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ESTIMATING ANGLER BENEFITS FROM A NEWLY DEVELOPED TROUT FISHERY: A TRAVEL COST APPROACH

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I. Introduction

The Oklahoma Department of Wildlife Conservation(ODWC) is expanding its put-and-take trout stocking program to include the Mountain Fork River below Broken Bow Dam in southeastern Oklahoma in the United States. The ODWC is conducting a trout stocking feasibility study to determine water flow requirements, changes in water quality, angler use, and recreational and economic impacts. The U.S. Army Corps of Engineers will release water flows from unallocated storage through the spillway of Broken Bow Dam throughout the duration of the stocking period to assure water temperatures will not exceed the tolerance level for the year-round trout fishery(Schreiner et al.).

Establishing a year-round put-and-take rainbow trout fishery in the Mountain Fork River could greatly enhance angler use of the area by providing an additional fishery. This new fishery would be unique to this locality and would attract anglers from a wide area.

The Mountain Fork River and the developing fishery need to be evaluated (1) to determine water quality during various water release regimes and to determine water release requirements needed to maintain the trout fishery; (2) to monitor angler use of the trout fishery by conducting a creel survey; and (3) to assess the recreational

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and economic impacts associated with the trout fishery.

Consider the problem that the policymaker faces in developing a recreation activity such as the Mountain Fork Trout Fishing Project. The policymaker needs to determine if it is worthwhile to implement the project, and if so, the amount and timing of resources, and the policies needed to influence private decision makers(i.e., trout fisherman) so that their behavior conforms to a desired social objective. More specifically, the policymaker requires information on the following issues.

(1) The demand for services from the project must be estimated. This step is not straightforward because the demand for trout fishing cannot be observed directly but must be inferred using indirect methods based on the market of a related input or by direct elicitation of willingness to pay. Moreover, in the outdoor recreation market, consumers do not face a unique price, but each consumer faces a particular price according to his location with respect to the recreational project. Most of the research in the outdoor recreation literature has focused on developing methods for measuring the demand for and benefits of recreational services, which has been useful to project managers in determining willingness to pay for developing projects. However, what managers are ultimately more interested in knowing is if a project should be undertaken.

(2) The average and marginal costs of providing recreation services(including stocking of fish) in the recreation market must be estimated. In particular, if the average cost turns out to be decreasing over the relevant range, then this finding has important implications for the management policies of the project. Moreover, externality costs such as congestion may be an important variable in determining the optimal trout fishing attendance in the project. Similarly, externality costs associated with providing other purposes and services at the Broken Bow Lake(i.e., power generation, flood control, lake fishing, and other related water-based recreation activities) need to be included in the analysis of costs of providing the trout fishing activity.

(3) When and if the capacity of the trout fishing activity should be changed is a long-term investment decision that must be determined. A delay in the expansion of current capacity decreases discounted social costs but potential benefits are also foregone.

(4) What policies should be adopted to ration attendance at the trout fishing project, assuming that social costs are higher than the private costs of recreation because the anglers do not pay all the costs of operating and maintaining the project. Each policy may have significant differences for project management. For example, a nonexclusionary policy may result in a considerable need for expanding stocking and maintaining project facilities compared with a policy that requires recreationists to pay the full cost of operating and maintaining the activity.

(5) The cost-sharing among the federal, state, and/or local governments, and the recreationists must be determined. This issue is closely related to the previous consideration. The cost-sharing may affect those who must cover the financial needs of the project on a current expenditure basis. Further, how does a given cost-sharing rule affect level of benefits derived at the local level and thus contribute to the goal of regional economic development.

(6) The relevance of substitution effects among recreation projects needs to be assessed. The project evaluation becomes more complicated if substitution effects are significant. The substitution effects may occur because of pricing policies or through changes in the characteristics of alternative and competing projects.

The purpose of this paper is to briefly review the economic literature on the travel cost method (TCM) and to determine annual angler benefits of the trout fishing activity using a travel cost method.

