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By Donn M. Johnson
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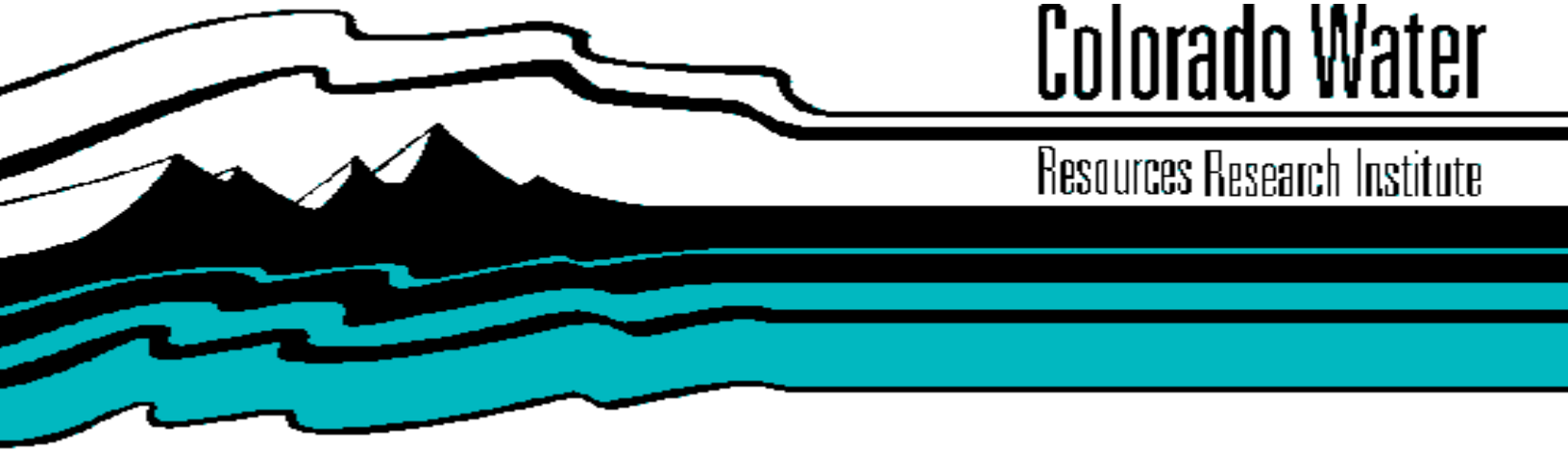

Colorado Water
Resources Research Institute

Colorado State University

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Donn M. Johnson and Richard G. Walsh*

EXECUTIVE SUMMARY

Understanding the value of alternative fishery management practices can help managers improve the efficiency of state programs. This report provides new evidence on the value of alternative fish stocking practices. We apply the contingent valuation method, recommended by the U.S. Water Resources Council, in a study of 200 recreation users of the cold water fishery at Blue Mesa Reservoir, near Gunnison, Colorado. At current catch rates, the gross economic value to anglers is $5.43 million. Of this amount, $2.64 million represents trip expenditures by anglers with impacts on state and local economic development. The remaining $2.79 million is the net value to anglers above what they spend. The net economic value to anglers greatly exceeds the cost of stocking and management reported as $0.44 million. Statistical functions relate marginal willingness to participate and pay to the number and size of fish caught. The results indicate that anglers place a higher marginal value on the size of fish caught, $1.25 per additional inch, than the number caught, $0.95 per additional fish.

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INTRODUCTION

Managers increasingly face important problems of evaluating fishing opportunities in a way that will allow comparisons with their economic costs. The problem is especially acute at many fishing sites, where it is not enough to know how many fishing days are produced. It is necessary to determine how much anglers value specific levels of fishing quality in order to make managerial decisions relating benefits to costs of alternative fishery management practices.

The contingent valuation method is the most important tool that we have to address such questions. The approach was recently recommended as providing an acceptable measure of the economic value of recreation opportunities and resources. The U.S. Water Resources Council (1979 and 1983) authorized use of the contingent valuation method and established procedures for its application to recreation and environmental quality problems. In this approach, a sample of the affected population is asked to report their maximum willingness to pay, contingent on hypothetical changes in recreation opportunities or resources. The approach has been successfully applied to a number of fishery valuation problems (Stevens, 1966) since its initial proposal by Davis (1963).

The purpose of this study is to apply the contingent valuation method to measure the effect of fishing quality on willingness to pay for the experience. The primary objective is to develop marginal benefit functions for the number and size of fish caught.

PROBLEM STATEMENT

The opportunity to engage in recreation fishing at Blue Mesa Reservoir is a product of the cooperation of many government agencies, including the Colorado Division of Wildlife, the Bureau of Reclamation, the National Park

Service and the U.S. Fish and Wildlife Service. The U.S. Fish and Wildlife Service conducts a fish stocking program as part of the Curecanti Project at a cost of approximately $57,500 per year to produce fish to stock Blue Mesa Reservoir for the Bureau of Reclamation. In addition, the Colorado Wildlife Division who administers recreation fishing at Blue Mesa under the state licensing program conducts a stocking and management program at a cost of approximately $250,000 per year for stocking and an additional $132,000 for management.[1]

Managers of the agencies involved are interested in improving efficiency of government operations, in particular, cost effectiveness of the fish stocking program at the reservoir. The program was initiated under Section 8 of the Colorado River Project Act of 1956 (Public Law 485, 70 Stat. 105) which established federal responsibilities for stocking. The Bureau of Reclamation administers Section 8 funding for the development and operation of recreation, fish, and wildlife facilities. Funding is provided to mitigate losses of and improve conditions for the propagation of fish and wildlife. This study responds to the question: What are the benefits and costs of the fish stocking program?

STUDY SITE

The study was conducted at Blue Mesa Reservoir, one of three reservoirs, which also include Morrow Point and Crystal, that constitute the Curecanti National Recreation area with over 1.1 million visitors per year. Blue Mesa was completed in 1965, Morrow Point in 1968, and Crystal in 1977 along a

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[1]Personal communication from Mr. Edward Kochman. The figure for management is based on a statewide estimate of $0.80 per angler day and does not include stocking costs.

