREAM FLOWS
REST OF YEAR SUBSAMPLE
UPPER SUBBASIN
RESIDENTS
RIVERS

OBS	FLOW	PREDICT	DERIV	MARG	SEMARG
1	0	0.01813	0.001076	0.59272	0.12022
2	5	0.02499	0.001474	0.81168	0.16463
3	10	0.03437	0.002009	1.10613	0.22435
4	15	0.04709	0.002719	1.49745	0.30372
5	20	0.06425	0.003648	2.00912	0.40751
6	25	0.08713	0.004836	2.66345	0.54022
7	30	0.11722	0.006310	3.47516	0.70486
8	35	0.15607	0.008065	4.44121	0.90080
9	40	0.20507	0.010037	5.52763	1.12116
10	45	0.26507	0.012089	6.65734	1.35030
11	50	0.33591	0.013995	7.70719	1.56324
12	55	0.41607	0.015478	8.52412	1.72893
13	60	0.50252	0.016276	8.96363	1.81808
14	65	0.59105	0.016232	8.93890	1.81306
15	70	0.67703	0.015353	8.45499	1.71491
16	75	0.75634	0.013813	7.60674	1.54286
17	80	0.82611	0.011879	6.54181	1.32686
18	85	0.88495	0.009827	5.41160	1.09763
19	90	0.93285	0.007871	4.33486	0.87923
20	95	0.97073	0.006144	3.38383	0.68634
21	100	1.00000	0.004701	2.58866	0.52505

FLOW = Percentage of actual flows
PREDICT =The predicted visitation rate for each flow

MARG =The marginal value per acre/foot of water.
SEMARG =[illegible]

UPPER SUBBASIN
RESIDENTS
RESERVOIRS

OBS	FLOW	PREDICT	DERIV	MARG	SEMARG
1	0	0.01412	0.000645	0.05084	0.4754
2	5	0.01882	0.000857	0.06752	0.6313
3	10	0.02505	0.001135	0.08945	0.8364
4	15	0.03330	0.001499	0.11811	1.1043
5	20	0.04417	0.001970	0.15526	1.4517
6	25	0.05841	0.002575	0.20293	1.89 73
7	30	0.07696	0.003340	0.26323	2.4612
8	35	0.10091	0.004291	0.33814	3.1616
9	40	0.13147	0.005443	0.42895	4.0107
10	45	0.16993	0.006796	0.53556	5.0075
11	50	0.21748	0.008318	0.65554	6.1292
12	55	0.27498	0.009937	0.78316	7.3225
13	60	0.34269	0.011533	0.90894	8.4985
14	65	0.41997	0.012944	1.02011	9.5379
15	70	0.50508	0.013991	1.10261	10.3093
16	75	0.59522	0.014520	1.14433	10.6995
17	80	0.68683	0.014448	1.13862	10.6460
18	85	0.77608	0.013785	1.08640	10.1578
19	90	0.85956	0.012637	0.99589	9.3116
20	95	0.93468	0.011166	0.88000	8.2280
21	100	1.00000	0.009551	0.75274	7.0381

ACRE FOOT VALUATION OF INSTREAM FLOWS
REST OF YEAR SUBSAMPLE
UPPER SUBBASIN
RESIDENTS
RESERVOIRS

OBS	FLOW	PREDICT	DERIV	MARG	SEMARG
1	0	0.01412	0.000645	0.05084	0.0 5382
2	5	0.01882	0.000857	0.06752	0.0 7147
3	10	0.02505	0.001135	0.08945	0.0 9468
4	15	0.03330	0.001499	0.11811	0.1 2502
5	20	0.04417	0.001970	0.15526	0.1 6434
6	25	0.05841	0.002575	0.20293	0.2 1480
7	30	0.07696	0.003340	0.26323	0.2 7863
8	35	0.10091	0.004291	0.33814	0.3 5792
9	40	0.13147	0.005443	0.42895	0.4 5405
10	45	0.16993	0.006796	0.53556	0.5 6689
11	50	0.21748	0.008318	0.65554	0.6 9389
12	55	0.27498	0.009937	0.78316	0.8 2898
13	60	0.34269	0.011533	0.90894	0.9 6211
14	65	0.41997	0.012944	1.02011	1.0 7979
15	70	0.50508	0.013991	1.10261	1.1 6712
16	75	0.59522	0.014520	1.14433	1.2 1128
17	80	0.68683	0.014448	1.13862	1.2 0523
18	85	0.77608	0.013785	1.08640	1.1 4996
19	90	0.85956	0.012637	0.99589	1.0 5416
20	95	0.93468	0.011166	0.88000	0.9 3149
21	100	1.00000	0.009551	0.75274	0.7 9678

