Economic Valuation of Fisheries: Nonmarket Studies in the Clark Fork Basin

John Duffield
Department of Economics
University of Montana
Missoula, MT 59812

Abstract

This paper provides an introduction to methods used by economists a value nonmarket resources. Recent applications to valuing Montana trout stream fisheries, including the major waters in the Clark Fork Basin are described. One finding is that the present recreational value of the Montana stream fisheries is quite large on the order of 3.0 billion dollars. This estimate is conservative since includes nonangling recreational use and potentially significant existence (or intrinsic) values. The valuation across streams varies considerably reflecting differences in both water quality and quantity. The highest value/mile (annual basis) in the state IS on the Madison River at $184.000/mile. The Upper Clark Fork value per mile ($7.400) is the second lowest for the group of 20 major waters compared. Angler characteristics (such as average distance traveled. fishing technique angler preferences. and mean trip length) also vary considerably across site and help explain differences in value per trip. Consistency, reliability and precision of the results are discussed.

Introduction

Although fishery and wildlife resources are generally not traded in established markets, there are often situations where it would be useful to know the dollar value of these resources. For example, in 1981 an electric cooperative proposed to build a 144-mega watt hydroelectric facility at on the Kootenai River below Libby. The project would have substantially altered Kootenai Falls and a popular fishery, the China Rapids. In deciding whether society is better off with or without the dam, it is useful to know if the dollar value of the electricity exceeds the project costs, including the cost of the foregone recreation (Duffield. 1984). Similar situations arise when public agencies consider investing in facilities to improve fisheries; then the question is whether the investment in a hatchery or boat access is justified by the recreational benefits.

Motivated initially by the need to evaluate public investment decisions, economists have developed a variety of methods to measure the value of nonmarket resources. The latter include not only fish and wildlife, but other public goods such as clean air, visibility and the value of health. These procedures have been defined and endorsed by the U.S. Water Resources Council (1983) and are now being applied to a variety of state and federal policy decisions. A new and potentially important application of these methods is in evaluating natural resource damage due to toxic wastes under the Superfund legislation. For example, a group of economists are currently working on estimating the total damage to the Alaskan marine and coastal environment resulting from the Exxon- Valdez oil spill. Relatedly, these methods can be used to guide resource management decisions. An interesting current project is examining the effect of downstream releases from Glen Canyon Dam on boaters in the Grand Canyon of the Colorado. The tradeoff is the value of electricity to meet peak loads versus the impacts on recreation and the environment.

In 1985, the Montana Department of Fish, Wildlife and Parks (DFWP) initialed the Montana Bioeconomics Project, a series of nonmarket valuation studies aimed at evaluating Montana fish and wildlife resources. The motivation for this paper is to provide scientists in other disciplines with an overview of economic methods and results concerning Montana's coldwater stream fisheries.

The general focus in this symposium is, of course, on the environmental degradation associated with more than 125 years of copper and silver mining and smelting activities in the Clark Fork Basin. Botanists, entomologists and fishery biologists have long examined the potential impacts on biota of water quality degradation in the basin. However, one way to think of the social science work described here is also as a type of "biotic response" -but for an organism further up the food chain. Anglers are attracted by fish and “good fishing" (though there are of course a large variety of nonpredative motivations associated with fishing. perhaps especially in the days of catch and release regulations). We are in fact far from having an integrated model of the basin that begins with sediment transport and hydrology and ends with the social response. The work described below is only casually connected to the biological state of a given river. However, there does seem to be evidence that the depressed fishery in the Upper Clark Fork is mirrored by depressed (or mainly absent) anglers.

The emphasis here is on a comparison across the twenty major trout streams in the state. This comparison provides some insights into the relative quality of the major fisheries in the Clark Fork Basin: the mainstem Clark Fork, Rock Creek, the Bitterroot and the Blackfoot. Recent work concerning the validity, precision and reliability of the estimated values is also summarized. In addition, simpler and more robust measures of potential values such as angler use per river mile are also compared across the major streams.

Overview and Methods

The most obvious economic dimension of recreational activity is the associated expenditure on travel, lodging, meals, and equipment. Expenditures are of interest to economists because of the regional and local economic activity (measured by employment and income) that expenditures generate. However, expenditures are ~ inappropriate way to value a given recreational resource, such as a river-based fishery. The value of these resources is instead correctly measured by the net benefits they provide to society. From the standpoint of the river recreationist, travel and related expenditures indicate the cost of a given activity, not the benefit. Benefits are measured by individual and aggregate willingness to pay (over and above costs) for the use of the resource. Net benefits are also termed "efficiency" measures in that they are used in benefit-cost type analysis to identify the most efficient use of a given resource (i.e., the use that yields the greatest net benefits to society).

Where markets exist for recreational resources, the observed relationship of prices and quantity of use (the economic demand function) can be used to measure net benefits. For example, in many European countries, fishing rights are owned by the adjacent landowner. In Norway prices on the best Atlantic salmon waters are on the order of $200 per day. There are a few examples of fee fisheries in Montana, including Nelson's Spring Creek near Livingston where the charge is currently $40 per day for the summer season and $20 in the winter. The fee on Red Rock River south of Dillon is now $45 per day. However, in an area where free public access characterizes most fishing opportunities, fees on restricted access sites may only indicate the value of the quality differential between the fee fishery and open access sites (Stoll, 1988).