II. Travel Cost Models for Estimating Recreation Demand

The travel cost method (TCM) is one of two more commonly used methods for valuing non-market goods such as outdoor recreation. The other method is contingent valuation. The values measured by the two approaches are considered to be equivalent to consumer surplus, defined as willingness to pay less travel costs or price paid by individual recreationists.

The idea of inferring consumers' willingness to pay for recreational services from cost of travel was suggested by Hotelling in a letter to the National Park Service, United States Department of

Interior. The travel cost approach to the estimation of the value of recreation has been preferred by some economists because it is based on observed market behavior of recreationists in response to direct money and time cost of travel. The basic premise of the approach is that the number of trips to a recreation site will decrease(increase) with increases(decreases) in distance traveled, and in subsequent increases(decreases) in money and time cost. Contingent valuation is based more on direct information solicited from recreationists on what they would be willing to pay to continue having access to a particular recreation amenity. Analytical content of the TCM is given in Bowes and Loomis, Rosenthal(1985 and 1987), and Smith and Desvousges. Various forms of the TCM exist and differ principally in how substitution effects are treated in outdoor recreation. Contingent valuation is presented in Smith and Desvousges, and Michell and Carson.

The Own Price Only TCM model is the most widely applied method. It is generally justified in estimating benefits from sites that are rather unique such as trout fishing in Oklahoma. When applied to sites that are common, however, substitution effects may become important. Public agencies are aware of the potential bias of not considering substitution effects in measuring benefits as in the case reported by Rosenthal(1985) where the U.S. Forest Service Planning Office lowered the values reported by published research by as much as 50 percent. In the Own Price Only TCM the dependent variable is usually some measure of quantity of visits and the explanatory variables include, in addition to the cost of travel and time in reaching the site, such factors as income and population but do not include substitute sites. Rosenthal(1987) found that a travel cost model without substitute sites gives values for the consumer surplus per trip that are significantly higher than methods where subsitutes are considered. He also concludes that no general statement can be made since the amount of the difference depends on the site being studied.

Classical travel cost models include substitution measures in the demand function. Numerous applications have been carried out within this framework. The paper by Burt and Brewer is a classic work representing these models. Their model can be formulated as

$$V_{ij} = a_j + b_j P_{ij} + b_k P_{ik} + cY + e_{ij} \qquad (1)$$

where: V_{ij} = visits per household from origin i to site j
P_{ij} = cost of travelling from origin i to site j
P_{ik} = cost of travelling from origin i to substitute site k
Y = household income and/or other independent socioeconomic variables
e_{ij} = error term

By taking into account the cross-price effects, this model overcomes the econometric bias of the own price only TCM model. Burt and Brewer introduce a simplifying assumption, namely, that perfect substitution holds among lakes. This simplification implies that for a given class of sites, individuals will always visit the one with the minimum travel cost. This assumption allowed them to set an upper bound of integration for the computation of the net benefits and also to diminish the number of cross-price parameters that need to be estimated.

A travel cost model which incorporates an index of relative attractiveness and availability of other recreation sites into the site 's demand equation (Knetsch et al.; Talhelm) has intuitive appeal since it can capture a negative relationship between visits to site i and the attractiveness of other sites as reflected by the index. Moreover, the changes in quality can be represented by the index(Rosenthal 1985). However, this method is considered by Smith and Desvousges as the least desirable since the index is arbitrarily constructed. That is, the definition of the index implies a knowledge of the substitution relationships which presupposes the same information it tries to derive. Rosenthal(1985) shows by using the Burt and Brewer framework that this approach is pointless if the objective is to estimate the value of an existing recreation site since higher quality sites can be expected to have larger estimated parameters in the demand equation. That is, separate price terms avoid the need to construct an index since the effects of both price and quality on substitution are already embodied in those price terms. On the other hand, if the objective is to determine the effect of changing quality on benefits at an existing site, then the use of an index is valid method to valuing quality, but still is an inferior method since its definition remains arbitrary.