FLOW = Percentage of actual flows MARG =The marginal value per acre/foot of water

RESIDENTS
RIVERS

OBS	FLOW	PREDICT	DERIV	MARG	SEMARG
1	0	0.02941	0.001559	2.9392	0.80684
2	5	0.03925	0.0 02061	3.8862	1.0 6681
3	10	0.05221	0.0 02709	5.1067	1.4 0185
4	15	0.06918	0.0 03530	6.6563	1.8 2724
5	20	0.09119	0.0 04553	8.5850	2.3 5668
6	25	0.11938	0.0 05793	10.9227	2.99841
7	30	0.15493	0.0 07244	13.6585	3.74942
8	35	0.19891	0.0 08865	16.7142	4.58825
9	40	0.25203	0.0 10565	19.9201	5.46831
10	45	0.31434	0.012202	23.0057	6.31535
11	50	0.38502	0.013590	25.6225	7.03369
12	55	0.46215	0.014537	27.4078	7.52379
13	60	0.54291	0.014893	28.0793	7.70811
14	65	0.62383	0.0 14598	27.5234	7.55551
15	70	0.70145	0.013702	25.8344	7.09186
16	75	0.77284	0.012348	23.2819	6.39117
17	80	0.83601	0.010727	20.2252	5.55206
18	85	0.89001	0.009026	17.0176	4.67153
19	90	0.93484	0.007393	13.9386	3.82631
20	95	0.97116	0.0 05923	11.1675	3.06562
21	100	1.00000	0.004662	8.7905	2.41309

ACRE FOOT VALUATION OF INSTREAM FLOWS
REST OF YEAR SUBSAMPLE
MIDDLE SUBBASIN
RESIDENTS
RIVERS

OBS	FLOW	PREDICT	DERIV	MARG	SEMARG
1	0	0.01769	0.0 00820	0.42222	0.1 1591
2	5	0.02345	0.0 01082	0.55709	0.1 5293
3	10	0.03104	0.0 01423	0.73275	0.20115
4	15	0.04101	0.0 01865	0.95985	0.2 6349
5	20	0.05403	0.0 02429	1.25059	0.3 4330
6	25	0.07093	0.0 03143	1.61803	0.4 4417
7	30	0.09270	0.0 04030	2.07455	0.56949
8	35	0.12045	0.005107	2.62918	0.7 2174
9	40	0.15536	0.0 06378	3.28349	0.9 0136
10	45	0.19856	0.007821	4.02614	1.1 0522
11	50	0.25094	0.0 09377	4.82711	1.3 2510
12	55	0.31290	0.0 10944	5.63384	1.5 4656
13	60	0.38410	0.012379	6.37242	1.7 4931
14	65	0.46321	0.013514	6.95690	1.9 0975
15	70	0.54793	0.014194	7.30704	2.0 0587
16	75	0.63512	0.0 14316	7.36962	2.0 2305
17	80	0.72128	0.013859	7.13474	1.9 5857
18	85	0.80305	0.0 12896	6.63896	1.8 2248
19	90	0.87776	0.0 11565	5.95383	1.6 3440
20	95	0.94365	0.0 10034	5.16544	1.4 1798
21	100	1.00000	0.0 08458	4.35436	1.1 9533

FLOW = Percentage of actual flows

MARG =The marginal value per acre/foot of water.