In the absence of extensive markets for Montana's recreational fisheries, nonmarket valuation methods are used to measure net willingness to pay. The two most widely used approaches are the travel cost method and contingent valuation. The travel cost approach is based on observations of how participation varies with the cost of travel to a site. For example, per capita visits to the Madison River are much higher from nearby communities such as Ennis or Bozeman than from Billings or Salt Lake. The key assumption of the model is that individuals would react to a fee for use at the site in the same way that they respond to the cost of travel. In this way a demand curve relating price (entrance fee) and quantity demanded (total trips) is derived. There are a variety of methodological issues related to this approach including choice of functional form and the value of travel time. For a discussion of these issues see Dwyer, Kelly and Bowes (1977) and Duffield, Loomis and Brooks (1988).

The contingent valuation approach is more straightforward in that participants are surveyed and asked directly what they are willing to pay for use of the resource. Generally a hypothetical situation that involves a payment is described to the respondent and her valuation response is given contingent on accepting the situation -hence the term, contingent valuation. Hypothetical payment vehicles in previous studies have included entrance fees, increases in monthly electrical bill, changes in taxes, increases in travel costs, and contributions to trust funds. Methodological issues associated with contingent valuation include choice of question format and welfare measure. Cummings. Brookshire and Schultze (1986 and Mitchell and Carson (1989) provide recent surveys of this literature. 6)

There has been an increasing use of these methods to value outdoor recreation in the United States. In a 1978 1iterature review, Dwyer identified 15 such studies while Walsh, Johnson and McKean (1988) in a recent review discuss a total of 120 studies completed in 1968-1988. The majority of these studies (82 percent) have been concerned with hunting and fishing uses of wildlife, while comparatively little attention has been given to so called nonconsumptive uses such as wildlife viewing, photography or nature study.

The discussion to this point has been in terms of nonmarket resource values related to direct recreational use. As first proposed by Krutilla (1967), there are additionally indirect or intrinsic values associated with the preservation or existence of a given resource, such as a unique natural environment or species. These values, generally termed existence values, are independent of personal use and may involve motives such as altruism, concern for other species or a desire to protect resources for future generations. Existence values are evidenced by donations to organizations such as the Nature Conservancy or the World Wildlife Fund. Randall and Stoll (1983) have described a total valuation framework for estimating both direct use and existence values for a given resources. A recent review (Butkay and Duffield, 1990) identified only five such studies of wildlife resources including estimates for bald eagles, whooping cranes, and bighorn sheep.

Application to Mont Ana Stream Fisheries

This section provides an overview of recent application of both travel cost and contingent valuation to Montana trout stream fisheries. These estimates are limited to direct angling use and are therefore conservative for excluding existence values and the value of other direct recreational uses such as boating or general shoreline activity. The intent here is to provide insight into methods and basic findings. Detailed discussion of the theoretical motivation, data, methods and results are available in the referenced studies.

Contingent Valuation

A contingent valuation study of seventeen major Montana trout streams was initiated in 1986 (Duffield and Allen, 1988). A total of 2672 questionnaires were mailed to resident and nonresident license holders who where known to have fished 111 given water in the previous year. A total of 2171 completed questionnaires were received for a response rate of 81 percent; this is a very high response for a mail survey.

For the contingent valuation question, anglers were asked a question in the so- called dichotomous choice format. In this format the response is “yes” or “no” as to willingness to pay a specific offer amount. This general format was first utilized by Bishop and Heberlein (1979). In the current application, anglers were asked to identify total trip expenditures for their most recent fishing trip, and then were asked "would you still have made the trip if your share of the expenses had been (dollar amount) more?” (yes or no). The dollar amount was varied randomly from $1 to $500 across respondents. It may be noted that an alternative question format is to ask an open-ended "what is the largest amount you would be willing to pay before you would discontinue use... This is a much harder question to answer and generally results in lower respondent participation rates.

For purposes of illustration, the response for the Missouri River (Holler to cascade section) is tabulated in Table I for the sub sample of 156 respondents whose most recent trip was to this river. As one would expect, respondents were much more likely to be willing to pay low offer amounts than high amounts. For example, 24 of 26 respondents asked to pay $1 to $5 said yes, while only 1 of 27 was willing to pay an amount of $150 to $500. Respondents also provided information on their socio-economic characteristics and trip characteristics. The relationship of the probability of paying to the offer amount and selected variables can be estimated using a logistic functional form. Maximum likelihood procedures were used in the SPSSX statistical package. The estimate for the Missouri is:

$$\mathbf{In\ (P/(I\text{-}P)) = 2.55 - 1.63\ LDOLAMT + .323\ LRGCOT} \qquad (1)$$
$$(8.75)\ (-5.96) \qquad\qquad (3.77)$$
$$+ .902\ LINCOME\ (2.24)$$

where: p = probability of a yes response

LDOLAMT = log of dollar bid amount

LRGCOT = log of number of large trout caught this trip

LINCOME = log of reported household income

(t-statistic in parenthesis)

The estimated coefficients are highly significant and the signs are consistent with a priori expectations. The more successful the trip and the higher the income of the participant, the more likely the respondent will be willing to pay a given amount, The estimated relationship of bid amount and the probability of a yes for the Missouri River sample is plotted in Figure 1, One measure of the average net willingness to pay is given by the area under the curve in Figure 1 up to the maximum and asked ($500), This truncated mean for the example is estimated at $63 dollars per trip, A variety of other measures can also be computed from the relationship in Equation 1 such as the median of the distribution of willingness to pay values. There is an ongoing debate among economists as to which of these measures is most appropriate.