40-mile stretch of the Gunnison River a short distance from the Gunnison National Monument. The primary function of Blue Mesa is a to provide flood control, water storage, and power production. At maximum capacity it is 20 miles in length, has a shoreline of 96 miles, a storage capacity of 1 million acre feet of water with a surface area of 9,000 acres.

Fishing is good with rainbow trout, kokanee salmon, brown trout, and lake trout entering the catch. A 1982 creel survey by the Wildlife Division reported 76.7 percent rainbow trout, 10.3 percent kokanee, with the remaining 13.0 percent brown trout and lake trout. The area has two of Colorado's better known trout streams--the Gunnison River and the Lake Fork, a stream feeding into the south side of Blue Mesa. There are three major campgrounds and several smaller ones around the reservoir. Boating, water skiing, sailing, windsurfing, hiking, and horseback trails are available. In addition, boating tours are conducted on Morrow Point Lake, which offer spectacular scenery in deep canyon settings.

Indications are that the catch of rainbow trout is dependent on decisions regarding the stocking program. The evidence is that 90 to 95 percent of the rainbow trout caught in Blue Mesa are stocked fish. Wiltzius (1978) found that 92 percent of the creel census in 1975 were fluorescent-marked rainbow trout from 1974 stockers. Since unmarked rainbow trout have been stocked in the main river above the reservoir each year and in other tributaries, it seems likely that most of the unmarked catch were also stocked fish. Consequently, it is apparent that naturally reproduced rainbow trout contributed little if anything to the Blue Mesa fishery.

Other species may have different stocking requirements to maintain a viable fishery. The kokanee salmon fishing is maintained by stocking, while a

small brown trout fishery is maintained by natural reproduction. It is uncertain whether the lake trout fishery depends on stocked fish or natural reproduction.

STUDY DESIGN

The data used in this study were obtained from on-site interviews by sampling 200 fishermen at the reservoir. Interviews were conducted on random days throughout July and August of 1986. Interviewing was initiated at the beginning of the day with the first person encountered at the study sites. Subsequent interviews were conducted with persons randomly selected throughout the day. Anglers were interviewed at the major boat launching areas and along the shoreline. The National Park Service requested that no interview be conducted in the campgrounds. The interviewer was identified as an employee of Colorado State University to establish the legitimate scientific purpose of the study. Of those approached only 2 persons refused to participate in the survey (thus sample bias should be insignificant).

The value questions were designed to be as realistic and credible as possible. Respondents were first asked to report the direct costs of their current trip. Then, they were asked to estimate the maximum amount they would be willing to pay rather than forego the recreation experience. Direct trip costs represent a generally accepted method of paying for recreation trips. This relatively neutral measure of value was selected over alternatives such as an entrance fee or tax in an effort to avoid emotional reaction and protest against the method of valuing fishing quality. As a result, protest responses, which were removed from the analysis, represented less than 5.0 percent of the sample, well within the Water Resources Council's (1979, 1983) standard of 15.0 percent.

An iterative bidding technique, recommended by the Council, was used to encourage fishermen to report maximum values, representing the point of indifference between having the amount of income reported or the specific change in quality of the resource. The respondents were asked to react to a series of dollar values posed by the interviewer. Respondents answered "yes" or "no" to whether they were willing to pay the stated amount of money to obtain the increment in recreation opportunity or resource. The interviewer increased the dollar value by random amounts until the highest amount the respondent was willing to pay was identified.

The Council recommends net willingness to pay (consumer surplus) as an acceptable economic measure of the benefits of public recreation programs. These net benefits are measured as the area below a demand curve and above direct cost or price. Interviewers asked fishermen to report their maximum willingness to pay for the current or marginal trip. The response represents a direct estimate of one point on a demand curve in which change in willingness to pay is related to the change in number of trips. Integrating under this marginal benefit function provided an estimate of total benefit. Subtracting direct travel costs from total benefits and dividing by number of days resulted in consumer surplus of $18.83 per day, with an average catch reported as 5.64 fish, 12.78 inches in length (12.12 inches for rainbow trout, 15.21 inches for kokanee salmon).

From this starting point, respondents then were asked to report changes in net willingness to pay and to participate contingent on changes in the quality of fishing. Values were obtained from each individual for two changes in the number and size of fish caught. These observations trace out the

representative individual anglers marginal benefit function for quality of the resource.

DESCRIPTIVE RESULTS

Table 1 summarizes the quality of fishing at Blue Mesa Reservoir. Anglers caught 5.64 fish per day and fished 4.87 hours for a catch rate of 1.16 fish per hour (The DOW creel census of 1982 showed a catch rate of 0.715 fish per hour). They primarily caught rainbow trout while kokanee salmon made up less than one quarter of the catch (brown and lake trout were incidental catch). Anglers stated that historically they caught an average of 6.95 fish per day. The difference between the catch recorded when interviews were conducted (5.64) and the stated average catch per day (6.95) might be explained, in part, by interviewers only contacting anglers once per day who occasionally fished more than once during the day, or the 1986 catch rate was less than usual due to greater numbers of anglers. The weighted average size of rainbow and kokanee, 12.78 inches, is very close to the historical average size anglers stated they caught, 12.91 inches.

Table 2 shows expenditure and time spent on the trip. The average trip was almost 270 miles one way and cost each member of the party approximately $16 per day. Individuals stated that the net benefit (consumer surplus) per day fo fishing above what they actually spent was $18.83. Individuals spent almost half of their total trip time fishing, while more than three-quarters of the benefits of the trip were attributed to fishing.