RESIDENTS
RESERVOIRS

OBS	FLOW	PREDICT	DERIV	MARG	SEMARG
1	0	0.02158	0.0 01111	0.11251	0.0 2754
2	5	0.02887	0.0 01476	0.14953	0.0 3660
3	10	0.03853	0.0 01954	0.19786	0.0 4843
4	15	0.05129	0.0 02570	0.26028	0.0 6371
5	20	0.06800	0.0 03355	0.33976	0.0 8316
6	25	0.08970	0.0 04335	0.43909	0.10748
7	30	0.11757	0.005531	0.56015	0.1 3711
8	35	0.15283	0.0 06940	0.70288	0.1 7205
9	40	0.19662	0.0 08530	0.86392	0.2 1147
10	45	0.24977	0.0 10221	1.03522	0.2 5339
11	50	0.31249	0.0 11881	1.20331	0.2 9454
12	55	0.38411	0.0 13331	1.35018	0.3 3049
13	60	0.46291	0.0 14378	1.45620	0.3 5644
14	65	0.54610	0.0 14860	1.50497	0.3 6838
15	70	0.63020	0.0 14695	1.48832	0.3 6430
16	75	0.71158	0.0 13913	1.40910	0.3 4491
17	80	0.78706	0.0 12640	1.28014	0.31335
18	85	0.85435	0.011060	1.12013	0.2 7418
19	90	0.91227	0.0 09364	0.94841	0.2 3215
20	95	0.96063	0.0 07711	0.78094	0.1 9116
21	100	1.00000	0.006205	0.62843	0.1 5382

ACRE FOOT VALUATION OF INSTREAM FLOWS
REST OF YEAR SUBSAMPLE
MIDDLE SUBBASIN
RESIDENTS
RESERVOIRS

OBS	FLOW	PREDICT	DERIV	MARG	SEMARG
1	0	0.00827	0.000485	0.01793	0.00982
2	5	0.01159	0.000678	0.02506	0.01372
3	10	0.01622	0.000945	0.03495	0.01913
4	15	0.02267	0.001313	0.04856	0.02658
5	20	0.03161	0.001817	0.06719	0.03677
6	25	0.04395	0.002498	0.09238	0.05056
7	30	0.06084	0.003405	0.12592	0.06892
8	35	0.08372	0.004587	0.16966	0.09286
9	40	0.11432	0.006084	0.22503	0.12317
10	45	0.15448	0.007903	0.29232	0.16000
11	50	0.20594	0.009993	0.36962	0.20230
12	55	0.26992	0.012213	0.45170	0.24723
13	60	0.34650	0.014318	0.52955	0.28984
14	65	0.43412	0.015988	0.59135	0.32366
15	70	0.52935	0.016912	0.62550	0.34236
16	75	0.62723	0.016892	0.62478	0.34196
17	80	0.72224	0.015934	0.58933	0.32256
18	85	0.80947	0.014239	0.52664	0.28825
19	90	0.88555	0.012124	0.44841	0.24543
20	95	0.94902	0.009905	0.36636	0.20052
21	100	1.00000	0.007824	0.28939	0.15839

FLOW = Percentage of actual flows

MARG =The marginal value per acre/foot of water.

RESIDENTS
RIVERS

OBS	FLOW	PREDICT	DERIV	MARG	SEMARG
1	0	0.04580	0.001833	1.45282	0.32895
2	5	0.05794	0.002295	1.81837	0.41172
3	10	0.07310	0.002856	2.26305	0.51240
4	15	0.09190	0.003529	2.79670	0.63323
5	20	0.11502	0.004324	3.42624	0.77577
6	25	0.14321	0.005241	4.15298	0.94032
7	30	0.17715	0.006271	4.96928	1.12514
8	35	0.21745	0.007389	5.85492	1.32567
9	40	0.26450	0.008549	6.77413	1.53380
10	45	0.31838	0.009685	7.67461	1.73768
11	50	0.37869	0.010714	8.49032	1.92238
12	55	0.44454	0.011545	9.14883	2.07148
13	60	0.51449	0.012093	9.58297	2.16978
14	65	0.58669	0.012297	9.74426	2.20629
15	70	0.65901	0.012132	9.61382	2.17676
16	75	0.72930	0.011619	9.20695	2.08464
17	80	0.79567	0.010814	8.56941	1.94029
18	85	0.85662	0.009802	7.76702	1.75861
19	90	0.91121	0.008672	6.87224	1.55601
20	95	0.95899	0.007511	5.95227	1.34771
21	100	1.00000	0.006387	5.06104	1.14592