For comparison purposes, the response for 146 Madison River anglers is also shown in Table 1. At a given bid amount, the proportion of Madison River anglers wining to pay is much higher; for example, only 19 percent of Missouri River anglers faced with offers in the range of $35 to $50 said yes, while 68 percent of Madison River anglers would pay this amount. This relatively higher probability is shown in Figure 2. The resulting estimated truncated mean value for the Madison is therefore also much higher at $228 compared to $63 for the Missouri. Estimated values per trip for 17 rivers using the contingent valuation method are shown is Table 2.

Travel Cost Model

A travel cost model application to 49 specific rivers or tributaries and 28 lakes in Montana was begun in 1985 (Duffield, Loomis and Brooks). Data was collected through two separate surveys administered by Montana Department of Fish, Wildlife and Parks (DFWP). The DFWP annual angler pressure survey (where 1500 to 3000 license holders are sampled monthly) was utilized to obtain basic origin-destination information. A total of 36.000 surveys were mailed in 1985 with a response of 54 percent or 19,271 surveys. A supplemental phone survey of 2000 licensed anglers was conducted in September and October of 1985 with a response rate of 75 percent. The latter survey provided detailed socioeconomic and trip expenditure data. Only the stream results are discussed here.

The basic relationship in the travel cost model is between per capita participation from a given zone and the associated travel cost to a given site. Origin zones at the county, county group, state and regional level were defined at increasing distances from the river sites. A total of 836 origin-destination pairs were identified for the stream model; a scatter plot of trips per capita versus distance for this sample is shown in Figure 3. The basic relationship is for decreasing visitation with higher distance. The statistical relationship of visitation and other explanatory variable was estimated using an ordinary least squares estimate of a linear regression model:

$$\text{In}(TRIPSij/POPij) = -1.615 - 1.798\ \text{In}(RTDISTij) \qquad (2)$$

(t-statistic) (-2.96) (-50.13)

$$+.389\ \text{In}(SUMTRTj) - 4.43\ \text{In}(A\ VYRSFi)$$

(7.25) (-4.32)

where:

lRIPSij = stream fishing trips from origin i to site j

POPi = origin i's population

RmISTij = round trip road distance from i to j

SUMTRTj = sum or trout catch at j

AVYRSFi = average years fished by anglers in origin i

Equation (2) is based on a total of 727 observations with complete information. The model provides a good fit to the data and has high explanatory power (adjusted r-square is. 782). All reported parameters are highly significant. The sign on distance and trout catch is as hypothesized; the sign on the fishing experience variable does not have an obvious interpretation.

A limitation of this particular model is the absence of a variable measuring the price and availability of substitutes.

Net benefit estimates at the site level were estimated by integrating equation 2 for every origin-destination up to the maximum observed distance for the given site. (It can be shown that this approach is analytically equivalent to the usual approach of estimating the relationship of incremental travel cost and total visitation.) The implicit intercept on the quantity axis at a zero site price was set at the observed trip level following Gum and Martin (1975). Distance was convened to travel cost based on estimated variable costs of 22.4 cents per mile derived from angler reported expenditures and trip distances. Additionally travel time was valued at one-fifth the reported wage rate or 4.6 cents per mile. The latter is based on a contingent valuation estimate of Montana angler willingness to pay to shorten travel time and is somewhat conservative compared to the U.S. Water Resources Council (1983) standard recommended procedure of one-third the wage rate.

Travel cost model estimates of value per trip for 20 major Montana trout streams are provided in Table 2.

Other Fishery Economics Results

In addition to estimating baseline values by stream, a number of other aspects of fishery economics have been examined for Montana fisheries. Duffield and Allen 1988) undertook a market segmentation analysis to identify angler types. Cluster, analysis based on angler reported reasons for fishing yielded four distinct angler experiences or subgroups. These were consistent with the theory of angler specialization described by Bryan (1979) and included occasional users, generalists and a specialist category. Estimated trip values for the subgroups based on contingent evaluation varied markedly from $7.56 per trip for the occasional user to $91.03 and 117.07 for two generalist groups and $170.28 for specialists. These findings provide further insight into why average values vary across rivers; the more highly valued rivers are attracting a greater share of the specialized anglers.