Table 3 describes fishing activity and preferences of anglers. The anglers at Blue Mesa spent over 90 percent of their fishing time using either bait or lures at all sites during the year. They prefer lakes to streams and often fish from boats as evidenced by the almost $5,000 average investment in

Table 1. Quality of Fishing at Blue Mesa Reservoir, Colorado

Variable	Mean	Standard Deviation
On the Day Interviewed		
Number of fish caught per day	5.64	4.69
Boat	5.92	4.62
Bank	4.46	4.82
Number of hours fished per day	4.87	2.16
Boat	4.92	2.07
Bank	4.67	2.51
Number of trout caught per day	4.42	4.12
Boat	4.57	4.12
Bank	3.77	4.10
Number of kokanee caught per day[a]	1.22	2.52
Boat	1.35	2.46
Bank	0.69	2.70
Average size of trout caught (inches)	12.12	2.31
Boat	12.75	1.49
Bank	9.42	3.11
Average size of kokanee caught (inches)	15.21	1.23
Boat	15.21	1.20
Bank	15.25	0.89
Number of fish kept per day	4.62	3.77
Boat	5.11	3.63
Bank	2.59	3.70
Percent catching at least 1 fish	90.0	
Boat	91.9	
Bank	82.1	
Percent catching more than 1 species	30.0	
Boat	32.9	
Bank	7.7	
Percent fishing from a boat	80.5	
Percent fishing from the bank	19.5	
On an Average Day at Blue Mesa (Historic)		
Average number of fish caught per day	6.95	4.15
Boat	7.34	4.13
Bank	5.31	3.88
Average size caught (inches)	12.91	1.70
Boat	13.38	1.31
Bank	10.95	1.74
Average number of days fished per year at Blue Mesa	14.67	19.11
Boat	14.83	18.27
Bank	14.03	22.35

[a] Only 3 of 39 bank fishermen caught kokanee.

Table 2. Expenditures, Value, and Use Patterns of Fishermen at Blue Mesa Reservoir, Colorado, 1986.

Variable	Mean
Length of trip in miles (one-way)	268.18
Trip cost per party in dollars	$ 391.69
Number of people in the party	3.66
Amount spent per individual in dollars	$ 107.02
Number of days on the trip	6.68
Amount spent per individual per day in dollars	$ 16.02
Consumer surplus per individual per day	$ 18.83
Boat	$ 19.75
Bank	$ 15.07
Percent of trip time spent fishing	49.50
Percent of trip time spent driving	21.48
Percent of trip time spent on other activities	29.05
Percent of trip costs attributed to fishing	32.94
Percent of trip costs attributed to driving	47.74
Percent of trip costs attributed to other activities	19.25
Percent of trip benefits attributed to fishing	77.24
Percent of trip benefits attributed to driving	13.91
Percent of trip benefits attributed to other activities	8.86

Table 3. Preferences of Fishermen at Blue Mesa Reservoir, Colorado, 1986

Variable	Mean
Percent of time spent fishing with bait (yearly)	33.89
Percent of time spent fishing with lures (yearly)	57.22
Percent of time spent fishing with flies (yearly)	8.89
Days fished at all sites during the year	35.80
Miles from home to closest comparable alternative to Blue Mesa Reservoir	153.25
Percent preferring lakes as alternative sites	88.50
Percent preferring streams as alternative sites	11.50
Percent belonging to sportsmen organizations	24.50
Percent belonging to environmental organizations	8.50
Investment in fishing equipment (including boats)	$4977.42
Percent choosing rainbow trout as their preferred species at Blue Mesa[a]	41.50
Percent choosing kokanee as their preferred species at Blue Mesa	48.00
Percent choosing other species	10.50
Preference variables (Scale 1-5)	
Importance of number of fish caught	2.59
Importance of size of fish caught	3.15
Importance of method used to catch fish	2.69
Importance of having a variety of species	2.90
Importance of environmental quality	4.11
Importance of crowding (how undesirable)	2.68

[a] Since Rainbow and Kokanee are the primary species caught at Blue Mesa, it was expected that anglers would choose them as their preferred species. Although kokanee are a much smaller part of the catch than rainbow, they were preferred by more anglers than rainbow. This may be explained by the size difference (3 inches) between the species. If rainbow trout had been 3 inches larger than kokanee, they may well have been the preferred species.

fishing equipment. About one-quarter belong to sportsmen's organizations (usually NRA) and very few belong to environmental organizations. The preferred species caught at Blue Mesa was kokanee salmon (48.0%) but that was closely followed by rainbow trout (41.5%). A few anglers (10.5%) preferred other species such as brown, cutthroat or lake trout. Anglers also stated that size is somewhat more important than the number of fish caught at Blue Mesa.

Table 4 presents socio-economic and demographic data on the persons interviewed at Blue Mesa. The average number of vacation days was over 30 which is a consequence of the number of retired people fishing Blue Mesa (24% of this sample). People that fished Blue Mesa had completed an average of a little more than one year at college and had an average family income of $38,140, well above the national average of $28,737. Of the anglers interviewed slightly less than one-fifth were nonresidents while over 40 percent of those interviewed came from the Front Range of Colorado from Pueblo north to Fort Collins.

Table 4. Socio-economic Characteristics of Fishermen at Blue Mesa Reservoir, Colorado, 1986

Variable	Mean
Number of vacation days per year	31.83
Age of person interviewed	48.75
Family size	2.64
City size	142,000
Education level (years)	13.31
Family income per year (thousand dollars)	38.14
Percent of males in sample	88.00
Percent of nonresident anglers	18.0
Percent of anglers from the "front range", (the area from Pueblo north to Fort Collins)	43.0

REGRESSION RESULTS

Following the usual procedure in the study of recreation values, least-squares statistical methods were used to estimate the willingness to pay for fishing at Blue Mesa.

$$CS = 2.50680 + 0.40374\ Y + 0.08493\ TC + 0.00012\ I - 0.07011\ DAYS \quad (1)$$
$$\quad\quad (1.66) \quad\quad (12.53) \quad\quad (2.47) \quad\quad (1.55) \quad\quad (-1.96)$$

$$R^2 = 0.624$$

where CS = net benefits (consumer surplus) per day fished at Blue Mesa; Y = yearly family income (in thousands); TC = expenditure per day per person at Blue Mesa; I = investment in fishing equipment; and DAYS = average days fished at Blue Mesa by each angler. T-statistics are shown in parentheses below the coefficients.