ACRE FOOT VALUATION OF INSTREAM FLOWS
REST OF YEAR SUBSAMPLE
LOWER SUBBASIN
RESIDENTS
RIVERS

OBS	FLOW	PREDICT	DERIV	MARG	SEMARG
1	0	0.01734	0.000981	0.25011	0.05663
2	5	0.02371	0.001333	0.33989	0.07696
3	10	0.03233	0.001804	0.45992	0.10414
4	15	0.04398	0.002427	0.61875	0.14010
5	20	0.05958	0.003240	0.82597	0.18702
6	25	0.08030	0.004281	1.09121	0.24707
7	30	0.10748	0.005579	1.42201	0.32197
8	35	0.14259	0.007142	1.82034	0.41216
9	40	0.18703	0.008936	2.27771	0.51572
10	45	0.24185	0.010867	2.76995	0.62717
11	50	0.30737	0.012766	3.25402	0.73678
12	55	0.38280	0.014401	3.67068	0.83111
13	60	0.46596	0.015519	3.95565	0.89564
14	65	0.55339	0.015920	4.05800	0.91881
15	70	0.64086	0.015528	3.95807	0.89619
16	75	0.72409	0.014418	3.67506	0.83211
17	80	0.79963	0.012788	3.25963	0.73805
18	85	0.86528	0.010891	2.77600	0.62854
19	90	0.92022	0.008959	2.28356	0.51704
20	95	0.96478	0.007162	1.82558	0.41335
21	100	1.00000	0.005596	1.42646	0.32298

FLOW = Percentage of actual flows
MARG =The marginal value per acre/foot of water.

RESIDENTS
RESERVOIRS

OBS	FLOW	PREDICT	DERIV	MARG	SEMARG
1	0	0.03548	0.001569	0.007553	0.002722
2	5	0.04580	0.002007	0.009661	0.003482
3	10	0.05896	0.002553	0.012291	0.004429
4	15	0.07565	0.003226	0.015531	0.005597
5	20	0.09665	0.004042	0.019457	0.007012
6	25	0.12282	0.005010	0.024117	0.008692
7	30	0.15504	0.006128	0.029498	0.010631
8	35	0.19413	0.007374	0.035498	0.012793
9	40	0.24072	0.008703	0.041892	0.015098
10	45	0.29506	0.010037	0.048314	0.017412
11	50	0.35692	0.011272	0.054260	0.019555
12	55	0.42536	0.012288	0.059152	0.021318
13	60	0.49877	0.012969	0.062426	0.022498
14	65	0.57492	0.013226	0.063665	0.022945
15	70	0.65125	0.013026	0.062703	0.022598
16	75	0.72514	0.012396	0.059670	0.021505
17	80	0.79432	0.011417	0.054955	0.019806
18	85	0.85708	0.010202	0.049110	0.017699
19	90	0.91241	0.008875	0.042719	0.015396
20	95	0.95998	0.007541	0.036298	0.013082
21	100	1.00000	0.006280	0.030232	0.010895

ACRE FOOT VALUATION OF INSTREAM FLOWS
REST OF YEAR SUBSAMPLE
LOWER SUBBASIN
RESIDENTS
RESERVOIRS

OBS	FLOW	PREDICT	DERIV	MARG	SEMARG
1	0	0.01952	0.001000	0.001661	0.001339
2	5	0.02616	0.001333	0.002213	0.001784
3	10	0.03500	0.001769	0.002938	0.002367
4	15	0.04669	0.002336	0.003878	0.003125
5	20	0.06208	0.003062	0.005083	0.004097
6	25	0.08215	0.003977	0.006603	0.005321
7	30	0.10807	0.005104	0.008474	0.006829
8	35	0.14108	0.006451	0.010711	0.008632
9	40	0.18241	0.007998	0.013279	0.010701
10	45	0.23303	0.009681	0.016074	0.012953
11	50	0.29343	0.011384	0.018901	0.015232
12	55	0.36325	0.012939	0.021484	0.017313
13	60	0.44109	0.014150	0.023494	0.018933
14	65	0.52445	0.014835	0.024633	0.019851
15	70	0.60993	0.014882	0.024710	0.019913
16	75	0.69381	0.014282	0.023713	0.019110
17	80	0.77261	0.013135	0.021809	0.017575
18	85	0.84367	0.011616	0.019287	0.015543
19	90	0.90543	0.009922	0.016475	0.013277
20	95	0.95742	0.008228	0.013662	0.011010
21	100	1.00000	0.006657	0.011054	0.008908

FLOW = Percentage of actual flows
PREDICT =The predicted visitation rate for each flow

MARG =The marginal value per acre/foot of water.