Discrete choice recreational demand models incorporate substitution effects influencing recreationists' choices of where and how often to recreate(Caulkins et al.; Morey; Hanemann; Rosenthal 1985 and 1987). These models are both multi-site and multi-attribute travel cost model. They are based on the assumption that households make two separate decisions leading to visitation at a lake. The first choice is whether or not an individual will undertake a recreational activity on a particular day given that the individual is among the lake recreation user population. The second choice is which site to visit given that the choice of visiting a lake has been made. Therefore, as Small and Rosen have shown, it is possible to represent a demand function as the product of two separate functions.

Caulkins et al. use the laws of conditional probability to represent demand as follows:

$$P_{g}n_{i} = P_{i|g} \cdot P_{g|r} \tag{2}$$

Where $P_{g}n_{i}$ is the joint probability of choosing to take a trip to a lake and choosing lake i from the choice; and $P_{i|g}$ is the conditional probability of choosing lake i from the choice set given that one has decided to take a trip to a lake; and $P_{g|r}$ is the conditional probability of choosing lake recreation on a particular day given that one participates in lake recreation.

A variation on these models is to specify a gravity model to determine the level and distribution of trips across sites(Sutherland; Rosenthal 1985 and 1987). Following Rosenthal(1987), the number of trips from the origin to a recreations sites is represented as

$$T_{ij} = T_{i} \cdot P_{ij} \tag{3}$$

Where T_{ij} is the number of trips from origin i to recreation site j; T_{i} is the total number of recreation trips from origin i; and P_{ij} is the probability that a trip from origin i will have j as its destination. That is, the gravity model consists of trip generation function(T_{i}) and trip distribution function(P_{ij}). Rosenthal(1987) estimated the trip distribution function with a multinomial logit model whereas the trip generation function was estimated using log-linear regression and maximum likelihoodd logistic regression.

Some of the advantages of using a discrete choice travel cost model include: (1) perfect substitution assumptions need not be made; (2) several problems associated with zero observations are handled such as non-normality of errors, heteroskedasticity, and taking the logarithm of zero; and (3) it can be related within a choice theoretic framework.

There are two principal ways of organizing and collecting data for estimating the travel cost model: (1) zonal method and (2) individual observation method. Zonal models utilize aggregate trip data as the dependent variable organized into zones such as counties around the recreation site. The individual observation model utilizes individual or household trip data to the recreation site.

There are two major disadvantages of the zonal model (Brown and Nawas). The first disadvantage is the difficulty in creating efficient zoning for both the variable cost and distance simultaneously. Generally, zoning by distance is not an efficient zoning scheme for transfer cost. The second disadvantage is the increase in multicollinearity between explanatory variables when data are grouped. Even when direct survey data are available, individual observations have to be aggregated into groups if the zonal approach is used. In this case, individual variations in the trip demand are averaged out, and hence, the zonal approach may appear to explain more of the variation in the quantity of the trip demand than the individual approach. However, it is the case not because the zonal model is superior to the individual model but because there is less variation in the dependent variable.

Moreover, if individual observations are aggregated into zonal averages, then the socioeconomic variables usually show little or no significant relationship to trip demand. Another problem in applying the zonal approach is the determination of the relevant market boundary for a recreation site (Walsh). If information is desired only on a specific recreation activity at a multiple-purpose site, a common problem which applies to both the zonal and the individual approach is the allocation of the travel and time cost among various recreation activities. This problem can be resolved by directly asking respondents to allocate total on-site time and travel cost among their various recreation activities at the site.

Measurement error is generally the most serious problem in using the individual observation approach. However, measurement error can be reduced if trip information is obtained immediately after the trip.

Recreation benefits estimated with the zonal model generally underestimate the value of the resource if distance from residence to the study site or travel time is not included because of multicollinearity with travel cost. Brown and Nawas show that the individual model can include travel distance as a surrogate variable for travel time in the trip demand equation without causing multicollinearity. However, they did not incorporate the possible substitutability between sites.