The coefficient of determination, R^2, adjusted for degrees of freedom, indicates that 62 percent of the variation in net benefits was explained by income, daily expenditure, investment in fishing equipment (including boats) and the average number of days fished per year at Blue Mesa. The regression coefficient for investment was significant at the 0.12 level, the constant at the 0.10 level while all the other variables were significant at the 0.05 level or higher. Net benefits per day are positively related to yearly income, investment and daily expenditure but negatively related to the number of days anglers visit Blue Mesa. This can be interpreted as, the more often anglers visit Blue Mesa the less an additional day adds to their net benefits.

The following model estimated how participation changes when the number of fish or size of fish caught changes. Least squares statistical methods were used for the estimation.

Number of Fish

$$CDAY = 0.46\ Q \quad (2) \qquad R^2 = 0.103$$
$$(6.84)$$

Size of Fish

(3) $CDAY = \underset{(7.77)}{0.68\ S}$ $\qquad R^2 = 0.129$

where CDAY = change in number of days fished at Blue Mesa; Q = change in number of fish caught; and S = change in size of fish caught (length in inches). T-statistics are shown in parentheses below the coefficients.

The number of observations was sufficient for statistically significant analysis of the relationship between participation at Blue Mesa and change in the number and size of fish caught. The coefficient of determination, R^2, adjusted for degrees of freedom, indicates that 10 percent of the variation in participation was explained by number of fish caught, while 13 percent was explained by the size of fish caught. This is considered a satisfactory level of explanation from a cross-sectional survey of individual consumers. The regression coefficients were significantly different from zero at the 0.01 level, as indicated by the T-statistics for each term in the equations. Alternative forms of the equation were evaluated including cubic and semi-logarithmic. The linear form provided the best fit of the relationship.

Figure 1 shows that participation for each angler would decrease/increase by 0.46 days per year for each less/additional fish caught per day. Anglers historically have fished 14.67 days per year with a stated historic average catch of 6.95 fish per day while they caught 5.64 fish on the day interviewed. Figure 2 shows that participation for each angler would decrease/increase by 0.68 days per year for each less/additional inch in average size of fish caught at Blue Mesa. The stated historic average size and the average size caught on the day interviewed are both about 13 inches.

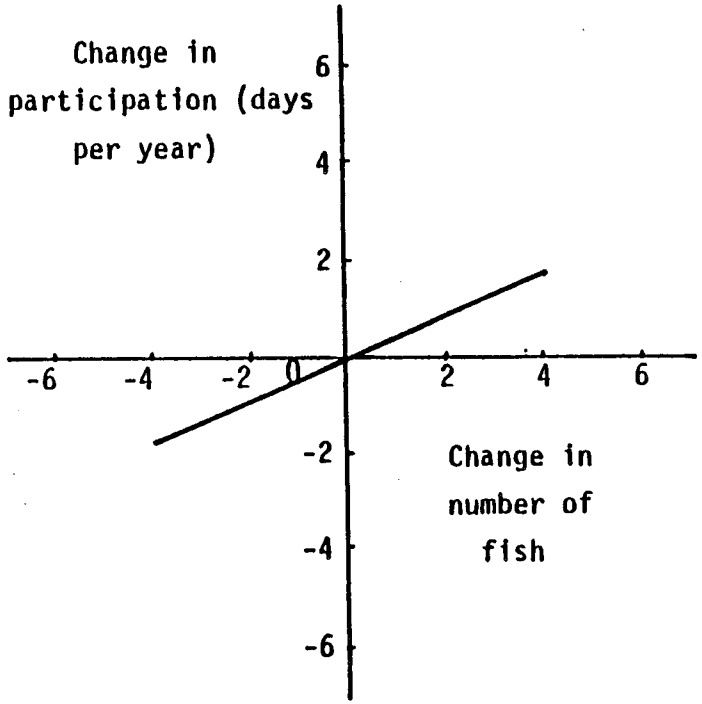

Figure 1. Effect of Change in the Number of Fish Caught on Participation

Zero Point = 6.95 Fish
14.67 Days

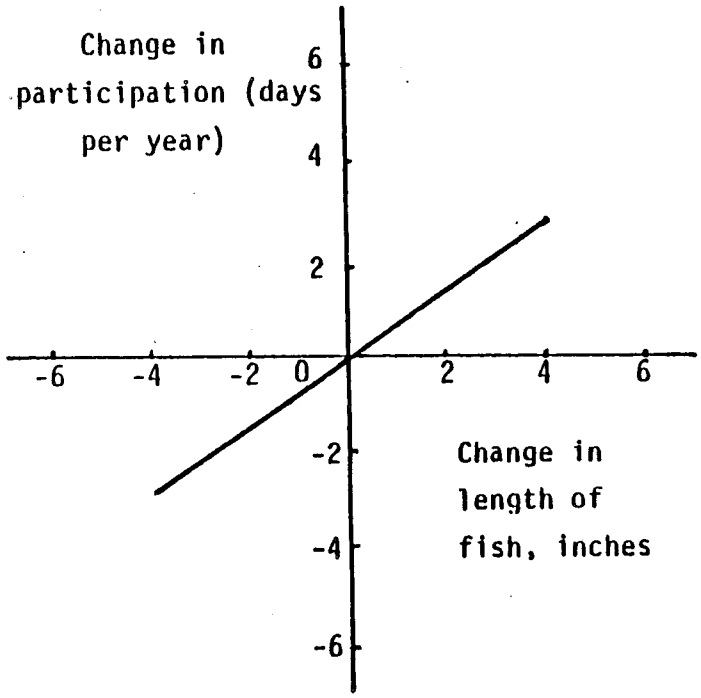

Figure 2. Effect of Change in the Size of Fish Caught on Participation

Zero Point = 12.91 Inches
14.67 Days

An additional model estimated deals with how net benefits change when the number of fish or size of fish caught changes. Least squares statistical methods were used for the following estimation.