There are also interesting differences in values across activities and trip qualities. For example, in a detailed contingent valuation study of Rock Creek anglers (Duffield. 1989) it was found that the average float angler trip was worth about 50 percent more than the average trip for fishing from the bank on this stream. Similarly, trips with chances of catching more trout or more large trout were more highly valued. The value of increased catch or higher success can also be inferred from the travel cost model reported above. Loomis (1989) applied this model to estimate the cost of lowered fishing quality on the Gallatin and Upper Yellowstone if a proposed wilderness area in the Gallatin National Forest was logged. Loomis estimated the foregone recreation benefits associated with reduced trout catch. The latter in turn was due to sedimentation that lowered sustainable fish populations.

Validation, Reliability, and Prcision of Estimates

Validation of Estimates

One indication of the validity of the estimated values presented in Table 2 is to determine the consistency across methods. The mean value for the 17 streams based he CVM approach is $126.69 while the mean for the TCM approach for the same set of streams is quite similar at $121.69. It should be noted that in the original report, a variety of specific CVM and TCM models and welfare measures were mined. The values reported are for two specific measures that appeared to be superior (the travel cost model using reported angler costs and the observed trip intercept and the CVM model using the logistic mean truncated at the maximum bid level of $500).

The two methods also are fairly consistent across sites. The ratio of the TCM/ M values at the site level is provided in Table 2; 10 of] 7 estimated TCM values are within plus or minus 25 percent of the CVM estimate. The greatest differences appear to be for sites with small sample sizes. This is as one would expect, since precision is a function of sample size. Tthe estimates are highly correlated. The Pearson correlation coefficient for the 17 site level estimates is .72 while Spearman is .71. The latter indicates that the methods provide similar site rankings in terms of value. When the sites with CVM samples of less than .80 observations are excluded, the remaining 12 river value estimates are even more highly correlated: .80 for the Pearson measure and .81 for the Spearman. This consistency is remarkable given the difference in method and data for the two models.

The ranking of rivers by TCM value is provided in Table 4. Generally the listing is consistent with a notion of which are the "best" fishing streams by rcputation. The Madison, Upper Yellowstone, Rock Creek, Big Hole, Gallatin and Bighorn are in the top ten, while the lower valued streams include the Clark Fork, Swan, Flathead and Kootenai. The TCM values are closely related to the average round trip distance anglers actually drive to fish the river. It makes sense that the better fisheries will have a larger spatial market. For example, the average trip to the Madison is 1146 miles, while the average trip to the Upper Clark Fork is 227 miles round trip. This indicates that the Upper Clark Fork is, comparatively, a fishery of only local importance. The Madison is a river of regional importance or a "destination" fishery.

Generally speaking, the higher valued streams have a greater share of fly fishermen, have more anglers saying it is their favorite stream and draw anglers spending more lime per trip al the given stream (Table 4).

Reliability of Estimates

The reliability of the methods is indicated by examining whether similar results are obtained in repealed applications. The CVM current trip question again asked of anglers on one of the sites, Rock Creek, in a 1988 survey (Duffield, 1989). The simple bivariate logit models estimated on the 1986 and 1988 data were very similar, with a predicted probability of a yes response al $250, $500 and $2000 bid levels being .170, .107 and .039 in the 1986 model and .164, .090 and .024 in the 1988 model. The mean values when the two models were truncated al the $500 bid level were very similar al $113 for 1986 and $118 for 1988. Corrected for inflation, the estimates would be even more similar.

Precision of Estimates

Only recently have methods been developed for estimating standard errors for welfare estimates in travel cost (Adamowicz, Fletcher and Graham- Tomasi, 1989) and contingent valuation dichotomous choice models (Duffield and Patterson, 1989). Standard errors have been estimated for contingent valuation welfare estimates on a sub sample of the 1986 stream database. A nonparametric method indicates 95 percent confidence intervals on the order of plus or minus 30 to plus or minus 70 percent for four specific streams examined. The relatively imprecise estimate (for the Middle Clark Fork) is for a case where the logistic model does not provide a good fu to the data. Results using a bootstrap approach are similar (Duffield and Patterson, 1989). Other things equal, it has been demonstrated in the latter reference that the magnitude of standard errors is an inverse function of sample size.

Comparision of Rivers by Valuation and Use Density

The findings described above can be used to develop a simple comparison of the major trout streams in the state in terms of value and use per mile. The purpose of looking at per mile measures is simply to make a comparison across streams that corrects for the length of the stream. This could be taken further by additionally looking at the level of now in cubic feet per second. One should be cautious in interpreting the value per mile measures; it would certainly be inappropriate to interpret these as marginal measures of the value associated with any specific mile of river. Use per mile is presented because this is a very simple and robust measure of recreational "productivity" of the different streams that abstracts from the more complex valuation measures.

Net Value Per Mile

An estimate of the 1otal value of each major trout stream fishery in Montana in 1985 is provided in Table 6. This estimate is based on value per angler day (derived from the travel cost model estimates described above) times the total angler use for that stream. The latter are based on McFarland (1989). The total value ranges from $17.5 million per year on the Madison to $531,000 on the Swan. The total value of Montana stream fisheries in 1985 was estimated to be $122 million. The present value of this resource in perpc1uity at a four percent real discount rate and assuming no growth in use is $3.1 billion.