The individual observation model which is generally employed to estimate the trip demand equation to a specific site may be expressed as

$$Q = f(C, Y, D, S, E, A, T, \ldots)$$

where: Q = number of trips a respondent has taken in a year
C = travel cost per trip
Y = income
D = travel distance or travel time
S = travel cost to substitute sites
E = other socioeconomic variables
A = relative attractiveness of the site
T = individual taste and preference

III. Survey Method

A series of four survey instruments were used to obtain data for this study. The first two survey instruments are the Pressure Count Survey administered by the Oklahoma Department of Wildife Conservation (ODWC) at the site of the trout fishery. The Pressure Count Survey is used by the ODWC to estimate the number of angler hours. The Creel Survey is used to estimate the return rate of stocked trout and to obtain limited information about the angler at the time of the Creel

Survey. Anglers were given the third instrument which was a self-addressed, postage paid postcard with a minimum of questions to be answered at the end of the trout fishing trip. Because the Creel Survey is a random sample, the postcard survey should also represent a random sample if there is an 100 percent return rate. The postcard survey instrument includes information on (1) time spent on trout fishing, time spent on travelling, and total time away from home; (2) number of people coming in the same vehicle; (3) estimated cost of trip per person; (4) place of residence(city, state, zip); and (5) telephone number for follow-up survey.

The last survey instrument is a follow-up telephone survey for a randomly selected subsample of replies to the postcard survey. These telephone surveys were administered to obtain more complete socioeconomic data from anglers including information on occupation, income, multiple trips to the Mountain Fork River trout fishery and other potential substitute fishing sites, trip expenditures including location of expenditures and quality information on the trout fishing activity.

A total of 620 postcard surveys were handed out by the creel surveyors in 1989, but only 180 were returned for a 29 percent response rate. Distribution of anglers by geographic divisions for the postcard survey and the Creel Survey are shown in Table 1. These results indicate our sample response is highly biased toward an under-representation of anglers residing in McCurtain County where the trout fishery is located and an over-representation of anglers coming from other areas in Oklahoma and from out-of-state.

TABLE 1 Geographic Distribution of Anglers by Postcard Survey and Creel Survey

Geographic Area	Postcard Survey	Creel Survey
McCurtain County Residents	70 (38.9%)	419 (54.0%)
Oklahoma Residents Excluding McCurtain County	41 (22.8%)	129 (16.6%)
Out of State Residents	69 (38.3%)	228 (29.4%)
Total	180 (100%)	776 (100%)

IV. Characteristic Data

Characteristic data of anglers reported in this section is based on the 112 telephone surveys completed in 1990. Results of the telephone survey data are weighted by zip code proportions contained in the Creel Survey to adjust for geographic sample bias contained above.

Distribution of anglers by one-way travel distance and hours spent fishing per trip are presented in Tables 2 and 3, respectively. Over 63 percent of the anglers came from within a 25 mile distance of the Mountain Fork River. The average distance travelled by anglers was 53.4 miles. The average hours spent fishing per trip was 6.7. The number of days fished was 1.56. Approximately 80 percent of the trips were one day trips indicating that a large share of the anglers came to the Mountain Fork River specifically to fish and then returned to their residence.

The average number of trips per angler was 22(Table 4) indicating a high frequency of trips. Because the river is stocked on a bi-monthly bases, local anglers tend to fish frequently expecting to have a high catch rate each time they fish.