NONRESIDENTS
RIVERS

OBS	FLOW	PREDICT	DERIV	MARG	SEMARG
1	0	0.01643	0.000815	2.4063	0.39324
2	5	0.02202	0.001087	3.2200	0.52460
3	10	0.02947	0.001445	4.2684	0.69756
4	15	0.03935	0.001914	5.6512	0.92354
5	20	0.05240	0.002519	7.4391	1.21574
6	25	0.06951	0.003291	9.7191	1.58835
7	30	0.09175	0.004258	12.5735	2.05483
8	35	0.12034	0.005438	16.0604	2.62468
9	40	0.15657	0.006835	20.1836	3.29851
10	45	0.20164	0.008416	24.8531	4.06162
11	50	0.25644	0.010106	29.8446	4.87736
12	55	0.32126	0.011776	34.7761	5.58329
13	60	0.39549	0.013250	39.1279	6.39449
14	65	0.47738	0.014332	42.3251	6.91699
15	70	0.56409	0.014858	43.8766	7.17054
16	75	0.65202	0.014738	43.5232	7.11278
17	80	0.73736	0.013994	41.3252	6.75357
18	85	0.81672	0.012746	37.6412	6.15152
19	90	0.88765	0.011178	33.0112	5.39487
20	95	0.94883	0.009483	28.0037	4.57651
21	100	1.00000	0.007820	23.0941	3.77415

ACRE FOOT VALUATION OF INSTREAM FLOWS
REST OF YEAR SUBSAMPLE
UPPER SUBBASIN
NONRESIDENTS
RIVERS

OBS	FLOW	PREDICT	DERIV	MARG	SEMARG
1	0	0.00720	0.000469	0.4146	0.06775
2	5	0.01033	0.000670	0.5925	0.09683
3	10	0.01478	0.000955	0.8447	0.03805
4	15	0.02112	0.001357	1.2001	0.09613
5	20	0.03011	0.001918	1.6965	0.07725
6	25	0.04277	0.002693	2.3815	0.08919
7	30	0.06045	0.003743	3.3102	0.04097
8	35	0.08486	0.005132	4.5387	0.04173
9	40	0.11802	0.006905	6.1075	0.09811
10	45	0.16208	0.009061	8.0143	1.00973
11	50	0.21895	0.011505	10.1754	1.66292
12	55	0.28966	0.014010	12.3909	2.02499
13	60	0.37362	0.016216	14.3424	2.34391
14	65	0.46799	0.017702	15.6562	2.55862
15	70	0.56777	0.018127	16.0326	2.62012
16	75	0.66665	0.017388	15.3785	2.51323
17	80	0.75858	0.015664	13.8535	2.26401
18	85	0.83907	0.013333	11.7925	1.92720
19	90	0.90596	0.010815	9.5647	1.56312
20	95	0.95915	0.008434	7.4590	1.21899
21	100	1.00000	0.006378	5.6410	0.92188

FLOW = Percentage of actual flows

MARG =The marginal value per acre/foot of water

NONRESIDENTS
RIVERS

OBS	FLOW	PREDICT	DERIV	MARG	SEMARG
1	0	0.01643	0.000815	0.19641	0.03210
2	5	0.02202	0.001087	0.26202	0.04282
3	10	0.02947	0.001445	0.34840	0.05694
4	15	0.03935	0.001914	0.46127	0.07538
5	20	0.05240	0.002519	0.60721	0.09923
6	25	0.06951	0.003291	0.79332	0.12965
7	30	0.09175	0.004258	1.02631	0.16772
8	35	0.12034	0.005438	1.31092	0.21424
9	40	0.15657	0.006835	1.64747	0.26924
10	45	0.20164	0.008416	2.02862	0.33153
11	50	0.25644	0.010106	2.43604	0.39811
12	55	0.32126	0.011776	2.83857	0.46389
13	60	0.39549	0.013250	3.19379	0.52195
14	65	0.47738	0.014332	3.45476	0.56459
15	70	0.56409	0.014858	3.58139	0.58529
16	75	0.65202	0.014738	3.55255	0.58058
17	80	0.73736	0.013994	3.37313	0.55126
18	85	0.81672	0.012746	3.07244	0.50211
19	90	0.88765	0.011178	2.69452	0.44035
20	95	0.94883	0.009483	2.28578	0.37355
21	100	1.00000	0.007820	1.88504	0.30806