The value per mile for the mainstem fisheries is also shown in Table 6, based on river milts from the DFWP stream database. The Madison is the most valuable fishery per mile at $184,300 per mile while the Smith is the lowest at $6,400. Val per mile is a function of both use and value per day. The Smith is in the middle rank of rivers in value per day, but has very low use (Table 7). This low use reflects the limited access to this river and the very short season when floating is feasible.

The Clark Fork Basin streams are underlined in the list in Table 6. Rock Creek is in the top five streams in the state in value per mile, while the Bitterroot and Blackfoot are in the middle rank. The Middle Clark Fork (from the confluence of the Bitterroot in Missoula downstream to Segal Creek) is the sixth lowest valued stream while the Upper Clark Fork is second lowest. The low value for the Clark Fork is due to both low value per trip (lowest for the 20 streams listed in Table 2) and low use (Table 7).

Use Per Mile

Value per mile depends on both use per mile and value per day. It is of interest to briefly examine the use per mile, which simply shows the popularity of a given river segment independent of the more complex value per day estimate.

Use per mile reflects on both the quality of a given recreational site and its location vis-a-vis population centers. For the 20 major river segments examined, the Missouri River between Holter and Cascade has the highest use per mile at 2022 angler days per year in 1985. This use is in pan due to this 36-mile segment's proximity (via interstate) to both Helena and Great Falls. Shorter segments of the Bighorn (the eight miles below Yellowtail dam) and the Madison also have had angler pressure on the order of 2000 days per mile.

In the Clark Fork Basin, the Bitterroot is most heavily used (692 days per mile) while the Upper Clark Fork is the least used (144 days per mile).

The effect of proximity to population centers is shown in Table 8 for subsections of the major Clark Fork Basin rivers. For example, use on the Bitterroot is much higher (1017 days per mile) in the section close to Missoula compared to the section from Bell Crossing near Victor to above Darby (375 per mile). The same phenomenon holds for the Blackfoot. By contrast, use on Rock Creek is more or less homogeneous throughout its entire length. This may reflect the very high quality of the Rock Creek fishery and the fact that the mouth is some distance upstream from Missoula (about 20 miles).

It is interesting to compare four river segments, all of which end about 80 miles from Missoula: the mainstem Bitterroot, Rock Creek, the Blackfoot to Arastra Creek, and the Upper Clark Fork to the Little Blackfoot. This comparison at least controls for proximity to the largest population center in the basin, although there are of course population differences in each valley. These segments average 692, 558, 336 and 149 days per mile respectively. It may be noted that Rock Creek use is almost as high as the Bitterroot even though it lacks a segment on the 20 miles closest to Missoula. All the other river segments begin in Missoula. Use on the Upper Clark Fork is only one-fourth the use on the two highest quality streams: the Bitterroot and Rock Creek. There is no comparable data for an 80 mile segment of the Clark Fork downstream from Missoula, but the 104 mile segment for that river downstream has a use of 292 days per mile-about the same as the Blackfoot.

Summary and Conclusions

Methods for estimating nonmarket values have been developed and widely applied by economists to recreational resources. Application of the contingent valuation and travel cost methods to Montana trout stream fisheries have yielded estimates that are remarkably consistant across sites. The validity, reliability and precision of these values has been examined. Comparison of values per mile for a set of 20 Montana rivers indicate that the Upper Clark Fork is much lower than on other major river segments in the Clark Fork Basin near Missoula. The extent to which this low value and use is due to degradation of the fishery remains to be investigated.

Acknowledgements

I would like to acknowledge the work of a number of other individuals that contributed to the series of fishery and wildlife valuation studies summarized here. This group of studies, the Montana Bioeconomics Project, was initiated by Pat Graham of the Montana Department of Fish, Wildlife and Parks (DFWP) and was a cooperative project directed by the University of Montana and DFWP. The research team included John Loomis at the University of California at Davis, Stewart Allen at the University of Idaho and Rob Brooks and Bob McFarland at DFWP. The author is solely responsible for the interpretations made here.

References

Adamowicz, W.L., J.J. Fletcher and T. Graham-Tomasi. 1989. “Functional Form and the Statistical Properties of Welfare Measures.” American Journal of Agricultural Economics 71:414-421.

Allen, Stewart. 1988. Montana Bioeconomics Study: Results of the Trout Stream Angler Preference Survey. Report for Montana Department of Fish, Wildlife and Parks. Helena.

Bishop, R.C. and T .A. Heberlein. 1979. "Measuring Values of Extra-Market Goods: Are Indirect Measures Biased?" American Journal of Agricultural Economics 61:926-930.

Bryan, Hobson. 1979. "Leisure Value Systems and Recreational Specialization: the Case of Trout Fishermen," Journal of Leisure Research 11:174-187.

Butkay, Susan and John Duffield. 1990. Wildlife and Fish in the Northern Region: Literature Review of Economic Studies of Hunting, Fishing and Wildlife Viewing. Report for U.S. Forest Service. Missoula.

Cummings, Ronald G., David S. Brookshire and William D. Schulze. 1986. Valuing Environmental Goods. Totowa: Rowman & Allanheld.

