ECONOMIC ANALYSIS OF THE MOUNTAIN FORK RIVER TROUT FISHERY IN SOUTHEASTERN OKLAHOMA USING TRAVEL COST METHOD

By

Se-Hyun Choi

Bachelor of Science
Korea University
Seoul, Korea
1985

Master of Science
Oklahoma State University
Stillwater, Oklahoma
1989

Submitted to the Faculty of the
Graduate College of the
Oklahoma State University
in partial fulfillment of
the requirements for
the Degree of
DOCTOR OF PHILOSOPHY
May, 1993

ECONOMIC ANALYSIS OF THE MOUNTAIN
FORK RIVER TROUT FISHERY IN
SOUTHEASTERN OKLAHOMA
USING TRAVEL COST
METHOD

Dean F. Schreiner
Thesis Adviser

D. J. Sanders

Brian Adam

Thomas C. Collins
Dean of the Graduate College

ACKNOWLEDGEMENTS

Glory and praise the living God.

I would like to express my gratitude to those who assisted me in this project. Special thanks to my advisor, Dr. Dean F. Schreiner, for the guidance and consideration given to me during this study. I am also appreciative to my committee members, Dr. Larry Sanders, Dr. Brian Adam and Dr. William Warde, for the efforts and suggestions that made my tenure at Oklahoma State University valuable.

I extend my appreciation to other individuals who provided inputs to this project including Dr. David Leslie, Oklahoma Cooperative Fish and Wildlife Research, Dr. Harold Namminga, Oklahoma Department of Wildlife Conservation (ODWC), Mr. Jack Harper, ODWC, and Mr. Don Smith, ODWC, as well as others involved with the survey. I will not forget the spiritual guidance provided by Dr. Daniel Badger, whose love I respect.

The analytical guidance provided by Dr. Wade Brorsen and Suhk-Hyun Kim, Brent Tweeten's computer assistance, proofreading assistance from David Marcouiller, and the typing skills of Gloria Cook are greatly appreciated.

I dedicate this work to my mother, Soon-Ja Chun for her sacrifice and support for the whole of my life as well as study in the United States. Also, warmest thanks go to my wife, Hee-Seop Yoon. Her encouragement and support is the most valuable resource I have.

TABLE OF CONTENTS

Chapter Page

Chapter | Page

LIST OF TABLES

Table | Page

Table		Page

Table		Page

LIST OF FIGURES

CHAPTER I

INTRODUCTION

Recreation is an important activity that enhances the welfare of individuals and society as a whole. Physical health, mental health, and economic activity are the most important benefits of recreation activities (U.S. Department of Interior, 1979). Therefore, people devote a large proportion of their resources (monetary and time) to recreation activities explicitly or implicitly. Studies have shown that in the United States direct spending on recreation is increasing and the recreation industry appears to be growing, becoming increasingly important to the economy. This tendency will be accelerated as disposable income and leisure time increases and more diversified recreation is demanded. Recreation in the U.S. is one of the largest retail industries, promoting about 264 billion dollars of personal consumption expenditures in 1989 (U.S. Bureau of the Census)[1].

A large proportion (about 50 percent in 1982) of outdoor recreational opportunities was provided by the public sector in the U.S. (Walsh, 1986). The amount of resources used in public outdoor recreation activities is not determined in the competitive market. Hence, no equilibrium prices are known for determining the quantity of outdoor recreation demanded and supplied. The fact that prices for these goods are not observed in the market does not mean

1 The absolute monetary value varies significantly depending on the definition of recreation.

that they have no value. They should be valued just as market goods are valued as long as they enter human preferences (Randall, 1987).

For some public outdoor recreation resources the geographic market area is not well defined. For example, it is difficult to define the market area for resources such as the Yellowstone National Park or the Grand Canyon. Randall (1987) has stated that the pursuit of economic values may involve estimating values where markets are absent, and correcting market estimates of value where markets are distorted. Creative valuation methods are needed to measure the demand and supply or value of public outdoor recreation resources.

Even though the importance of recreation economics is acknowledged, prior to the 1970's there were few empirical studies that estimated the use and benefit of outdoor recreation activities. The most important reason for estimating use and benefits of nonmarket goods such as outdoor recreation activities is to determine value for the purpose of efficient allocation of resources to individuals and society.

With respect to outdoor recreation, the economic estimation of use and benefit is important for public decisionmaking. The feasibility of a project should be made based on all benefits and costs of the project. If costs exceed benefits, the project should not be undertaken. For example, a proposed project is the construction of a dam upstream of a recreation area. Costs should include the value of recreation activities foregone because of the construction of the dam. Neglect to include these values leads to the underestimation of total project costs[2].

2 Construction of the dam may provide alternative recreation activities. The values for these should be accounted for in the benefits of the project.

From a policy perspective, the quantitative analysis of recreational use and benefit provides justification for continued and increased funding from constrained government budgets (Wilder, 1981). The public sector may consider projects for constructing additional facilities at existing sites or for constructing new sites. In either case, information on expected future use and benefit from proposed facilities is critical in determining whether or not to proceed with projects.

Background

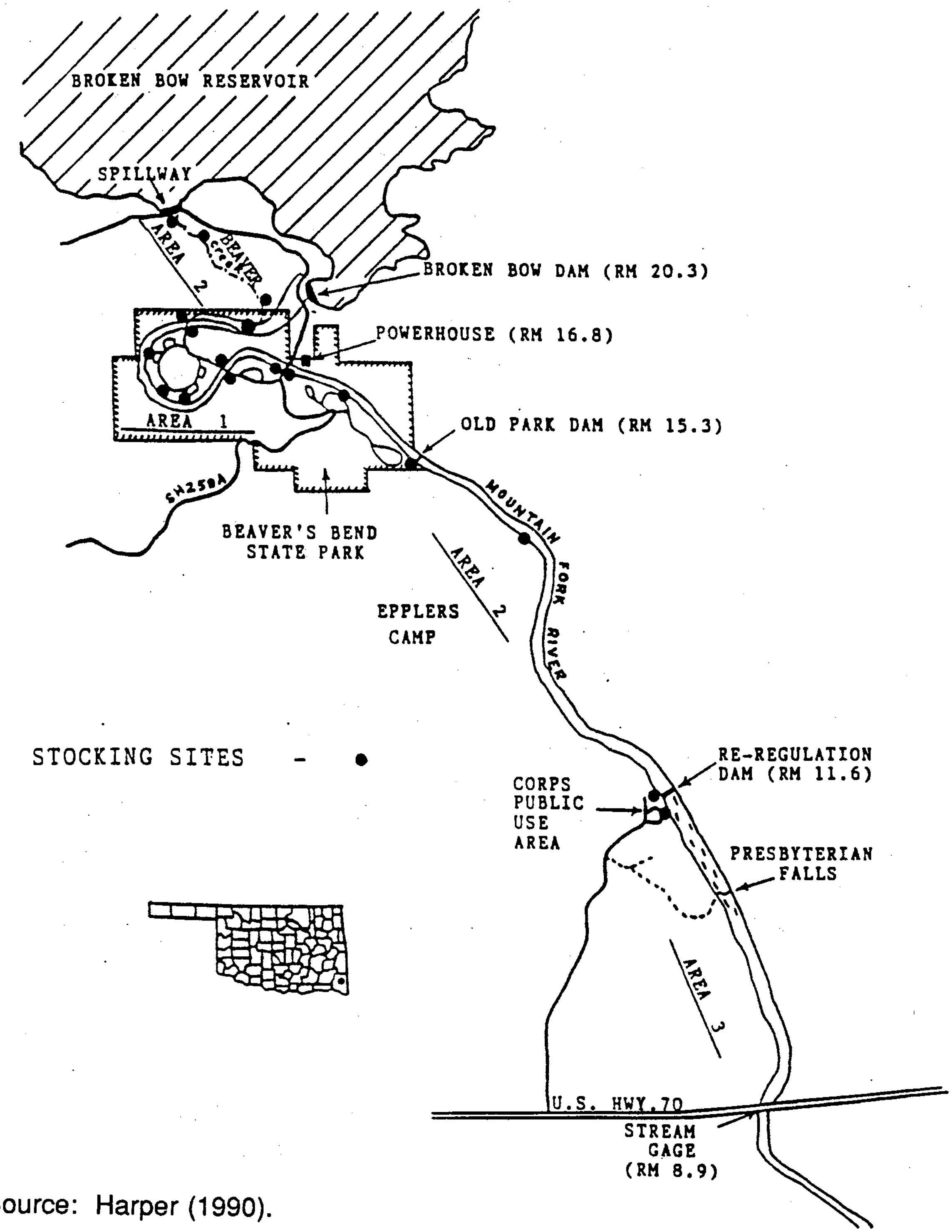
The development and operation of a natural resource may impact other adjacent resources through a variety of ways. Ecological change downstream of a hydroelectric dam is a good example. The background of this dissertation is the construction of Broken Bow Dam creating Broken Bow Lake in southeastern Oklahoma. The construction of this dam altered the periodic rate of water flow and water temperature which, in turn, changed ecology downstream of the dam (Harper, 1990).

The Mountain Fork River (MFR) and the Broken Bow Lake are located in McCurtain County in the extreme southeastern part of Oklahoma. Before construction of the Broken Bow Dam, the MFR was habitable to warmwater fish species. After construction of the Broken Bow Dam, operation of the hydropower complex released large volumes of cold water (water released from lower depths of the reservoir) into the MFR below the dam making water temperature regimes uncertain and irregular (mixed warmwater and cold water) and changing the periodic rate of water flow. Hence, for several miles below the dam, the changed environment of the MFR made it no longer habitable for the native fish species.

However, by converting the water temperature regime from uncertain and irregular to certain and regular coldwater, a trout fishery could be established. In 1986, a preliminary biological feasibility study for a trout fishery in the MFR was initiated by the Oklahoma Department of Wildlife Conservation (ODWC) and the U.S. Fish and Wildlife Service (FWS) with assistance from the U.S. Army Corps of Engineers (COE). Positive results of that study provided the basis for developing a trout fishery on the Mountain Fork River below the Broken Bow Dam. From January 1, 1989, the ODWC Commission designated approximately 12 miles of the MFR and tributaries from Broken Bow Dam downstream to the U.S. Highway 70 bridge as a year-round trout fishery area (Harper, 1990).

The ODWC established the MFR trout fishery by stocking 3,850 catchable (8.5 inch minimum) rainbow trout on a biweekly basis (Harper, 1990, 1991, and 1992). The trout were stocked in areas below the Broken Bow Dam to U.S. highway 70 including the Beavers Bend State Park (Figure 1). The U.S. Army Corps of Engineers was contracted to release water from the Broken Bow Lake at appropriate times and in sufficient volume to maintain the environment for the operation of the year-round put-and-take trout fishery.

The MFR below the Broken Bow Reservoir was the ODWC's fourth put-and-take rainbow trout fishery site. The first site was the lower Illinois River below Tenkiller Reservoir initiated in 1965 (Harper, 1990). The second site was the upper Blue River and the third was Lake Watonga. Of the four sites, the MFR and the lower Illinois River are the only sites for a year-round trout fishery. The other sites stock trout for only the winter season.



Source: Harper (1990).

Figure 1. Mountain Fork River Trout Stream Showing Trout Stocking Sites During 1989.

Problem Statement

An economic evaluation of the MFR trout fishery is required to assess feasibility of the project, to justify current and future public expenditures, and to efficiently manage the public resource.

Public expenditures includes operation and maintenance costs (O&M cost) of the trout fishery and the opportunity costs foregone because of implementation of the project. Trout stocking costs are included as operating and maintenance costs. Opportunity costs include the value of water released exclusively for maintaining the trout fishery and the benefits foregone from prior fishing activities. Conflict in water use may exist between generating electricity and water release for the trout fishery. Furthermore, this is complicated by the irregular nature of cold water emissions from the hydroelectric complex at the Broken Bow Lake. This can be addressed through identifying opportunity costs involved in changing from irregular to regular water flows. During the summer season, this situation becomes critical in maintaining the trout fishery resource.

Benefits from the public recreation program created by the MFR trout fishery project need to be identified and quantified for the economic evaluation. Market transaction information on the demand for the MFR trout fishery by anglers is not available for estimating benefits. Nonmarket valuation methods are thus required to achieve the needed evaluation. This study addresses this need.

Objective of the Study

The principle objective of this study is to analyze the economic value of a year-round put-and-take trout fishery in the MFR below Broken Bow Dam. To accomplish this objective, economic benefits and costs to the anglers of the

MFR trout fishery are estimated. Also, the overall economic feasibility of the MFR trout project needs to be estimated. Finally, management and policy decisions are evaluated based on the results above.

Specific objectives are as follows:

1. to obtain characteristic data for a sample of MFR anglers over the three years of observation of the trout fishery.
2. to ascertain variables that explain angler consumption behavior of the MFR trout fishery.
3. to estimate angler demand for and benefit derived from the MFR trout fishery.
4. to detect and measure possible seasonal variation in angler demand and benefit for the MFR trout fishery.
5. to measure the overall economic benefits and costs of the MFR trout fishery project.
6. to suggest and evaluate policy and management decisions for the project based on results above.

The Organization of the Study

Chapter II introduces the theoretical basis of outdoor recreation benefit analysis. The first part of the chapter presents basic measures of welfare change and reviews federal guidelines for water resource projects. In the next part, the theoretical basis of nonmarket valuation methods are reviewed. Empirical issues in recreation benefit analysis are discussed in the last part. Procedures of this study are contained in Chapter III. Procedures for sample survey design are presented. The nonmarket valuation approach used and type of model selected for demand and benefit estimation of the MFR trout fishery are presented. Finally, demand and benefit estimation methods employed by other outdoor recreation literature are reviewed. Chapter IV serves to present results of survey data of the MFR anglers organized under the broad headings of angler trip information and angler characteristic data. In Chapter V, analysis of the demand and benefit of the MFR trout fishery is presented. The demand estimation model is specified and data used for this analysis are explained. Results of demand and benefit estimation of the MFR trout fishery are presented. Chapter VI summarizes and concludes this study with evaluations on policy and management decisions for the MFR trout fishery.

CHAPTER II

THEORY OF RECREATION DEMAND AND BENEFIT ANALYSIS

The purpose of this chapter is to present and discuss the theoretical basis of nonmarket valuation methods. In the first section, basic concepts of measures of welfare change are presented. Principles and Guidelines (P&G) of the U.S. Water Resources Council (1983) for National Economic Development (NED) as related to recreation are presented in the section. Next the derivation process and theoretical validity of alternative nonmarket valuation methods are reviewed with emphasis on the expenditure function approach. Also, several types of travel cost models are presented. Then the contingent valuation method (CVM) is introduced and compared with travel cost method (TCM). The focus is on advantages and disadvantages of each approach. The last section of Chapter II is devoted to empirical issues of recreation demand and benefit analysis when the travel cost method (TCM) is used.

Measures of Welfare Change

This section briefly reviews some basic concepts related to the measurement of welfare change. These basic concepts are defined and compared. The following section is devoted to introducing the national economic development (NED) benefit evaluation procedures for recreation. These are the Federal Principles and Guidelines (P&G) for water and related land resources implementation studies by the U.S. Water Resources Council (1983). The P&G are used as a guide for this dissertation, both theoretically and practically.

Many studies exist that have defined, reviewed, and discussed alternative measures of welfare change since the pioneer study of Hicks (Freeman, 1979, Randall, 1984, Chapter 2, etc.). Generally, five measures of welfare change have been identified. Consumer surplus is the most commonly used measure of welfare change. It is defined as the willingness of consumers to pay in excess of their actual payment and is represented as the area under the demand curve above the price line (Vincent et al., 1986). However, the consumer surplus is not an ideal measure of welfare change unless the income elasticities of demand are unitary for all consumers.

The other four measures of welfare, the so called Hicksian welfare measures, are refinements of the ordinary consumer surplus. Based on Desvousges et al. (1983, Chapter 2), these measures in the event of a price decrease are defined as follows:

- Compensating variation (CV) is the amount of compensation that must be taken from an individual to leave him at the same level of satisfaction as before the change.

- Equivalent variation (EV) is the amount of compensation that must be given to an individual, in the absence of the change, to enable him to realize the same level of satisfaction he would have with the price change.

- Compensating surplus (CS) is the amount of compensation that must be taken from an individual, leaving him just as well off as before the change if he were constrained to buy at the new price the quantity of the commodity he would buy in the absence of compensation.

- Equivalent surplus (ES) is the amount of compensation that must be given to an individual, in the absence of the change, to make him as well off as he would be with the change if he were constrained to buy at the old price the quantity of the commodity he would actually buy with the new price in the absence of compensation.

The compensating and equivalent measures of welfare change differ because their frames of reference are different. For example, in the case of a price decrease, the CV takes the initial price set as an individual's frame of reference and asks the maximum amount that the individual would be willing to pay for the opportunity to consume at the new price set. On the contrary, EV takes the new price set as an individual's frame of reference and describes the minimum amount the individual would be willing to accept to forego the opportunity to purchase at this new price set. The difference between the variations and the surpluses is that for the former, the individual has made optimizing adjustments in his consumption set whereas the latter do not permit such adjustment (Randall, 1984, Chapter 2). The first two concepts (CV,EV) are more often used than the latter two (CS,ES) because the concepts of the latter two measures are too restrictive to be applied in the real world (Freeman, 1979).

Though it is not a rigorous measure of welfare change, the consumer surplus is more commonly used in empirical welfare analysis because Marshallian demand curves are more easily estimated than Hicksian demand curves. Willig (1976) has demonstrated and justified consumer surplus as an approximation of the Hicksian measure of welfare if the income effect[1] of a price change is small.

Two other important concepts are the willingness to pay (WTP) and the willingness to accept (WTA). WTP is the maximum amount of money that an individual would be willing to give up to achieve a change and still be as well off as before. WTP represents a buyer's best offer. WTA is the minimum amount of money that an individual must receive in order to forego the change and leave

---

1 The income effect of the price change is small when a price change for a good is small and the budget share of that good is also small.

the individual as well off as if the change occurred. WTA represents a seller's reservation price.

Other concepts related to the evaluation of recreation benefits include total benefit and net benefit. Total benefit is the maximum amount that individuals are willing to pay rather than go without a recreation activity. This is identical to the total willingness to pay (WTP). Net benefit is total benefit less the amount actually paid as direct costs. It is equal to the difference between the amount an individual is willing to pay (total benefit) and the amount an individual actually pays. This concept is identical to consumer surplus.

Federal Guideline Procedures of Recreation Benefit Evaluation for National Economic Development

Federal water resource projects may lead to both construction of and replacement of recreation sites. Recreation opportunities can be enhanced or decreased according to the specific project considered. Therefore, net recreation benefits equal the value of benefits gained minus the value of benefits lost and hence can be positive or negative.

Based on the Principles and Guidelines (U.S. Water Resources Council, 1983), project benefits of recreation opportunities are measured by willingness to pay (WTP). Total WTP is the sum of entrance fees and user charges actually paid for the site and any unpaid value (surplus) enjoyed by users.

Because most recreation opportunities are provided by the public sector, explicit prices (or price-consumption relationships) do not exist for the recreation site. Other means of measuring the use and value of these recreation opportunities are needed. Generally, the criteria for an acceptable evaluation procedure recommended by the P&G have the following characteristics:

(1) evaluation is based on an empirical estimate of demand applied to the particular project;

(2) estimates of demand reflect the socioeconomic characteristics of market area populations, qualitative characteristics of the recreation resources under study, and characteristics of alternative existing recreation opportunities;

(3) evaluation accounts for the value of losses or gains to existing sites in the study area affected by the project (without project condition); and

(4) willingness to pay projections over time are based on projected changes in underlying determinants of demand (ibid, p. 67).

Three techniques are recommended by the P&G for estimating use and WTP (value) of a recreation site. These are travel cost method (TCM), contingent valuation method (CVM), and unit day value method (UDV). The TCM and CVM are discussed in the next section on valuation of nonmarket goods. The remaining part of this section discusses other procedures in the evaluation of project benefits related to recreation resource use.

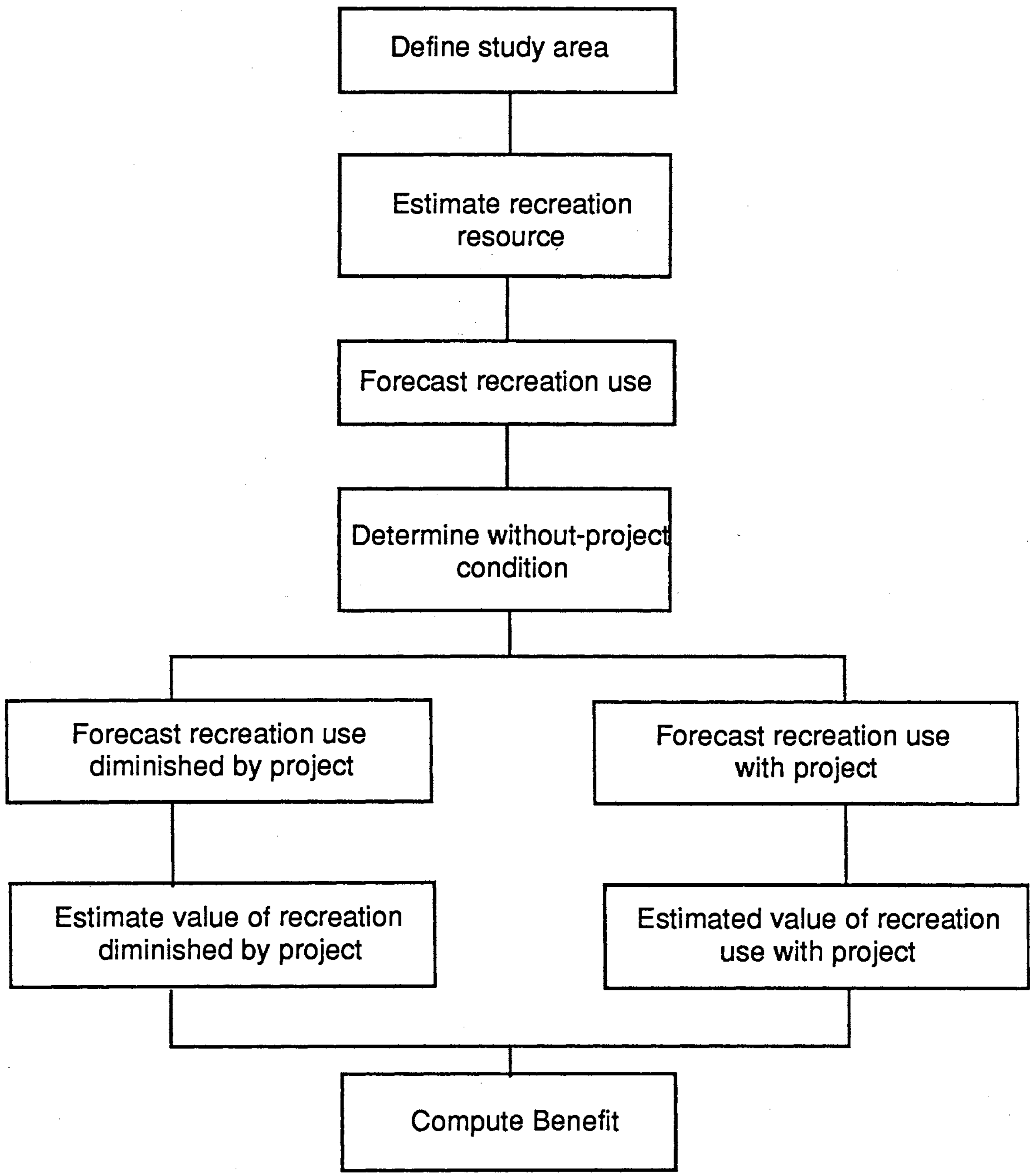
The unit day value method (UDV) relies on expert judgement to estimate the average WTP of recreation users for a day of recreation activity (ibid, p. 68). Annual benefit of recreation demand, for example, can be estimated by the multiple of average WTP for a day of recreation activity at the site and the estimated average annual demand. Estimates of the range of average WTP values for each type of recreation activity are available in the Federal Guidelines (ibid, p. 83). Selection of the appropriate range of values adjusted for the study of interest is key for reliable benefit estimation.

The net benefit arising from a project is estimated by comparing the benefits and costs of with project and without project. The without project condition is the pattern of recreation activity expected to prevail over the prescribed period of analysis in the absence of the recreation project or plan. On the contrary, the with project condition is the pattern of recreation activity expected to prevail over the prescribed period of analysis with a recreation project or plan (ibid, p. 70). Recreation resources included in the without project condition provide the basis for the with project condition.

General procedure of recreation benefit evaluation for a project is presented in Figure 1 (ibid, p. 71). The computation of benefit should be based on the gross value of recreation opportunities provided by with project condition less the gross loss in recreation opportunities displaced by the project. The core part is the procedures of estimating the use and value of recreation with project.

Three techniques for estimating recreation use are recommended: (1) use estimating models (UEM), (2) similar project method, and (3) capacity project method (ibid, p. 72).

Use estimating models relate use to relevant use-determining variables and hence, technically sound methods for prediction of recreation use. The problem of this technique is availability of data on use-determining variables. There are two types of UEM, regional models and site specific models. Regional use estimating models are defined as statistical models that relate use to the relevant determinants based on data from existing recreation sites in the study area (ibid, p. 72) The site-specific models differ from regional models in that they use data for only one project. One of the main advantage of regional models over site-specific models is that by using cross sectional data from a



Source: U.S. Water Resource Council (1983).

Figure 2. Flowchart of Recreation Benefit Evaluation Procedures.

number of different sites, the effect of different project features on actual behavior can be explicitly tested (Vincent et al., 1986).

The similar project method may be used when a UEM is not available and can not be estimated because of data limitation. This method uses information of existing projects that have similar characteristics to the proposed one in resources, use, and operation. The critical point is matching the proposed project as closely in character as possible to projects already existing. The characteristics compared are project type, size, and quality; demographic and socioeconomic characteristics of market area; existence and location of competing recreation opportunities; and other demand shifters.

The capacity project method estimates the use of site based on instantaneous resource or facility capacity (ibid). This method is used when data are not available or not cost effective to obtain and there exists sufficient excess demand in the market area for additional capacity to be supplied by a proposed project. Information on trip generation can not be estimated by this method, hence it precludes the use of the travel cost method.

Use estimating models are the most theoretically sound and therefore the preferred method for estimating recreation use. Regional models are preferred to site-specific models if the former are available except in situations where the proposed project is unique in resource or activity. Similar project approach is simpler to apply than UEM, though it depends heavily on planners' judgement about characteristics of the proposed and existing projects for comparison purposes. However, this approach does not explicitly include variables such as substitution sites, quality differences, and socioeconomic characteristics (ibid).

The Valuation of Nonmarket Goods

This section begins by identifying alternative approaches for valuing nonmarket goods. The expenditure function approach is presented in detail whereas the income compensation approach is presented briefly[2]. Several types of models using the travel cost method (TCM) are presented which are representative of the expenditure function approach. The contingent valuation method (CVM) representing the income compensation approach is discussed. Finally, a comparison of alternative approaches is made with emphasis on the advantages and disadvantages of the two approaches.

Most public recreational goods (lakes, parks, aesthetics) are not priced in the market place. They are assigned an implicit value based on political or institutional considerations. That is, explicit markets generally do not exist for these goods that allow for market price discovery. Without market price discovery, the value of recreation goods is difficult to measure. Consequently, efficient allocation of recreation resources is difficult. Therefore, nonmarket valuation methods requiring considerable creative efforts have been developed by researchers.

Nonmarket goods can generally be valued by either the expenditure function approach or the income compensation approach (Randall, 1984, Chapter 1). The travel cost method is categorized as an expenditure function approach whereas the contingent valuation approach is classified as an income compensation approach. The two approaches are theoretically based on the pioneering work of Mäler (1974). A large number of research studies have followed this original work explaining and interpreting more understandable

---

2 The expenditure function approach is applied for empirical benefit estimation later in this dissertation.

forms (Freeman, 1979; Randall, 1984; and Rosenthal, 1985). The following outline of theoretical approaches is an interpretation of the works of the researchers mentioned above.

Expenditure Function Approach

Following the standard notations from similar work, a vector of nonmarket goods (Q) and a vector of market goods (X) can be expressed as $Q = (Q_1,...Q_i,...Q_m)$ and $X = (X_1,...X_i,...X_n)$. Then, individual utility, U, can be written as

$$U = U(X,Q) \tag{2.1}$$

if Q directly affects the utility level of the individual. Maximizing utility subject to income constraint ($\sum_i P_i X_i = Y$) yields Marshallian demand functions for the X's,

$$X_i = X_i\,(P, Q, Y) \tag{2.2}$$

where P is the price vector of marketed goods and Y is money income. The dual problem of utility maximization can be stated as minimization of expenditures (i.e. $Y = \sum_i P_i X_i$) subject to the given level of utility (U^o). The solution of this problem yields the expenditure function of the form:

$$Y = E(P, Q, U^o). \tag{2.3}$$

The Hicksian compensated demand function can be derived by the partial derivative of the expenditure function with respect to the price of a good, i.e.

$$X_i = \frac{\partial E}{\partial P_i} = E_{P_i}\,(P,Q,U^o). \tag{2.4}$$

Assume the proposed policy change is a price change from P_i^o to P_i^1. Then, the change in welfare (W) can be derived by the following integration:

$$W = \int_{p_i^o}^{p_i^1} E_{P_i}(P, Q, U^o)dP_i. \qquad (2.5)$$

The value of the above integral is equal to the compensating or equivalent variations of welfare change. If the level of U^o in the expenditure function (2.3) is before the welfare change, then compensating variation is an appropriate measure of the welfare change. If the level of U^o in the expenditure function (2.3) is after the welfare change, then equivalent variation is an appropriate measure of the welfare change[3]. An empirical estimation of (2.5) depends on the types of restrictions imposed on the form of the utility function (2.1).