The typical angler is an avid fisherman. About 65 percent of the anglers indicated that fishing was their single most favorite recreation activity. Twenty-two percent of the anglers have fished for trout in other locations in Oklahoma and 53 percent have fished for trout

TABLE 2 Distribution of Anglers by One-way Travel Distance

Miles	Percent
1 - 25	63.1
26 - 50	10.1
51 - 100	8.7
101 - 150	3.8
151 - 200	9.1
201 - 250	3.9
> 250	1.2
Average: 53.4 miles	

TABLE 3 Distribution of Anglers by Hours Fishing Per Trip

Hours Fishing	Percent
1 - 5	70.7
6 - 10	17.2
11 - 15	4.1
16 - 20	2.1
21 - 25	2.4
> 25	3.5
Average: 6.7 hours	

TABLE 4 Distribution of Anglers by Number of Fishing Trips Per Angler to Mountain Fork River

Number of Trips	Percent
1 - 10	51.4
11 - 20	14.3
21 - 30	9.9
31 - 40	6.8
41 - 50	4.8
> 50	12.8
Nonresponse	10.8
Average: 22.0 trips	

before their Mountain Fork experience. The average number of all fishing trips per year excluding the Mountain Fork River was 25. The average number of years of fishing experience was 34 indicating a mature, experienced group of anglers.

The average age of anglers was 46 with approximately 35 percent of the anglers over 50 years of age (Table 5). About 84 percent of the anglers were male and 16 percent female. The average number of persons in the fishing party was 1.3.

The distribution of expenditures per person per trip are shown in Table 6. Over 35 percent of the anglers spent less than $10 per trip

TABLE 5 Distribution of Anglers by Age

Age	Percent
< 20	4.6
21 - 30	7.7
31 - 40	29.7
41 - 50	22.5
51 - 60	15.8
61 - 70	12.2
> 70	7.5
Average: 46	

TABLE 6 Distribution of Expenditure Per Person Per Trip

Dollars	Percent
1 - 10	35.6
11 - 20	22.0
21 - 50	18.2
51 - 100	8.6
> 100	15.6
Average: $56.67	

TABLE 7 Distribution of Expenditures by Categories

Category	Percent
Lodging	23.6
Food and beverage	26.9
Transportation	27.4
Purchased items	18.7
Purchased services	3.3

TABLE 8 Distribution of Expenditures by Location of Purchase

Location	Percent
Within 25 mile radius of Mountain Fork River	78.1
Outside local area but within state of Oklahoma	16.7
Outside state of Oklahoma	5.1

but the weighted average expenditure was $56.67. The distribution of expenditures (Table 7) were fairly evenly distributed among the categories of lodging, food and beverage, transportation, and purchased items and services. About 78 percent of the purchases were made in the local area and about 95 percent of the expenditures were made within the state of Oklahoma (Table 8). When asked to estimate their expenditures for an alternative activity if they had not come to the Mountain Fork River, the average expenditure was $28.02.

On a quality scale of 1 to 10 (10 represents the best), 37.6 percent of the anglers gave the Mountain Fork River fishing trip a value of 10 and 65.8 percent gave it a value of 8 or higher. About 50 percent of the anglers indicated they would decrease the number of fishing trips made to other sites now that there was trout fishing at the Mountain Fork River. Distribution of anglers by level of household income is presented in Table 9. The average of annual household income level is about $35,000 and the mode income range is $30,000 - $34,999.

V. Angler Benefits

Results of the telephone survey were used to estimate the trip demand function for the first year of the trout fishery. Of the 112 telephone surveys administered in 1990, 90 were used in estimating the travel cost model. Nonresponse on household income, inadequate information on travel costs, and extremely long distance location away form the trout fishery contributed to the reduced number of