ACRE FOOT VALUATION OF INSTREAM FLOWS
REST OF YEAR SUBSAMPLE
MIDDLE SUBBASIN
NONRESIDENTS
RIVERS

OBS	FLOW	PREDICT	DERIV	MARG	SEMARG
1	0	0.00720	0.000469	0.03085	0.00504
2	5	0.01033	0.000670	0.04409	0.00721
3	10	0.01478	0.000955	0.06286	0.01027
4	15	0.02112	0.001357	0.08931	0.01460
5	20	0.03011	0.001918	0.12625	0.02063
6	25	0.04277	0.002693	0.17722	0.02896
7	30	0.06045	0.003743	0.24634	0.04026
8	35	0.08486	0.005132	0.33775	0.05520
9	40	0.11802	0.006905	0.45450	0.07428
10	45	0.16208	0.009061	0.59639	0.09747
11	50	0.21895	0.011505	0.75722	0.12375
12	55	0.28966	0.014010	0.92209	0.15069
13	60	0.37362	0.016216	1.06732	0.17443
14	65	0.46799	0.017702	1.16509	0.19040
15	70	0.56777	0.018127	1.19309	0.19498
16	75	0.66665	0.017388	1.14442	0.18703
17	80	0.75858	0.015664	1.03093	0.16848
18	85	0.83907	0.013333	0.87756	0.14342
19	90	0.90596	0.010815	0.71177	0.11632
20	95	0.95915	0.008434	0.55507	0.09071
21	100	1.00000	0.006378	0.41978	0.06860

FLOW = Percentage of actual flows

MARG =The marginal value per acre/foot of water.

NONRESIDENTS
RIVERS

OBS	FLOW	PREDICT	DERIV	MARG	SEMARG
1	0	0.01643	0.000815	0.07894	0.01290
2	5	0.02202	0.001087	0.10530	0.01721
3	10	0.02947	0.001445	0.14002	0.02288
4	15	0.03935	0.001914	0.18538	0.03030
5	20	0.05240	0.002519	0.24403	0.03988
6	25	0.06951	0.003291	0.31883	0.05210
7	30	0.09175	0.004258	0.41246	0.06741
8	35	0.12034	0.005438	0.52685	0.08610
9	40	0.15657	0.006835	0.66211	0.00820
10	45	0.20164	0.008416	0.81529	0.03324
11	50	0.25644	0.010106	0.97903	0.06000
12	55	0.32126	0.011776	1.14080	0.08644
13	60	0.39549	0.013250	1.28356	0.00977
14	65	0.47738	0.014332	1.38844	0.02691
15	70	0.56409	0.014858	1.43933	0.03522
16	75	0.65202	0.014738	1.42774	0.03333
17	80	0.73736	0.013994	1.35564	0.02155
18	85	0.81672	0.012746	1.23479	0.00180
19	90	0.88765	0.011178	1.08291	0.07697
20	95	0.94883	0.009483	0.91864	0.05013
21	100	1.00000	0.007820	0.75758	0.02381

ACRE FOOT VALUATION OF INSTREAM FLOWS
REST OF YEAR SUBSAMPLE
LOWER SUBBASIN
NONRESIDENTS
RIVERS

OBS	FLOW	PREDICT	DERIV	MARG	SEMARG
1	0	0.00720	0.000469	0.01461	0.002387
2	5	0.01033	0.000670	0.02088	0.003412
3	10	0.01478	0.000955	0.02976	0.004864
4	15	0.02112	0.001357	0.04228	0.006910
5	20	0.03011	0.001918	0.05977	0.009768
6	25	0.04277	0.002693	0.08391	0.013712
7	30	0.06045	0.003743	0.11663	0.019060
8	35	0.08486	0.005132	0.15991	0.026133
9	40	0.11802	0.006905	0.21518	0.035166
10	45	0.16208	0.009061	0.28236	0.046145
11	50	0.21895	0.011505	0.35851	0.058589
12	55	0.28966	0.014010	0.43656	0.071346
13	60	0.37362	0.016216	0.50532	0.082582
14	65	0.46799	0.017702	0.55161	0.090147
15	70	0.56777	0.018127	0.56487	0.092314
16	75	0.66665	0.017388	0.54182	0.088548
17	80	0.75858	0.015664	0.48809	0.079767
18	85	0.83907	0.013333	0.41548	0.067900
19	90	0.90596	0.010815	0.33699	0.055073
20	95	0.95915	0.008434	0.26280	0.042948
21	100	1.00000	0.006378	0.19875	0.032480

FLOW = Percentage of actual flows
PREDICT =The predicted visitation ...

MARG =The marginal value per acre/foot of water.