Assume the utility function is strongly separable, i.e.,

$$U(X, Q) = U[f(X) + g(Q)]. \qquad (2.6)$$

Strong separability in the above context indicates that the changes in Q have no effect on marginal rates of substitution of any of the market goods (X) (Freeman, 1979). This means that Q can be excluded as an argument in all of the market demand functions. The demand function for the market good (X) is then

$$X_i = X_i(P,Y). \qquad (2.7)$$

---

[3] A policy change of quantity can also be assumed and can be measured in the same way.

The demand for Q can not be estimated from observing market data on transaction in X (Freeman, 1979). In these cases, empirical valuation methods via the expenditure function approach do not work. Instead valuation of nonmarket goods should be performed based on the income compensation approach or not at all (Randall, 1984). On the contrary, if the utility function is not strongly separable, the demand for nonmarket goods can be estimated from observable market data on transactions in market goods. This is because the changes in the quantity of the nonmarket good leave an impact in the market place (Rosenthal,1985). The demand function for X is the same as the previous equation (2.2)

$$X_i = X_i\,(P, Q, Y)\,. \tag{2.8}$$

This is the core idea of the expenditure function approach.

Assume that the demand functions (2.8) can be empirically estimated. The question is whether these demand functions satisfy the Slutsky conditions for integrability. Integrability implies that there exists utility and expenditure functions that can be integrated from the estimated demand functions. However, it is not generally possible to solve completely for the utility and expenditure functions with the estimated demand functions. Therefore, further assumptions between market goods and nonmarket goods are required in addition to strong separability in order to estimate welfare change of the proposed policy by the expenditure function approach. Different valuation techniques can be developed depending on the further assumptions.

Randall (1984) discusses three sets of valuation techniques that fall within the general expenditure function approach based on different assumptions of demand relationships between market goods and nonmarket goods. These are (1) weak complementarity, (2) perfect substitution, and (3) hedonic prices. Of these three assumptions, weak complementarity is the basis of the TCM and hence presented here.

Assume the system of demand equations is of the form (2.8). Also assume that the expenditure function can be estimated from equation (2.8). Based on Mäler's work (1974), weak complementarity between market good i and nonmarket good i is defined as

$$\frac{\partial U\,(X1, X2,.X_{i-1},0,X_{i+1}...X_n,Q_1,...Q_m)}{\partial Q_i} = 0. \qquad (2.9)$$

The above equation means that if the demand for market good i is zero, then individual utility does not change from the change in quantity demanded of nonmarket good i. Similarly, with the constraint on the expenditure function, equation (2.9) is of the form:

$$\frac{\partial E\,(P_1,P_2, ...\, P_i^h, \,...\, P_n,\, Q_1, ...\, Q_m,U^o)}{\partial Q_i} = 0 \qquad (2.10)$$

where P_i^h is the price at which quantities demanded for X_i decreases to zero.

Equation (2.10) implies that if the price of market good i is so high that demand for the good is zero, the change in the demand for nonmarket good i has no effect on the expenditure function[4]. Assume that there exists only a market good i and nonmarket good i. If it is also assumed that Q_i represents the existing quantity of the recreational site i and Q_i^h represents removal of the site i, the welfare loss of removing Qi as measured by the compensating variation criteria can be expressed as

$$CS\,(Q_i) = E\,(P_i,Q_i^h) - E\,(P_i, Q_i)\,. \qquad (2.11)$$

---

4 Assume that there exist weak complementarity between X_i and Q_i.

Also, the welfare loss associated with increasing the price of travel (including entrance fee) to the site to P_i^h such that quantity demanded falls to zero is

$$CS\ (T_i) = E\ (P_i^h, Q_i) - E\ (P_i, Q_i) \qquad (2.12)$$

where CS and T_i stands for consumer surplus and the travel activity carried out to the recreational site i by recreationists, respectively.

The weak complementarity condition implies that

$$E\ (P_i^h,\ Q_i^h) - E\ (P_i^h,\ Q_i) = 0\ . \qquad (2.13)$$

This means that if the price is too high for recreationists to visit the recreational site i, the amount of welfare loss associated with removal of the site i is zero.

From equations (2.11), (2.12), and (2.13), the following equation can be obtained

$$CS\ (Q_i) = CS\ (T_i) - [\ E\ (P_i^h,\ Q_i^h)\ -\ E\ (P_i,\ Q_i^h)\ ]. \qquad (2.14)$$

Because of the weak complementarity assumption, the last term of the equation (2.14) is zero and leaves the equation of the form[5]:

$$CS\ (T_i)\ =\ CS\ (Q_i). \qquad (2.15)$$

This means that the consumer surplus associated with trips to the ith site equals the consumer surplus of the ith site itself. Consequently, the TCM is established on a valid theoretical basis.

Limitations of the expenditure approach are stated by Mäler (1974). The most important limitation is that the estimated demand functions should satisfy the integrability conditions. Functional forms commonly used in empirical

5 The reciprocal weak complementarity assumption should hold for the last term to be equal to zero.

analysis of demand estimation such as linear, quadratic, or common log transformations do not satisfy these conditions. Because of its practical usefulness in measuring welfare change and policy implications, the expenditure function approach is commonly used by researchers.

The following travel cost models represent most applied studies in the current recreation literature. Ways to incorporate substitution effects in the demand equation are important in separating the types of models. The choice of model depends on the specific purpose and characteristic of the particular study.

Own Price Only TCM. As the most widely applied method, the own price only TCM is used in estimating recreation demand when the interested site has unique attributes (Cannock, 1988). The trip demand function is estimated by regressing the travel cost and other demand shifters on the frequency of trips to the interested site. Other demand shifters include travel time cost, income, and socioeconomic variables. The travel cost to substitute sites is excluded. General models of this type are as follows:

$$Q = f(p, X) \tag{2.16}$$

where Q = frequency of individual trips taken to a recreational site,

p = travel costs, and

X = a vector of demand shifters excluding substitute measures.

Caution should be used in excluding travel costs to substitute sites. If relevant variables are omitted from the model, parameters of remaining variables become biased. Caulkins et al. (1985) have demonstrated that the sign of the omission bias is determined by the true economic relationship between the sites and the sign and degree of correlation between their corresponding travel costs.

For example, consider the true economic relationship between sites as substitutes. Then the sign of the estimated coefficient of the omitted variable (travel cost to the substitute site) is positive. If the correlation between travel costs of the own site and the substitute site has the same sign as that of the omitted variable (positive), the bias of the estimated coefficient is positive. The true demand curve lies inside and below the observed demand curve, hence this leads to overestimation of consumer surplus.

The economic relationship between sites can be complements or the sign of the correlation between corresponding travel costs can be negative. Therefore, as Allen et al. (1981) have demonstrated, the nature and extent of bias in omitting variables is likely to vary from study to study.

Quality Enhanced Own Price Only TCM. As a special case of the general own price only TCM, quality enhanced own price only TCM was first labeled by Mendelsohn and Brown (1983). With these models, changes in net benefits from changes in site characteristics can be directly estimated. For demonstration purpose, two-stage estimation procedures of Vaughan and Russell (1982) are illustrated.

In the first-stage, a travel cost model with linear demand functions is estimated for each site as follows:

$$Q_{ij} = a_j + b_j P_{ij} + \sum_{k=1}^{K} c_{jk} X_{ik} + e_{ij} \text{ for } (j = 1...J) \tag{2.17}$$

where Q_{ij} = trips per capita from origin i (i = 1...I) to site j (j = 1...J),

P_{ij} = travel cost from origin i to site j,

X_{ik} = the kth (k=1···K)characteristics of the population of origin i,

a_j, b_j, c_{jk} = parameters to be estimated, and

e_{ij} = random error term.

Those variables that vary from origin to origin are included in this stage. In the second stage, the parameters of the above equation estimated in the first stage are regressed on the characteristics of each site:

$$
\begin{aligned}
a_j &= q + r \sum_{n=1}^{N} Z_n \\
b_j &= s + t \sum_{n=1}^{N} Z_n \\
c_{jk} &= u_k + \sum_{n=1}^{N} w_{kn} Z_n \quad (k=1...K)
\end{aligned}
\tag{2.18}
$$

where Z_n = measure of nth site characteristic.

Combining the two stages, i.e. equations (2.17) and (2.18), the trip frequency of the ith site can be expressed as a function of the set of characteristics of that site.

The advantage of this approach over the simple TCM is the inclusion of multiple characteristics in the demand equation. With some manipulation, the demand equation for a site can be estimated by only the characteristics of that site. The quality enhanced own price only TCM used in the study of Vaughan and Russell (1982) assumed that cross-prices were constant for all origins. Hence, the price effect of substitute sites, if they exist, are not accounted for in the model. Rosenthal (1985) has argued that the own-price and cross-price terms should vary from origin to origin considering the spatial location of origins and sites. This is a weakness of the quality enhanced own price only TCM.

Classical Travel Cost Models. The classical TCM includes the attributes of substitute sites in the model. If the substitution measures are not included in the model and the excluded variables are relevant, then statistical misspecification bias occurs. Following the study of Burt and Brewer (1971), the classical TCM can be expressed as

$$V_{ij} = a_j + b_j P_{ij} + \sum_{k=1}^{5} b_k P_{ik} + cY + e_{ij} \qquad (2.19)$$

where V_{ij} = visits per household from origin i to site j,

P_{ij} = price of traveling from origin i to site j,

P_{ik} = price of traveling from origin i to substitute site k,

Y = household income, and

a, b, c = parameters to be estimated, and

e_{ij} = random error terms.

The main achievement of the above model is that it overcomes the misspecification bias that may occur if only the effect of own price is accounted for. The substitution effects of the above model, P_{ik}, are indexed by origin. Burt and Brewer classified water-based recreation sites in the state of Missouri by six according to the sites' characteristics. Then, they assumed that the sites within the six groups were perfect substitutes for one another. The assumption implies that for a given type of site, people will always visit the nearest site. This greatly mitigates the data requirements for the effect of substitute measures. However, the perfect substitution assumption may not be a reasonable assumption because those situations can seldom be observed in the real world.

The minimum travel distance from the origin of each household to each of six types of sites was measured and converted to travel cost. Six representative demand curves for each type of recreation site is derived using the following form:

$$Q_j = f(P, P_t, Y) \qquad (2.20)$$

where Q_j = the demand function for recreation type j (j = 1...6),

P = own price,

P_t = vector of cross prices, and

Y = income.

The net benefit (W) of an existing site can be estimated as follows:

$$W = \int_{p^a}^{p^b} Q_j \, dP \tag{2.21}$$

where P^a = travel cost of arriving at a type j recreation site before removal of the site of interest, and

P^b = travel cost of arriving at a type j recreation site after removal of the site of interest.

A second major way to account for substitutes in the TCM is to calculate an index of the availability of substitutes. This method was used by Knetsch et al., (1976) in measuring use and benefit of seven reservoirs in the Sacramento District of the Corps of Engineer, located in the Central Valley of California. The demand equation was formed as

$$V_{ij} = a + b\frac{P_i}{D_{ij}} + c\frac{P_i A_j}{D_{ij}} + d\frac{P_i}{D_{ij}\, S_{ij}} \tag{2.22}$$

where V_{ij} is number of recreationists going from origin i to site j,

P_i is population of origin i,

D_{ij} is distance from origin i to site j,

A_j is the size of the recreation pool for reservoir j, and

S_{ij} is the substitute index to site j for origin i and computed as follows

$$S_{ij} = \sum_{k=1}^{K} \frac{\ln(L_k)}{D_{ik}} \qquad (2.23)$$

for all k where

$$j \neq k$$

$$\frac{\ln(L_k)}{D_{ik}} > \frac{\ln(L_j)}{D_{ij}}, \quad \text{and}$$

L_k is the pool size of the alternative reservoir k.

The substitute index S_{ij} incorporates both the price and quality of substitution sites. Specifically, it is the total value of the attractiveness of the substitute sites for those sites that are more attractive than site j to origin i. However, Rosenthal (1985) has argued that the incorporation of substitution effects by index should be avoided because of arbitrariness in definition.

Discrete Choice Travel Cost Models. The basic assumption of the discrete choice TCM is that individuals make two separate choices that lead to a visit to a specific recreation site (Ewing, 1980; Morey, 1981; Peterson, et al., 1982; Caulkins, et al., 1986; Rosenthal, 1985, 1987; and Cannock, 1988). If a recreation site is a lake, for example, the two separate choices are 1) whether or not an individual will undertake a recreational activity on a particular day given that the individual is among the user population of the recreation site, and 2) which site to visit given that the choice of visiting a site has been made. The advantage of this model is explicit incorporation of both the relevant substitute sites and site quality effects that influence recreationists' choices regarding where and how often to recreate. The above statement can be expressed in probability notation based on the notation of Caulkins et al. (1986):

$$P_{gni} = P_{i|g} \cdot P_{g|r} \qquad (2.24)$$

where P_{gni} = the joint probability of choosing to take a trip to a lake and choosing lake i from their choice set,

$P_{i|g}$ = the conditional probability of choosing lake i from their choice set given that one has decided to take a day trip to a lake, and

$P_{g|r}$ = the probability of choosing lake recreation on a particular day given that one participates in lake recreation.

A variation on the discrete choice TCM is a gravity type model (regional gravity model). The gravity model estimates the level and distribution of trips across the sites (Sutherland, 1982a). The main difference is that the discrete choice TCM involves an individuals' choices regarding where and how frequently to recreate whereas the regional gravity TCM involves the choices of total population in a specific area. Rosenthal (1985,1987) presented a gravity model as follows:

$$T_{ij} = T_i \cdot P_{ij} \qquad (2.25)$$

where T_{ij} = the number of trips from origin i to recreation site j;

T_i = the total number of recreation trips from origin i; and

P_{ij} = the probability that site j is selected as a destination given a trip from origin i is taken.

Similar to discrete choice TCM, the regional gravity TCM consists of two parts 1) a trip generation model and 2) a trip distribution model. When discrete choice is used for multiple sites (more than two sites), the multinomial logit model is specified. A detailed review of logit models related to recreation choice can be found in Stynes and Peterson (1984) and Ewing (1980).

The estimation procedure of the regional gravity model (or discrete choice TCM) is demonstrated based on the work of Rosenthal (1985,1987). The trip distribution part of the model is of the following general form:

$$P_{ij} = \frac{\exp(U_{ij})}{\sum_{k=1}^{J} \exp(U_{ik})} \tag{2.26}$$

where P_{ij} = the probability of a trip from origin i to site j and

U_{ij} = the net utility of visiting site j for origin i, and specified by Rosenthal (1985) as:

$$U_{ij} = f(C_{ij}, A_j, S_i) + e_{ij} \tag{2.27}$$

where C_{ij} = a round-trip travel cost from origin i to site j,

A_j = characteristic or quality of site j, and

S_i = characteristic of origin i.

Combining equations (2.27) and (2.28) yields

$$P_{ij} = \frac{\exp[f(C_{ij}, A_j, S_i)]}{\sum_{k=1}^{J} \exp[f(C_{ik}, A_k, S_i)]} \tag{2.28}$$

The trip generation part of the model is of the form

$$T_i = \beta_0 P_i^{\beta_1} G_i^{\beta_2} \left[\sum_{k=1}^{J} \exp f(C_{ik}, A_k, S_i) \right]^{\beta_3} \tag{2.29}$$

where T_i = trips from origin i,

P_i = population of origin i,

G_i = characteristics of the origin i such as age, income, and education, and

$\beta_0, \beta_1, \beta_2, \beta_3$ = are parameters to be estimated.

The term inside the brackets [ ] of equation (2.30) is the denominator of the trip distribution model. This means that the trip generation model will be affected by the variables in the $f(C_{ik},A_k,S_i)$.

Combining equations (2.29) and (2.30) results in the site demand model

$$T_{ij} = \beta_o P_i^{\beta_1} G_i^{\beta_2}\left[\sum_{k=1}^{J} \exp f(C_{ik},A_k,S_i)\right]^{\beta_3} \frac{\exp f(C_{ij},A_j,S_i)]}{\sum_{k=1}^{J} \exp f(C_{ik},,A_k,S_i)]} \qquad (2.30)$$

or

$$T_{ij} = \beta_o P_i^{\beta_1} G_i^{\beta_2}\left[\sum_{k=1}^{J} \exp f(C_{ik},A_k,S_i)\right]^{\beta_3 -1} \exp f(C_{ij},A_j,S_i)]. \qquad (2.31)$$

The trip distribution portion of the above model (multinomial logit model) is estimated by maximum likelihood estimator (MLE) whereas the trip generation portion of the model is estimated using log-linear regression or maximum likelihood logistic regression.

A number of shortcomings were identified when the multinomial logit model was applied to recreation choice problems (Stynes and Peterson,1984)[6]. Also, further research is needed to answer the question whether recreation choices are sequential or simultaneous.

Income Compensation Approach

This approach directly attempts to measure monetary value paid or received by an individual to keep the same utility level before the welfare change in response to the welfare change that affects the individual's utility level (Randall, 1984, Chapter 1). The monetary value paid or received can be revealed by individuals as their WTP or WTA. The WTP and WTA can be implied by the indifference curves that are not observed directly. Hence, the

---

6 An example is the independence from irrelevant alternative (IIA) assumption.

estimation methods of the income compensation approach involve construction of experimental or hypothetical situations from which the information about an individual's indifference curves can be obtained. The success in valuation of nonmarket goods by the income compensation approach, thus, depends largely on how well the experimental or hypothetical situations as constructed represent opportunities to observe an individual's indifference curves. The most common situation is a hypothetical market. The contingent valuation method (CVM) represents the income compensation approach.

The CVM creates a hypothetical market of which the features of non-hypothetical markets and institutions are employed as mechanisms to reveal demand for the nonmarket good (Durden and Shogren, 1988). By using survey methods, respondents values for nonmarket goods are revealed[7].

Bidding approaches are the most widely used form of eliciting value information from respondents (Stoll, 1983). The bidding approach can be divided into two categories, iterative bidding and noniterative bidding. The iterative bidding takes the form of a series of closed-ended questions where the respondents are asked to reveal their willingness to pay for the described quantity at some initial price (ibid). The response is "yes" or "no" and the interviewer reiterates the question by increasing or decreasing the monetary value until the highest amount the respondent is willing to pay is identified. Noniterative bidding can be divided into two types depending on the format of questions, open-ended or close-ended. An example of noniterative bidding with an open-ended format can be asking respondents to report maximum WTP contingent on hypothetical changes in the level of nonmarket good provided.

---

7 Examples of survey methods include personal survey, telephone survey, mail survey, etc.

This reported value of WTP is identically equal to the Hicksian compensating (or equivalent) measure of consumer surplus.

Potential biases in the contingent valuation mechanism may limit usefulness of this method (Durden and Shogren, 1988). The mechanism includes survey administration and design. A number of studies have identified and discussed biases in CVM and/or have tested whether the biases of estimates are significant (Schulze et al., 1981; Rowe and Chestnut, 1983; Cummings et al., 1986; Edwards and Anderson, 1987; and Reiling et al., 1990). The studies can be either validity studies or reliability studies. Reiling et al. (1990) have stated that a contingent value is valid if it measures the correct theoretical construct. A contingent value is reliable if the variance of the estimated mean is the same as the true variance of values across the population.

Generally speaking, the empirical studies for the existence of potential bias in the contingent valuation mechanism is still inconclusive. Several biases commonly reported in CVM studies are strategic bias, information bias, instrument bias, or hypothetical bias. Other biases include sampling bias, nonresponse bias, and selection bias. Strategic bias occurs when the respondents reveal an untrue WTP in order to improve their own position (Forster,1989). Information bias is said to exist if the structural content of the contingent market is different from the valuation problem at hand (Schulze et al., 1981). Instrument bias exists if characteristics of the mechanism for obtaining WTP possibly influences the outcome (ibid). Biases from starting point and payment vehicles in bidding procedures are included in this category. Hypothetical bias concerns whether respondents respond as they would to an actual market situation when a hypothetical market situation is employed.

Comparison of Alternative Approachs

In principle, both income compensation and expenditure function approaches are based on the same theory of economic value (Randall, 1984, Chapter 1). The income compensation approach relies on direct analysis of survey data from individuals responding to hypothetical market conditions. On the contrary, the expenditure function approach uses actual market data on transactions in market goods for estimating demand of nonmarket goods. Therefore, assumptions of weak complementarity should be made for the approach to be theoretically valid.

An advantage of CVM over TCM is that the CVM estimates Hicksian compensating and equivalent measures whereas TCM estimates Marshallian consumer surplus (Durden and Shogren, 1988). The Hicksian compensating and equivalent measures of consumer surplus are an ideal monetary measure of changes in economic welfare for an individual. However, Willig (1976) has demonstrated that the Marshallian consumer surplus measure closely approximates the Hicksian equivalent and compensation measures when the income effect is small.

The CVM is a flexible method for empirical application because a hypothetical market can be constructed that is suited to the study of interest regardless of the dimensions of time and space. Hence, CVM can be used to estimate nonuser values as well as user values, whereas the application of TCM is restricted to current users (Walsh et al., 1984).

Adamowicz (1988) has stated that the contingent valuation mechanism suffers from a variety of problems. The CVM WTP estimates may be suspected to be hypothetical (as opposed to actual) results because the estimates are derived from hypothetical market situations. TCM overcomes the problem of a hypothetical market by using actual market data. This is the biggest advantage of TCM over CVM.

Walsh (1986) has argued that no standard approach has been developed for the valuation of nonmarket goods that is suitable for all purposes of measurement. Consequently, the choice between alternative approaches, CVM and TCM, depends on the specific study of interest (Forster, 1989).

Empirical Issues Related to Recreation Demand Analysis

Empirical issues resulting from estimating recreational demand and benefits by the TCM are presented in this section. In particular, specification of the demand function is considered. This includes what variables to include such as quantity, price, time cost, substitution, congestion, and socioeconomic and in what form. Three methods are identified for representing the quantity variable and are (1) zonal, (2) individual, and (3) hybrid. The zonal and individual methods are explained with emphasis on the advantages and disadvantages of each. Time cost has received attention in recent years and thus is discussed in detail. Substitution, congestion, and socioeconomic variables are also discussed. Choice of functional form is the last issue of this section.

Quantity Specification of Demand

Several alternative measures of the quantity of recreation are used in empirical TCM studies. Walsh (1986) has classified these variables as (1) recreation day, (2) recreation visitor day, (3) recreation trip, and (4) entrance permit, license, or ticket issued. Each of the measures has advantages and disadvantages. Therefore, none can represent a universal measure for all purposes.

A recreation day is a visit by one user to a recreation site for recreation activities during any portion of a 24 hour period of time. A recreation day can be an appropriate dependent variable when hours staying at the site per day by users does not vary considerably among users. Burt and Brewer (1971) and Schreiner et al. (1987) used visitor day as a measure of quantities of outdoor recreation services. The recreation visitor day is defined as 12 person-hour use of the recreation site. A 12 person-hours can be one person for 12 hours or 12 persons for one hour or any equivalent combination of persons and time period. Sinden (1974) used the number of hours of a specific recreation activity per family member during the 12 months prior to the interview as a dependent variable. However, this dependent variable can be linearly transformed to recreation visitor days.

McConnell (1975) argued that recreation trip is the dependent variable consistent with a utility maximization framework. This is because travel costs are more directly related to a recreation trip rather than to any other measure stated above. In empirical TCM studies, measurement of recreation demand by trip basis is the most common.

In general, two approaches have been used in TCM studies for observed quantity specification and are the zonal travel cost method and the individual travel cost method. These two methods are discussed in detail.

Zonal Travel Cost Method. Zonal TCM was first employed by Clawson (1959) and became the most commonly used method in recreation studies[8]. In zonal TCM, the recreation visitors residing at similar distances from a recreation

---

8 Zonal TCM is also called aggregate TCM.

site are aggregated into zones. These zones can be counties, towns, or a series of concentric rings around the recreation site. With information about the number of trips from each zone to a recreation site and information on each zone's population, the visit rate of each zone is calculated. Visit rate is expressed as either visits per capita or visits per 1000 population. This visit rate is the dependent variable of the zonal TCM.

The zonal TCM can be illustrated by a two stage procedure. To simplify the procedure, several assumptions are made. First, assume absence of user fees. Second, assume that all visitors originating from the same zone incur the same travel cost across all zones. Based on the recommendations found in the Principles and Guidelines (P&G) (U.S. Water Resources Council, 1983), distance traveled is used as an acceptable proxy for the price per trip to the recreation site (Walsh, 1986). In the first stage, the trip demand function is estimated by regressing the visit rate of each zone (dependent variable) on the travel distance from each zone to the recreation site (independent variable)[9]. In the second stage, the demand curve of a recreation site is derived based on the information from the first stage. This is done by successively increasing the hypothetical travel distance from the recreation site to each zone. As a result, the visit rate decreases for all zones. This procedure is continued until no visits occur in any zones.

An assumption necessary to use zonal TCM is that visitors within a zone are similar, on average, in tastes and preferences across all zones (Ward and Loomis, 1986). If the zonal TCM is employed when this is not true, the different rates of participation, because of different tastes and preferences of individuals

---

9 Other independent variables are also included in this stage.

within each zone, can not be included in the aggregate demand curve for the site (Gum and Martin, 1975).

Advantages of the zonal method include (1) data are readily available or easily obtained, (2) greater applicability and ability to overcome budget constraints in obtaining data (Bowes and Loomis, 1980), and (3) visit rate will be automatically reduced at higher travel cost because the visit rate is calculated by dividing total number of trips from a zone by the total population of the zone (Ward and Loomis, 1986).

Limitations of the zonal TCM have been discussed in the literature (Fletcher et al., 1990). First, when individual information on recreational demand is aggregated within each zone, individual variations are averaged out (Brown and Nawas, 1973). This leads to the loss of statistical efficiency in the estimates of parameters compared with those based on individual TCM.

Second, if zonal populations are not equal, heteroskedasticity may be introduced by grouping observations within zones. Bowes and Loomis (1980) have argued that demand curves should be estimated using generalized least squares (GLS) rather than conventional Ordinary Least Squares (OLS). They used actual data (Westwater Canyon in Utah) with unequal zonal population and illustrated that GLS estimates were more efficient than OLS estimates. Strong (1983) tested whether alternative functional forms reduced heteroskedasticity. When applied to steelhead fishing in Oregon, regression results for alternative functional forms showed significant differences in demand estimates and estimates of consumer surplus. Semilog functional form using OLS gave better estimates than linear functional forms using weighted least squares (WLS).

Finally, using zonal TCM, it is difficult to include travel time in the demand equation because of high correlation between travel cost and travel time for the same zone (Ward and Loomis, 1986).

Individual Travel Cost Method. This approach was utilized by Brown and Nawas (1973) in an effort to overcome limitations of the zonal travel cost approach. The quantity variable is defined as the number of recreation trips by individuals or households. Regressing this quantity variable on individual travel cost, travel time, and other demand shifters gives more precise estimates of parameters than the zonal travel cost approach. The multicollinearity problem due to high correlation between travel cost and travel time is also reduced (Brown and Nawas, 1973; and Gum and Martin, 1975). Allen et al. (1981) argue, however, that without abundant data, the multicollinearity problem may still exist even if individual observations are used.

The main advantage of the individual TCM is that it is more appropriate and efficient than the zonal TCM when the objective of an analysis is to explain individual consumer behavior (Cordell and Bergstrom, 1989).

Limitations of the individual TCM approach have been identified as follows. First, if most of the recreationists take one trip per season or per year, it is almost impossible to detect the demand curve by the individual approach (Freeman, 1979). This is because there will not be sufficient variation in the number of visits even if travel distance increases. Second, the individual observation approach does not include the potential recreationist who may become a user if the price is reduced or the quality of the recreation site improved. This leads to underestimation of aggregate visitation when a closer similar site is included (Ward and Loomis, 1986). On the other hand, the demand function derived by using individual observations may overestimate consumer surplus if the dependent variable is not expressed on a per capita basis (that is each observation is divided by its relative proportion of total population) (Brown et al. 1983). Usually, participation in recreation activity proportionally decreases for populations at more distant zones. Total number of trips, a dependent variable for individual observation method, does not account for the above except when per capita visit rates are the same for all zones.

Independent Variables

Price (Travel Cost). The definition of price of a trip in TCM studies is not as clear as one might expect (Ward and Loomis, 1986). Assume there is no existing pricing policies for recreation site use and that the purpose of the TCM study is to estimate user benefits. In this case, the price variable should be chosen in such a way that site users would react in a manner similar to varying the entrance fees (ibid).

Walsh (1986) has identified several measures of alternative prices that may be suitable depending on the particular study assessed. These are (1) entrance fee, (2) direct transportation costs, (3) total direct costs, and (4) travel and recreation time costs.

Entrance fee is seldom used as the price variable because most recreational activities incur other expenditures including travel costs. Direct transportation costs include only variable costs such as operating costs of an automobile. Fixed costs such as depreciation and insurance are excluded because these costs do not affect the recreation user's decision to travel additional miles to a recreation site. The principle advantage of this approach over others is the minimal data requirement. The only survey data required is the number of trips from different zones. Transportation cost is calculated by converting travel distance to a standard monetary value.

Total direct costs are total out-of-pocket money costs incurred by recreation users for participating in recreational activities. These include on-site costs such as costs for lodging, food, etc. as well as transportation costs of travel. This approach is used satisfactorily when the costs (excluding transportation costs) of recreation users vary with distance traveled. The main problem of this approach is in obtaining survey data related to price information from a sample of recreation users. Time cost for travel and on-site recreation is discussed next.

Cost of Time. The validity of including travel time in recreational demand estimation procedures, is more easily recognized than it is in knowing the exact specification (Dwyer et al., 1977).