Number of Fish

(4) $WTP = \underset{(9.24)}{0.95}\ Q$ $\qquad R^2 = 0.174$

Size of Fish

(5) $WTP = \underset{(10.91)}{1.25}\ S$ $\qquad R^2 = 0.227$

Where WTP = change in willingness to pay (net benefits) per day; and Q, S are defined as before. T-statistics are shown in parentheses below the coefficients.

Equations 4 and 5 show the relationship between willingness to pay for fishing at Blue Mesa and change in number and size of fish caught. The coefficient of determination, R^2, adjusted for degrees of freedom, indicates that 17% of the variation in willingness to pay was explained by the number of fish caught, while 23% was explained by the size of fish caught. The regression coefficients for quantity and size were significantly different from zero at the 0.01 level. The linear form of the equation again provided the best fit of the relationship.

Figure 3 shows that willingness to pay per day for each angler would decrease/increase by almost $1 for each less/additional fish caught above what anglers have historically caught 6.95 fish per day. Figure 4 shows that willingness to pay per day for each angler would decrease/increase by $1.25 if the fish caught averaged 1 inch less/greater than presently, about 13 inches.

The results indicate that anglers are more responsive to changes in size than to changes in the number of fish caught. The coefficients for changes in size of fish caught are larger than those for number of fish caught yet a

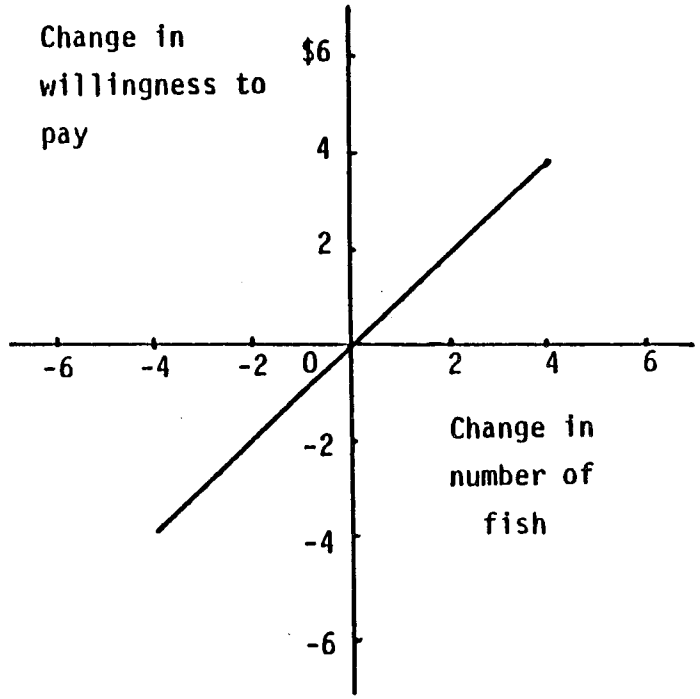

Figure 3. Effect of Change in the Number of Fish Caught on Willingness to Pay

Zero Point = 6.95 Fish
$18.83 WTP

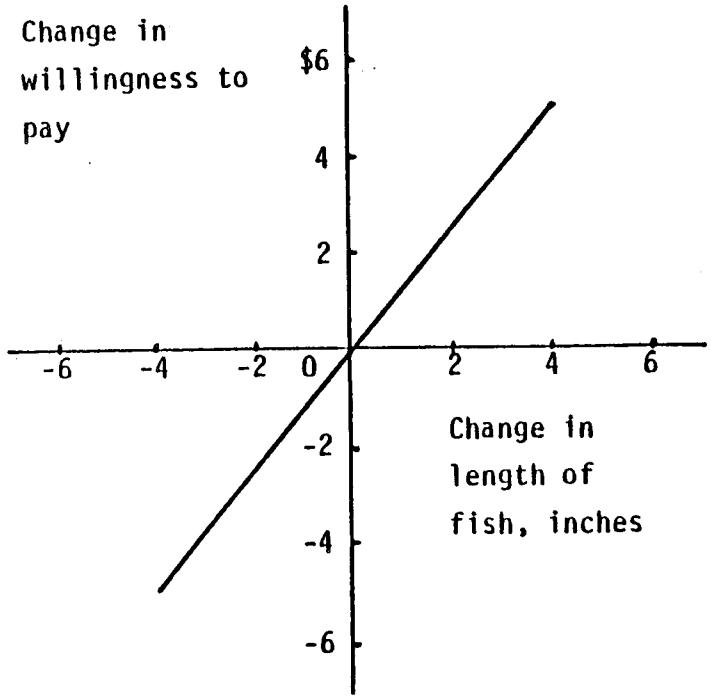

Figure 4. Effect of Change in the Size of Fish Caught on Willingness to Pay

Zero Point = 12.91 Inches
$18.83 WTP

1-inch increase in fish size is less than an 8% increase while a 1-fish increase in the number caught is more than a 14% increase in catch.

To the extent that fish size and number caught are substitutes for anglers, it is not possible to simply add the value of increases in size and increase number caught. Increasing both these measures of quality at the same time would result in a smaller increase in value than the sum of the coefficients. If these measures of quality were complements to anglers at Blue Mesa, the opposite result would hold.

COMPARATIVE STUDIES

Sorg, et al. (1985) summarized the results of a telephone survey of resident and nonresident anglers conducted during 1982 in Idaho. The value of a coldwater angler day was calculated to be $25.55 by the travel cost method using actual expenditure data and $15.65 for primary and multipurpose trips by the contingent valuation method.

The value of an angler day at Blue Mesa Reservoir for those anglers interviewed was $18.83 which is somewhat higher than reported by Sorg, et al. However the study at Blue Mesa is for a specific site, not a statewide average, and anglers caught an average of 5.64 fish averaging 12.8 inches at Blue Mesa as compared to 3.32 fish per day averaging an estimated 10 inches in the Idaho study.

Few previous studies have measured the effect of the number and size of fish caught on the value of fishing. Adamowicz and Phillips (1983) surveyed 272 resident fishermen in Alberta, Canada. The authors reported the marginal value of an additional fish ranged from $1.27 to $2.00 in 1976 U.S. dollars.