TABLE 9 Annual Household Income

Annual Income	Percent
< $5,000	0.8
$5,000 - $9,999	4.6
$10,000 - $14,999	3.9
$15,000 - $19,999	11.9
$20,000 - $24,999	5.3
$25,000 - $29,999	7.7
$30,000 - $34,999	18.8
$35,000 - $39,999	13.6
$40,000 - $44,999	8.6
$45,000 - $49,999	5.2
$50,000 - $54,999	3.6
$55,000 - $59,999	2.8
> $60,000	8.9
Nonresponse	4.6
Average income: $35,005	

observations. Several different functional forms such as linear, quadratic, semilog, and double log, were used for estimating the trip demand function. The following double log model yields the most reasonable result:

$$\ln Q = \underset{(1.282)}{4.794} - \underset{(0.150)}{0.379} \ln P - \underset{(0.156)}{0.134} \ln D - \underset{(0.118)}{0.132} \ln Y + \underset{(0.007)}{0.0129} A - \underset{(0.240)}{0.7057} S$$

adjusted $R^2 = 0.39$ $F = 12.38$
standard errors are in parenthesis

where: Q = number of trout fishing trips to the site during 1989
P = expenditure per trip($)
D = one-way distance from residence to the site(miles)
Y = annual household income
A = age of the respondent
S = sex of the respondent (male = 0, female = 1)

Coefficients for expenditure per trip, age, and sex are all significant at the 5 percent probability level or better and with the expected signs. The price elasticity of demand is -0.38 and reasonable when compared to other studies. The regression coefficient on household income is negative but not significant. The coefficient on distance is negative but not significant.

The mean value of each explanatory variable (except travel cost) is multiplied by each regression coefficient and added to the value of the constant term to obtain the intercept term of the trip demand curve. Consequently, the relationship between changes in travel cost and changes in number of trips demanded is expressed as the following equation:

$$\ln Q = 3.3321 - 0.3794 \ln P$$

The latter result is used to estimate the consumers' surplus (angler benefits). The consumers' surplus (*CS*) function is evaluated using:

$$CS = [\exp(a) / (b+1)] (p_h^{b+1} - p^{b+1})$$

where a is 3.3321, b is -0.3794, P_h is the highest observed travel cost per trip which is $200, and P is observed travel cost for individual respondents.

Total angler participation in terms of the number of trips and the distribution of those trips by travel cost is needed to estimate total angler benefits. However, the number of trips must be estimated using information from the various survey instruments. Total angler hours is estimated by the ODWC using information from the Pressure Count Survey. The postcard survey and the Creel Survey is used to estimate the average angler hours per fishing trip. These results indicate a total of 68,091 angler hours for the year and a total of 10,163 trips. Distribution of angler trips by travel cost is estimated from results of the telephone survey corrected for geographic bias using zip code information from the more extensive Creel Survey. The consumers' surplus or angler benefits from the Mountain Fork River trout fishery is estimated at about $808,000. This indicates an average angler benefit per trip is equivalent to $79.50.

A major shortcoming of the method used in this study for the evaluation of the consumers' surplus is in determining the maximum willingness to pay for an angler trip. The highest observed travel cost was about $200. Not all anglers, however, are willing to pay this amount of money.

VI. Concluding Remarks

Establishing a year-round put-and-take rainbow trout fishery in the Mountain Fork River has greatly enhanced angler participation in southeastern Oklahoma in the United States. This new fishery is unique to the locality and attracts anglers from a distance over 250 miles. Because much of the stream is within or very close to Beaver's Bend State Park, the increased visitation would enhance the economic benefits of the park and surrounding areas.

This study estimates the consumers' surplus or angler benefits from the Mountain Fork River trout fishery. An upper estimate of the aggregate benefits is about $808,000. This indicates an average angler benefit per trout fishing trip is equivalent to $79.50.

Further study needs to include an estimate of the social costs of the trout fishery. For example, the cost of stocking the rainbow trout is $0.69 per trout. Other costs of maintaining the trout fishery at this time are minimal. However, if fishing pressure continues to increase, more facilities such as access trails and roads, parking and sanitary services will be needed. Competing use of the water releases will need to be determind and valued. Effects of the trout fishery on competing sites need to be determined and valued in adjusting overall social benefits and costs. Winter and early spring trip demand may have different angler benefits because there are few or no alternative fishing sites around the study area during these seasons. Thus estimation of seasonal differences in trip demand and angler benefits needs to be included in further study.

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