Cesario and Knetsch (1970) have identified that both travel cost and travel time affect the decision of recreation users to take a trip to a destination site. Omitting the time variable may result in recreational demand that is highly sensitive to the travel cost. Travel time can be perceived as either utility or disutility to the recreationist depending on the particular mode of travel and the individual's opportunity cost of travel time (Oort, 1969).

Generally, travel time is perceived as disutility to recreationists and if only travel cost is included in the demand function as a price variable, the resulting consumer surplus will be underestimated. Travel time, however, may be perceived as a net benefit to recreationists. For example, sightseeing during driving time may be an important recreational activity of a trip. In this case, consumer surplus will be overstated if monetary travel cost alone is included as a price variable. Sanders (1985), in a river-based study in Colorado, estimated that the WTP for travel time on recreation trips to rivers is positive or zero for responding households.

The difficulty of including travel time in the demand function is its high correlation with the monetary travel cost variable, especially when the zonal TCM method is employed (Ward and Loomis, 1986). Cesario and Knetsch (1976) and Cesario (1976) overcame this difficulty by combining the two variables into a single cost variable. The assumption used is the existence of specific trade-offs between monetary costs and travel time costs. In estimating annual benefits of state parks in Pennsylvania, they valued the opportunity cost of recreational travel time at some fraction (0.33) of an individual's wage rate. Specifically, the average value of travel time for recreationists from a particular county was set to be equal to one-third of that county's average wage rate. The Principles and Guidelines (U.S. Water Resources Council, 1983) recommends that travel time be valued at 25 to 50 percent of the wage rate for adults and 25 percent of the adult value for children under the age of 12. On the contrary, Morrison and Winston (1985) reported that the opportunity cost of vacation travel time by automobile may be valued at closer to 6 percent of the wage rate.

Brown and Nawas (1973) and Gum and Martin (1975) used individual TCM and estimated the separate effect of travel time on the visit rate. Individual data gives more reliable results in that each individual's travel time and travel costs are not as highly correlated as those observed in zonal TCM.

Tradeoffs between travel time and monetary travel cost have been generally assumed linear. Nichols et al. (1978) have illustrated three functional forms - linear, convex to the origin, and concave to the origin. A linear-trade off implies that per unit travel time is valued by a constant rate in dollar terms. The convex money-time tradeoff appears theoretically more plausible because of the diminishing marginal rate of change in monetary cost when a marginal change in travel time occurs. The problem of the convexity assumption is that the resulting consumer surplus estimates may be overstated (Cesario, 1976). Knetsch et al. (1976) have also concluded that the linear assumption leads to a more conservative consumer surplus estimate than with use of the convexity assumption. Sanders (1985), in the study of household WTP for travel time on recreation trips to rivers in Colorado, found that demand for recreation travel is a function of distance rather than a constant for each mile traveled. Specifically, he classified total recreation trips as single day, weekend, and longer trips and derived the demand curves for travel time, one for each type of trip. The elasticity of travel time on distance traveled for the three demand curves shows that the elasticity is lower the longer the trip.

Controversy exists in the literature on treatment of on-site time cost. McConnell (1975) has argued that on-site time cost should be included in the price variable so that the derived demand functions are consistent with utility maximization. Smith et al. (1983) also emphasized the importance of on-site time cost. On the other hand, Cesario and Knetsch have argued that an on-site time variable should be excluded from the recreation demand equation. Ward and Loomis (1986) recognize existence of the opportunity cost of on-site time although they also recognize that on-site time may produce a desired utility for the recreationist. Generally, on-site time cost may be excluded from the recreational demand function if the assumption of constant on-site time for all trips is made (Wilman, 1980, 1987; Desvousges et al., 1983; and Ward, 1984). Wilman (1987) has proposed a simple repackaging model that derives demand curves exhibiting constant visit lengths from demand curves exhibiting variable visit lengths.

Attempts have been made to measure the cost of time in recreation demand analysis. McConnell and Strand (1981) have estimated the opportunity cost of time (i.e. proportion of wage rate if assumed) from sample data. Hof and Rosenthal (1987) followed procedures of McConnell and Strand and estimated the opportunity cost of time for recreation trips to 11 reservoirs in Kansas and Missouri. They argued that the principal advantage of this approach is that it avoids prespecifying a travel time opportunity cost[10].

Substitute Sites. Effects of substitute sites play an important role in estimating recreational demand functions. Failure to include relevant substitution site effects leads to bias in the estimated demand coefficients, which in turn are carried over into the estimated benefits. The problems are generally identifying the appropriate substitutes and obtaining data.

Kling (1989) has identified three cases where it is difficult to include the effects of substitute sites: (1) when data sets are not available, (2) even when data sets are available high correlation between variables prohibit inclusion in the demand function, and (3) the revealed substitute qualities across the sampled respondents lack sufficient variation.

Appropriate measures of substitution in recreational demand are not clear. Walsh (1986), based on economic theory, states that price is the most appropriate measure to represent substitution effects in recreation demand analysis. Possible alternative measures are the quantity of available substitutes and quality of substitutes.

Caulkins et al. (1985) have demonstrated that the following statement is generally not correct: "The omission of the cross-price term leads to an overestimate of the benefit of a specific recreation site studied." Assume there exists only two lakes, the original lake (A) and an alternative lake (B), and that

---

[10] Comments by Johnson (1983) and Ward (1983) on the study of McConnell and Strand (1981) and the reply by McConnell and Strand (1983) are useful for further understanding this subject.

the travel costs to each lake are P_A and P_B, respectively for an angler who resides anywhere spatially. Also assume that the cross-price term (P_B) is omitted from the demand function. This may lead to bias in the benefit estimates as follows. If the two sites are substitutes and if the correlation between P_A and P_B is positive (negative), then overestimation (underestimation) of the consumer surplus results. If the two sites are complements and if the correlation between P_A and P_B is positive (negative), then underestimation (overestimation) of the consumer surplus results[11]. Two sites can actually be complements as well as substitutes. For example, if there is more than one trout fishing lake located around an anglers residence, then the probability of purchasing special equipment for trout fishing may increase and the angler fishes more often than if only one lake existed.

Several approaches have been proposed to incorporate substitution effects into TCM demand equations. First, sites are grouped into similar types and for each type of site, corresponding demand equations are specified (Burt and Brewer, 1970; and Cicchetti et al., 1976). For each equation of these systems of demand equations, an own price variable of each type and cross-price variables of other sites are included. The problem in estimating this system of demand equations is multicollinearity between the own price variable and cross price variables (Ward and Loomis, 1986). In addition to the multicollinearity problem, collecting data on all substitute and complement sites requires considerable time and resources (Hof and King, 1982).

Vaughan and Russell (1982), in their demand model for freshwater recreational fishing, used dummy variables that represented the degree of competition of other sites perceived by the site owner. Rosenthal (1987) has

[11] Positive correlation between P_A and P_B implies that the further an angler resides from lake A, the further the angler also resides from lake B.

argued that such dummy variables are frequently arbitrarily constructed and hence may not be an appropriate measure of substitution effects.

Rosenthal (1985, 1987) used a discrete choice model specified as a gravity/logit or regional gravity type model in his recreation demand study of U.S. Army Corp of Engineers Reservoirs in Kansas and Missouri. The discrete choice models explicitly incorporate substitute sites and site quality effects that influence the choice of recreationists regarding where and how often to recreate. Two other models also applied are (1) a traditional TCM with no substitute price and (2) a traditional TCM with substitute price that is similar to the Burt and Brewer model. Results show that estimated recreation benefits are lower when substitute measures are used compared to the without case of substitute measures.

Congestion. Congestion is defined as the loss of satisfaction experienced by the user of a facility as a result of the presence of other users (Harrington, 1987). Because many recreational facilities in the U.S. are publicly provided, with no entrance fee or fees established, the problem of congestion becomes worse than when equilibrium price determines the demand for the recreation site. McConnell and Duff (1976) and Wetzel (1977) have pointed out that the model without specification of congestion leads to inaccurate measures of total benefits of recreation facilities. They have shown that true benefits of the site are underestimated if demand models omit congestion measures when congestion actually exists. Cesario (1980) considered the case when new sites are developed in an original recreation system that suffers from congestion. It was assumed that the sites are interdependent. He has shown that if newly developed sites can substitute for existing congested sites, the true benefits of developing new sites should include the gains from alleviating the congestion of existing sites as well as gains from changes in travel distance. If congestion does not exist in the study site, then the demand model without specification of congestion can be used.

McConnell and Sutinen (1984) have argued that peak time and off peak time demand should be estimated separately when the degree of congestion at a site varied substantially by season. Fletcher et al. (1990) have argued that in the study of multiple sites, decisions on total level of site visits and site choices are determined by expectations and realizations about the level of congestion.

Socioeconomic Variables. Walsh (1986) has illustrated various socioeconomic measures used as explanatory variables in recreation studies. Variables likely to be important in the participation of recreationists to different recreation activities are age, level of education, household income, gender, and race. Participation in recreational activities varies by the effect of different socioeconomic variables. For example, age has a negative effect on most outdoor recreation activities. However, several recreational activities such as fishing, walking, and sightseeing can be enjoyed long after middle age of the recreationist.

Together with the sign of the coefficients, statistical significance of the socioeconomic variables is also important. Walsh (1986) has pointed out that small samples of on-site users may not always reveal statistically significant relationships between participation and socioeconomic variables that may be observed in national household surveys of the entire population.

Functional Form

Choice of functional form can have a significant effect on estimates of total recreation benefit. In empirical recreation studies using TCM, functional forms such as linear, quadratic, semilog, and double log are most widely used. Ziemer et al. (1980) have observed that functional form is usually selected based on computational and analytical ease, statistical significance, and consistency of the parameters with general economic theory. In the study of a warm water fishery in Georgia, Ziemer et al. (1980) used the Box-Cox transformation procedure to select the appropriate functional form among a set of linear, semilog, and quadratic models. Benefit estimates with linear specification greatly overestimated those estimates when using semilog or quadratic functional forms.

Strong (1983) estimated benefits of steelhead fishing in Oregon using a zonal TCM and found that the semilog functional specification was superior to that of the linear on statistical bases. Sutherland (1982b) found that the semilog specification is most commonly used in recreation studies and demonstrated that the semilog form is more appropriate than the double log form. Smith and Kopp (1980) used the double log functional form in their study of the Vantana Wilderness Area in Northern California. This functional form implies that the elasticity of demand is constant throughout the demand function. Smith and Kopp have argued that choice of functional form is made unambiguous only after the behavior of recreation users has shown varying elasticities.

CHAPTER III

PROCEDURE OF THE STUDY

Sample Survey Design

A series of measurements were used to obtain three years of characteristic data about the Mountain Fork River (MFR) anglers and evaluation data about the trout fishery[1]. The first two methods are the pressure count survey and the creel survey administrated by the Oklahoma Department of Wildlife Conservation (ODWC) at the site of the trout fishery. Beavers Bend State Park (BBSP) employees conducted the surveys in that portion of the river which is within BBSP. The pressure count survey was used to estimate the total number of angler hours at the trout fishery by the ODWC. The creel survey was used to estimate the return rate of stocked trout and to obtain limited information from the anglers at the time of the survey. The creel survey is a random non-uniform survey conducted on each of three divisions along the 12 mile length of river. There were 20 survey days (12 weekends and 8 weekdays) for each three month period during the year. Trout stocking sites and areas where creel surveys were conducted was shown in Figure 1. The ODWC follows a state-wide seasonal delineation starting on December 1. Because January 1, 1989 was the starting date of the MFR trout fishery, the first year of operation was for 11 months. The second (1990) and third year (1991) of operation were for the full 12 months.

---

1 From January, 1989 to November, 1991.

For the first year (1989), at the conclusion of the creel survey, anglers were given a third survey instrument which was a postage-paid postcard to be returned to Oklahoma State University (OSU) with a minimum of questions. Because the creel survey is a random survey, the returned postcard survey should be a random sample of total anglers if all postcards handed out are returned. The postcard survey instrument included information on (1) time spent trout fishing, time spent traveling 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.

A total of 620 postcard surveys were handed out by the creel surveyors in 1989, but only 180 were returned (29 percent return rate). Geographic distribution of sampled anglers by creel survey, postcard survey, and telephone survey is shown in Table 3.1. These results indicate the postcard sample response was highly biased geographically when compared to the creel survey sample for 1989. These results show an underrepresentation of anglers residing in McCurtain County where the trout fishery is located and to an overrepresentation of anglers coming from other regions[2].

The last survey was a follow-up telephone survey administered by trained interviewers at the OSU for a randomly selected sub-sample of replies to the postcard survey. The effectiveness of the telephone survey in collecting data for estimating angler effort has been supported by many studies. Weithman (1991) used the telephone survey to collect statewide angler information throughout Missouri. He concluded that the telephone survey is superior in quality of data, cost, and statewide consistency to other methods

---

2 A weighting procedure to adjust for this bias is presented later in this section.

TABLE 3.1

GEOGRAPHIC DISTRIBUTION OF SAMPLED ANGLERS BY POSTCARD, CREEL AND TELEPHONE SURVEYS, MOUNTAIN FORK RIVER, 1989 -1991

Angler Locations	1989	1990					1991				
	Annual	Winter	Spring	Summer	Fall	Annual	Winter	Spring	Summer	Fall	Annual
McCurtain County											
Creel	419 (54.0)[a]	226 (58.7)	147 (37.7)	101 (29.9)	81 (26.3)	565 (39.0)	221 (50.9)	162 (32.9)	115 (24.7)	49 (16.4)	547 (32.4)
Postcard	70 (38.9)										
Telephone	38 (33.9)	56 (58.9)	20 (23.3)	25 (27.5)	23 (24.5)	124 (33.9)	39 (48.8)	27 (33.3)	17 (21.0)	9 (11.3)	92 (28.6)
Oklahoma[b]											
Creel	129 (16.6)	74 (19.2)	104 (25.0)	88 (26.0)	77 (25.0)	343 (23.7)	77 (17.7)	127 (25.8)	134 (28.8)	96 (32.1)	434 (25.7)
Postcard	41 (22.8)										
Telephone	32 (28.6)	18 (18.9)	24 (27.9)	24 (26.4)	18 (19.1)	84 (23.0)	16 (20.0)	24 (29.6)	24 (29.6)	21 (26.3)	85 (26.4)
Out-of-State											
Creel	228 (29.4)	85 (22.1)	155 (327.3)	147 (43.5)	148 (48.1)	535 (37.0)	136 (31.3)	202 (41.1)	214 (46.0)	154 (51.5)	706 (41.8)
Postcard	69 (38.3)										
Telephone	42 (37.5)	21 (22.1)	42 (37.3)	42 (43.5)	53 (48.1)	158 (37.0)	25 (31.3)	30 (41.1)	40 (46.0)	50 (51.5)	145 (41.8)
Nonresponse											
Creel[c]				2 (0.6)	2 (0.6)	4 (0.3)		1 (0.2)	2 (0.4)		3 (0.2)
Postcard											
Telephone											
Total											
Creel	776 (100.0)	385 (100.0)	416 (100.0)	338 (100.0)	308 (100.0)	1447 (100.0)	434 (100.0)	492 (100.0)	465 (100.0)	299 (100.0)	1690 (100.0)
Postcard	180 (100.0)										
Telephone[d]	112 (100.0)	95 (100.0)	86 (100.0)	91 (100.0)	94 (100.0)	366 (100.0)	80 (100.0)	81 (100.0)	81 (100.0)	80 (100.0)	322 (100.0)

a Data in parentheses are percent of each total survey.
b Oklahoma residents excluding those from McCurtain County.
c Observations that did not include zip code information in the creel survey.
d Only completed observations are reported.

such as on-site surveys and mail surveys in estimating statewide angler effort and success.

The telephone surveys completed in this study included socioeconomic data about anglers as well as information on MFR trout fishing trips, alternative recreational activities, etc. Total number of telephone surveys completed was 112 for the first year (1989). Results of the telephone survey data for 1989 were weighted by zip code proportions contained in the creel survey to adjust for geographic sample bias shown in Table 3.1. Where appropriate, characteristic and evaluation data presented in Chapter IV were weighted by the zip code proportions of the creel survey for 1989.

Because of the significant non-response rate (71 percent) and geographic bias of the postcard survey, it was not used for the two following years (1990 and 1991). Instead, seasonal (quarterly) telephone surveys were conducted starting winter season (first quarter) of the second year. The telephone number and zip code of each angler were obtained directly in the creel survey taken at the MFR. A random sample was selected from the creel survey for each season and a telephone survey was conducted by season. Because seasonal differences exist in the estimated number of angler trips, this information was used in weighting seasonal telephone survey data to determine annual averages for the years 1990 and 1991.

Questionnaires for the telephone survey were changed each year based on experience in administering the survey for the previous year. Most changes were in wording of questions to assist anglers in interpreting and responding to the interviewer. However, several changes were made at the end of the first year because some of the questions were judged to add little useful information. There was also a need to reduce the amount of time needed to complete an interview. The most significant change for the 1990 and 1991 survey instruments was in reference to seasonal information on the number of trips. Annual information regarding trips was collected for the 1989 survey instrument. Therefore, the questionnaire used in 1989 is significantly different from those used in 1990 and 1991. There were about twice as many questions in the 1989 instrument compared to the 1990 and 1991 survey instruments.

The anglers near the fishing site (McCurtain County) take more trips than anglers from some distance. This leads to an increased probability to be creel surveyed and hence, telephone interviewed. It is possible that anglers who were interviewed once knew that the interview was time consuming and tiresome, and therefore would not cooperate in later telephone interviews. This would be more likely to occur when the telephone survey is conducted on a seasonal basis because some anglers might be interviewed every three months. This may lead to an underestimation of the anglers residing near the MFR and visit the MFR more frequently.

Efforts were taken to reduce nonresponse from the telephone survey. Nonresponse can be minimized by carefully planned follow-up calls on sampled anglers (Scheaffer et al., 1986). A minimum of three follow-up calls were made for each sampled angler on different days of the week and at different hours of the day. Telephone survey data obtained were checked regularly and erroneous or unreasonable responses were corrected by calling back to the anglers.

Because the first year was limited to 11 months (two months for winter season of 1989), and because different survey instruments were employed, comparisons of data between 1989 and 1990 or 1991 should be made carefully. The number of creel, postcard, and telephone surveys completed for the three years of the MFR trout fishery are shown in Table 3.1. The response rate of telephone survey for the sampled anglers of the MFR is shown in Table 3.2. Survey instruments are contained in Appendix A.

Selecting Nonmarket Valuation Approach

This section provides the basis for selecting the appropriate nonmarket valuation approach to the analysis of demand and benefit estimation for the MFR trout fishery. Selection is based on a comparison of the travel cost method (TCM) and contingent valuation method (CVM) presented in Chapter II. The specific situation of the current study was considered. Other choices are type of model, specification of quantity variable (individual versus zonal), and functional form.

Criteria for Selecting Nonmarket Valuation Approach

General criteria for selecting alternative approaches is contained in the literature (Clawson and Knetsch, 1963, and 1966 Chapter 3; U.S Water Resources Council, 1983; and Walsh, 1986). Walsh (1986) has classified valuation problems based on different assumptions about quality of the recreation activity. For recreation activities at a site of given quality, the TCM is recommended only for the study of intermediate sites. Intermediate sites include state parks and federal facilities that provide hiking, camping, fishing, boating, and hunting while on day outings and weekend trips within two hours' drive from home (Walsh, 1986). This is because there usually exists sufficient variation in travel distance (price) to these sites which allow statistical estimation of the relationship between distance and frequency of trips.

Sample data of anglers in Chapter IV show that one-way travel distance from the residence of anglers to the site (MFR) averages about 100 miles. Also,

TABLE 3.2

THE RESPONSE RATE OF THE TELEPHONE SURVEY FOR THE MOUNTAIN FORK RIVER ANGLERS

Year	Surveys Conducted (No.)	Surveys Completed (No.)	Surveys Not Completed (No.)	Percentage Completed (%)
1989	180	112	68	62
1990				
Winter	129	95	34	74
Spring	133	86	47	65
Summer	155	91	64	59
Fall	145	94	51	65
Total	562	366	196	65
1991				
Winter	146	80	66	55
Spring	156	81	75	52
Summer	148	81	67	55
Fall	157	80	77	51
Total	607	322	285	53

the Beavers Bend State Park includes the MFR trout fishing site. Note that this study is limited to estimating the demand and benefit of current anglers of the MFR trout fishery. In other words, the object of interest is only the current on-site users, not non-users[3]. Furthermore, actual market data for current on-site anglers are required for project operation and management decisionmaking. With the availability of these actual market data, the TCM, not CVM, is more readily applicable. Therefore, the TCM was selected over CVM as an empirical demand and benefit estimation approach for this study. As discussed previously, this decision does not mean that the TCM is a generally preferred approach to CVM in empirical studies of recreation demand and benefit estimation for all purposes.

Type of TCM Model

Four types of TCM models were classified in Chapter II depending on the method of incorporating substitution in the model. The characteristics of the trout fishery in the study area can be thought of as representing its uniqueness. There does not exist other fishing sites that have characteristics the same as the MFR trout fishery within the surrounding region. However, there exists many other fishing sites where MFR anglers may visit. Even though these sites are not perfect substitutes to the MFR trout fishery, they can represent partial substitutes. Also, the recreationists studied are only current users of the MFR. The probability of participation by changing travel cost (price) is thus not of concern. Therefore, the classical TCM was selected as the appropriate model for the empirical analysis of demand and benefit estimation. The own-price only TCM was used in 1991 because data for a substitute site were not available.

---

[3] Non-user values include option value, existence value, and bequest value (Walsh et al., 1984).

Specification of Quantity

The TCM can be zonal (aggregate) or individual observation depending on the quantity specification. Advantages and disadvantages of each method were discussed in Chapter II. The selection between the two methods should be made according to the particular study (or objective of study) of interest. Brown and Nawas (1973) have illustrated that individual TCM is more efficient in measuring individual effects. Because the current study is for purposes of estimating angler benefits and because telephone survey data from samples of anglers are available, the individual TCM was selected over the zonal TCM.

Empirical Recreation Demand and Benefit Models

Several empirical applications of recreation demand and benefit analysis are reviewed with emphasis on the types of models, the specification of quantity variables (individual and zonal TCM), specification of independent variables, and functional forms of the model. Specific choice of variables in the recreation demand model is important for practical research as well as the definition of variables. All of this gives valuable information for the empirical demand and benefit analysis of the MFR trout fishery. Benefit estimates of a recreation site by alternative nonmarket valuation approaches are compared to ascertain theoretical validity of the applied approaches. Procedures for deriving consumer surplus from the estimated demand curve are illustrated. The manner in which benefit estimates are compared from different studies using different methodologies and different units of measurement are shown.

Empirical Demand Models

Gum and Martin (1975) used individual TCM to estimate the demand and benefit of outdoor recreation activities in areas of Arizona. The model is the following:

$$Q_{ij} = a_{ij} + \sum_{k=1}^{K} b_{ij} X_{ijk} + e_{ij} \tag{3.1}$$

where Q_{ij} = the number of household trips to the jth region for the ith activity,

X_{ijk} = the value for the kth explanatory variable, and

e_{ij} = the error term.

Various combinations of independent variables were included to find the best equation. The price variable (average variable cost of trip) was included in all cases. Demand functions that yield significant t values, correct signs, and R^2 were selected for the benefit estimation procedure. The equation that gave reasonable benefits of resources compared to similar areas and activities was regarded as the best equation. A total of twenty explanatory variables were considered, although most variables except prices did not have consistent results. A substitute variable was defined as the average variable cost for all other outdoor recreation trips taken.

A conclusion of this study is that individual TCM reduces the problem of high correlation between monetary cost variables and time variables. Individual TCM gave a demand curve more efficient than the zonal TCM in the sense that there was more variation on variables such as tastes and preference as well as on frequency of trips and travel cost. The resulting benefit estimates are comparable to those of the gross expenditure method. The estimated benefits using the demand curve from the zonal TCM were usually smaller than the gross expenditure estimates.

Weithman and Hass (1982) estimated socioeconomic value of a trout fishery in Lake Taneycomo, Missouri. Three methods were employed to accomplish this objective: (1) replacement cost method to estimate the value of the trout, (2) the TCM to estimate the value of the fishery to anglers, and (3) the income-multiplier method to estimate the value of the fishery to the local economy. Zonal TCM (each zone was defined as a concentric ring of 80km intervals and up to a maximum distance of 800 km from the lake) with the following demand equation was used to derive a trip demand curve for the Lake Taneycomo area:

$$\ln V_i = a + b \ln(C_i + r_i \cdot T_i) \tag{3.2}$$

where V_i = visits per 1000 population from within ring i,

C_i = round-trip travel cost from ring i to Lake Taneycomo,

r_i = a fraction of the average wage rate of population within ring i, and

T_i = round-trip travel time in hours from ring i to Lake Taneycomo.

The variable r_i was set to 0.35. This type of model is the own-price only TCM. A substitute measure was not included in the model because the trout fishery at Lake Taneycomo was unique. However, this may lead to a biased estimation of the demand functions if there exist activities, such as warmwater fishing, that can be substituted for the trout fishery of Lake Taneycomo. Therefore, some preliminary information about angler consumption behavior is required regarding the direction and degree of relationship between the trout fishery at Lake Taneycomo and fisheries at other places.

There are few studies that provide a comparative analysis of the alternative nonmarket valuation approaches of TCM and CVM. As discussed in Chapter II, comparison between the two methods should be made with caution. The two approaches give different estimates of resource benefit (Duffield, 1984; and Seller et al., 1985). Three things should be considered in making comparisons. First, the TCM gives estimates of the Marshallian consumer surplus, whereas the CVM gives estimates of Hicksian compensating or equivalent measures of welfare change. However, the expected difference between Marshallian and Hicksian measures of surplus is small (Willig, 1976; Desvousges, et al., 1983; and Kling, 1992). This is especially true when the income effect is small. Second, TCM estimates only the user values of the resource whereas the CVM can estimate user and non-user values such as option, existence, and bequest (Walsh et al., 1984; Sutherland and Walsh, 1985; and Durden and Shogren, 1988). Finally, the TCM gives estimates of benefits for the total recreation experience, whereas the CVM usually provides estimates for one specific aspect of the experience.

Seller et al. (1985) used the TCM and two variants of the CVM to estimate the value of recreational boating in East Texas. The CVM part of the study attempted to elicit individual WTP bids using different instruments (the open-ended format and close-ended format). Only the TCM portion of the study is presented here. The regional TCM model was applied and demand for recreation at four lakes was jointly estimated.

The system of demand equations for the four lakes was specified as follows:

$$V_{ij} = \alpha_j + \sum_{k=1}^{4} \beta_{jk} C_{ik} + \partial_j Y_i + \gamma_j Z_i + e_{ij} \tag{3.3}$$

where i = observations or recreation group (1,...,n),

j,k = sites (1,...,4),

V_{ij} = number of trips to the jth site by the ith recreation group,

Y_i = annual household income of the head of group i,

Z_i = preference and behavioral variables introduced in the model,

$\alpha_j, \beta_{jk}, \partial_j, \gamma_j$ = parameters to be estimated,

e_{ij} = random error term, and

C_{ik} = cost of on site and traveling to site k by group i

$$= \left(\frac{2d_{ik}}{mpg_i} \times 1.10\right) + E_{ik} + \left(gas_{ik} \times 1.10\right) + fee_{ik} \tag{3.4}$$

where

d_{ik} = one-way distance for group i to site k,

1.10 = average cost of gas per gallon during 1980 in the study region,

mpg_i = miles per gallon of gas of group i's vehicle,

E_{ik} = other variable costs reported by respondent i for each visit to site k,

gas_{ik} = number of gallons of gas used for boat by group i while at site k, and

fee_{ik} = any user and/or entrance fees at site k.

The cost of time was defined as follows:

$$T_{ik} = \frac{(Y_i \cdot W)}{2080} \times (time_{ik}) \tag{3.5}$$

where $\frac{Y_i}{2080}$ = hourly wage rate [2080 is the total annual work time calculated as 52 (weeks) x 40 (hours/week) and is also equal to 260(days) x 8 (hours/day)].

$time_{ik}$ = time spent by ith group while traveling to and from site k; and

W = represents travel time opportunity cost.

The value of W was assumed to be zero in the model because it provided better results in the signs of coefficients and R^2. The authors argued that users were taking trips during the weekend when opportunity cost of time is not much different from zero. A linear functional form was used in the absence of prior information. One of the important variables in explaining the dependent variable (the number of visits) was a subjective quality[4] rating score. The resulting benefit estimates were comparable for TCM and CVM close-ended format whereas the CVM open-ended format gave very low estimates of the benefit .

Smith et al. (1986) also estimated and compared benefits from environmental quality improvement using both direct (CVM) and indirect (TCM) methods. Although the empirical results of estimated benefits were comparable, they argued that both methods may be greatly influenced by the judgement of the analyst. The judgement of the analyst included, for example, survey design, payment vehicle for CVM, and demand specification by functional forms.

In a study of a Kootenai Fall in Montana, Duffield (1984) used both the TCM and CVM to estimate the benefit of the resource. The main finding was

---

4 Quality was assigned from one to five, five being the best.

that estimates of benefits were similar between TCM and CVM of willingness to pay.

Some studies have measured the time cost of recreation travel (McConnell and Strand, 1981; and Hof and Rosenthal, 1987). The approach is to assume that the opportunity cost of travel time is some fraction of an individual's market wage rate. A simple linear demand function for a recreation trip for individual i is as follows:

$$r_i = \beta_o + \beta_1(c_i + ka_iv_i) + \beta_3Z_i + e_i \qquad (3.6)$$

where r_i = number of trips for individual i,

c_i = total out-of-pocket cost per trip,

k = a constant (a proportion of wage rate)[5],

a_i = round-trip travel time,

v_i = average hourly income (annual income / 2080),

Z_i = a vector of other exogenous variables, and

e_i = an error term.