Sorg et al. (1985) reported an incremental value of $1.80 per day for each additional fish when anglers caught an average of 3.32 fish per day. Benefits

per day increased by about $1.60 per added inch in length, based on a 10 inch average size, holding number of fish constant.

Compared to these results, this study indicates that the value of catching additional fish, $0.95, and larger fish, $1.25 per inch, at Blue Mesa Reservoir is somewhat less than Sorg, et al. However, the results from Idaho are state averages, and the valuation questions were asked for double the catch and 50 percent larger fish while anglers at Blue Mesa were asked to value a 50 percent increase in catch and a 25 percent increase in size.

DISCUSSION OF BENEFITS AND COSTS

The total use by fishermen of Blue Mesa Reservoir is difficult to determine precisely. Based on a 1982 creel survey by the Colorado Division of Wildlife (DOW) and assuming that angler use grows at the same rate as general use of the Curecanti National Recreation area (2.315 percent per year from 1982 to 1986) we estimate that approximately 165,000 anglers fished Blue Mesa in 1986 (based on four hours per angler day). The average of National Park Service angler use estimates for the years 1985 and 1986 is very close to this future. The survey shows that people spend $16.02 per day while fishing at Blue Mesa. Thus, total expenditure, or impact on the state economy, of anglers, fishing at Blue Mesa for 1986 was approximately $2.64 million. The survey also shows that the net benefits (consumer surplus) per angler day was $18.83 for the people interviewed.

Based on the past history of the fishery at Blue Mesa, it would appear that anglers may keep as many as 400,000 fish per year. Assuming 165,000 angler days, this would indicate that each angler could keep about 2.5 fish per day over the course of the year. Adjusting the sample catch figures down by 2 fish per day would reduce the sample fish kept figure to about 2.5 fish per

day. This would reduce the estimated consumer surplus per day from $18.83 to $16.93 (18.83 minus $0.95 for each less fish). Thus, net value of the fishery per year (1986 figures) is about $2.79 million per year. This is the number that should be used to determine the value of the fishery at Blue Mesa to Colorado.

The demand curve in Figure 5 shows the relationship between willingness to pay and quantity of angler days at Blue Mesa. The daily expenditure by anglers was $16.02 and total expenditure by anglers is $2.64 million ($16.02 times 165,000 days). The net value to anglers, $2.79 million per year, is the area below the demand curve and above average daily expenditure.

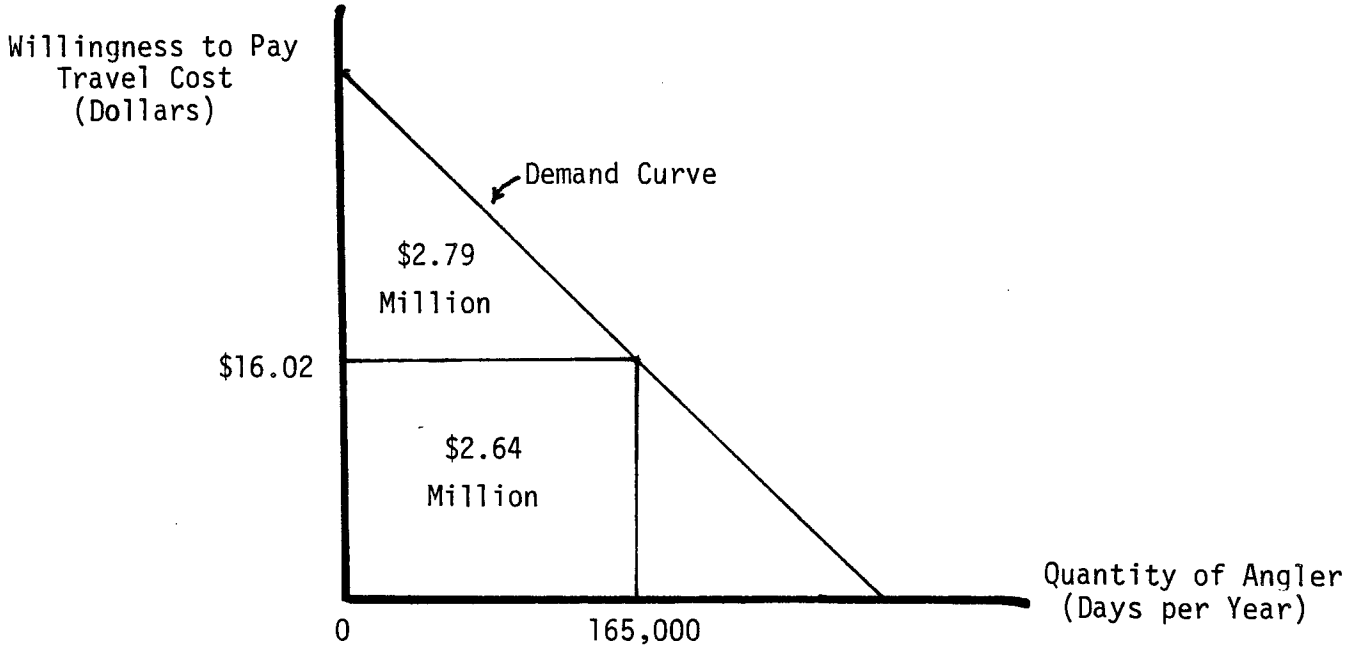

Figure 5. Demand Curve for Fishing at Blue Mesa Reservoir

The growth in value of the fishery is difficult to predict. Park Service data indicates that growth in use of the Curecanti National Recreation area has been 2.56 percent from 1977 to 1986 but 2.315 percent from 1982 to 1986. Thus, based on these figures and assuming angler use grows at the same rate, one can conservatively expect angler use and thus benefits to grow at more than 2 percent in the near future but this would only be true in the long term if the quality of the fishing can be maintained. There is an important possible exception to this and that is the possible substitution of Two Forks reservoir proposed on the South Platte River near Denver. Over 40 percent of the anglers sampled came from the Front Range metropolitan area of Colorado from Pueblo to Fort Collins. Depending on the quality of the potential fishery at Two Forks and the degree that front range anglers perceive it as a substitute for Blue Mesa, use of Blue Mesa Reservoir could decline rather than increase.