Duffield, John. 1984. "Travel Cost and Contingent Valuation: A Comparative Analysis." Advances in Applied Micro-Economics. Vol.l11. V .Kerry Smith and Ann D. Witte (eds.). Greenwich: JAI Press.

Duffield, John. 1989. Economic Analysis of Fishery Management Policy On Rock Creek. Report for Montana Department of Fish, Wildlife and Parks. Helena.

Duffield, John and Stewart Allen. 1988. Angler Preference Study Final Economics Report: Contingent Valuation of Montana Trout Fishing by River and Angler Subgroup. Report for Montana Department of Fish, Wildlife and Parks. Helena.

Duffield, John, John Loomis and Rob Brooks. 1987. The Net Economic Value of Fishing in Montana. Report for Montana Department of Fish, Wildlife and Parks. Helena.

Duffield, John and David Patterson. 1989. " A Discrete Probability Model: Implications for Design and Interpretation of Logistic Contingent Valuation". In Kevin Boyle and Trish Heekin, ed., Benefits and Costs in Natural Resources Planning, Department of Agricultural and Resource Economics, University of Maine, Orono.

Dwyer, J. 1978. Estimating Recreational Values for the 1980 RP A Program. Paper presented at RPA Workshop on Resource Value. Washington, D.C., May 8- 9.

Dwyer. J.J. Kelly and M. Bowes. 1977. Improved Procedures for the Valuation of the Contribution of Recreation to National Economic Development. Research Report77-128. Water Resources Center. University of Illinois at Champaign- Urbana.

Gum, R. and W.E. Martin. 1975. "Problems and Solutions in Estimating the Demand for the Value of Rural Outdoor Recreation." American Journal of Agricultural Economics 57:558-66.

Krutilla, John A. 1967. "Conservation Reconsidered." American Economic Review 57:77-86.

Loom is, John. 1989. II A More Complete Accounting of Costs and Benefits from Timber Sales," Journal of Forestry 87(3):19-23.

McFarland, Robert. 1989. Montana Statewide Angler Pressure Survey 198 Montana Department of Fish, Wildlife and Parks, Helena.

Mitchell, Robert C. and Richard T. Carson. 1989. Using Surveys to Value Public Goods: The Continent Valuation Method. Washington: Resources for the Future.

Randall, Alan and John R. Stoll. 1983. "Existence Value in a Total Valuation Framework." in Managing Air Quality and Scenic Resources at National Parks and Wilderness Area. R.D. Rowe and L.G. Chestnut, eds. Boulder: Westview Press.

Stoll. John R. 1988. Private Sector Transactions, Private Lands and the Valuation of Public Land Recreation. Departments of Agricultural Economics and of Recreation and Parks. Texas A&M University, College Station. Texas.

U.S. Water Resources Council. 1983. Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies. Washington: U.S. Government Printing Office.

Walsh, R.G., D .M. Johnson and J .R. McKean. 1988. Review of Outdoor Recreation Economic Demand Studies with Nonmarket Benefit Estimates, 1968-1988. USDA Forest Service. Rocky Mountain Forest and Range Experiment station. Fort Collins. CO.

Table 1. Summary of response to dichotomous choice valuation questions for the most recent trip: Missouri and Madison Rivers.

Dollar bid range	Missouri River yes/sample	Missouri River ratio yes	Madison River yes/sample	Madison River ratio yes
1-5	24/26	.92	17/17	1.00
6-15	22/25	.88	18/22	.82
18-30	14/32	.44	23/29	.79
35-50	7/30	.23	22/32	.69
70-100	3/16	.19	15/22	.68
150-500	1/27	.03	5/24	.25

Notes: Derived from Duffield and Allen, 1988. Missouri River is Holter to Cascade segment; Madison River is mainstem.

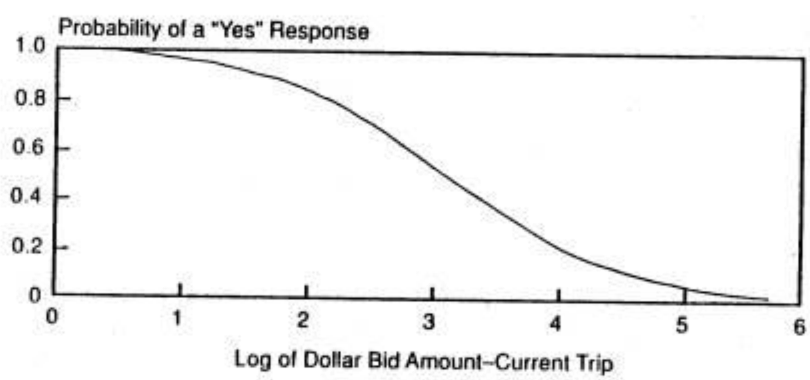

Figure 1. Probability of a "Yes" CVM answer for the Missouri River anglers (1986).

Table 2. Estimated value/trip for major cold water stream fishery in Montana.