Equation (3.6) can be rewritten as:

$$r_i = \beta_o + \beta_1c_i + \beta_2a_iv_i + \beta_3Z_i + e_i. \qquad (3.7)$$

Equation (3.7) is estimated and estimates of $\hat{\beta}_1$ and $\hat{\beta}_2$ are used to compute the estimate of k, $\hat{k} = \left(\frac{\hat{\beta}_2}{\hat{\beta}_1}\right)$. Consequently, the constant proportion (k) of the opportunity cost of travel time was estimated from the particular sample data analyzed.

---

5 Footnote:kv_i is per hour opportunity cost of time of the individual i.

Ziemer et al. (1980) in a Georgia warmwater fishing study used three types of functional forms to investigate if estimates of consumer surplus were significantly different depending on the choice of functional form. Functional forms considered were as follows:

Linear: $$Q_i = \beta_o + \beta_1 AC_i + \beta_2 D_i + \beta_3 I_i + \beta_4 E_i + e_i \quad (3.8)$$

Quadratic: $$Q_i = \beta_o + \beta_1 AC_i + \beta_2 (AC_i)^2 + \beta_3 D_i + \beta_4 I_i + \beta_5 E_i + e_i \quad (3.9)$$

Semilog: $$\ln Q_i = \beta_o + \beta_1 AC_i + \beta_2 D_i + \beta_3 I_i + \beta_4 E_i + e_i \quad (3.10)$$

where Q_i = quantity of recreation trips demanded by the household i,

AC_i = average monetary cost per trip,

D_i = average distance traveled per trip,

I_i = income,

E_i = years of education, and

e_i = a stochastic error term.

Applying the Box-Cox transformation procedure to the Georgia warmwater fishing data, functional form with semilog specification was selected as the appropriate one. The linear functional form was judged to be inappropriate for the data. Average consumer surplus per trip was about \$79 (linear), \$20 (quadratic), and \$26 (semilog). Quadratic and semilog functional forms gave more conservative estimates of consumer surplus. They concluded that the estimated consumer surplus can be significantly different depending on the choice of functional form.

<u>Benefit Estimation</u>

The benefit of a recreation site is measured from the estimated recreation demand curve for the site. McConnell (1975) employed a utility maximization framework in an analysis of the demand for outdoor recreation to address specific issues in empirical research[6]. Assume that each individual is a utility maximizer, then this individual will maximize his/her utility function (Rosenthal and Anderson, 1984).

$U = U(q,x)$ subject to the constraints

$$pq + cx \leq Y \tag{3.11}$$

where q = number of trips to a recreation site,
x = quantity of a composite good,
p = total cost per recreation trip including travel and time cost and entry fee,
c = price of composite good, and
Y = income.

The first order condition for the above problem yields the following Marshallian (ordinary) demand functions:

$$\begin{aligned} q &= q(p, c, Y) \\ x &= x(p, c, Y). \end{aligned} \tag{3.12}$$

Then the Marshallian consumer surplus of the recreation demand is

$$\int_{p}^{p^h} q(p, c, Y)\, dp \tag{3.13}$$

6 Specific issues included (1) the value of time in the recreation demand, (2) units of measurement for the TCM, and (3) a prior specification of recreation demand function.

where p = existing price per trip and

p^h = price per trip for which $q = 0$.

Consequently, the total value of the recreation site would be the summation of the integral (3.13) across all individual recreation users of the site. However, if individual data are not available, equation (3.12) can not be estimated. In this case, the zonal method may be used that provides an aggregate demand function of the form

$$T_i = T(C_i, P_i, Z_i) \tag{3.14}$$

where T_i = number of trips to the recreation site from origin i (i=1...m),

C_i = price of composite good for the ith origin,

P_i = price per trip from the ith origin, and

Z_i = other socioeconomic data of the ith origin.

Information on the number of individual trips to the recreation site are not required for the zonal method. This is because in the zonal TCM, the dependent variable is the total number of trips from a specified area. Consumer surplus of the site using equation (3.14) is

$$\sum_{i=1}^{m} \int_{P_i}^{P_i^h} T(C_i, P_i, Z_i)\, dP_i \tag{3.15}$$

where P_i^h = value of Pi which corresponds to zero predicted trips.

Comparative Analysis

Sorg and Loomis(1984) have compared empirical estimates from a variety of outdoor recreation activities and environmental resources contained in the recreation economics literature. Adjustments were necessary for the estimated benefits of the same type of recreation activity because of differences in methodologies and units of measurement employed in different studies. Types of adjustment used for coldwater fishing activities, for example, were as follows;

1. Quantity of recreation demand was converted to a visitor day basis if other quantity specifications were used.
2. 30 percent upward adjustment was used for omission of travel time from TCM recreation demand models.
3. If individual TCM was employed for those activities where probability of participation was expected to vary significantly with travel cost, downward adjustments in the estimated benefits were made. For the coldwater fishing activity, which requires specialized equipment and skill, the probability of participation does not exhibit a strong inverse relationship to travel costs. Hence, no adjustments were made for using individual TCM.
4. Studies that omitted out-of-state users were adjusted upward by 15 percent in estimated benefits because coldwater fishing is considered to be a regional or multi-state activity in most areas of the U.S.
5. Adjust monetary values to the base year of January 1982 by using the GNP price deflator[7].

---

7 If CVM studies do not include a protest mechanism, upward adjustment of 15 percent in the estimated benefit was made.

The estimated benefits of coldwater fishing from the studies were fairly similar for comparable quality and location once methodological adjustments were made.

Benefit-Cost Analysis

For the evaluation of public investment projects, the benefit-cost analysis can be used as a conceptual framework.[8] Benefit-cost analysis is concerned with social gains (benefits) and losses (costs) Walsh, 1986). The Flood Control Act of 1936 states (Krutilla, 1975) "benefit-cost analysis seeks to determine whether the benefits to whomever they accrue exceed the costs". Usually, this can be done by calculating a benefit-cost ratio or other measures such as net present value.

Walsh (1986) defined the benefit-cost ratio of different objects as follows:

(1) for the individual consumers, the present value of the total WTP (total benefits) is divided by the present value of the price or direct costs to consumers,

(2) for public recreation programs the denominator is the present value of the sum of agency operating and opportunity costs and the numerator is the present value of consumer surplus (net benefits) of individual users, and

(3) for the private recreation sites, the owner's benefit cost ratio would be the present value of total revenue divided by the present value of total costs incurred by the corporation.

Both the benefits and costs of the project should be identified and measured. For the public recreation projects, benefits are the total utility or

8 It can also be applied to evaluate private projects.

pleasure individual users gain from the experience provided by public agents. Costs are usually measured based on the concept of opportunity costs.[9] The stream of benefits and costs should also be discounted or compounded using appropriate social discount rate to obtain comparable present values. As a public recreation project, the benefit-cost analysis of the MFR trout fishery should be approached considering the above results. The benefits of the MFR trout fishery include the value anglers associate with trout fishing trips to the MFR. Public costs of the MFR trout fishery include operating costs (stocking trout) and opportunity costs such as the costs of cold water release from the Broken Bow Lake and fishing activities foregone by replacement with the trout fishery in 1989.

---

9 In general, benefits are not measurable in monetary value whereas costs can be measured by actual monetary value.

CHAPTER IV

SAMPLE

DATA OF THE MOUNTAIN FORK RIVER TROUT FISHERY AND PARTICIPATING ANGLERS

This chapter presents a summary of sample data for the Mountain Fork River (MFR) and the participating anglers. Most of these data were obtained from telephone surveys of the MFR anglers. However, total angler hours and trout harvest were estimated from pressure count and creel surveys administered by the Oklahoma Department of Wildlife Conservation (ODWC). Number of anglers sampled in each season by the different surveys are shown in Table 3.1. That table gives information on the geographic distribution of anglers sampled by postcard, creel, and telephone surveys administered from 1989 to 1991. Conclusions about the trout fishery and the participating anglers are made based on the results of analysis of data presented in this chapter.

Three important facts should be considered, however, in drawing comparative conclusions about data presented in this chapter:

(1) the 1989 sample data are limited to annual results whereas seasonal data are available for the years 1990 and 1991;

(2) the fishing year 1989 is for 11 months (two months for the winter season) whereas the years 1990 and 1991 are for the full 12 months; and

Mountain Fork River Trout Fishery

Total angler hours and trout harvest were estimated by the ODWC for the three years of the trout fishery based on the pressure count and creel surveys. The estimated angler (fishing) hours and trout harvest by season for the three years are shown in Table 4.1.

The estimated total angler hours is slightly higher for the second year compared to the first year (11 months) and significantly higher for the third year compared to the first and second years. Estimated trout harvest increased from about 40,000 in the first year to about 54,200 in the second year, but decreased in the third year to about 38,600. Trout harvest rate, which is computed by dividing estimated trout harvested by angler hours, increased in the second year because of the increment in the trout harvest for that year, but decreased significantly in the third year because of a decrease in the total number of trout harvested and an increase in total angler hours.

Seasonal variation shows significantly greater numbers of angler hours during spring and summer seasons compared to fall and winter. Trout harvest rates appear uniform across the spring, summer, and fall seasons for the second and third years but significantly higher for the winter season.

Mountain Fork River Anglers

Results of the three years of telephone surveys of MFR anglers are organized under the broad headings of angler trip information and characteristic data about anglers.

TABLE 4.1

ESTIMATED SEASONAL ANGLER HOURS AND TROUT HARVEST FOR THE FIRST THREE YEARS OF THE MOUNTAIN FORK RIVER TROUT FISHERY[a], 1989-1991

Season	1989 Jan.1, 1989 - Nov. 30, 1989			1990 Dec. 1, 1989 - Nov. 30, 1990			1991 Dec. 1, 1990 - Nov. 30, 1991		
	Angler Hours (no.)	Trout Harvest (no.)	Trout Harvest (no./hr.)	Angler Hours (no.)	Trout Harvest (no.)	Trout Harvest (no./hr.)	Angler Hours (no.)	Trout Harvest (no.)	Trout Harvest (no./hr.)
Winter (Dec.-Feb)	11,493[b]	10,146[b]	0.9	16,181	23,890	1.5	13,512	10,332	0.8
Spring (Mar. - May)	18,606	13,353	0.7	21,569	13,589	0.6	29,893	12,147	0.4
Summer (June - Aug.)	26,472	9,536	0.4	18,209	9,056	0.5	32,155	9,026	0.3
Fall (Sept. - Nov.)	11,520	6,905	0.6	12,686	7,701	0.6	16,688	7,113	0.4
Total	68,091[c]	39,940[c]	0.6	68,645	54,236	0.8	92,248	38,618	0.4

[a] The source for these data are Oklahoma Department of Wildlife Conservation surveys.

[b] Two months (Jan. and Feb., 1989)

[c] Eleven months (Jan. - Nov., 1989)

Angler Trip Information

Geographic Data. Place of residence (state) of the sample of MFR anglers interviewed by telephone is shown in Table 4.2. Over 90 percent of the anglers were Oklahoma and Texas residents. Except for fall season 1990 and 1991, Oklahoma residents made up more than 50 percent of the total anglers. A higher proportion of anglers were from McCurtain County during the winter season compared to the other seasons. Only a small percentage of anglers were coming from Arkansas and other states. The percentage of anglers from out-of-state was higher for spring, summer, and fall compared to winter.

Information from the creel and telephone surveys was combined to map the estimated number of angler trips by county of residence of the Mountain Fork River anglers in 1990 and 1991 (Figures 3 and 4). The geographic data appear consistent for the two years. The highest number of trips were taken by anglers from McCurtain County, location of the trout fishery. The metropolitan areas of Dallas/Fort Worth, Oklahoma City, and Tulsa also show high frequency of angler trips. The state boundary of Oklahoma is a significant constraint limiting number of anglers from the states of Arkansas and Louisiana, but is less of a constraint to anglers from Texas. The cost of out-of-state fishing permits and more alternative in-state trout fisheries contribute to limiting Arkansas anglers from participating in the MFR trout fishery. For Texas anglers, there are fewer in-state trout fisheries competing with the MFR.

Figures 5 and 6 show the same data on frequency of angler trips but relative to the aggregate county population. The darker shading shows a higher proportion of angler trips per 1,000 county population. Except for the counties across state boundaries, the more proximate counties to the trout

TABLE 4.2

PLACE OF RESIDENCE FOR SAMPLES OF ANGLERS AT THE MOUNTAIN FORK RIVER TROUT FISHERY, 1989-1991

State	1989	1990 (Percent)					1991 (Percent)				
	Percent	Winter	Spring	Summer	Fall	Annual[a]	Winter	Spring	Summer	Fall	Annual[a]
Oklahoma	62.5	77.9	51.2	53.8	43.6	61.5	68.8	63.0	50.6	37.5	56.3
(McCurtain County)[b]	(54.3)	(75.7)	(45.5)	(51.1)	(56.2)	(63.2)	(70.9)	(52.1)	(41.5)	(30.0)	(52.0)
Texas	33.0	20.0	39.5	45.1	51.1	34.5	27.5	30.9	43.2	61.3	38.8
Arkansas	0.9	1.0	2.3	0.0	3.2	1.5	3.8	3.7	2.5	0.0	2.7
Other	0.0	1.1	7.0	1.1	2.1	2.6	0.0	2.5	3.7	1.3	2.1
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

[a] Weighted by the estimated proportion of trips taken each season by anglers.

[b] The figures in parenthesis represent the percentage of trips taken by McCurtain County anglers out of total Oklahoma anglers.

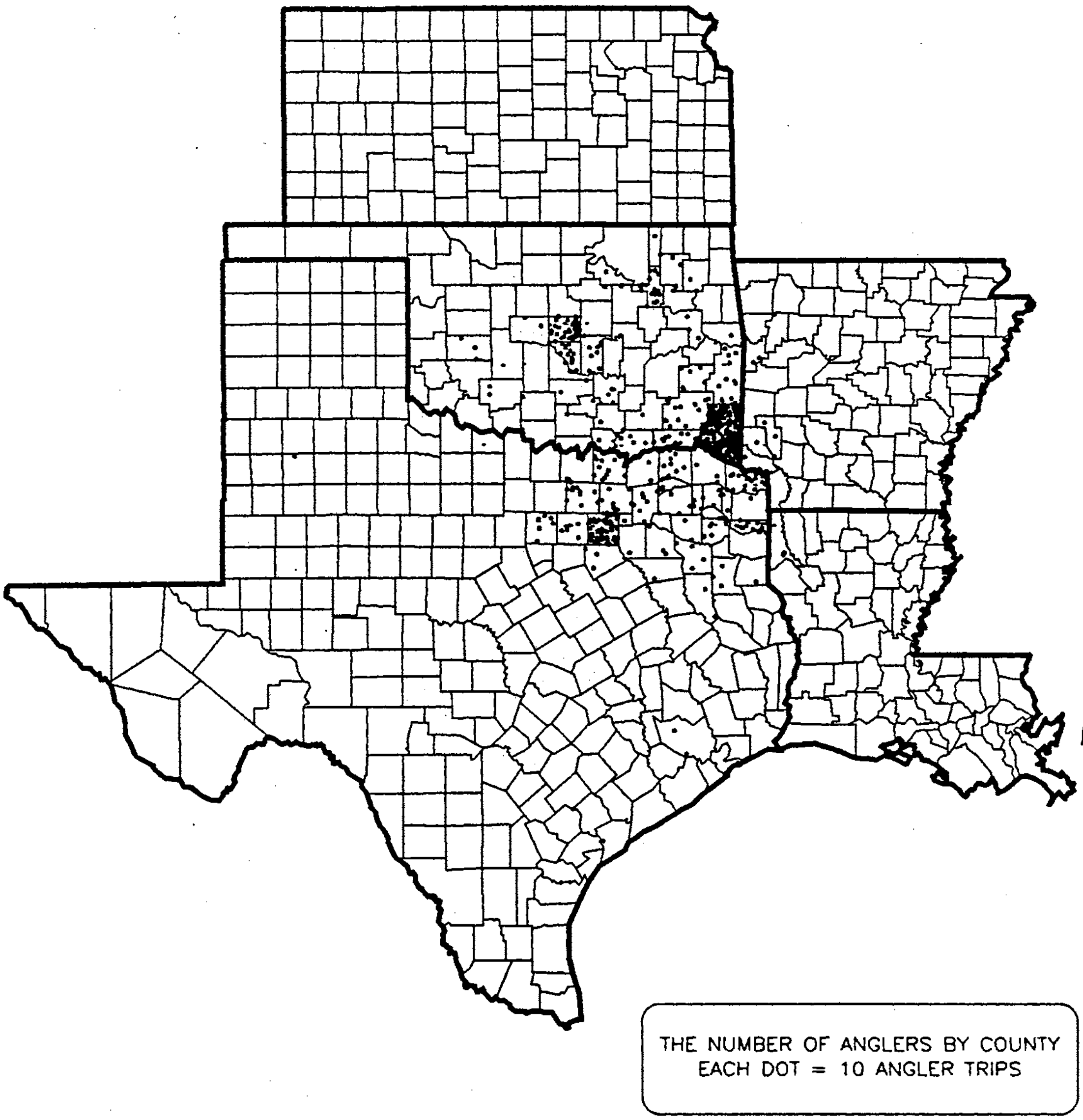


Figure 3. The Estimated Number of Angler Trips to the Mountain Fork River Trout Fishery Based on the Creel Survey, 1990

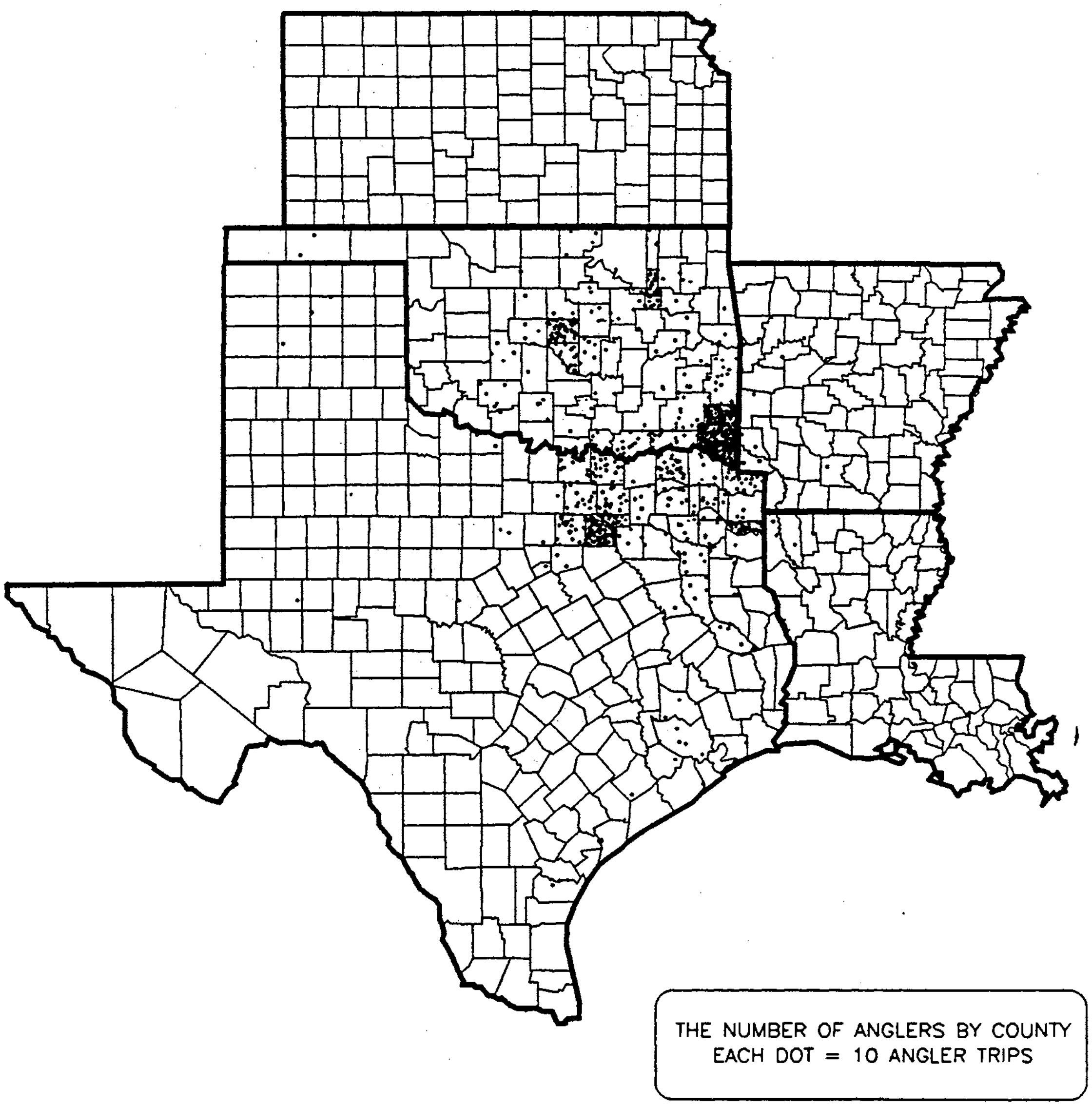


Figure 4. The Estimated Number of Angler Trips to the Mountain Fork River Trout Fishery Based on the Creel Survey, 1991

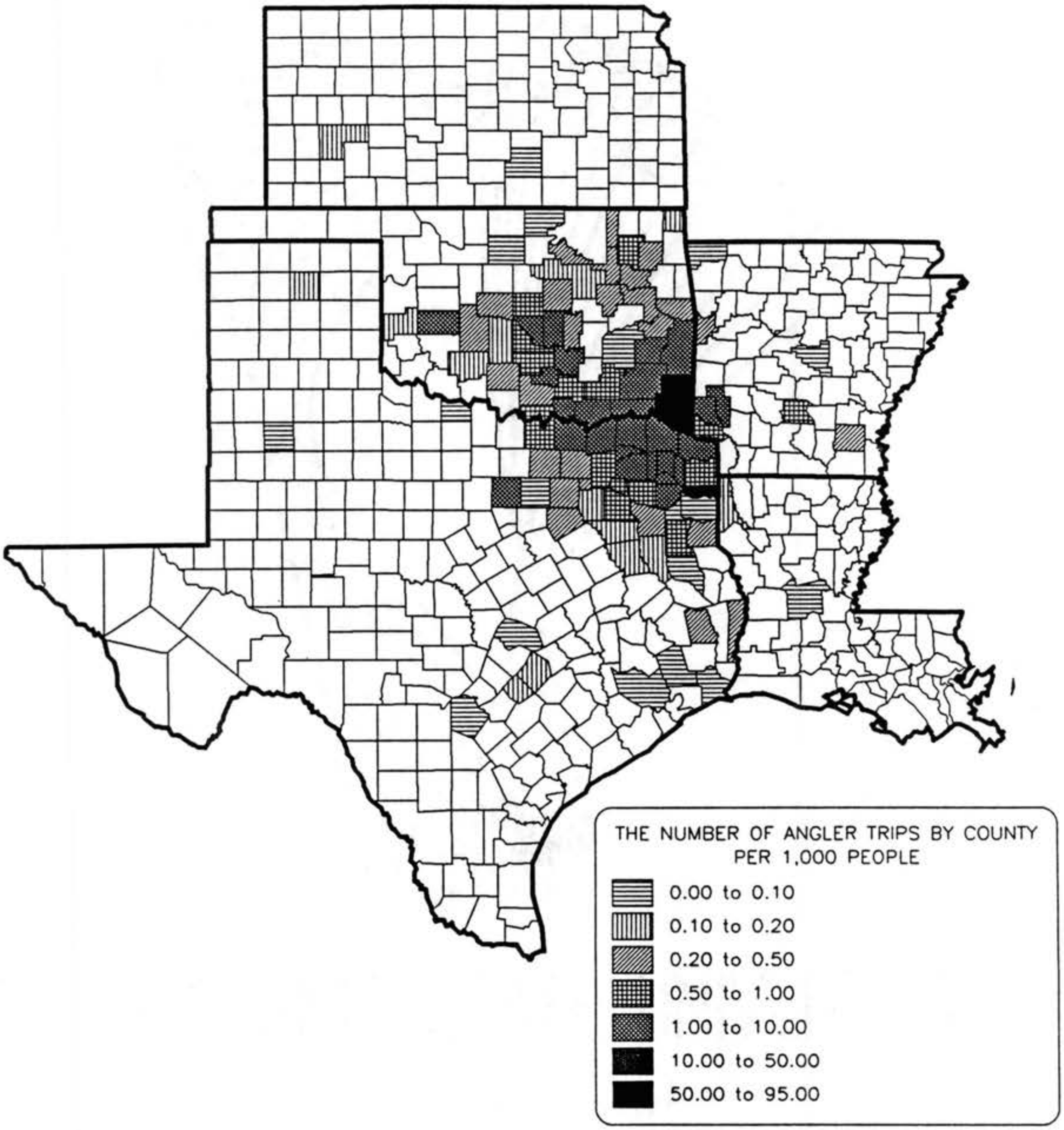


Figure 5. The Estimated Number of Angler Trips to the Mountain Fork River Trout Fishery Per 1,000 County Population Based on the Creel Survey, 1990

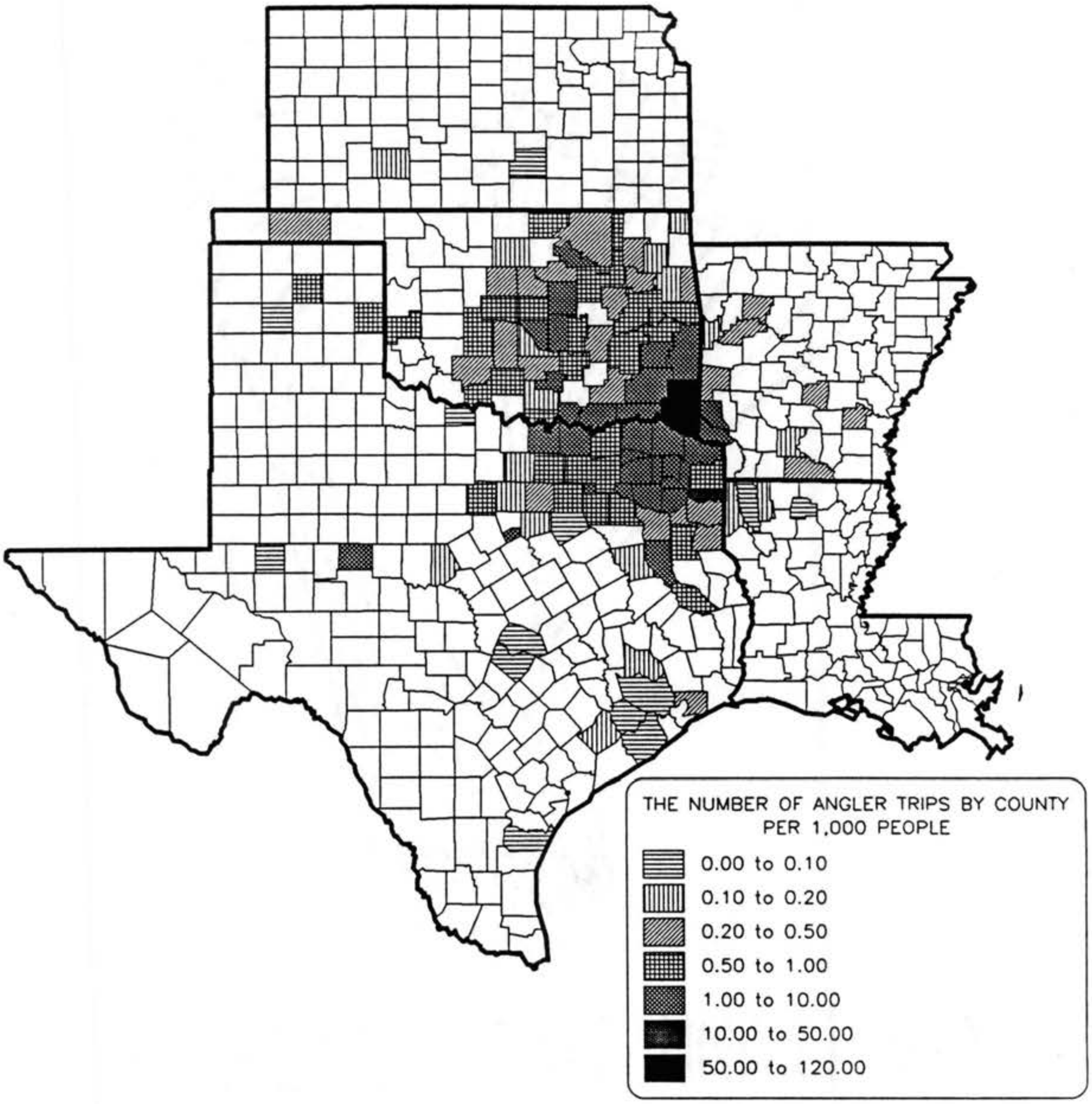


Figure 6. The Estimated Number of Angler Trips to the Mountain Fork River Trout Fishery Per 1,000 County Population Based on the Creel Survey, 1991

fishery show higher frequency of county population participation. This implies that the travel distance from the MFR is a principle constraint in the decision process of participation.

One-way travel distance for anglers is shown in Table 4.3. Results of travel distance indicate that spring, summer, and fall show a higher percentage of anglers coming from a one-way distance of over 150 miles compared to the winter season. A significantly higher proportion of winter anglers (ranging from 46 percent to 53 percent depending on year) came from the local area (within a 25 mile radius of the MFR). Average one-way travel distance to the MFR for anglers ranged from 74 miles to 167 miles depending on season and year. The annual average one-way travel distance increased each year indicating the MFR became known to people residing further from the MFR.