The present costs of stocking Blue Mesa Reservoir has three components: (1) The Wildlife Division annually stocks approximately 450,000 rainbow trout 5-7 inch at a cost of approximately $0.25 each for a total yearly cost of approximately $125,000; (2) The DOW stocks approximately 2.1 million 1-3 inch kokanee salmon a year at approximately $0.06 each for a total yearly cost of approximately $125,000; and (3) The U.S. Fish and Wildlife service stocks approximately 500,000 5 inch rainbow trout a year at approximately $0.115 each for a total yearly cost of approximately $57,500. The total cost of all fish stocked is approximately $307,500. In addition, management costs are estimated at $132,000. Based on data from the DOW the costs of stocking rainbow and kokanee have not increased in recent years although the costs fluctuate quite a bit from year to year. Unless labor costs increase significantly in the future one would expect costs of stocking fish to stay fairly constant. Thus, the net

benefit of the fishery at Blue Mesa is approximately $2.35 million above the cost of stocking the reservoir.

The benefits to anglers of potential changes in the stocking procedures at Blue Mesa Reservoir are difficult to estimate due in part to the uncertainty of the effect of the changes on angler catch. Table 5 shows how benefits to anglers might change if for example 200,000 fewer rainbow trout were stocked in Blue Mesa and the potential cost savings that could be realized by stocking fewer trout.[2] The estimates were calculated for return rates to the creel ranging from 10 to 50 percent.

At a return rate of 17 percent (34,000 trout), the reduction in angler benefits is approximately $50,000 equal to the cost savings to the DOW. Present creel returns seem to be from 20-30 percent indicating that such a stocking reduction would reduce angler benefits by $58,945 to $88,202 and only save the DOW $50,000.[3]

Table 5. Effect on Angler Benefits of a 200,000 Reduction in Trout Stocking At Various Harvest Levels

Reduced Harvest	Reduction in Angler Benefits due to reduced catch
20,000	$25,545
40,000	$58,945
60,000	$88,202
80,000	$117,313
100,000	$146,281

[2]The return rate for kokanee is uncertain and thus rainbow trout were used for this example. Many kokanee from Blue Mesa are not harvested until they run up the East River to spawn. If the Division stocked more kokanee directly into the reservoir and reduced the indirect stocking into the East River at Roaring Judy Hatchery, it may be possible to reduce the total number of kokanee stocked and realize a cost saving, while potentially improving kokanee fishing at the reservoir.

[3]Based on Wildlife Division cost figures, $0.25 per 6 inch fish.

If a reduction in the number of trout stocked would increase the average size of the fish caught, the results from table 5 overstate the cost to anglers of a reduction in their catch. Although anglers were not specifically asked how they would trade off catch rate for size of catch, the results shown in equations 2, 3, 4, and 5 indicate that anglers place a higher value on equal percentage changes in size of catch than changes in number caught. Thus if reducing the number of trout stocked by 200,000 lead to a significant increase in average size angler benefits would fall by less than shown in table 5.

CONCLUSION

Understanding the value of alternative fishery management practices can help managers improve the efficiency of state programs. This report provides new evidence on the value of alternative fish stocking practices. We apply the contingent valuation method, recommended by the U.S. Water Resources Council, in a study of 200 recreation users of the cold water fishery at Blue Mesa Reservoir, near Gunnison, Colorado. At current catch rates, the gross economic value to anglers is $5.43 million. Of this amount, $2.64 million represents trip expenditures by anglers with impacts on state and local economic development. The remaining $2.79 million is the net value to anglers above what they spend. The results demonstrate that the net value of the fishery at Blue Mesa is at least $2.35 million per year ($2.79 million net value to anglers less $0.44 million costs of stock and management). In addition, this study presents statistical willingness to pay and participate functions for changes in the number and size of fish caught. The results suggest that at Blue Mesa the marginal value of size of fish caught is greater than the marginal value of number caught. The relative preference by anglers at Blue Mesa for kokanee (which are larger) compared to rainbow trout seems to

reinforce this economic finding. This indicates that anglers might prefer that fishery management at Blue Mesa be weighted more toward increasing the size of fish caught rather than increasing the number caught.

The results are applicable to a single site. Caution is advised in extrapolations to other lakes and rivers in Colorado. Blue Mesa Reservoir is a special situation where many anglers own boats, prefer to fish in large lakes, and their average income level is well above the national average. There is a need for further research on the benefits and costs of fishery management programs for different types of fishing experience. This would allow managers to compare the benefits and costs of alternatives such as catch and release regulations, stocking catchable size fish, using different strains of wild species, and habitat improvement measures.

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Interview No._____
Interviewer_____
Date_____Time_____
Location_____
Weather Cond. & Temp._____
Recreation Activity_____
Boat_____Bank_____

ECONOMICS OF THE QUALITY OF FISHING

Good morning/afternoon. My name is_____and I am employed by Colorado State University in Fort Collins. Would you mind if I asked you a few questions? It will probably take about 10 to 15 minutes. We are studying the effects of the quality of fishing (number of fish, their size, and species) in Colorado. Since programs to improve the quality of fishing cost money, we are especially interested in finding out what you pay for fishing. Your opinions will be compared with other people interviewed, and may help improve fish management programs in Colorado. You personally will not be identified in reporting the results of the study.

1. a. How many fish have you caught today, what species are they, how large are they (size range), and how many did you keep?_____

   _____

   b. Number and size caught on a typical day_____

2. a. About how many hours did (will) you fish today?___hours

   b. How many road miles from your home is this recreation area, one-way? _____miles

   c. About how many days do you visit this recreation area each year, on average? days _____

3. a. Please estimate the number of days you fish at all areas in a single year on average. _____days

4. If you were unable to visit this recreation area, how many miles would you have to travel from your home to reach the closest available substitute (i.e. same quality) recreation area for fishing?