River	Dollar value/trip		Ratio	Sample size	
	TCM	CVM	TCM/CVM	TCM	CVM
Madison	234	228	1.03	357	148
Upper Yellowstone	230	150	1.53	81	121
Boulder	180	149	1.21	57	69
Rock Creek	173	92	1.88	89	78
Big Hole	164	218	.75	187	140
Gallatin	161	180	.89	264	152
E. Gallatin	143			37	
Blackfoot	142	133	1.07	149	97
Bighorn	121	159	.60	160	151
Beaverhead	112	188	.59	120	108
Smith	94	153	.61	43	44
Stillwater	82	85	.96	133	113
Bitterroot	73	59	1.24	88	117
Middle Clark Fork	68	86	.79	231	126
Middle Yellowstone	63	74	.85	174	105
Swan	61			26	
Missouri Holter-C.	60	63	.95	357	148
Upper Flathead	56	99	.57	66	65
Kootenai	56	38	1.47	121	72
Upper Clark Fork	51			94	

Notes: Derived from Duffield and Allen, 1988. Underline denotes major Clark Fork Basin water. TCM (travel cost model) is in 1985 dollars CVM (contingent valuation) is in 1986 dollars. River segments are mainstems except: U. Clark Fork is Bitterroot R. to Warm Springs Cr.; M. Clark Fork is Bitterroot R. to Segal Cr.; U. Flathead is Flathead Lake to South Fork; Missouri is Holter to Cascade; U. Yellowstone is Springdale to Gardner; M. Yellowstone is Springdale to Huntley.

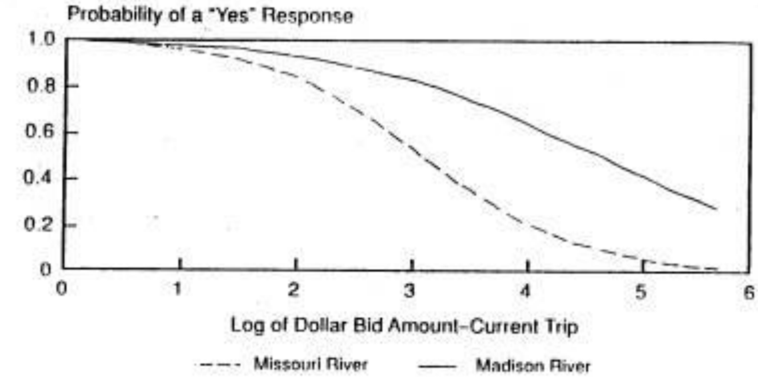

Figure 2. Comparison of Missouri and Madison rivers angler contingent valuation response (1986).

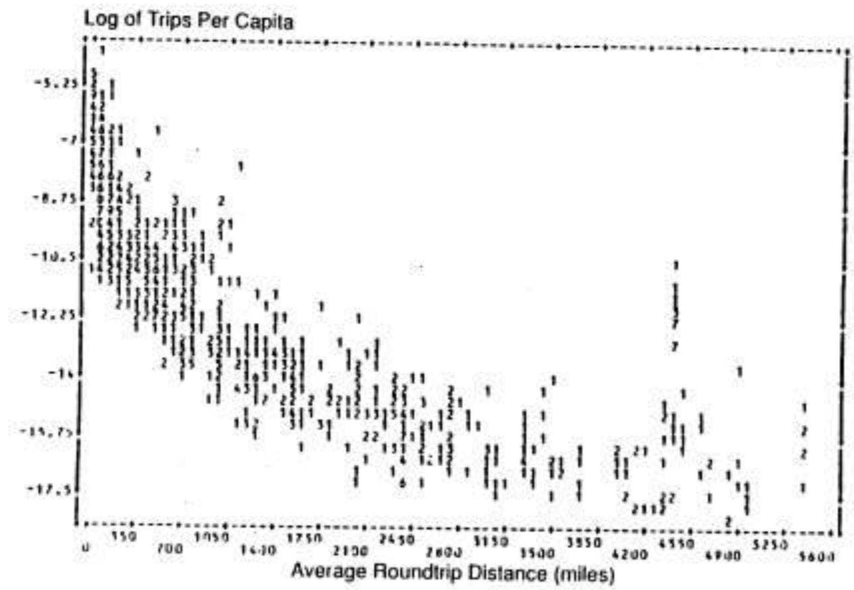

FIG. 3. Scatterplot of trips per capita versus distance for 836 origin destination pairs in 1985 travel cost model data base. (Frequencies equal numerical symbol except A=10, B=11, C=12 and D=13.)

Table 3: Correlation of value per trip estimates for two nonmarket valuation methods (travel cost and contingent valuation) for Montana rivers.

Sample	Correlation coefficient Pearson	Spearman
A. Complete sample (17 rivers):		
	.7253	.7132
	p = .000	p = .001
B. Subsample excluding sites with less than 80 observations (sample of 12 rivers):		
	.7993	.8112
	p = .001	p = .001

Notes: Derived from Duffield and Allen, 1988.

Table 5. Precision of estimates from dichotomous choice contingent valuation, subsample of Montana rivers.

River	Sample size	Nonparametric estimator Mean	Standard error	c.v.
M.Clark Fork	133	86.78	30.81	.35
Madison	160	185.19	27.15	.15
Missouri H-C.	157	47.60	8.28	.17
Smith	44	111.46	27.42	.21

Notes: Derived from Duffield and Patterson, 1989. "c.v." is the coefficient of variation. Mean is a truncated mean, with truncation at highest asked bid or $500 for Middle Clark Fork and Madison, $300 for Missouri Holter-Cascade and $250 for Smith.