Fishing Time and Length of Trip. The estimated hours of fishing per trip are shown in Table 4.4. Over 55 percent of the winter trips were four hours or less in fishing time. Over 30 percent of trips for other seasons were more than ten hours of fishing. The average number of hours fished per trip for the winter season was significantly less than for the other seasons.

Anglers were asked the length of trip in number of days (Table 4.5). The average length of trip was over two days during the spring, summer, and fall seasons whereas over 66 percent of the trips were one-day trips during the winter season. This again reflects the large majority of local anglers during the winter season that came to the MFR only for trout fishing and not for other recreation activities.

The information in Tables 4.3, 4.4, and 4.5 indicates that a high percentage of winter anglers were local people, residing within 25 miles of the MFR, and took many short trips (one-day trips).

TABLE 4.3

ONE-WAY TRAVEL DISTANCE TO THE MOUNTAIN FORK RIVER TROUT FISHERY FOR SAMPLES OF ANGLERS,1989-1991

Miles	1989[a]	1990 (Percent)					1991 (Percent)				
	Percent	Winter	Spring	Summer	Fall	Annual[b]	Winter	Spring	Summer	Fall	Annual[b]
Up to 25	43.0	52.6	18.6	23.1	23.4	34.2	46.3	25.9	13.6	8.8	23.8
26 - 50	6.0	11.6	9.3	14.3	13.8	12.0	12.5	9.9	13.6	12.5	12.0
101 - 150	7.9	7.4	14.0	13.2	22.3	12.4	11.3	9.9	12.3	18.8	12.4
151 - 200	15.6	11.6	25.6	27.5	19.2	19.3	13.8	24.7	24.7	25.0	22.3
201 - 250	7.8	7.4	14.0	13.2	17.0	11.6	7.5	12.3	14.8	26.3	14.3
> 250	1.6	2.1	11.6	1.1	2.1	4.1	3.8	9.9	11.1	6.3	8.3
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Average (miles)	60.3	73.8	169.7	122.4	129.1	114.5	86.7	133.9	159.0	167.0	136.6

a Weighted by zip code proportions in creel survey.

b Weighted by the estimated proportion of trips taken each season by anglers.

TABLE 4.4

ESTIMATED HOURS OF FISHING PER TRIP FOR SAMPLES OF ANGLERS AT THE MOUNTAIN FORK RIVER TROUT FISHERY, 1989 - 1991

Hours	1989[a] Percent	1990 (Percent)					1991 (Percent)				
		Winter	Spring	Summer	Fall	Annual[b]	Winter	Spring	Summer	Fall	Annual[b]
0.1 - 2.0	11.6	23.2	15.1	8.8	10.6	16.4	21.3	12.4	11.1	10.0	13.5
2.1 - 4.0	19.6	46.3	25.6	26.4	20.2	33.4	33.8	23.5	21.0	15.0	23.6
4.1 - 6.0	17.9	9.5	5.8	19.8	14.9	11.6	13.8	8.6	12.4	16.3	12.1
6.1 - 8.0	10.7	11.6	9.3	6.6	11.7	10.0	6.3	6.2	8.6	6.3	7.0
8.1 - 10.0	11.6	2.1	7.0	5.5	5.3	4.4	7.5	13.6	11.1	8.8	10.7
10.1 - 12.0	8.0	3.2	4.7	6.6	4.3	4.4	10.0	11.1	8.6	20.0	11.5
> 12.0	20.5	4.2	32.6	26.4	33.0	19.8	7.5	24.7	27.2	23.8	21.5
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Average (miles)	9.59	5.04	11.90	11.08	10.64	8.74	6.02	9.43	10.06	10.26	9.01

[a] Weighted by zip code proportions in creel survey.

[b] Weighted by the estimated proportion of trips taken each season by anglers.

TABLE 4.5

LENGTH OF TRIP FOR SAMPLES OF ANGLERS AT THE MOUNTAIN FORK RIVER TROUT FISHERY, 1989 - 1991

Number of Days	1989[a] Percent	1990 (Percent)					1991 (Percent)				
		Winter	Spring	Summer	Fall	Annual[b]	Winter	Spring	Summer	Fall	Annual[b]
1	63.9	77.9	36.1	37.4	35.1	53.3	66.3	37.0	24.7	21.3	37.1
2	15.7	8.4	19.8	19.8	30.9	16.8	12.5	11.1	16.1	17.5	14.0
3	10.0	7.4	23.3	19.8	19.2	15.4	18.8	24.7	34.6	40.0	28.9
4	4.2	4.2	10.5	2.2	5.3	5.4	- -	12.3	11.1	8.8	8.7
>4	6.2	2.1	10.5	20.9	9.6	9.1	2.5	14.8	13.6	12.5	11.4
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Average Length (Days)	1.51	1.46	2.91	3.53	2.52	2.39	1.65	2.58	3.14	3.10	2.63

[a] Weighted by zip code proportions in creel survey.

[b] Weighted by the estimated proportion of trips taken each season by anglers.

Frequency of Trips. Fishing trips per angler to the MFR by season are shown in Table 4.6. The average number of fishing trips per angler was highest during the winter season with more than eight trips. Other seasons ranged from about 2.7 to 5.9 trips per season. Over 48 percent of the anglers who took a trip to the MFR during the spring, summer, and fall seasons did not take another trip to the MFR during the same season. The data for 1989 represent an annual basis, not seasonal basis.

Anglers of the MFR were asked the number of fishing trips to other locations during the season in which they took a trip to the MFR. These results are reported in Table 4.7. Average number of fishing trips to other locations was lowest for the winter season (3.1 trips for 1990, 2.7 for 1991) and highest in the summer season (7.2 trips for 1990, 9.5 for 1991). A high percentage of anglers indicated that they did not fish at any location other than the MFR during the same season they fished at the MFR in 1990 and 1991. However, for those who did fish one or more times at another location, the average number of trips per angler per season ranged from about 7 (winter 1991) to 18 (spring 1990).

From Tables 4.6 and 4.7, it appears that there is an inverse relationship between the seasonal average number of MFR trout fishing trips and the average number of fishing trips to other locations. This indicates that the MFR provides a unique fishing location, particularly for the winter season. This also tends to support the hypothesis that the MFR provides a unique winter season fishing experience.

Frequency of fishing trips per year to the MFR prior to establishment of the trout fishery on January 1, 1989 is shown in Table 4.8. Only 1989 data are available. Almost half of the anglers were first-time visitors to the MFR after the trout fishery began operation. About 34 percent of the anglers visited one to five times a year, and about 20 percent of the anglers visited more than five times a

TABLE 4.6

SEASONAL NUMBER OF FISHING TRIPS PER ANGLER TO THE MOUNTAIN FORK RIVER TROUT FISHERY, 1989 - 1991

Number of Trips	1989[a] Percent	1990 (Percent)				1991 (Percent)			
		Winter	Spring	Summer	Fall	Winter	Spring	Summer	Fall
1	16.6	21.1	58.1	48.4	53.2	25.0	50.6	48.1	61.3
2 - 5	30.6	30.5	24.4	33.0	26.6	26.3	25.9	27.2	30.0
6 - 10	18.5	16.8	5.8	8.8	5.3	22.5	8.6	4.9	5.0
11 - 15	10.8	11.6	3.5	4.4	4.3	20.0	8.6	8.6	2.5
16 - 20	1.3	5.3	2.3	1.1	3.2	3.8	3.7	2.5	0.0
> 20	22.2	14.7	5.8	4.4	7.5	2.5	2.5	8.6	1.3
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Average (No.)	15.15[b]	11.80	4.61	4.87	5.09	8.21	5.89	5.94	2.74

a Weighted by zip code proportions in creel survey.

b Annual average number of fishing trips to MFR for a sample of anglers.

TABLE 4.7

TOTAL NUMBER OF FISHING TRIPS TO OTHER LOCATIONS
FOR SAMPLES OF ANGLERS TO THE MOUNTAIN
FORK RIVER, 1989 - 1991

Number of Trips	1989[a] Percent	1990 (Percent)					1991 (Percent)				
		Winter	Spring	Summer	Fall	Annual[b]	Winter	Spring	Summer	Fall	Annual[b]
None	13.7	67.4	72.1	58.2	68.1	66.7	58.8	38.3	21.0	41.3	37.8
1 - 5	11.6	17.9	10.5	20.9	16.0	16.5	22.5	28.4	39.5	31.3	31.0
6 - 10	13.6	6.3	2.3	4.4	3.2	4.5	11.3	14.8	18.5	15.0	15.2
11 - 20	27.0	4.2	5.8	2.2	7.4	4.7	6.3	12.3	8.6	10.0	9.5
21 - 30	8.8	3.2	4.7	5.5	3.2	4.0	1.3	2.5	6.2	0.0	3.0
> 30	25.4	1.1	4.7	8.8	2.1	3.7	0.0	3.7	6.2	2.5	3.5
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Average (No.)	26.4	3.1	5.1	7.2	3.7	4.5	2.7	6.7	9.5	4.6	6.3
( )[c]	(31.1)	(9.5)	(18.4)	(17.2)	(11.6)	(13.4)	(6.5)	(10.8)	(12.0)	(7.8)	(9.8)

[a] Weighted by zip code proportions in creel survey.

[b] Weighted by the estimated proportion of trips taken each season by anglers.
Quarterly number of fishing trips to the locations other than Mountain Fork River was asked in each quarter of 1990 and 1991.
Annual number of fishing trips to the locations other than Mountain Fork River was asked in 1989.

[c] The parenthesis represent the average number of trips to other locations excluding anglers who did not take any trip other than to the MFR.

TABLE 4.8

FREQUENCY OF FISHING TRIPS PER YEAR TO THE MOUNTAIN FORK RIVER PRIOR TO ESTABLISHMENT OF THE TROUT FISHERY ON JANUARY 1, 1989[a]

Number of Trips	Number of Respondents	Percent[b]
None	53	45.7
1 - 5	39	33.5
6 - 10	8	7.0
11 - 20	5	6.1
> 20	7	7.7
Total	112	100.0
Average (No.)	6.3	N.A.

[a] Limited to the 1989 survey.

[b] Weighted by zip code proportions in creel survey.

year. Average annual number of fishing trips to the MFR prior to January 1, 1989 for this sample of anglers was about six, whereas the average after January 1, 1989 was about 15 (Table 4.6). Therefore, the establishment of the trout fishery greatly enhanced the frequency of fishing trips to the MFR.

Angler Trip Expenditures. Angler expenditures per trip were estimated and classified by category (food, lodging, transportation, etc.) and by location of purchase (local, state, out-of-state). The distribution of angler trips by level of expenditure is presented in Table 4.9. The expenditure per angler per trip averaged over all seasons ranged from about $60 to $90 over the three years. Seasonal differences in angler expenditures are evident for 1990 and 1991. Spring, summer, and fall expenditures per angler per trip were two to three times greater than for winter in 1990, whereas the differences were smaller for 1991. This was the result of longer trips for anglers and anglers coming from greater distances in these seasons compared to the winter season. The majority of anglers spent less than $20 per trip during the winter season, whereas the majority spent over $50 per trip in the other seasons.

The distribution of expenditures for the sample of MFR anglers by category is given in Table 4.10. On the average, almost equal expenditures occurred for lodging, food and beverages, and transportation, except for 1991 where the expenditure for food and beverages was higher. The three categories above comprised over three-fourths of the total expenditure for all three years of the trout fishery. The expenditure per angler per trip averaged over all seasons ranged from $14 to $26 for each of the three categories, depending on year. Purchased items (bait, tackle, insect repellents, souvenirs, etc.) accounted for about 10 to 16 percent or $7 to $15. Purchased services (canoe rental, putt-putt golf, etc.) and other items were negligible.

The distribution of angler expenditures by location of purchase is presented in Table 4.11. Generally, more than 70 percent of angler expenditures occurred in the local area or within a 25 mile radius of the MFR. Expenditures occurring out-of-Oklahoma were higher in 1991 compared to previous years. However, there were no significant seasonal differences across years in the distribution of angler expenditures by location.

Alternative Recreational Activities. Anglers were asked about other recreational or pleasurable activities they would have engaged in if they had

TABLE 4.9

ESTIMATED EXPENDITURE PER ANGLER PER TRIP TO THE MOUNTAIN FORK RIVER FOR SAMPLES OF ANGLERS, 1989 - 1991

Expenditure per Angler ($)	1989[a] Percent	1990 (Percent)					1991 (Percent)				
		Winter	Spring	Summer	Fall	Annual[b]	Winter	Spring	Summer	Fall	Annual[b]
0.01 - 10.00	27.7	41.1	17.4	16.5	11.7	26.0	36.3	21.0	17.3	10.0	21.4
10.01 - 20.00	21.0	14.7	3.5	9.9	11.7	10.7	20.0	12.3	4.9	7.5	10.9
20.01 - 50.00	18.9	23.2	16.3	13.2	16.0	18.4	10.0	4.9	22.2	25.0	14.6
50.01 - 100.00	11.9	10.5	17.4	19.8	17.0	15.0	23.8	39.5	30.9	26.3	31.2
100.01 - 200.00	13.8	7.4	30.2	22.0	30.9	19.3	6.3	18.5	23.5	28.8	19.0
> 200.00	5.9	3.2	15.1	18.7	12.8	10.6	3.8	3.7	1.2	2.5	2.8
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Average ($)	61.72	42.18	122.19	135.97	113.84	91.13	49.97	68.92	66.93	72.88	64.77
Median ($)	NA	20.0	100.0	100.0	89.0	NA	18.5	60.0	60.0	56.5	NA

a Weighted by zip code proportions in creel survey.

b Weighted by the estimated proportion of trips taken each season by anglers.

TABLE 4.10

DISTRIBUTION OF ANGLER EXPENDITURES BY CATEGORY FOR SAMPLES OF ANGLERS TO THE MOUNTAIN FORK RIVER, 1989 - 1991

Category	1989[a] Percent	1990 (Percent)					1991 (Percent)				
		Winter	Spring	Summer	Fall	Annual[b]	Winter	Spring	Summer	Fall	Annual[b]
Lodging	29.9	26.1	30.1	25.2	24.8	26.7	29.4	28.4	24.8	28.6	27.5
Food & Beverage	24.1	25.0	28.0	32.2	29.9	27.9	30.0	37.6	40.6	40.5	37.3
Transportation	24.7	29.8	26.9	26.2	30.4	28.5	26.0	22.0	20.6	19.9	22.1
Purchased Items	15.7	18.4	14.9	15.7	13.0	16.2	11.3	10.6	9.5	8.9	10.1
Purchased Services	5.3	0.7	0.0	0.7	1.9	0.7	0.0	1.4	4.0	0.9	1.8
Other	0.3	0.0	0.0	0.0	0.0	0.0	3.3	0.0	0.5	1.2	1.1
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

a Weighted by zip code proportions in creel survey.

b Weighted by the estimated proportion of trips taken each season by anglers.

TABLE 4.11

DISTRIBUTION OF ANGLER EXPENDITURES BY LOCATION FOR SAMPLES OF ANGLERS TO THE MOUNTAIN FORK RIVER, 1989 - 1991

Location	1989[a] Percent	1990 (Percent)					1991 (Percent)				
		Winter	Spring	Summer	Fall	Annual[b]	Winter	Spring	Summer	Fall	Annual[b]
Within 25 mile radius of MFR	79.8	88.5	83.2	79.6	81.5	84.4	78.3	68.7	72.8	71.3	72.5
Outside local area but within State of Oklahoma	13.2	8.2	6.0	9.8	8.9	8.1	8.3	15.8	9.9	7.1	10.9
Outside State of Oklahoma	7.1	3.3	10.8	10.6	9.6	7.5	13.4	15.5	17.3	21.6	16.6
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

a Weighted by zip code proportions in creel survey.

b Weighted by the estimated proportion of trips taken each season by anglers.

not made this trip to the MFR (Table 4.12). Fishing at other locations was the highest of all substitute activities for the MFR trout fishery, especially in spring and summer. Home-based recreation was the second most popular alternative activity. Other activities included outdoor recreational or pleasurable activities such as enjoying sports, camping, hiking, etc. Working, traveling, visiting friends/relatives etc. were also included in this category and were examples of frequent response from the anglers. The questionnaire was changed for 1991 to include only fishing at another location and an all other category of activities.

Anglers were asked to estimate their expenditures if they had not come to the MFR fishery but instead had participated in an alternative recreational or pleasurable activity (Table 4.13). About 55 to 85 percent of the anglers would spend less than $50. The average expenditure for spring, summer, and fall was greater than for winter indicating an availability of a variety of other outdoor recreational activities during those seasons.

Other locations fished by MFR anglers excluding the MFR and farm ponds are shown in Table 4.14. Each respondent could give up to five alternative locations in answering this question. The most frequent alternative locations given by the MFR anglers were Pine Creek, Broken Bow Lake, Lake Texhoma, Little River, and Lake Hugo, respectively.

Change in expected number of fishing trips per year at other locations when trout fishing became available on the MFR is shown in Table 4.15. Possible answers to this question was (1) a decrease or (2) remain the same. Responses were evenly divided between the two categories.

<u>Other Data</u>. Mode of travel for anglers at the MFR is shown in Table 4.16. Pick-up and car were the dominant means of transportation for MFR anglers and comprised over 70 percent of all modes of travel. Access to most sites on

TABLE 4.12

ALTERNATIVE RECREATIONAL OR PLEASURABLE ACTIVITIES FOR ANGLERS IF THEY DID NOT MAKE THIS TRIP TO MOUNTAIN FORK RIVER FOR SAMPLES OF ANGLERS, 1989 - 1991

Category	1989[a] Percent	1990 (Percent)					1991 (Percent)				
		Winter	Spring	Summer	Fall	Annual[b]	Winter	Spring	Summer	Fall	Annual[b]
Fishing at other location	39.9	45.3	58.1	49.5	35.1	47.6	40.0	58.0	51.9	51.3	51.1
Home-based recreation[c]	36.1	38.9	24.4	22.0	33.0	31.1					
Community-based recreation[c]	0.0	0.0	0.0	1.1	1.1	0.4					
Other	24.0	15.8	17.4	27.5	30.9	20.9	60.0	42.0	48.1	48.8	48.9
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

a Weighted by zip code proportions in creel survey.

b Weighted by the estimated proportion of trips taken each season by angler.

c These categories were not asked in 1991.

TABLE 4.13

ESTIMATED EXPENDITURE OF AN ANGLER IF THE ANGLER HAD NOT MADE THIS TRIP TO MOUNTAIN FORK RIVER BUT HAD PARTICIPATED IN THE OTHER RECREATION OR PLEASURABLE ACTIVITY FOR SAMPLES OF ANGLERS, 1989 - 1990[a]

Expenditure ($)	1989 Percent[b]	1990 (Percent) Winter	Spring	Summer	Fall	Annual[c]
Less than 10	53.7	45.3	25.6	29.7	35.1	35.9
10.01 - 20.00	7.2	18.9	11.6	14.3	8.5	14.7
20.01 - 50.00	24.6	20.0	17.4	14.3	17.0	17.8
50.01 -100.00	7.7	9.5	16.3	15.4	17.0	13.4
> 100.00	6.7	6.3	29.1	26.4	22.3	18.2
Total	100.0	100.0	100.0	100.0	100.0	100.0
Average ($)	34.5	49.75	96.51	101.83	85.75	76.89
Median ($)	NA	15.0	50.0	27.5	30.0	NA

a 1991 data were not available.

b Weighted by zip code proportions in creel survey.

c Weighted by the estimated proportion of trips taken each season by anglers.

TABLE 4.14

OTHER PLACES FISHED EXCLUDING MOUNTAIN FORK RIVER AND FARM PONDS FOR SAMPLES OF ANGLERS TO THE MOUNTAIN FORK RIVER, 1989[a]

Location	Number of Respondents
Pine Creek	25
Broken Bow Lake	21
Texhoma	17
Little River	16
Hugo	12
Eufaula	9
Blue River	8
White River	7
Glover River	5
Ray Hubbard	5
Little Missouri	5
Red River	5

a Limited to the 1989 Survey. Each respondent could give up to five different locations in answering this question.

TABLE 4.15

EXPECTATION OF THE NUMBER OF FISHING TRIPS PER YEAR AT OTHER LOCATIONS WHEN TROUT FISHING BECAME AVAILABLE ON THE MOUNTAIN FORK RIVER, 1989[a]

Expectation of Fishing Trips at Other Locations	Number of Respondents	Percent
Decrease	47	49.0
Remain the same	49	51.0
Total	96	100.0
Non-Response	16	NA

a Limited to the 1989 Survey.

TABLE 4.16

MODE OF TRAVEL FOR SAMPLES OF ANGLERS AT THE MOUNTAIN FORK RIVER TROUT FISHERY, 1989-1991

Mode	1989	1990 (Percent)					1991 (Percent)				
	Percent	Winter	Spring	Summer	Fall	Annual[a]	Winter	Spring	Summer	Fall	Annual[a]
Car	25.0	23.2	33.7	28.6	38.3	29.0	28.8	29.6	29.6	36.3	30.5
Pick-Up	49.1	60.0	50.0	45.1	39.4	51.4	55.0	56.8	56.8	37.5	53.3
Camper	4.5	0.0	2.3	2.2	1.1	1.2	2.5	2.5	2.5	1.3	2.3
Van	13.4	8.4	5.8	11.0	9.6	8.5	5.0	6.2	3.7	15.0	6.5
Motor Home	3.6	2.1	4.7	7.7	7.5	4.7	2.5	1.2	7.4	10.0	4.8
Motorcycle	0.9	0.0	0.0	1.1	1.1	0.4	0.0	0.0	0.0	0.0	0.0
Bicycle	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.2	0.0	0.0	0.4
Walking	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Other	3.6	6.3	3.5	4.4	3.2	4.8	6.3	2.5	0.0	0.0	2.1
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

[a] Weighted by the estimated proportion of trips taken each season by anglers.

the MFR was easily obtained with conventional vehicles. Van, motorhome, and camper were other modes of travel used for transportation.

The specific purpose of the trip to the MFR by the anglers is presented in Table 4.17. Data for 1989 were not available. Over 70 percent of the anglers came to the MFR just for trout fishing during all seasons for 1990 and 1991. The winter season had the highest percentage of the single purpose of trout fishing. Purposes of the trip other than trout fishing included recreational activities such as camping, bass fishing, canoeing, sightseeing, and taking a break away home.

Anglers were asked to express their satisfaction of the trout fishing trip to the MFR on a scale of 1 to 10 with 10 being the highest value (Table 4.18). Results indicate a high level of satisfaction with the trip. Over 70 percent gave it a quality scale of 7 or higher. A small percentage of anglers gave a quality score of less than 5. There appears to be little seasonal variation and little difference among the three fishing years in anglers' evaluation of trips to the MFR trout fishery. The average quality scale is different in the year 1991 because the anglers were asked to use a quality scale of 1 to 5 with 5 being the highest. It was assumed that the quality scale of 1 or 2 for 1989 and 1990 was equivalent to that of 1 for 1991 and so on.

Angler perception of the MFR trout fishery is shown in Table 4.19. No angler replied that the MFR trout fishery was inadequate and should be discontinued. The majority of the anglers (65 percent) perceived that the MFR trout fishery was adequate and should be maintained as is. About 32 percent indicated that the fishery was adequate but needed to be improved.

TABLE 4.17

THE SPECIFIC PURPOSE OF THE TRIP FOR SAMPLES
OF ANGLERS TO THE MOUNTAIN FORK RIVER,
1990-1991[a]

Purpose of Trip	1990 (Percent)					1991 (Percent)				
	Winter	Spring	Summer	Fall	Annual[b]	Winter	Spring	Summer	Fall	Annual[b]
Just for Trout Fishing	90.5	81.4	71.4	75.5	82.2	86.3	76.5	74.1	78.8	78.3
Not just for Trout Fishing	9.5	18.6	28.6	24.5	17.9	13.8	23.5	25.9	21.3	21.7
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

a 1989 data were not available.

b Weighted by the estimated proportion of trips taken each season by anglers.

TABLE 4.18

QUALITY OF THIS FISHING TRIP TO THE MOUNTAIN FORK RIVER TROUT FISHERY FOR SAMPLES OF ANGLERS, 1989 - 1991

Quality	1989	1990 (Percent)					1991 (Percent)				
Index[a]	Percent[b]	Winter	Spring	Summer	Fall	Annual[c]	Winter	Spring	Summer	Fall	Annual[c]
1 - 2	2.7	2.1	9.4	2.2	4.3	4.1	0.0	0.0	0.0	0.0	0.0
3 - 4	9.6	5.3	8.2	6.6	4.2	6.1	5.0	8.6	1.2	6.3	5.2
5 - 6	8.7	21.1	15.1	20.9	17.0	19.0	12.5	9.9	17.3	12.5	13.2
7 - 8	31.0	25.2	38.3	28.6	42.6	31.6	32.5	32.1	37.0	38.8	34.8
9 -10	48.0	46.3	29.0	41.7	31.9	39.2	50.0	49.4	44.4	42.5	46.9
Non-Response	0.1										
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Average	7.8	7.8	6.9	7.7	7.6	7.6	4.3	4.2	4.3	4.2	4.2

[a] Quality scale 1 to 10 with 10 being the highest. For 1989 and 1990, scale of 1 to 10 was used and for 1991, 1 to 5 was used. Therefore the scale of 1 for 1991 is assumed to be equivalent to 1 - 2 for 1989 and 1990.

[b] Weighted by zip code proportions in creel survey.

[c] Weighted by the estimated proportion of trips taken each season by anglers.

TABLE 4.19

HOW MOUNTAIN FORK RIVER ANGLERS PERCEIVE THE TROUT FISHERY, 1989[a]

Perception	Number of Respondents	Percent
Adequate and should be maintained as is	73	65.2
Adequate but needs to be improved	36	32.1
Inadequate and should be discontinued	0	0.0
Inadequate but with significant changes should be continued	3	2.7
Total	112	100.0

[a] Limited to the 1989 Survey.

Potential problem areas with the MFR trout fishery included the size of trout stocked, sanitary facilities, catch limit, number of anglers, and water swiftness during electricity generation (Table 4.20). Parking facilities, size of stream, and road accessibility to river were perceived to be the least problematic to the MFR anglers.

Anglers were asked how they first heard about the MFR trout fishery (Table 4.21). Even though the MFR trout fishery had been widely discussed prior to its initiation in January 1989, 29 out of the 112 anglers interviewed had not heard about the fishery until after that date. The most frequent response when asked how they learned of the MFR trout fishery was from another person.

TABLE 4.20

POTENTIAL PROBLEM AREAS WITH THE MOUNTAIN FORK RIVER TROUT FISHERY FOR SAMPLES OF ANGLERS, 1989[a]

Possible Problems	Percentage of Anglers Indicating Problem	Percentage of Anglers Indicating No Problem
Catch rate	19	81
Size of trout	32	68
Catch limit	23	77
Size of stream	7	93
Water swiftness during electricity generation	22	78
Number of anglers	23	77
Walking access trails to river	12	88
Road access to river	8	92
Parking facilities	7	93
Sanitary facilities	24	76

[a] Limited to the 1989 Survey.

TABLE 4.21

HOW ANGLERS FIRST LEARNED OF THE MOUNTAIN FORK RIVER TROUT FISHERY, 1989[a]

Response	Number of Respondents	Percent
From another person	47	42.0
Newspaper	32	28.6
Radio	1	0.9
Television	2	1.8
Beaver's Bend State Park brochure	6	5.3
Other	24	21.4
Total	112	100.0

[a] Limited to the 1989 Survey.

Learning from other people and the newspaper accounted for over 70 percent of the responses. Information from Beaver's Bend State Park, television, and radio were other methods of first learning about the MFR trout fishery.

Anglers were asked if the MFR was the first place they had ever trout fished (Table 4.22). About 40 percent of the anglers replied that it was. This means that the MFR trout fishery was a new recreational activity to many anglers, especially for the local anglers.

Total number of anglers per party for the MFR anglers is shown in Table 4.23. Over 85 percent of the trips were made with a party of 3 or less. Average number of anglers per party was about 2. This was consistent throughout the three fishing years.

TABLE 22

IS MOUNTAIN FORK RIVER THE FIRST PLACE
YOU HAVE TROUT FISHED?
1989[a]

Response	Number of Respondents	Percent[b]
Yes	42	37.5
No	69	61.6
Non-Response	1	0.9
Total	112	100.0

[a] Limited to the 1989 Survey.

[b] Weighted by zip code proportions in creel survey.

TABLE 4.23

TOTAL NUMBER OF ANGLERS IN THE PARTY FOR THE TRIP TO THE MOUNTAIN FORK RIVER, 1989 - 1991

Number in Party	1989 Percent[a]	1990 (Percent)					1991 (Percent)				
		Winter	Spring	Summer	Fall	Annual[b]	Winter	Spring	Summer	Fall	Annual[b]
1	19.1	33.7	27.9	40.7	37.2	34.4	37.5	30.9	32.1	22.5	31.4
2	43.4	50.5	53.5	34.1	45.7	47.0	45.0	55.6	39.5	48.8	47.1
3	23.3	4.2	11.6	16.5	9.6	9.3	12.5	9.9	16.0	13.8	13.0
4	6.2	9.5	2.3	5.5	5.3	6.4	3.8	1.2	9.9	7.5	5.5
>4	8.0	2.1	4.7	3.3	2.1	3.0	1.3	2.5	2.5	7.5	3.0
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Average (No.)	2.4	2.0	2.1	2.0	1.9	2.0	1.9	1.9	2.1	2.4	2.0

a Weighted by zip code proportions in creel survey.

b Weighted by the estimated proportion of trips taken each season by anglers.