   _____ miles

   _____ where is this area and what is its name

5. How important to you is; or how do you rate (at this site):

	Extremely Important	Very Important	Moderately Important	Somewhat Important	Not Important
a. Number of fish caught?	____	____	____	____	____
b. Size (length and weight) of fish caught?	____	____	____	____	____
c. The method by which fish are caught (bait, lures or flies)?	____	____	____	____	____
d. Having a variety of species available?	____	____	____	____	____
e. The environmental quality (scenic beauty) where you are fishing?	____	____	____	____	____
f. The number of people in the vicinity (crowding)	____	____	____	____	____

   Comments: _____

   _____

6. a. Please estimate what this trip costs in total, including travel, food, accommodations, entertainment, etc. $_____

   b. How many people are in your party with whom these costs are shared? _____

   c. What is your individual share of these total trip costs (whether paid by yourself or by someone else for you)? ___% equals: $_____

   d. Were all or what part of these total trip costs required to make the trip (had to be spent)?

      ___% equals: $_____

FOR THE NEXT SEVERAL QUESTIONS, WE WILL BE TRYING TO FIND OUT HOW THE QUALITY OF FISHING AFFECTS YOUR MAXIMUM WILLINGNESS TO PAY FOR THIS TRIP. PLEASE KEEP IN MIND this is a hypothetical experiment intended to provide some notion of how strongly you feel about the quality of fishing. Assume that the only way to assure yourself of a quality recreation experience is through your payment of trip expenses.

7. a. What is the value of your total recreation experience on this trip? Is it worth more than the $_____ (from Q6c) actually spent on this trip? Yes _____ No _____

   b. About how much more is this trip worth? Assume that the trip became more expensive, due perhaps to travel costs or lodging, etc., what is the maximum you would pay for this trip (rather than give it up)? Would you pay $_____(from Q6c) per trip to continue coming to this recreation area the same number of times per year as currently? (Interviewer will then bid price up by random increments if respondent answers "yes" or down if respondent answers "no", and enter final amount.)

8. This question has three parts. What will be your total time away from home on this trip? Roughly what proportion of your total trip cost is being spent to fish at this site. Total time_____ What proportion of the $_____ (from Q7b) measure of your total enjoyment (or benefit) of this trip would you assign to fishing at this site?

	Percent of total trip time	Percent of total trip costs	Proportion of total trip enjoyment (benefits)
a) Fishing at this site	____	____	_____
b) Driving, round-trip	____	____	_____
c) Visiting other recreation areas	____	____	_____
d) Total	100	100	100

9. Are you willing to pay to maintain the fishery at Blue Mesa Reservoir. Yes____ No____

Why?_____

For the next several questions we will be trying to find out two things; (1) how changes in fishing quality would affect the number of days per year you participate in fishing at this site, and (2) how these same changes would affect the value of your fishing experience. I may show you several photos of different fishing conditions.

How would your net benefits (Q7b) and your participation (Q2c) in fishing change <u>if conditions changed in the following ways</u>?

a. The recreation site would have the same size of fish but the average number caught per day <u>with the same amount of effort</u> would change to:

(1) __less, ____days, $____. (2, 3, 4, 5, 6)
(2) __more, ____days, $____. (2, 3, 4, 5, 6, 7, 8)
(3) Catching the legal limit. ____days, $____.

b. You would catch as many fish at the recreation site with the <u>same amount of effort</u> as currently but average fish size would change to:

(1) __ inches shorter, ____ days, $____. (2, 3, 4)
(2) __inches longer, ____ days, $____. (2, 4, 6)

c. Does the species you catch matter to you? Yes__ No__

Your preferred species is _____. Suppose that due to a change in stocking policy you can catch your preferred species rather than _____. $____, days____.

d. Due to a new program, rather than fishing for hatchery fish (put and take) you could now fish for wild fish of the same size.

10. (If respondent reports no change); what is the reason?

a. Not enough information.
b. Objected to the way the question was presented.
c. That is what it's worth.
d. Cannot place a dollar value on it.
e. You do not suffer any disatisfaction from the quality of fishing and therefore see no reason to pay to improve it.
f. You believe fishing trips already cost too much.
g. You believe it is unfair to expect fishermen to pay the costs to protect fishing quality.
h. Other, please specify_____

11. a. Which of the following did you use most frequently during this year? (Percent of total fishing time)

___% Lures ___% Bait ___% Flies

12. How would you rate your skill in using the type of fishing equipment you use most frequently on your typical fishing trip in Colorado? (Check one)

___Beginner ___Moderately skilled ___Expert

___Skilled ___Very highly skilled

13. a. What is your total investment in fishing equipment (tackle, special clothes, books, maps, fly tying equipment and materials, lure making equipment, etc.?

$_____

14. THE FOLLOWING QUESTIONS ASK FOR SOME INFORMATION ABOUT YOURSELF. YOUR ANSWERS WILL BE HELD CONFIDENTIAL AND YOU PERSONALLY WILL NOT BE IDENTIFIED IN REPORTING THE RESULTS OF THE STUDY.

a. How much vacation do you take each year?

____days

b. Are you: ____Male ____Female

c. What is your age? ____years

15. How many people are in your household (including yourself) _____total

16. Where do you live? (City, County and State)_____

_____City population:_____

17. How long have you lived in this state:_____years

18. Do you belong to:

a. a sportsman organization ___Yes ___No
b. an environmental organization? ___Yes ___No

19. What is your occupation? (job that accounts for more than half of your work-time)_____

_____

20. What is the highest year of school you have completed? (Circle one number)

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22

21. To the best of your knowledge, what was your household income last year before taxes? (Check one)

___Under $5,000
___$5,000 to $9,999
___$10,000 to $14,999
___$15,000 to $19,999
___$20,000 to $24,999
___$25,000 to $29,999
___$30,000 to $34,999
___$35,000 to $39,999
___$40,000 to $49,999
___$50,000 to $74,999
___$75,000 and above
___(Please specify to nearest $10,000)
$_____

22. Is there anything else you would like to tell us about your interest in fishing in Colorado? Any comments you wish to make that you think may help us in future efforts to understand what you want done about fishing quality will be appreciated.

_____

_____

_____