Table 4 is on the next page.

Table 4: User and trip characteristics by river.

River	Roundtrip distance	Flyfish (percent)	Favorite river (percent)	Trip length (hours)
Madison	1146	69.5	25.6	20.1
U. Yellowstone	1154	43.2	19.7	16.9
Boulder	954	32.5	30.3	15.6
Rock Creek	856	66.0	23.2	13.5
Big Hole	788	43.3	23.3	12.1
Gallatin	848	52.5	17.8	6.5
E. Gallatin	771			
Blackfoot	692	30.1	10.7	7.5
Bighorn	542	59.4	24.6	13.7
Beaverhead	533	30.6	17.2	11.5
Smith	455	42.6	14.9	13.0
Stillwater	382	33.6	14.4	7.2
Bitterroot	364	41.2	13.5	8.4
M. Clark Fork	302	37.9	19.4	10.3
M. Yellowstone	314	5.8	6.4	18.1
Swan	291			
Missouri H-C.	256	26.9	20.8	9.6
U. Flathead	262	22.7	14.7	11.8
Kootenai	231	23.7	21.1	9.4
U. Clark Fork	227	38.7	6.3	7.4

Notes: Derived from Allen, 1988. Roundtrip distance (miles) and hours per trip on site are averages. Underline denotes major Clark Fork Basin water.

Table 6: Net economic value per mile for Montana rivers in 1985.

River	Value/mile (000's $)	Total value (000's $)	Miles
Madison	184.3	17509	95
U. Yellowstone	129.8	10905	84
Gallatin	110.5	9722	88
Missouri H-C.	101.8	3664	36
Rock Creek	73.9	3693	50
Bighorn	50.1	4210	84
Bitterroot	48.0	3891	81
Boulder	48.0	2351	49
Stillwater	44.5	2227	50
Big Hole	41.3	5201	126
Blackfoot	38.4	4029	105
Beaverhead	36.8	2321	63
Kootenai	27.2	1252	41
E. Gallatin	21.6	884	41
M. Clark Fork	19.0	1973	104
M. Yellowstone	16.0	1948	122
U. Flathead	15.4	849	55
Swan	8.9	531	60
U. Clark Fork	7.4	903	122
Smith	6.4	837	131

Notes: Derived from Duffield, Loomis and Brooks, 1987. Underline denotes major Clark Fork Basin water. All values are based on the travel cost model and are in 1985 dollars. River lengths are from the Interagency Stream Data Base defined on Montana Department of Fish, Wildlife and Parks river sections.

Table 7

Table 7. Angler-days per mile in 1985 for Montana rivers.

River	Angler-days/mile	length	1985 total use
Missouri H-C.	2022	36	72,788
Madison	1144	95	108,712
Gallatin	726	88	63,871
Bitterroot	692	81	56,024
Stillwater	657	50	32,857
U. Yellowstone	619	84	52,016
Rock Creek	558	50	27,881
Bighorn	534	84	44,814
Kootenai	491	46	22,591
Beaverhead	385	63	24,239
Big Hole	380	126	47,910
Boulder	356	49	17,429
M. Clark Fork	292	104	30,414
U. Flathead	277	55	15,262
Blackfoot	274	105	28,794
M. Yellowstone	255	122	31,156
E. Gallatin	151	41	6,191
Swan	146	60	8,746
U. Clark Fork	144	122	17,578
Smith	90	131	11,824

Notes: Angler use estimates for 1985 from Bob McFarland, Montana Department of Fish, Wildlife and Parks. Underline denotes major Clark Fork Basin water. River lengths from Interagency Stream Data Base. Use density for a longer (108 mile) section of the mainstem Missouri (Canyon Ferry to Moroni) is 1064 angler-days/mile and total use of 114,996.

Table 8: Angler-days per mile in 1985 for major waters in the Clark Fork Basin.

River/Section	length (miles)	angler-days total 1985	use/mile
Bitterroot			
01 Mouth-Bell crossing	40	40668	1017
02 Bell-Forks	41	15356	375
Mainstem	81	56024	692
Blackfoot			
01 Mouth-Clearwater R.	33	19802	600
02 Clearwater-Arastra Cr.	43	5751	134
03 Arastra Cr.-headwaters	29	3241	112
Mainstem	105	28794	274
Clark Fork			
01 Hwy 10A Bridge-Segal Cr.	44	11004	250
02 Segal Cr.-Bitterroot R.	104	30414	292
03 Bitterroot R.-L. Blackfoot R.	84	12501	149
04 L. Blackfoot-Warm Springs Cr.	38	5077	133
Mainstem	270	58996	219
Rock Creek			
01 Mouth-Hogback Cr.	29	15349	529
02 Hogback Cr.-Forks	21	12532	597
Mainstem	50	27881	558

Notes: Angler use estimates for 1985 from Bob McFarland, Montana Department of Fish, Wildlife and Parks. River section lengths from Interagency Stream Data Base.