Response of anglers to call-back in the future is shown in Table 4.24. The majority of the anglers (over 90 percent) responded positively to this question implying that this telephone survey did not bother the anglers much. In 1989, the response to this question was perhaps less positive because of the relatively lengthy questionnaire for that year.

Angler Characteristic Data

The median household income of MFR anglers was in the range of $25,000 to $40,000. Distribution of anglers by household income level is presented in Table 4.25. About 10 percent of the MFR anglers had annual average household income of less than $15,000 whereas over 30 percent had annual household income of $45,000 or more after spring of 1990. Average household income was slightly higher for anglers making trips to the MFR in fall compared to the other seasons.

Generally, 70 percent or more of the anglers were employed at the time they were interviewed at the MFR (Table 4.26). Status of retired or unemployed was asked separately in 1989, and 18 percent replied retired with two percent replying unemployed.

Of the 112 anglers interviewed in the telephone survey in 1989, 88 were male (Table 4.27). This is roughly 80 percent of total anglers interviewed.

Over 39 percent of the anglers were over 50 years of age (Table 4.28). Average age of anglers was 47. From Tables 4.27 and 4.28, it is likely that the majority of the MFR anglers were males over 45 years of age.

Principal occupation of the sample of anglers interviewed in 1989 is presented in Table 4.29. Category for retired, laborer or operative, and professional make up about 58 percent of the total anglers.

TABLE 4.24

RESPONSE OF SAMPLES OF ANGLERS TO
CALL-BACK IN THE FUTURE
1989 - 1991

Response	1989 Percent	1990 (Percent)					1991 (Percent)				
		Winter	Spring	Summer	Fall	Annual[b]	Winter	Spring	Summer	Fall	Annual[b]
Yes	92.0	94.7	96.5	97.8	95.7	95.9	96.3	98.8	95.1	98.8	97.1
No	8.0	5.3	3.5	2.2	4.3	4.1	3.8	1.2	4.9	1.3	2.9
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

[a] Weighted by the estimated proportion of trips taken each season by anglers.

TABLE 4.25

DISTRIBUTION OF MOUNTAIN FORK RIVER ANGLERS BY LEVEL OF HOUSEHOLD INCOME FOR SAMPLES OF ANGLERS, 1989 - 1991

Income Level	1989[a] Percent	1990 (Percent)					1991 (Percent)				
		Winter	Spring	Summer	Fall	Annual[b]	Winter	Spring	Summer	Fall	Annual[b]
Under $15,000	9.4	16.1	6.6	13.8	10.0	12.5	10.1	12.8	6.7	5.3	9.1
$15,000 - $24,999	15.0	24.1	18.4	22.5	18.8	21.7	20.3	15.4	26.7	19.7	20.7
$25,000 - $34,999	24.8	18.4	21.0	17.5	16.3	18.5	12.7	14.1	20.0	15.8	15.9
$35,000 - $44.,999	22.0	17.2	22.4	15.0	15.0	17.6	15.2	12.8	16.0	11.8	14.2
$45,000 - $54,999	11.9	11.5	14.5	13.8	16.3	13.4	19.0	16.7	12.0	18.4	16.0
Over $55,000	13.6	12.6	17.1	17.5	23.8	16.4	22.8	28.2	18.7	28.9	24.2
Non-Response	3.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Median Income ($)	35,000	30,000	30,000	26,250	31,500	N.A.	38,000	40,000	30,000	40,000	N.A.
Average Income ($)	35,865	34,784	39,428	36,395	43,936	37,582	41,729	41,865	36,569	44,579	40,613

a Weighted by zip code proportions in creel survey.

b Weighted by the estimated proportion of trips taken each season by anglers.

TABLE 4.26

STATUS OF EMPLOYMENT OF MOUNTAIN FORK RIVER ANGLERS, 1989 - 1991

Employment	1989[a] Percent	1990 (Percent)					1991 (Percent)				
		Winter	Spring	Summer	Fall	Annual[b]	Winter	Spring	Summer	Fall	Annual[b]
Employed	80.0	70.5	76.7	67.0	70.2	71.2	72.5	79.0	76.5	81.3	77.2
Retired or Unemployed	20.0[c]	29.5	23.3	33.0	29.8	28.8	27.5	21.0	23.5	18.8	22.8
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

a Weighted by zip code proportions in creel survey.

b Weighted by the estimated proportion of trips taken each season by anglers.

c Retired is 18 percent and unemployed is 2 percent.

TABLE 4.27

SEX OF THE ANGLERS FOR SAMPLES OF ANGLERS AT THE MOUNTAIN FORK RIVER TROUT FISHERY, 1989[a]

Sex	Number of Respondents	Percent
Male	88	78.6
Female	24	21.4
Total	112	100.0

[a] Limited to the 1989 Survey.

TABLE 28

AGE OF ANGLERS FOR THE MOUNTAIN FORK RIVER TROUT FISHERY, 1989[a]

Age (Years)	Number of Respondents	Percent
Under 20	3	2.7
20 - 30	11	9.8
31 - 40	29	25.9
41 - 50	25	22.3
51 - 60	22	19.6
> 60	22	19.6
Total	112	100.0
Average	46.6	

[a] Limited to the 1989 Survey.

TABLE 4.29

OCCUPATION OF THE ANGLERS AT THE MOUNTAIN FORK RIVER TROUT FISHERY, 1989[a]

Category	Number of Respondents	Percent
Professional	19	17.0
Manager or Administrator	11	9.8
Sales or Clerical	13	11.6
Craftsman	12	10.7
Laborer or Operative	22	19.6
Service Worker	2	1.8
Farmer or Farm Worker	0	0.0
Retired	24	21.4
Not employed	2	1.8
Other	7	6.3
Total	112	100.0

[a] Limited to the 1989 Survey.

Years of fishing experience for a sample of anglers to the MFR is shown in Table 4.30. Only 4 percent of the anglers had less than 10 years of fishing experience with an average of 34 years for the sample. About 64 percent had less than 10 years of trout fishing experience with an average of 10 years. This

TABLE 4.30

YEARS OF FISHING EXPERIENCE FOR SAMPLES OF MOUNTAIN FORK RIVER ANGLERS, 1989[a]

Years	Number of Respondents		Percent	
	Fishing Experience	Trout Fishing Experience	Fishing Experience	Trout Fishing Experience
10 or less	4	72	3.6	64.3
11 - 20	24	18	21.4	16.1
21 - 30	24	9	21.4	8.0
31 - 40	29	6	25.9	5.4
41 - 50	15	3	13.4	2.7
over 50	12	0	10.7	0.0
Non-Response	4	4	3.6	3.6
Total	112	112	100.0	100.0
Median years	34.5	4.0	N.A.	N.A.
Mean years	34.1	10.3	N.A.	N.A.

[a] Limited to the 1989 Survey.

implies that the MFR participants were very experienced anglers but not necessarily experienced at trout fishing.

Estimated Total Angler Trips and Angler Expenditures

Data on estimated angler hours (Table 4.1) were combined with data on average hours fishing per trip per angler (Table 4.4) and average expenditure per trip per angler (Table 4.9) to estimate aggregate number of angler trips and aggregate angler expenditures associated with establishment of the MFR trout fishery. The estimated number of angler trips for the three years is shown in Table 4.31. The estimated number of angler trips is positively related to total angler hours and negatively related to average number of hours fishing. Because of higher aggregate angler hours and lower number of hours fishing per trip for spring and summer of 1991 compared to 1990, the number of trips was significantly higher for 1991. Fall season for both years had fewer total trips than any other season.

Estimated aggregate angler expenditures by season for those anglers utilizing the MFR trout fishery are presented in Table 4.32. The estimated aggregate expenditures ranged from about $517,000 in 1989 (11 months) to about $792,000 in 1990 (12 months). Over 70 percent of the expenditures occurred locally within a 25 mile radius of the MFR. The local expenditures ranged from about $413,000 in 1989 to about $655,000 in 1990.

Geographic distribution of the source of angler trips and angler expenditures is shown in Figure 7. The different shaded areas show the percentage of trips and expenditures originating from anglers coming from those counties. That is, category one is McCurtain County and shows that 33 percent of the trips and 6 percent of the expenditures were from anglers residing in that county. The second category shows those counties associated with 16 percent of the angler trips and 12 percent of the angler expenditures.

TABLE 4.31

ESTIMATED NUMBER OF ANGLER TRIPS BY SEASON
TO THE MOUNTAIN FORK RIVER, 1989 - 1991

		1990 (Percent)					1991 (Percent)				
	1989	Winter	Spring	Summer	Fall	Annual[b]	Winter	Spring	Summer	Fall	Annual[b]
Angler Hours[a] (No.)	68,091	16,181	21,569	18,209	12,686	68,645	13,512	29,893	32,155	16,688	92,248
Average number of Hours Fishing per Trip per Angler[b]	8.13	5.01	9.70	10.15	10.35	8.04	5.82	8.25	9.30	10.01	8.32
Total Number of Angler Trips	8,376	3,230	2,225	1,794	1,226	8,475	2,327	3,623	3,458	1,667	11,075

a Table 4.1.

b Table 4.4.

TABLE 4.32

ESTIMATED AGGREGATE ANGLER EXPENDITURES BY SEASON
FOR THE MOUNTAIN FORK RIVER TROUT FISHERY,
1989 - 1991

		1990					1991				
	1989	Winter	Spring	Summer	Fall	Annual[b]	Winter	Spring	Summer	Fall	Annual[b]
Number of Angler Trips[a]	8,376	3,230	2,225	1,794	1,226	8,475	2,327	3,623	3,458	1,667	11,075
Expenditure per Angler Trip[b] ($)	61.72	42.18	122.19	135.97	113.84	91.13	49.97	68.92	66.93	72.88	64.77
Aggregate Expenditure[c] ($1,000)	517	136	272	244	140	792	116	250	231	121	718
Local Expenditure[d] (%)	79.8	88.5	83.2	79.6	81.5	84.4	78.3	68.7	72.8	71.3	72.5
Aggregate Local Expenditure[e] ($1,000)	413	121	226	194	114	655	91	172	168	87	518

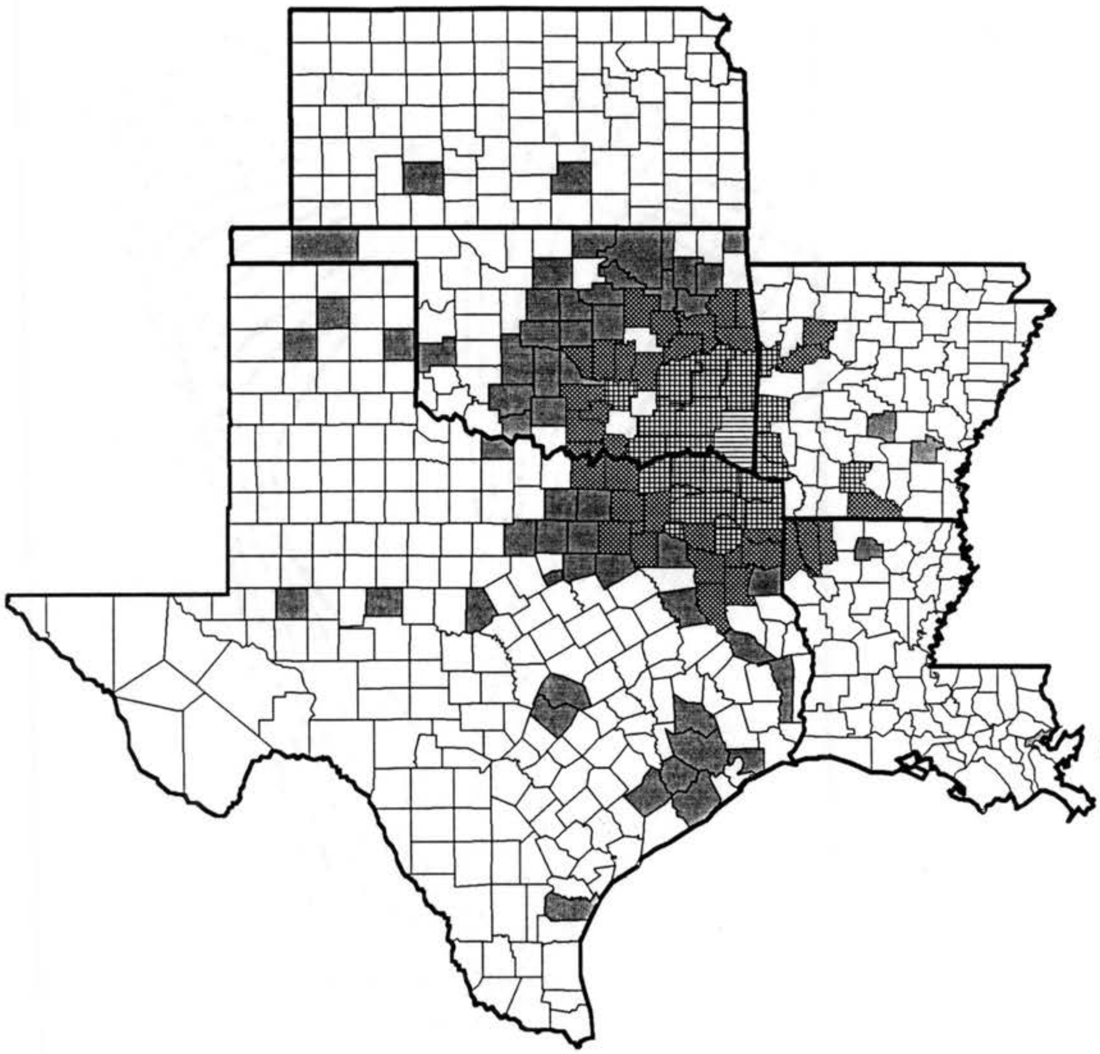
[a] Table 4.31.

[b] Table 4.9.

[c] This is calculated as number of angler trips multiplied by expenditure per angler trip

[d] Table 4.11.

[e] $c \times \frac{d}{100}$. This is calculated as aggregate expenditure multiplied by local expenditure divided by one hundred.



Category	Angler Trips (%)	Angler Expenditures (%)
1	33	6
2	16	12
3	29	38
4	22	44
	100	100

Figure 7. County Distribution of Total Angler Trips and Angler Expenditures for the Mountain Fork River Trout Fishery, 1991

Similarly, the third category of counties accounts for 29 percent of the trips and 38 percent of the expenditures. The cumulative sum of the counties with the first three categories account for 78 percent of the trips and 56 percent of the expenditures. This contrasts with the counties of category four that account for 22 percent of the trips and 44 percent of the expenditures.

The graphic data in Figure 7 is useful in showing the approximate zonal source of anglers and their associated expenditures. The two closer zones account for about one-half of the angler trips but only about 18 percent of the angler expenditures whereas the two more distant zones account for about one-half of the angler trips but over 80 percent of the angler expenditures. Some counties appear unshaded indicating no angler trips. However, this in part, is due only because the data are based on sample information. Counties not shaded may well be considered as part of the zone indicated by surrounding shaded counties.

Conclusions

Several important findings are observed from the sample data of the MFR trout fishery and participating anglers:

1. Seasonal variation in angler hours is significant. The number of angler hours in spring and summer was about 66 percent of the total angler hours in 1989, about 58 percent in 1990, and about 67 percent in 1991. The trout harvest per angler per hour was much higher during winter than during the other seasons. This may indicate a need to adjust stocking rates by either lowering the rate during winter or increasing the rate during spring and summer.

2. Seasonal differences exist in where anglers are coming from. Most winter season anglers were from local areas whereas higher proportions of anglers during the other seasons came from areas of greater distance. Over 29 percent of the anglers came from McCurtain County. Roughly over 55 percent of the anglers came from the state of Oklahoma (including McCurtain County).
3. The average length of trip was shorter during the winter (1.46 days) compared to spring (2.91 days), summer (3.53 days), and fall (2.52 days) in 1990. The fishing year 1991 also had similar seasonal variation of the trip length (winter 1.65 days, spring 2.58 days, summer 3.14 days, and fall 3.10 days). The annual average length of trips increased slightly year by year from 1.51 days in 1989, to 2.39 days in 1990, and to 2.63 days in 1991.
4. Except for the winter season, the number of fishing trips per angler by season to the MFR was fairly uniform, ranging from 2.7 to 5.9 trips per season. For the winter season, the average number of trips per angler was over 8.
5. The median annual household income of the MFR anglers was between $25,000 and $40,000 indicating a relatively high income class of anglers. Anglers frequenting the fishery during the winter and summer seasons were more concentrated in the lower income levels.
6. Average expenditure per angler per trip was estimated to range from $42 to $136 depending on season and fishing year. Over three-fourths of the expenditures occurred within the local area for lodging, food and beverages, and transportation.

7. Establishment of the trout fishery at the MFR increased the frequency of trips by anglers. The average number of trips per year increased from 6 before January 1, 1989 to 15 after January 1, 1989.
8. Aggregate trip expenditures of the MFR anglers were estimated to be from $517,000 to $792,000 per year. From 73 to 84 percent of these expenditures, that is $413,000 to $655,000, were estimated to occur locally or within a 25 mile radius of the MFR.

CHAPTER V

DEMAND AND BENEFIT ESTIMATION FOR ANGLERS OF THE MOUNTAIN FORK RIVER TROUT FISHERY

This chapter presents the demand estimation model for the anglers of the MFR trout fishery. The model is specified and the variables are defined. Data used for empirical estimation of the equations are explained. Results of the demand and benefit estimation for anglers of the MFR trout fishery are also presented.

Specification of the Basic Demand Estimation Model

The individual trip demand function for anglers at the MFR trout fishery is of the general form:

$$Q = f(P_f, P_o, T, SUB, Y, A, SOCIO) \qquad (5.1)$$

where Q is the number of angler trips, P_f is the monetary trip cost, P_o is the monetary cost of the other activities (except trout fishing) engaged in at the MFR, T is the time cost for travel, SUB represents the substitute measure, Y is the annual household income, A is attractiveness or quality of the trip as perceived by the anglers, and SOCIO is socioeconomic variables other than annual household income that may affect the dependent variable, Q.

One of the objectives of the present study was to detect whether there exists seasonal variation in angler demand for the MFR trout fishery. Result of seasonal variation is an important component in management decisions.

Regression analysis was employed with pooled data for each year (1990 and 1991) to test for seasonal difference in intercept term. The regression results and tests are presented in the Table 5.1. The t-statistics show that all of the seasonal dummy variables were statistically significant at the 5 percent probability level. Also, a joint test was used to test the hypothesis that the coefficients on the seasonal variables (S3, S3,S4) were significantly different from zero. Based on the F-statistic, the null hypothesis that the coefficients on the seasonal variables were jointly zero was rejected.

Results of these tests indicate that there exists significant seasonal variation in angler demand for the MFR trout fishery. Therefore, the demand function was estimated for each season with only the data of the specific season[1]. This means that there exist four seasonal demand functions for anglers of the MFR trout fishery in 1990 and 1991.

The above functional form (5.1) is the basic specification for this study. Some modification of variables were necessary and alternative variables were included. For example, the monetary costs of trout fishing (P_f) were defined in two different ways - total direct cost and direct transportation cost. Total direct cost includes all the costs incurred on - site (food, lodging, services, etc.) as well as the transportation cost of the trip. Direct transportation cost includes only the portion of cost incurred during the round trip. Most of this cost, therefore, is the cost of driving vehicles. No entrance fee exists at the MFR trout fishery that may be a part of monetary cost of trout fishing (P_f).

The monetary cost of other activities engaged in at the MFR (P_o) is thought to be a cost of complement recreational activities to the trout fishing experience. Note that Beavers Bend State Park is a part of the MFR below

---

1 For 1989, only one annual demand function exists.

TABLE 5.1

TEST FOR SEASONAL DIFFERENCES IN ANGLER DEMAND FOR MOUNTAIN FORK RIVER TROUT FISHERY

1990

$$\ln Q = \underset{(8.33)}{1.6739} - \underset{(-7.77)}{0.0016}\, TCF_t - \underset{(-5.04)}{0.0032}\, TCO_t + \underset{(0.64)}{0.00013}\, SUB - \underset{(-0.99)}{0.00113}\, Y$$

$$+ \underset{(0.71)}{0.0136}\, A - \underset{(-5.48)}{0.8312}\, S2 - \underset{(-4.13)}{0.6333}\, S3 - \underset{(-4.33)}{0.7040}\, S4$$

( ): t statistic
F statistic = 10.52 with 3, 304 D.F.

1991

$$\ln Q = \underset{(6.67)}{1.6433} - \underset{(-9.65)}{0.0059}\, TCFt - \underset{(-5.09)}{0.0041}\, TCOt - \underset{(-0.40)}{0.0000009}\, Y + \underset{(0.89)}{0.0217}\, A$$

$$- \underset{(-2.81)}{0.3586}\, S2 - \underset{(-3.20)}{0.4216}\, S3 - \underset{(-4.72)}{0.5375}\, S4$$

( ): t statistic
F statistic = 7.81 with 3, 290 D.F.

Q = The number of trips taken to the MFR by sampled anglers of the MFR trout fishery.

TCFt = Total direct cost of trout fishing activity plus travel time cost proportionate to trout fishing activity ($).

TCOt = Total direct cost for other recreational activities plus travel time cost proportionate to other recreational activities ($).

SUB = The substitute effect of other fishing sites to the MFR anglers. Data were not available for substitute variable for 1991.

Y = The annual household income of MFR anglers ($1,000).

A = Attractiveness or quality of the trip to the MFR trout fishery.

S2,S3,S4 = Seasonal dummy variables where winter is equal to zero.

Broken Bow Lake and provides several recreational activities other than the trout fishery.

Following Cesario's work (1976), both the monetary and time costs were combined into a single cost variable to incorporate travel time effect in the demand function. This procedure is often used to reduce multicollinearity. The formula to compute the travel time cost of the ith angler in the current study is of the following form:

$$T_i = \left(\frac{DT_i \times 2}{55}\right) \cdot \left(\frac{Y_i}{2080}\right) \cdot k \qquad (5.2)$$

where DT_i = one-way distance traveled (miles) of angler i,

Y_i = the annual household income of angler i, and

k = a parameter that represents proportion of opportunity cost of travel time.

Individual survey data were used for both the one-way travel distance (DT_i) and annual household income[2] (Y_i). Therefore, cost of travel time varies among individuals.

Cost of travel time for angler i (T_i) is computed using the following procedure. First one-way travel distance for angler i was doubled to account for round-trip distance. This number is divided by the average velocity of driving time (miles/hour) to derive total time spent for round-trip. A road map of the area surrounding the MFR shows that anglers may drive on both local roads and interstate highway. For this study, 55 miles per hour was assumed to be the average velocity of driving a vehicle. Secondly, the opportunity cost of time on an hourly basis was calculated by dividing annual working hours per angler by annual income. Individual wage data was not available hence household

2 In zonal TCM, zonal average of both DT and Y is used.

income was used. Annual working hours was set at 2080 which is 260 work days times 8 hours per day. The opportunity cost of travel time was assumed to be a proportion of the angler's wage rate. Initially, this proportion (k) was estimated with data at hand based on the work of McConnell and Strand (1981). However, the estimated value was very high[3]. Thus, the proportion (k) was set at one-third following other studies (Cesario and Knetsch, 1970; and Cesario, 1976). If an angler responded that he/she was retired or unemployed at the time of the trip to the MFR, the opportunity cost of travel time was assumed to be zero. Finally, total time spent for round-trip to the MFR for angler i was multiplied by the opportunity cost of travel time per hour of angler i to compute time cost of travel for angler i.

The substitute measure (SUB) was computed as the following form:

$$SUB_i = 2 \sum_{j=1}^{J} DT_j \left[NOTRIP_j/TOTTRIP\right] \qquad (5.3)$$

where SUB_i = the substitution effect of other fishing sites to the MFR for angler i,

DT_j = one-way travel distance to fishing site j (j=1...J) where ith angler actually fished at least once during the given period,

$NOTRIP_j$ = number of trips to fishing site j by angler i, and

TOTTRIP = total trips taken to other fishing sites during the given period.

The term in the brackets was used to give weight to other sites where MFR anglers visited at least once. This assumes that because the more an angler

---

3 $\hat{k}$ was 1.45, 1.64, 0.58 for winter, spring, and summer of 1990, respectively.

visits a specific alternative fishing site j, the more substitutable that site is to the MFR trout fishery.

Attractiveness or quality of the MFR trout fishing trip perceived by MFR anglers (A) was included in the demand model. Attractiveness or quality was represented by an index ranging from 1 to 5, with 5 being the highest quality.

For 1989, the basic demand model (5.1) was modified to include travel time and two socioeconomic variables other than household income:

$$Q = f(TCF_t, TCO_t, SUB, Y, A, AGE, SEX) \quad (5.4)$$

TCF_t is total direct cost of trout fishing activity plus travel time cost proportionate to trout fishing activity, and TCO_t is total direct cost of other recreational activities plus travel time cost proportionate to other recreational activities. The proportions of trip cost related to the trout fishery and to other activities were based on survey results. This information was also used to assign the total time cost of travel to trout fishing activity and other recreational activities. Socioeconomic data available in the 1989 survey included age of the MFR anglers and sex (a dummy variable where male = 1 and female = 0).

For 1990, the following demand model was specified for seasonal analysis of the MFR trout fishery:

$$Q = f(TCFt, TCOt, SUB, Y, A). \quad (5.5)$$

Socioeconomic variables were excluded from the model because these data were not available[4].

[4] As noted in Chapter III, telephone interview time needed to be shortened . To accomplish this, a number of questions were excluded from the 1990 and 1991 telephone surveys.

Data for a substitute site was not available for 1991 and hence the demand model did not include the substitute variable (SUB) from the above model (5.5).

As discussed above, an alternative model was also considered for the demand analysis of MFR trout fishery for 1990 and 1991 as follows:

$$Q = f(TRCF_t, TRCO_t, SUB, Y, A) \tag{5.6}$$

where the price variables ($TRCF_t$ and $TRCO_t$) were a combination of direct transportation cost and time cost of travel, respectively. Specification for 1991 did not include the substitute variable (SUB) from model (5.6).

Which price variables should be used depends on the relationship between on-site expenditures and travel distance of recreation users (Walsh, 1986). If a highly positive correlation exists between the two variables, total direct cost is a more satisfactory measure of price. However, significant effort and cost is generally required to obtain related survey data (e.g. on-site expenditure data such as lodging, food, services, etc.) from individual recreation users. Based on the information of the sample of MFR anglers, those anglers from outside the local area (about 25 mile radius from the MFR) were more likely to spend one or more nights at the site and hence spend more money. Moreover, the present study had survey information on all trip costs. Thus total direct cost represented the price variable best suited for this study because the on-site expenditures of anglers varied with distance traveled. Therefore, the demand and benefits of MFR trout fishery were estimated from models (5.4) for 1989 and (5.5) for 1990 and 1991[5].

---

5 Demand curves were estimated using model (5.6) for comparison with the demand curve using model (5.5).

A functional form should be chosen that is consistent with underlying theories of the study of interest (Johnson, et al., 1987). The semilog functional form is the most commonly used functional form in the recreation literature (Sutherland, 1982b). The basic demand model for the MFR trout fishery anglers for 1989 with a semilog functional form is written as follows:

$$\begin{aligned} \ln Q = \; & \beta_0 + \beta_1\, TCF_t + \beta_2\, TCO_t + \beta_3\, SUB + \beta_4\, Y + \beta_5\, A \\ & + \beta_6\, AGE + \beta_7\, SEX + e \qquad (5.7) \end{aligned}$$

where β_0 to β_7 are coefficients to be estimated and e is a random error term.

The theoretical procedure of consumer surplus estimation was presented in Chapter III. However, it is not possible to compute consumer surplus if the applied demand function does not meet the y axis such as with the semilog functional form used in this study. To estimate consumer surplus, the demand function needs to be truncated at some upper price level for all angler trips. It is reasonable to assume that this price is the highest price observed from the sampled anglers of the MFR trout fishery. The estimated consumer surplus varies depending on the assumed highest price.

Data

A telephone survey of MFR trout fishery anglers provided the data for empirically estimating the angler demand and benefit functions. The number of telephone surveys completed and data used in the TCM model are presented in Table 5.2. For the first year (1989), 112 telephone surveys were completed and 107 were used in the TCM model of annual demand and benefit estimation. For the second (1990) and third (1991) years, seasonal telephone surveys were conducted. Not all telephone surveys completed in each year or season could

TABLE 5.2

THE NUMBER OF TELEPHONE SURVEYS AND OBSERVATIONS USED BY YEAR IN THE TCM ANALYSIS OF THE MOUNTAIN FORK RIVER TROUT FISHERY

Year		Telephone Surveys (no.)	TCM Observations
1989		112	107
1990			
	Winter	95	85
	Spring	86	73
	Summer	91	78
	Fall	94	77
	Total	366	313
1991			
	Winter	80	77
	Spring	81	73
	Summer	81	72
	Fall	80	76
	Total	322	298

be used in the TCM model because of missing data. The most frequent missing data was information on household income. An occasional observation was eliminated based on irrational response and inability to contact angler for follow-up response. The dependent variable for the present study is the number of trips taken by the MFR anglers who actually fished at the MFR trout fishery and thus interpretation of results that follow should be made accordingly.

Estimation of Demand and Benefits for MFR Trout Fishing Anglers

Demand Estimation

Using the models discussed above and telephone survey data, demand functions were estimated for the MFR trout fishery. A semilog functional form was chosen to represent the relationship between the dependent and independent variables.

Initially, the demand functions were estimated using ordinary least squares (OLS). However, heteroskedasticity was detected for some seasons. There are three consequences of using OLS in the presence of heteroskedasticity (Kennedy, 1985). First, the OLS estimator no longer has minimum variance among all linear unbiased estimators. Second, the hypothesis tests are no longer valid because the variance-covariance matrix of OLS estimator is incorrect which, in turn, leads to a biased variance estimator. Finally, if the assumption is made that the error terms are distributed joint-normally, the generalized least squares (GLS) estimator and not the OLS estimator is the maximum likelihood estimator (MLE). Therefore, the GLS estimators should be used if the problem of heteroskedasticity is severe.

One problem in using the GLS estimator is that the variance-covariance matrix of the error terms (G) is rarely known. The estimated generalized least squares (EGLS) estimator[6] ($\hat{G}$) can be created by estimating G with the data of interest. Although the EGLS estimator is no longer linear or unbiased, it has desirable asymptotic properties corresponding to the small sample properties of the GLS estimator on the condition that $\hat{G}$ is a consistent estimator of G. The results of estimated demand functions with different variable specifications for each year (each season for 1990 and 1991) are shown in Tables 5.3 and 5.4.

All of the coefficients of the own price variables (TCFt or TRCFt) have the expected sign and are statistically significant at the 5 percent probability level. The coefficients of the cost for other activities provided to anglers at the MFR (TCOt and TRCOt) have negative sign. This indicates that the lower the cost of the other activities provided to the MFR anglers, the more trout fishing trips these anglers will make to the MFR. The negative sign indicates that the other activities are considered as complements to the trout fishery for the MFR anglers. About three-fourths of the coefficients are statistically different from zero at the 5 percent probability level.

The coefficients for the substitute variable (SUB) do not show the expected positive sign for about one-half of the cases nor are the coefficients statistically different form zero. This implies that the MFR trout fishery is a unique recreational site to the MFR anglers.

Coefficients for the household income variable (Y) and the quality or attractiveness variable (A) generally do not have consistent signs and most are not statistically significant. The positive sign for the variable AGE for 1989 implies that if other things are constant the older the MFR anglers, the

---

6 This is computed using SHAZAM 6.2 (Econometric computer program version 6.2)

TABLE 5.3

ESTIMATED DEMAND FUNCTIONS FOR THE MOUNTAIN FORK RIVER TROUT FISHERY USING TOTAL DIRECT COSTS

Year	Independent Variables								Adj.R^2	Ep[c]
	Constant	TCFt	TCOt	SUB	Y[a]	A	AGE[b]	SEX[b]		
1989[d]	0.6018	-0.0045	-0.0125	-0.0001	0.0040	0.0432	0.0184	0.4995	0.22	-0.37
	(0.95)	(-3.10)	(-2.26)	(-0.25)	(0.82)	(0.80)	(2.19)	(1.80)		
	0.5819	-0.0045	-0.0125		0.0040	0.0448	0.0184	0.4905	0.23	-0.34
	(0.93)	(-3.15)	(-2.28)		(0.83)	(0.84)	(2.21)	(1.79)		
1990										
Winter										
	1.3367	-0.0091	-0.0155	-0.0020	0.0152	0.0768			0.31	-0.48
	(2.89)	(-4.26)	(-3.60)	(-2.32)	(2.39)	(1.50)				
Spring										
	0.7990	-0.0016	-0.0022	0.0012	-0.0011	0.0072			0.32	-0.84
	(3.13)	(-5.56)	(-2.82)	(1.92)	(-1.76)	(0.28)				
Summer										
	1.4511	-0.0018	-0.0043	-2E-05	-0.0058	-0.0117			0.37	-0.52
	(4.62)	(-5.45)	(-3.66)	(-0.11)	(-2.97)	(-0.46)				
Fall										
	0.9691	-0.0031	-0.0028	0.0008	0.0011	0.0122			0.38	-0.47
	(4.20)	(-4.53)	(-4.39)	(1.62)	(0.57)	(0.48)				
1991[e]										
Winter										
	2.3048	-0.0095	-0.0050		-0.0083	0.0232			0.48	-0.57
	(4.55)	(-5.77)	(-1.09)		(-1.50)	(0.43)				
Spring										
	1.8751	-0.0054	-0.0051		0.0003	-0.0615			0.25	-0.74
	(3.44)	(-4.62)	(-2.12)		(0.07)	(-1.16)				
Summer										
	1.0026	-0.0084	-0.0057		0.0090	0.0330			0.48	-1.53
	(2.01)	(-6.77)	(-5.13)		(2.43)	(0.59)				
Fall										
	0.4122	-0.0020	-0.0006		-0.0042	0.0494			0.21	-0.34
	(2.01)	(-2.55)	(-0.70)		(-1.53)	(2.31)				

The parentheses show the t statistic

a In units of $1,000.

b Data were not available for 1990 and 1991.

c Ep represents the own price elasticity measured at mean level for each variable.

d Only annual data were available for 1989.

e Data were not available for substitute variable for 1991.

TABLE 5.4

ESTIMATED DEMAND FUNCTIONS FOR THE MOUNTAIN FORK RIVER TROUT FISHERY USING DIRECT TRANSPORTATION COSTS

Year[a]	Independent Variables						Adj.R^2	Ep[c]
	Constant	TRCFt	TRCOt	SUB	Y[b]	A		
1990								
Winter	1.3476	-0.0269	-0.0147	-0.0006	0.0144	0.0817	0.34	-0.64
	(3.01)	(-4.91)	(-2.74)	(-0.70)	(2.45)	(1.65)		
Spring	0.6860	-0.0038	-0.0027	0.0002	0.0007	0.0184	0.27	-0.72
	(2.36)	(-3.88)	(-1.78)	(0.38)	(0.81)	(0.58)		
Summer	1.5495	-0.0056	-0.0128	-3E-06	-0.0024	-0.0275	0.37	-0.73
	(4.24)	(-4.45)	(-4.15)	(-0.02)	(-0.90)	(-0.88)		
Fall	0.5574	-0.0066	-0.0094	0.0008	0.0057	0.0463	0.24	-0.50
	(2.34)	(-2.99)	(-3.83)	(1.82)	(1.71)	(1.47)		
1991[d]								
Winter	2.4073	-0.0163	-0.0131		-0.0075	0.0029	0.43	-0.52
	(4.52)	(-4.75)	(-1.41)		(-1.22)	(0.05)		
Spring	1.1468	-0.0083	-0.0074		0.0022	-0.0144	0.29	-0.83
	(2.60)	(-5.11)	(-1.99)		(0.59)	(-0.33)		
Summer	1.1882	-0.0014	-0.0044		-0.0014	-0.0225	0.08	-0.20
	(2.08)	(-0.61)	(-2.14)		(-0.23)	(-0.36)		
Fall	0.3325	-0.0071	-0.0075		0.0017	0.0562	0.14	-0.33
	(0.79)	(-2.46)	(-1.97)		(0.31)	(1.24)		

The parentheses show the t statistic.

[a] Data were not available for TRCFt or TRCOt for 1989.

[b] In units of $1,000.

[c] Ep represents the own price elasticity measured at mean level for each variable.

[d] Data were not available for substitute variable for 1991.

more trips will be taken to the MFR trout fishery. This variable is statistically significant at the 5 percent probability level. The gender variable, SEX, is not statistically significant, however, the sign of the coefficient is positive indicating that the number of trips to the MFR will be higher for male anglers, other things equal.

The own-price elasticity at the mean value for price is presented along with the adjusted R^2[7]. In the context of this study, the own price elasticity is the percent change in number of trips (demand) in response to a one percent change in TCFt or TRCFt (price). Generally, the own-price elasticities for this study fall in the range from -0.30 to -0.80 indicating that the number of trips to the MFR trout fishery is price inelastic to the MFR anglers.

Benefit Estimation

The next step is to derive a demand curve from a demand function. Except for the price variables (TCFt, TRCFt), mean values of the other explanatory variables are multiplied by corresponding coefficients and added to the intercept term of the demand function. Then, the demand curve is derived with the new intercept term and the coefficient of the price variable which is the same as in the demand function. The winter season has the highest intercept term for both 1990 and 1991. This is expected from results of the test on seasonal difference as discussed above. The estimated demand curves for the anglers of the MFR trout fishery are shown in Table 5.5.

Estimated number of trips to the MFR trout fishery is presented in Table 5.6. The total number of trips increased during the three year period from about

---

7 Own price elasticity $= \frac{\partial Q}{\partial P} \cdot \frac{\bar{P}}{\bar{Q}} = b\bar{P}$.

TABLE 5.5

ESTIMATED DEMAND CURVES FOR ANGLERS
OF THE MOUNTAIN FORK RIVER
TROUT FISHERY[a]

1989[b]

$Q = f(TCF_t, TCO_t, SUB, Y, A, AGE, SEX)$

$\ln Q = 2.0974 - 0.0045015\ TCF_t$

1990[c]

$Q = f(TCF_t, TCO_t, SUB, Y, A)$			$Q = f(TRCF_t, TRCO_t, SUB, Y, A)$		
Winter	lnQ	= 2.1907 - 0.0090624 TCF_t	Winter	lnQ	= 2.3504 - 0.026897 $TRCF_t$
Spring	lnQ	= 0.8045 - 0.0015624 TCF_t	Spring	lnQ	= 0.8218 - 0.003840 $TRCF_t$
Summer	lnQ	= 1.0201 - 0.0017607 TCF_t	Summer	lnQ	= 1.1146 - 0.0056251 $TRCF_t$
Fall	lnQ	= 1.0681 - 0.0031368 TCF_t	Fall	lnQ	= 1.0746 - 0.0066435 $TRCF_t$

1991[d]

$Q = f(TCF_t, TCO_t, Y, A)$			$Q = f(TRCF_t, TRCO_t, Y, A)$		
Winter	lnQ	= 2.1468 - 0.0094606 TCF_t	Winter	lnQ	= 2.0964 - 0.016311 $TRCF_t$
Spring	lnQ	= 1.2642 - 0.0054448 TCF_t	Spring	lnQ	= 1.0564 - 0.0082997 $TRCF_t$
Summer	lnQ	= 1.4123 - 0.0084378 TCF_t	Summer	lnQ	= 0.8644 - 0.0013933 $TRCF_t$
Fall	lnQ	= 0.6423 - 0.0020242 TCF_t	Fall	lnQ	= 0.8020 - 0.0070648 $TRCF_t$

TABLE 5.5 (Continued)

a Except for the price variables (TCF_t, $TRCF_t$), mean values of the other explanatory variables are multiplied by correponding coefficients and added to the intercept term of the demand function. Mean values of the variables are:

	Q	TCF_t ($TRCF_t$)	TCO_t ($TROC_t$)	SUB	Y	A	AGE	SEX
1989	13.262	81.716	19.193	83.889	39754	8.0654	46.542	0.7757
1990								
Winter	11.894	52.676 (23.686)	9.625 (7.000)	54.390	35014	7.8118		
Spring	3.767	150.43 (60.927)	21.717 (11.651)	40.660	39199	7.0000		
Summer	5.308	119.70 (49.786)	27.569 (10.151)	98.530	37526	7.8333		
Fall	4.623	100.74 (45.772)	34.751 (14.863)	69.028	42661	7.6494		
1991								
Winter	8.468	60.684 (32.108)	5.466 (3.089)		39548	8.4935		
Spring	5.589	81.888 (39.889)	17.944 (8.108)		42048	8.6575		
Summer	5.431	64.550 (30.271)	35.659 (18.015)		36676	8.5278		
Fall	2.276	95.127 (46.891)	20.648 (9.488)		41395	8.3947		

b Data for $TRCF_t$ and $TRCO_t$ were not available for 1989. Only annual data were available.

c Data for AGE and SEX were not available for 1990.

d Data for SUB, AGE and SEX were not available for 1991.

TABLE 5.6

ESTIMATED NUMBER OF TRIPS TO THE MOUNTAIN FORK RIVER TROUT FISHERY BY ORIGIN OF TRIP[a]

Year		Oklahoma			Texas	All Other States	Total
		McCurtain County	All Other Locations	Total Oklahoma			
1989		4,723	13,66	6,089	2,151	136	8,376
1990							
	Winter	1,978	586	2,565	630	35	3,230
	Spring	885	545	1,430	766	28	2,224
	Summer	577	476	1,053	719	23	1,794
	Fall	351	260	611	585	30	1,226
	Total	3,791	1,867	5,659	2,700	116	8,475
1991							
	Winter	1,261	364	1,625	673	29	2,327
	Spring	1,368	871	2,239	1,278	106	3,623
	Summer	850	1,032	1,882	1,551	25	3,458
	Fall	287	518	805	856	6	1,667
	Total	3,766	2,785	6,551	4,358	166	11,075

[a] An example of computations for estimated number of trips is given in Appendix B.

8.4 thousand trips in 1989 to about 11.1 thousand trips in 1991. Fall season has the least trips for 1990 and 1991. Number of trips by the origin of trip show that trips from McCurtain County is decreasing slightly. For other locations in Oklahoma, Texas, and all other states, however, number of trips is clearly increasing, especially from 1990 to 1991. This implies that the MFR trout fishery is becoming more widely known. Proportionately, more trips originate from residents of McCurtain County in the winter while during the other seasons more trips originate from residents in other locations in Oklahoma and from other states.

Net angler benefits of aggregate consumer surplus from trips to the MFR were estimated using the estimated demand curves. The benefit estimation procedure utilized the total direct cost plus travel time cost (TCFt). The alternative own price variable, TRCFt, was not used for benefit estimation. The substitute variable in the 1989 and 1990 demand functions had only negligible effects on benefit estimates. Therefore, because the substitute variable was excluded in the 1991 demand functions, the results should not significantly effect estimated benefits and thus the results for all years should be comparable.

As mentioned previously, the estimated consumer surplus varies depending on the assumed highest price. In the current study the highest observed price was not used for purposes of estimating consumers surplus. Instead, the consumers surplus was computed using the highest price for 90 percent of the trips ranked from lowest to highest price. This is consistent with providing a conservative measure of consumers surplus.

The estimated net angler benefits from trips to the MFR by season and by year are presented in Table 5.7. All the monetary values were inflated to

TABLE 5.7

ESTIMATED CONSUMER SURPLUS (NET ANGLER BENEFITS) OF THE MOUNTAIN FORK RIVER TROUT FISHERY BY ORIGIN OF TRIP ($1,000)[a]

Year		Oklahoma			Texas	All Other States	Total
		McCurtain County	All Other Locations	Total Oklahoma			
1989		513	234	747	231	31	1,009
1990							
	Winter	181	37	218	19	3	240
	Spring	96	88	184	122	19	325
	Summer	116	54	170	84	3	257
	Fall	58	18	76	58	9	143
	Total	451	197	648	283	34	965
1991							
	Winter	117	18	135	17	9	161
	Spring	213	101	315	119	16	449
	Summer	105	95	201	108	17	326
	Fall	30	46	76	109	4	189
	Total	466	261	726	353	46	1,126

[a] Values for 1989 and 1990 were inflated to 1991 dollars using the Consumer Price Index. An example of computations for estimated net angler benefits is given in Appendix C.

represent 1991 dollar value using the Consumer Price Index (CPI)[8]. Aggregate net angler benefits (consumer surplus for anglers) of the MFR trout fishery for the three year study period were estimated at $1,009,000 in 1989, $965,000 in 1990, and $1,126,000 in 1991. Seasonal variation shows higher net angler benefits for spring and summer compared to winter and fall. Geographically, aggregate net angler benefits are highest for McCurtain County anglers (about 46 percent of total benefits) for the three years. Roughly 68 percent of total benefits accrue to anglers of Oklahoma (including McCurtain County residents). Texas anglers account for about 28 percent of total benefits from the MFR trout fishery.

Estimated net angler benefits per trip to the MFR trout fishery are shown in Table 5.8. Average benefits per trip across seasons were generally over $100. Net angler benefits per trip were generally significantly lower in winter compared to all other seasons. Anglers from states other than Oklahoma and Texas gained the highest benefits per trip to the MFR trout fishery.

Estimated net angler benefits per trout harvest is higher during the spring and summer compared to fall and winter (Table 5.9). This is partially because trout fishing during the spring and summer is less successful than other seasons. The estimated net angler benefits per hour of fishing is presented in Table 5.10. Consumer surplus per hour of fishing ranged from $14.81 in 1989 to $12.20 in 1991, all values expressed in 1991 price level.

The estimated economic value of the MFR trout fishery is compared to other empirical studies of cold water fishing (Table 5.11). However, comparisons of the estimated value of recreation activity among empirical studies should be made with caution. The estimated benefits have been

---

8 Source of the CPI is Economic Report of the President, 1992.

TABLE 5.8

ESTIMATED CONSUMER SURPLUS (NET ANGLER BENEFITS) PER TRIP TO THE MOUNTAIN FORK RIVER TROUT FISHERY BY ORIGIN OF TRIP ($)[a]

Year		Oklahoma			Texas	All Other States	Total
		McCurtain County	All Other Locations	Total Oklahoma			
1989		109	171	123	107	228	120
1990							
	Winter	92	63	85	30	86	74
	Spring	108	161	129	159	679	146
	Summer	201	113	161	117	130	143
	Fall	165	69	124	99	300	117
	Average	119	106	115	105	293	114
1991							
	Winter	93	49	83	25	310	69
	Spring	156	116	141	93	151	124
	Summer	124	92	107	70	680	94
	Fall	105	89	94	127	667	113
	Average	124	94	111	81	277	102

[a] Values for 1989 and 1990 were inflated to 1991 dollars using the Consumer Price Index.

TABLE 5.9

CONSUMER SURPLUS PER TROUT HARVESTED
AT THE MOUNTAIN FORK RIVER
TROUT FISHERY

	Year	Dollars ($)[a]
	1989	25.25
1990		
	Winter	10.06
	Spring	23.89
	Summer	28.37
	Fall	18.55
	Overall	17.79
1991		
	Winter	15.51
	Spring	36.97
	Summer	36.10
	Fall	26.62
	Overall	29.10

[a] Values for 1989 and 1990 were inflated to 1991 dollars using the Consumer Price Index.

TABLE 5.10

CONSUMER SURPLUS PER HOUR OF FISHING
AT THE MOUNTAIN FORK RIVER
TROUT FISHERY

	Year	Dollars ($)[a]
	1989	14.81
1990		
	Winter	14.86
	Spring	15.05
	Summer	14.11
	Fall	11.26
	Overall	14.06
1991		
	Winter	11.93
	Spring	15.02
	Summer	10.13
	Fall	11.34
	Overall	12.20

[a] Values for 1989 and 1990 were inflated to 1991 dollars using the Consumer Price Index.

TABLE 5.11

COMPARISON OF ESTIMATED CONSUMER SURPLUS FROM VARIOUS COLD WATER FISHING STUDIES

Source (Author)	Year Studied	Location	Reported Value Per Fishing Day ($)	Adjusted Value Per Fishing Day ($)
Gum and Martin	1970	Arizona	10.15	40.98
Vaughan and Russell	1979	U.S.	19.49	36.58
USFWS	1980	Idaho	12.93	21.38
Weithman and Hass	1982	Missouri	15.67	29.41
Present Study	1991	Oklahoma	38.64	38.64

Source: Sorg and Loomis (1984).

standardized for methods of measurement and methodology following Sorg and Loomis (1984)[9]. The adjusted values reported in Table 5.11 are per fishing day basis. The estimated economic value of the MFR trout fishery is comparable to these other cold water fishery studies.

Benefit-Cost Analysis of the Mountain Fork River Trout Fishery

Public projects are generally evaluated using benefit-cost analysis[10]. Nonmarket estimates of benefits such as those derived from TCM are frequently used in the absence of market determined benefits (Propst and Gavrilis, 1987).

---

9 Refer to Chapter III for discussion of methods.
10 Benefit-cost analysis was discussed in Chapter III.

Costs of this fishing project were identified. The operating and maintenance cost most explicitly associated with the fishery was the cost of trout stocking (Table 5.12). On a biweekly basis 3,850 rainbow trout of a catchable size (8.5 inches) were stocked at different locations on the river (Harper, 1990). These costs are expressed in 1991 price level.

The cost of cold water release from the Broken Bow Lake for operation of the trout fishery was another identified cost. Water storage capacity is for purposes of hydroelectric power generation, flood control, municipal and industrial water supply, and recreation and wildlife use as reported in the U.S. Army Corps Master Plan for Broken Bow Lake (Uwakonye, 1990). There is currently abundant unallocated water in Broken Bow Lake. Hence, conflict in water usage is currently not an issue. For this study, the value of water used from Broken Bow Lake was assumed at a zero opportunity cost. When the situation changes and there exists conflicts in the amount of water use, the value of water used for the trout fishery should be included in total project costs.

Another opportunity cost identified was the value of fishing activities existing on the MFR prior to implementing of the trout fishery project. Tables 4.6 and 4.8 in Chapter IV imply that prior to implementation of the trout fishery there were 6.3 angler trips and after implementation 15.2 trips for the sample of anglers in 1989. Total estimated trips taken prior to January 1, 1989 was approximated at 3,483 which is 42 percent of the estimated total number of trips in 1989 (8,376). Unit day value of $19[11] recommended by the U.S. Forest Service (Walsh, 1986) was multiplied by 3,483 to estimate total benefits prior to

---

[11] Unit day value (1982 price level) per visitor day (12 hours) for wildlife and fish activity with standard quality provided in Southeastern region.

TABLE 5.12

COST OF STOCKING THE MOUNTAIN FORK RIVER TROUT FISHERY

Year	Current Cost[a] ($)	Constant Cost[b] ($)
1989[c]	66,415.50	72,950.79
1990		
Winter	17,267.25	17,994.20
Spring	17,267.25	17,994.20
Summer	17,267.25	17,994.20
Fall	17,267.25	17,994.20
Total	69,069.00	71,976.80
1991		
Winter	17,267.25	17,267.25
Spring	17,267.25	17,267.25
Summer	17,267.25	17,267.25
Fall	17,267.25	17,267.25
Total	69,069.00	69,069.00

[a] From Harper (1990).

[b] Values in 1991 price level.

[c] 11 months.

implementation of the fishery. It was assumed that all fishing trips were one day trips. This assumption is plausible because most trips were expected to be taken by local anglers prior to January 1, 1989. The opportunity costs, thus computed, are shown in Table 5.13.

TABLE 5.13

BENEFITS AND COSTS OF THE MOUNTAIN FORK RIVER TROUT FISHERY, 1989-1991

Year	Benefits[a] ($)	Costs: Operation[b] ($)	Costs: Opportunity Costs[c] ($)	Benefit-Cost Ratio: Excluding Opportunity Costs	Benefit-Cost Ratio: Including Opportunity Costs
1989[d]	1,009,000	72,951	85,036	13.8	6.4
1990					
Winter	240,000	17,994		13.3	
Spring	325,000	17,994		18.1	
Summer	257,000	17,994		14.3	
Fall	143,000	17,994		7.9	
Total	965,000	71,976	89,630	13.4	6.0
1991					
Winter	161,000	17,267		9.3	
Spring	449,000	17,265		26.0	
Summer	326,000	17,267		18.9	
Fall	189,000	17,267		10.9	
Total	1,126,000	69,068	93,402	16.3	6.9

a From Table 5.7.

b From Table 5.12.

c Opportunity costs represent value of fishing days prior to 1989 (see text). Costs are in 1991 price level. Seasonal information not available.

d 11 months.

Overall benefit-cost ratios were computed based on the estimated net angler benefits and costs of the MFR trout fishery (Table 5.13). The benefit-cost ratios excluding opportunity costs were about 14:1 for 1989, 13:1 for 1990, and 16:1 for 1991. When opportunity costs of foregone fishing activities were included, the benefit-cost ratios decreased to about 6:1 for 1989, and 1990, and 7:1 for 1991. However, all of the results are well above one implying that the angler benefits from the MFR trout fishery were far greater than the costs of the project from 1989 - 1991.

Seasonal analysis for 1990 and 1991 shows that the benefit-cost ratios excluding opportunity costs were significantly higher for spring and summer compared to fall and winter. The reason for this is the higher benefits for spring and summer even though costs are equal for all seasons. The stocking rate does not vary by season even though angler hours, angler trips, and type of angler (local, state, or out-of-state) vary significantly by season.

Public revenue from fishing licenses or trout stamps is generally excluded in benefit-cost analysis because the latter is concerned primarily with real resource benefits and costs, not transfer payments (Propst and Gavrilis, 1987). Revenue from fishing licenses and trout stamps is recorded in Table 5.14 for the three counties nearest to the MFR trout fishery. The number of trout stamps and revenue increased each year since initiation of the trout fishery. The revenue was equal to 55 percent of stocking costs in 1989, 68 percent in 1990, and 77 percent in 1991. Furthermore, because a fishing license is required before purchase of a trout stamp[12], a portion of the license revenue may be allocated to the trout fishery activity. From Tables 5.6 and 5.7 in Chapter IV the number of trout fishing trips to total fishing trips ranged from 36

---

12 A fishing license is required of all persons with exemptions as specified in the 1992 Oklahoma Fishing Regulations (Oklahoma Department of Wildlife Conservation, 1992).

TABLE 5.14

LICENSE SALES COMPARISONS 1989, 1990, AND 1991 IN McCURTAIN, PUSHMATAHA, AND LeFLORE COUNTIES, OKLAHOMA

LICENSE TYPE	1989		1990		1991	
	NUMBER SOLD[a]	$	NUMBER SOLD[a]	$	NUMBER SOLD[a]	$
Trout Stamp	5,432	36,666.00	6,925	46,743.75	7,914	53,419.50
Resident Annual Fishing	4,968	45,954.00	5,700	52,725.00	6,239	57,710.75
Non-Resident Annual Fishing	923	20,767.50	1,036	23,310.00	1,267	28,507.50
Non-Resident 10 Day Fishing	562	6,868.00	734	10,276.00	614	8,596.00
Non-Resident 3 Day Fishing	3,616	23,504.00	4,171	27,111.50	4,899	31,843.50
Totals	NA	134,760.00	NA	160,167.00	NA	180,077.25

Source: Harper, 1992.

[a] Only includes sales from dealers who sold trout stamps.

percent to 59 percent depending on year. Including these proportions of the fishing license revenue with the trout stamp total revenue would substantially exceed the trout stocking costs for each year of the fishery.

CHAPTER VI

SUMMARY AND CONCLUSIONS

Summary

The overall objective of this study was to analyze the economic value of a trout fishery established in the Mountain Fork River (MFR) below Broken Bow Dam. However, general approaches used for the economic analysis of market goods do not work for valuing nonmarket goods such as the MFR trout fishery. The obstacle is that the price-consumption relationship of the MFR trout fishery is not observed in the market place. Hence, a nonmarket valuation approach needed to be considered and applied in valuing the fishery.

Basic concepts in the measurement of welfare change were reviewed and procedures for their implementation were considered as presented in Principles and Guidelines (U.S. Water Resources Council, 1983). Nonmarket valuation approaches were reviewed and discussed as a theoretical basis for this study. Empirical issues related to nonmarket valuation methods were presented and discussed.

Procedures for the empirical estimation and analysis of demand and benefit for the MFR trout fishery were presented. Methods for obtaining information about the anglers of the MFR trout fishery were presented and the various survey instruments were discussed.

Analysis of sample survey data for the MFR trout fishery and participating anglers was presented for the three year period (1989 - 1991). Information about the fishery, angler trips, and angler characteristics gave important but broad information helpful for the empirical analysis of the fishery.

The travel cost method (TCM) was selected for estimating the demand and benefit. More specifically, the classical TCM was selected with specification of the dependent quantity variable as the number of individual angler trips.

Independent variables included in the empirical model were price of MFR trout fishery (total direct cost), price of other activities provided at the site of the MFR (portion of total direct cost), time cost of travel, a measure for substitute sites, household income, attractiveness or quality of the MFR trout fishery revealed by the anglers, and other socioeconomic variables. The own price and travel time variables were combined to overcome multicollinearity.

Using sample telephone survey data, the demand function for the MFR trout fishery was estimated with Estimated Generalized Least Squares (EGLS) estimator. The EGLS estimator was used because of heteroskedasticity detected in the error terms.

Seasonal variation in angler consumption behavior was tested for the 1990 and 1991 data. The coefficients of seasonal dummy variables were significantly different from zero at the 5 percent probability level. Therefore, seasonal demand equations were estimated and benefits were derived in each season for the MFR trout fishery. If summed up annually, they represent annual demands and benefits. This was not done for 1989 because only annual data were available.

Variables that best explained statistically the number of angler trips were the combined price and travel time variables for the MFR trout fishery and the other activities provided at the MFR. The coefficients of these variables had the expected signs and the t-statistics were all significant at the 5 percent probability level. The own price elasticities at the mean value for price generally ranged generally from -0.30 to -0.80 indicating inelastic demand for the MFR trout fishery.

The estimated number of trips to the MFR trout fishery increased each year, attaining 11,075 in 1991. Fall season attracted fewer angler trips than any other season for 1990 and 1991. Geographically, from 1989 to 1991 the proportionate number of trips decreased for McCurtain County residents and increased for residents from other locations in Oklahoma, Texas, and other states. This implies that the MFR trout fishery is becoming more widely known. Proportionately more trips originated from anglers of McCurtain County in the winter season while during the other seasons more trips originated from residents in other locations.

Aggregate net angler benefits of the MFR trout fishery for the three year study period in 1991 price level were estimated at $1,009,000 in 1989, $965,000 in 1990, and $1,126,000 in 1991. Seasonal variation showed higher net angler benefits for spring and summer compared to winter and fall. Roughly 46 percent of the overall aggregate net benefits for the three years accrued to McCurtain County anglers, 22 percent to anglers of Oklahoma excluding McCurtain County, and 28 percent to the anglers of Texas. Estimated net angler benefits per trip per person to the MFR trout fishery were about $111 for the three years in 1991 price level.

Economic evaluation of the MFR trout fishery was conducted employing benefit-cost analysis. Costs of the fishery project included operating costs and opportunity costs. Operating costs were limited to the cost of trout stocking. Opportunity costs were identified as costs of cold water release from Broken

Bow Lake and benefit loss from fishing activities existing before the MFR trout fishery project. Abundant unallocated water in the Broken Bow Lake allowed for the assumption of zero opportunity cost of cold water releases for the trout fishery. Information on the average number of trips taken before the trout fishing project in 1989 was used to estimate benefit loss. The benefit-cost ratios for the MFR trout fishery excluding opportunity costs were 14:1 for 1989, 13:1 for 1990, and 16:1 for 1991. The benefit-cost ratios including opportunity costs were 6.1 for 1989 and 1990 and 7.1 for 1991. Seasonal variation in benefit-cost ratios were shown for 1990 and 1991.

General conclusions are given in the following section as well as specific guidelines for management and policy decisions for the MFR trout fishery. Additional areas for research and limitations of the current research are also discussed.

Conclusions

General conclusions of the study are stated as the following:

(1) Travel cost and time cost of trip affect the number of trips taken by MFR anglers most significantly and consistently throughout the three year period of analysis (1989-1991). This conclusion is based on the analytical results of the classical travel cost model and empirical significance of the estimated demand equations.

(2) The MFR trout fishery has been widely accepted by residents in Oklahoma and frequent visitors from other states. Reasons to support this conclusion include the following:

(a) Annual number of trips has increased in each of the three years with an estimated 11,075 trips in the last year.

(b) Over 70 percent of the sampled anglers in each of the years gave a quality index of 7 or more out of a scale of 1 to 10. Over 65 percent of the anglers sampled in 1989 stated that the MFR trout fishery was adequate and should be maintained and an additional 32 percent stated that the fishery was adequate but needs to be improved.

(c) The estimated one-way travel distance for the sampled anglers has increased each year of the project implying a wider population base is becoming aware of the fishery. Similarly, the average length of trip has increased each year implying anglers are coming from greater distances and staying longer each trip.

(3) Seasonal variation in composition of angler trips to the MFR is significant. More trips are taken by local anglers (McCurtain County) in winter season compared to the other seasons. Consequently, the hours of fishing per trip and length of trip (days) are less during winter season compared to all other seasons. In general, expenditure per angler trip is less in winter compared to the other seasons. The purpose of the trip is more frequently exclusively for trout fishing in the winter season compared to all other seasons. Finally, the estimated net benefits per trout harvested are lower in winter compared to all other seasons.

(4) The MFR trout fishery generated roughly $1 million dollars of angler net benefits for each of the three years.

(5) The overall benefit-cost ratio excluding opportunity costs is over 13:1 for the MFR trout fishery and including opportunity costs it is over 6:1. This implies the benefits of the trout fishery far exceed its

costs. Furthermore, the revenue from trout stamps and fishing licenses associated with the trout fishery exceeds the cost of stocking the trout.

(6) Results of mapping summary sample data show that about 34 percent of angler trips originated in McCurtain County but only about 6 percent of angler expenditures were associated with these trips. On the contrary, 64 percent of the angler trips originated from other places and 94 percent of total expenditures were associated with these trips. This implies that a high proportion of total angler expenditures associated with the MFR trout fishery originate with anglers from outside of the county and thus have a potential impact on the local economy.

Management and Policy Decisions

Based on the above definitive conclusions and on other results stated in the body of the dissertation, the following are suggested guidelines for management and policy decisions concerning the MFR trout fishery.

(1) The benefit-cost analysis justifies strong consideration for continuing the MFR trout fishery. The public's acceptance and associated attributed value of the fishery is the basis for this proposed policy decision. If opportunity costs on water release should change, or if anglers change their apparent value of angler trips, there should be a reevaluation of the MFR trout fishery.

(2) Net angler benefits per trout harvested and variation in the seasonal benefit-cost ratios indicate a reallocation of stocking rates among seasons would increase net public benefits of the

trout fishery. In particular, it would enhance overall angler benefits if a higher proportion of trout were stocked during the spring and summer seasons compared to winter and fall.

(3) The trout fishery has been well received by the public as evidenced by results of a quality index ranking. However, size of trout is an important factor in the quality of the fishing trip as assessed by anglers. Therefore, increasing the size of trout stocked, or a portion of the stocking, has potential for inducing more angler trips.

(4) The primary beneficiaries of the MFR trout fishery are the anglers themselves. Therefore, the anglers should be assessed the major costs of operation and maintenance of the fishery. Increasing the cost of the trout stamp as costs of stocking increase is one way to assure that anglers are paying in accordance with benefits received.

(5) A clearer picture of the regional economic benefits of the trout fishery is needed. Expenditure data indicate that anglers from outside the county account for more total expenditures compared to anglers from within the county. County businesses and county population thus benefit from the trout fishery but contribute little to the operational costs of the fishery. A county sales tax on targeted expenditures of anglers would be one means of generating revenue to maintain the fishery and associated facilities such as access roads.

Additional Research

Regional economic impact of the MFR trout fishery needs further study. Several studies have utilized multiplier analysis to determine the impact expenditures made by recreationists from outside the region have on the local area economy (Propst and Gavrilis, 1987; Johnson and Obermiller, 1989; Cordell et al., 1990; Bergstrom et al., 1990; and Sah et al., 1992). The multiplier effect considers not only the direct but also the indirect and induced effects of recreational spending on the region's business output or sales, employment, income, tax revenue, and government spending. However, recreational expenditures should be assessed on the basis of how they impact welfare and welfare change. To do this, the expenditures should be traced through their effects on commodity and factor markets in the region.

Propst and Gavrilis (1987) have clearly distinguished the difference between the benefit-cost analysis and economic impact analysis of a public project. For a public fishery project, a benefit-cost ratio is the present value of net willingness to pay (WTP) or net benefits (consumer surplus) divided by the present value of the public costs of providing the project (operating and opportunity costs). On the other hand, economic impact analysis is typically concerned primarily with the effect of total expenditure (private and public) on the regional economy.

The economic impact effects of recreational spending on local regions is commonly estimated using an input-output model such as the IMPLAN model developed by the U.S. Forest Service (Cordell et al., 1990). With expenditure data of recreationists and the multipliers, economic impact effects of recreational expenditures are readily estimated. However, the multipliers developed from a model such as IMPLAN are averages and may vary greatly from region to region, from sector to sector, and from case to case (Propst and Gavrilis, 1987). Therefore, the limitations of multiplier analysis should be understood in its application to fishery project decision making.

For the present study the economic impact of the MFR trout fishery was not an objective to be completed. However, the expenditure data collected and presented in Chapter IV can be used for impact analysis and in tracing the expenditure effects on commodity and factor markets. However, additional data will be needed on such things as angler expenditures on fixed cost items, public agency revenues, and factor supply elasticities in regional markets.

Limitations

Although data results generally appear consistent for the three years, improvement in analytical methods and data collection are always needed. Specific limitations of this study include the following:

(1) Data sets between years could have been more consistent, particularly for estimating the demand and benefit models. Seasonal data were not available for 1989. Substitute site data were not available for 1991.

(2) Little variation was observed for some of the socioeconomic variables thus limiting the statistical significance of these variables in the estimated models. Larger size samples may be necessary to observe true significance in these variables.

(3) The current study accounts for only user benefits and excludes possible non-user benefits. This may lead to an underestimation of the total benefits of the MFR trout fishery.

(4) Opportunity cost of water used from the Broken Bow Lake for the trout fishery was assumed zero. This may not be true in the future as alternative demands for water increase or conflicts in timing of water used become important. Projection of alternative demands and conflicts in timing of water use were not critically analyzed.

(5) Current scale of the project would indicate that congestion at the MFR or capacity of the local economy to handle angler demands are not problems. However, capacity constraints were not tested in any fashion. There may be critical areas where congestion or capacity constraints limit the ability of the MFR trout fishery to handle increased demand. Such areas may include access roads, sanitary facilities, or hotel lodging.

BIBLIOGRAPHY

Adamowicz, Wiktor L. "Behavioral Implications of Nonmarket Valuation Models." Canadian Journal of Agricultural Economics 36(1988): 929-939.

Allen, P. Geoffrey, Thomas H. Stevens, and Scott A. Barrett. "The Effects of Variable Omission in the Travel Cost Technique." Land Economics 57(1981):173-180.

Bergstrom, John C., H. Ken Cordell, Alan E. Watson, and Gregory A. Ashley. "Economic Impacts of State Parks on State Economies in the South." Southern Journal of Agricultural Economics 22(1990):69-77.

Bowes, Michael D., and John B. Loomis. "A Note on the Use of Travel Cost Models with Unequal Zonal Populations." Land Economics 56(1980):465-470.

Brown, William G., Colin Sorhus, Bih-lian Chou-Yang, and Jack A. Richards. "Using Individual Observations to Estimate Recreation Demand Functions: A Caution." American Journal of Agricultural Economics 65(1983):154-157.

Brown, William G., and Farid Nawas. "Impact of Aggregation on the Estimation of Outdoor Recreation Demand Functions." American Journal of Agricultural Economics 55(1973):246-249.

Burt, Oscar R. and Durward Brewer. "Estimation of Net Social Benefits from Outdoor Recreation." Econometrica 39(1971):813-827.

Cannock, Geoffery M. "Analysis of Water-Based Recreation Markets for Two Competing Lakes in the McClellan-Kerr Arkansas River Navigation System under Alternative Government Policies." Unpublished Ph.D. Dissertation. Oklahoma State University, 1988.

Caulkins, Peter P., Richard C. Bishop, and Nicolaas W. Bouwes. "Omitted Cross-Price Variable Biases in the Linear Travel Cost Model: Correcting Common Misperceptions." Land Economics 61(1985):182-189.

Caulkins, Peter P., Richard C. Bishop, and Nicolaas W. Bouwes. "The Travel Cost Model for Lake Recreation: A Comparison of Two Methods for Incorporating Site Quality and Substitution Effects." American Journal of Agricultural Economics 68(1986):291-297.

Cesario, Frank J. "Value of Time in Recreation Benefit Studies." Land Economics 52(1976):32-41.

Cesario, Frank J. "Congestion and the Valuation of Recreation Benefits." Land Economics 56(1980):329-338.

Cesario, Frank J. and Jack L. Knetsch. "Time Bias in Recreation Benefit Estimates." Water Resources Research 6(1970):700-704.

Cesario, Frank J. and Jack L. Knetsch. "A Recreation Site Demand and Benefit Estimation Model." Regional Studies 10(1976):97-104.

Cicchetti, Charles J., Anthony C. Fisher, and V. Kerry Smith. "An Econometric Evaluation of a Generalized Consumer Surplus Measure: The Mineral King Controversy." Econometrica 44(1976):1259-1276.

Clawson, Marion. "Methods of Measuring the Demand for and Value of Outdoor Recreation." Washington D.C.: Resources for the Future, 1959.

Clawson, Marion and Jack L. Knetsch. "Outdoor Recreation Research: Some Concepts and Suggested Areas of Study." Natural Resources Journal 3(1963):250-275.

Clawson, Marion and Jack L. Knetsch. Economics of Outdoor Recreation. Baltimore: The Johns Hopkins Press, 1966.

Cordell, H. Ken, and John C. Bergstrom. "Theory and Techniques for Assessing the Demand and Supply of Outdoor Recreation in the United States." Research Paper SE-275 USDA Forest Service, September, 1989.

Cordell, H. Ken, John C. Bergstrom, Gregory A. Ashley, and John Karish. "Economic Effects of River Recreation on Local Economies." Water Resources Bulletin 26(1990):53-60.

Cummings, Ronald G., David S. Brookshire, and William D. Schulze. "Valuing Environmental Goods." An Assessment of the Contingent Valuation Method. Totowa, New Jersey: Rowman & Allanheld Publishers, 1986.

Desvousges, William H., V. Kerry Smith, and Matthew P. McGivney. "A Comparison of Alternative Approaches for Estimating Recreation and Related Benefits of Water Quality Improvements." Washington, D. C.: U.S. Environmental Protection Agency. EPA Contract No. 68-01-5838. 1983.

Duffield, John. "Travel Cost and Contingent Valuation: A Comparative Analysis." Advances in Applied Micro-Economics 3(1984):67-87.

Durden, Garey, and Jason F. Shogren. "Valuing Non-Market Recreation Goods: An Evaluative Survey of the Literature on the Travel Cost and Contingent Valuation Methods." The Review of Regional Studies 18 No. 3 (1988):1-15.

Dwyer, John F., John R. Kelly, and Michael D. Bowes. "Improved Procedures for Valuation of the Contribution of Recreation to National Economic Development." Water Resource Center Research Report No.128, University of Illinois, 1977.

Economic Report of the President, February 1992. Washington, D.C.: U.S. Government Printing Office, 1992.

Edwards, Steven F., and Glen D. Anderson. "Overlooked Biases in Contingent Valuation Surveys: Some Considerations." Land Economics 63(1987): 168-178.

Ewing, Gordon O. "Progress and Problems in the Development of Recreational Trip Generation and Trip Distribution Models." Leisure Sciences 3(1980):1-24.

Fletcher, Jerald J., Wiktor L. Adamowicz, and Theodore Graham-Tomasi. "The Travel Cost Model of Recreation Demand: Theoretical and Empirical Issues." Leisure Sciences 12(1990):119-147.

Forster, Bruce A. "Valuing Outdoor Recreational Activity: A Methodological Survey." Journal of Leisure Research 21(1989):181-201.

Freeman, A. Myrick, III. The Benefits of Environmental Improvement: Theory and Practice. Resources for the Future. John Hopkins University Press. 1979.

Freeman, A. Myrick, III. "Approaches to Measuring Public Goods Demands." American Journal of Agricultural Economics 61(1979):915-920.

Gum, Russell L.,and William E. Martin. "Problems and Solutions in Estimating the Demand for and Value of Rural Outdoor Recreation." American Journal of Agricultural Economics 57(1975):558-566.

Harper, Jack L. Fish Research and Surveys for Oklahoma Lakes and Reservoirs, Evaluation of Year-Round Put-and-Take Rainbow Trout Fishery in the Mountain Fork River. Annual Performance Reports, 1990, 1991, 1992. Oklahoma Department of Wildlife Conservation, Oklahoma City, Oklahoma.

Harrington, Winston. "Measuring Recreation Supply." Washington, D.C.: Resources for the Future. 1987.

Hicks, John R. "The Four Consumer's Surpluses." The Review of Economic Studies 11(1943):31-41.

Hof, John G., and David A. King. "On the Necessity of Simultaneous Recreation Demand Equation Estimation." Land Economics 58(1982):547-552.

Hof, John G., and Donald H. Rosenthal. "Valuing the Opportunity Cost of Travel Time in Recreation Demand Models: An Application to Aggregate Data." Journal of Leisure Research 19(1987):174-188.

Johnson, Aaron C. Jr., Marvin B. Johnson, and Rueben C. Buse Econometrics, Basic and Applied. New York, NY: Macmillan Publishing Company, 1987.

Johnson, Rebecca L., and Fred Obermiller. "The Economic Impact of Tourism Sales." Journal of Leisure Research 21(1989):140-154.

Johnson, Thomas G. "Measuring the Cost of Time in Recreation Demand Analysis: Comment." American Journal of Agricultural Economics 65(1983):169-171.

Kennedy, Peter. A Guide to Econometrics. Second Edition, Cambridge, Massachusetts: The MIT Press, 1985.

Kling, Catherine L. "A Note on the Welfare Effects of Omitting Substitute Prices and Qualities from Travel Cost Models." Land Economics 65(1989): 290-296.

Kling, Catherine L. "Some Results on the Variance of Welfare Estimates from Recreation Demand Models." Land Economics 68(1992):318-328.

Knetsch, Jack L., Richard E. Brown, and William J. Hansen. "Estimating Expected Use and Value of Recreation Sites." Planning for Tourism Development: Quantitative Approaches. New York, N.Y.: Edited by C. Gearing, Praeger Publisher, Inc. 1976.

Krutilla, John V. "The Use of Economics in Project Evaluation." Washington D.C.: Resources for the Future, 1975.

Mäller, Karl-Göran. "Environmental Economics: A Theoretical Inquiry." Johns Hopkins University Press. Resources for the Future Inc. 1974.

McConnell, Kenneth E. "Some Problems in Estimating the Demand for Outdoor Recreation." American Journal of Agricultural Economics 57(1975): 330-334.

McConnell, Kenneth E., and Ivar E. Strand. "Measuring the Cost of Time in Recreation Demand Analysis: An Application to Sportfishing." American Journal of Agricultural Economics 63(1981):153-156.

McConnell, Kenneth E., and Ivar E. Strand. "Measuring the Cost of Time in Recreation Demand Analysis: Reply." American Journal of Agricultural Economics (1983):172-174.

McConnell, Kenneth E., and Jon G. Sutinen. "An Analysis of Congested Recreation Facilities." Advances in Applied Micro-Economics 3(1984): 9-36.

McConnell, Kenneth E., and Virginia A. Duff. "Estimating Net Benefits of Recreation Under Conditions of Excess Demand." Journal of Environmental Economics and Management 2(1976):224-230.

Mendelsohn, Robert, and Gardner M. Brown. "Revealed Preference Approaches to Valuing Outdoor Recreation." Natural Resources Journal 23(1983):607-618.

Morey, Edward R. "The Demand for Site-Specific Recreational Activities: A Characteristics Approach." Journal of Environmental Economics and Management 8(1981):345-371.

Morrison, Steven A., and Clifford Winston. "An Econometric Analysis of the Demand for Intercity Passenger Transportation." Greenwich, Connecticut: Research in Transportation Economics: A Research Annual Vol. 2, JAI Press, 1985.

Nichols, Len M., Marianne Bowes, and John F. Dwyer. "Reflecting Travel Time in Travel Cost Based Estimates of Recreation Use and Value." Forestry Research Report No. 78-12. Agricultural Experiment Station, University of Illinois at Urbana-Champaign, December 1978.

Oklahoma Department of Wildlife Conservation. The 1992 Oklahoma Fishing Regulations. 1801 North Lincoln Oklahoma City, Oklahoma 73105-4998.

Oort, C. J. "The Evaluation of Traveling Time." Journal of Transport Economics and Policy 3(1969):279-286.

Peterson, George L., Dorothy H. Anderson, and David W. Lime. "Multiple-Use Site Demand Analysis: An Application to the Boundary Waters Canoe Area Wilderness." Journal of Leisure Research 14(1982):27-36.

Propst, Dennis B., and Dimitris G. Gavrilis. "Role of Economic Impact Assessment Procedures in Recreational Fisheries Management." Transactions of the American Fisheries Society 116(1987):450-460.

Randall, Alan. "Theoretical Bases for Non-Market Benefit Estimation." Valuation of Wildland Resource Benefits. George L. Peterson and Alan Randall, Eds. Westview Press, 1984.

Randall, Alan. "Total Economic Value as a Basis for Policy." Transactions of the American Fisheries Society 116(1987):325-335.

Reiling, Stephen D., Kevin J. Boyle, Marcia L. Phillips, and Mark W. Anderson. "Temporal Reliability of Contingent Values." Land Economics 66(1990):128-134.

Rosenthal, Donald H. "Representing Substitution Effects in Models of Recreation Demand." Unpublished Ph.D. Dissertation, Colorado State University, 1985.

Rosenthal, Donald H. "The Necessity for Substitute Prices in Recreation Demand Analyses." American Journal of Agricultural Economics 69(1987):828-837.

Rosenthal, Donald H., and Jana C. Anderson. "Travel Cost Models, Heteroskedasticity, and Sampling." Western Journal of Agricultural Economics 9(1984): 58-65.

Rowe, Robert D., and Lauraine G. Chestnut. "Valuing Environmental Commodities: Revisited." Land Economics 59(1983):404-410.

Sah, Jaysing, Dean F. Schreiner, and Mark Schorr. "Regional Economic Impact of Lake Texoma Striped Bass and Non-Striped Bass Fishing Activities." Research Report P-923. Oklahoma State University Agricultural Experiment Station. Stillwater, January 1992.

Sanders, Larry D. "Economic Benefits of River Protection: A Study of Recreation Use and Preservation Values." Unpublished Ph.D. Dissertation, Colorado State University, Fort Collins 1985.

Scheaffer, Richard L., William Mendenhall, and Lyman Ott. Elementary Survey Sampling. Third Edition, Boston: Duxbury Press, 1986.

Schreiner, Dean F., P. P.Chantaworn, and Daniel D. Badger. "Investment Planning for Multiple Purpose Uses of Water Resource Projects in Oklahoma." Bulletin B-74, Agricultural Experiment Station, Division of Agriculture, Oklahoma State University, 1987.

Schreiner, Dean F., Suhk-Hyun Kim, Daniel D. Badger, and Larry D. Sanders. "Survey Methodologies for Estimating Benefits from a Newly Developed Trout Fishery in Oklahoma." Paper presented at the Mid-Continent Regional Science Association. June 1989.

Schulze, William D., Ralph C. d'Arge, and David S. Brookshire. "Valuing Environmental Commodities: Some Recent Experiments." Land Economics 57(1981):151-172.

Seller, Christine, John R. Stoll, and Jean-Paul Chavas. "Validation of Empirical Measures of Welfare Change: A Comparison of Nonmarket Techniques." Land Economics 61(1985):156-175.

Sinden, J. A. "A Utility Approach to the Valuation of Recreational and Aesthetic Experiences." American Journal of Agricultural Economics 56(1974): 61-72.

Smith, V. Kerry, and Raymond J. Kopp. "The Spatial Limits of the Travel Cost Recreational Demand Model." Land Economics 56(1980):64-72.

Smith, V. Kerry, William H. Desvousges, and Ann Fisher. "A Comparison of Direct and Indirect Methods for Estimating Environmental Benefits." American Journal of Agricultural Economics 68(1986):280-290.

Smith, V. Kerry, William H. Desvousges, and Matthew P. McGivney. "The Opportunity Cost of Travel Time in Recreation Demand Models." Land Economics 59(1983):259-278.

Sorg, Cindy, and John B. Loomis. "Empirical Estimates of Amenity Forest Values: A Comparative Review." General Technical Report RM-107, 23P. Rockey Mountain Forest and Range Experiment Station, Fort Collins, Colo 1984.

Stoll, John R. "Recreational Activities and Nonmarket Valuation: The Conceptualization Issue." Southern Journal of Agricultural Economics 15(1983):119-125.

Strong, Elizabeth J. "A Note on the Functional Form of Travel Cost Models with Zones of Unequal Populations." Land Economics 59(1983):342-349.

Stynes, Daniel J., and George L. Peterson. "A Review of Logit Models with Implications for Modeling Recreation Choices." Journal of Leisure Research 16(1984):295-310.

Sutherland, Ronald J. "A Regional Approach to Estimating Recreation Benefits of Improved Water Quality." Journal of Environmental Economics and Management 9(1982a):229-247.

Sutherland, Ronald J. "The Sensitivity of Travel Cost Estimates of Recreation Demand to the Functional Form and Definition of Origin Zones." Western Journal of Agricultural Economics 7(1982b):87-98.

Sutherland, Ronald J. and Richard G. Walsh. "Effect of Distance on the Preservation Value of Water Quality." Land Economics 61(1985): 281-291.

U. S. Bureau of the Census. Statistical Abstract of the United States: 1991. Washington D. C., 1991.

U. S. Department of the Interior. The Third Nationwide Outdoor Recreation Plan. Executive Report. Washington D.C., December, 1979.

U. S. Water Resources Council. "Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies." Washington, D.C.: U. S. Government Printing Office, March 10 1983.

Uwakonye, Matthew Nga. "Social Accounting Matrix for Southeastern Oklahoma: A Case Study for Broken Bow Lake." Unpublished Ph.D. Dissertation, Oklahoma State University, Stillwater, 1990.

Vaughan, William J., and Clifford S. Russell. "Freshwater Recreational Fishing." The National Benefits of Water Pollution Control. Washington, D. C.: Resources for the Future, 1982.

Vincent, Mary K., David A. Moser, and William J. Hansen. "National Economic Development Procedures Manual - Recreation Volume 1 Recreation Use and Benefit Estimation Techniques." U.S. Army Corps of Engineers, IWR Report 86-R-4, Fort Belvoir, VA, March, 1986.

Walsh, Richard G. Recreation Economic Decisions: Comparing Benefits and Costs. State College, Pennsylvania: Venture Publishing Inc., 1986.

Walsh, Richard G., John B. Loomis, and Richard A. Gillman. "Valuing Option, Existence, and Bequest Demands for Wilderness." Land Economics 60 (1984):14-29.

Ward, Frank A. "Measuring the Cost of Time in Recreation Demand Analysis: Comment." American Journal of Agricultural Economics 65(1983): 167-168.

Ward, Frank A. "Specification Considerations for the Price Variable in Travel Cost Demand Models." Land Economics 60(1984):301-305.

Ward, Frank A., and John B. Loomis. "The Travel Cost Demand Model as an Environmental Policy Assessment Tool: A Review of Literature." Western Journal of Agricultural Economics 11(1986):164-178.

Weithman, A. Stephen, and Mark A. Hass. "Socioeconomic Value of the Trout Fishery in Lake Taneycomo, Missouri." Transactions of the American Fisheries Society 111(1982):223-230.

Weithman A. Stephen. "Telephone Survey Preferred in Collecting Angler Data Statewide." American Fisheries Society Symposium 12(1991):271-280.

Wetzel, James N. "Estimating the Benefits of Recreation under Conditions of Congestion." Journal of Environmental Economics and Management 4(1977):239-246.

White, Kenneth J., S. Donna Wong, Diana Whistler, and Shirley A. Haun. SHAZAM Econometrics Computer Program: User's Reference Manual. Version 6.2. New York: McGraw-Hill Book Caompany. 1990.

Wilder, Robert L. "Parks and Recreation - An Economic Justification." National Recreation and Park Association. Management Information Series 4000 1981.

Willig, Robert D. "Consumer's Surplus Without Apology." American Economic Review 66(1976):589-597.

Wilman, Elizabeth A. "The Value of Time in Recreation Benefit Studies." Journal of Environmental Economics and Management 7(1980):272-286.

Wilman, Elizabeth A. "A Simple Repackaging Model of Recreational Choices." American Journal of Agricultural Economics 69(1987):603-612.

Ziemer, Rod F., Wesley N. Musser, and R. Carter Hill. "Recreation Demand Equations: Functional Form and Consumer Surplus." American Journal of Agricultural Economics 62(1980):136-141.

APPENDICES

APPENDIX A

SURVEY INSTRUMENTS

PRESSURE COUNT SURVEY

LAKE	SEC.	MO.	DAY	YEAR	WEEKDAY WEEKEND	TIME OF COUNT
M T F O R K						
CC 1-6	CC8-9	CC11-12	CC13-14	CC15-16	CC18-19	CC 21-24

NO. OF BOAT ANGLERS	NO. OF BANK ANGLERS	NO OF TUBE ANGLERS
CC 32-36	CC 38-42	CC 44-48

REMARKS:

Source: Oklahoma Department of Wildlife and Conservation.

CREEL SURVEY

LAKE	SEC.	MO.	DAY	YEAR	WEEKDAY WEEKEND	TYPE OF FISHING
M T F O R K					D	
CC 1-6	CC8-9	CC11-12	CC13-14	CC15-16	CC18-19	CC 21-23

NO. IN PARTY RETURNED	TIME STARTED	TIME ENDED	FINISHED	SPECIES SOUGHT	NO. OF TROUT
CC 25-26	CC 28-31	CC 33-36	CC 38	CC 40-42	CC 44-45

ZIP-CODE	TRIP PURPOSE	FISHING QUAL.	RESIDENCE	FOLLOW-UP	TELEPHONE
CC 47-51			RES NON		

DISTRICT TRAVELED

1-WAY (MILES)

REMARKS:

Source: Oklahoma Department of Wildlife and Conservation.

POSTCARD SURVEY

Sec.
[|]

Dear Angler:

Please complete this brief questionnaire and drop it in a mailbox. No postage necessary.

1. About how many hours on this trip will you
   a. be away from home? ______ hrs.   b. spend trout fishing? ______ hrs.
   c. spend in travel (driving)? ______ hrs.
2. How many people in addition to yourself came in the same vehicle on this trip?
   ______ people
3. Please estimate how much this trip cost for <u>you</u> in total including transportation, food, accommodations, and other expenses. (For example, if you travelled with a party of 4 and total cost was $40, your cost was $10)
   $__________
4. What is your place of residence?
   ______________________________City______________State_________Zip
5. May we phone you if we need more information on your fishing experience?
   ______Yes ______No   (____) ____________ Telephone number

Thanks

Source: Schreiner et al. (1989).

1989 MOUNTAIN FORK RIVER TROUT FISHING TELEPHONE SURVEY

Department of Agricultural Economics
Oklahoma State University
Stillwater, OK 74078

Section 0 Identification

*(0.01) Fishing Quarter ______________ 19 ___ River Section __________

*(0.02) Postcard No. ________ Sample _________ Replacement _________

*(0.03) Place of Residence _____________ _____________ _______ _______
City County State Zip

*(0.04) Telephone No. (_____) _____ - ________

*(0.05) Interview Schedule:

First Call:

Date __________ Time _________ Interviewer________ Result _______________________

Second Call:

Date __________ Time _________ Interviewer________ Result _______________________

Third Call:

Date __________ Time _________ Interviewer________ Result _______________________

Fourth Call:

Date __________ Time _________ Interviewer________ Result _______________________

Fifth Call:

Date __________ Time _________ Interviewer________ Result _______________________

Section 1 Trip Information

*(1.01) Date of Trip: Month ______________ Day ______, Year 19 ____

(1.02) Weather ______ Sunshine ______ Cloudy ______ Windy ______ Rainy ______ Snowy

(1.03) Temperature ______ Cold (<45°) ______ Cool (45-64°) ______ Warm (65-84°) ______ Hot (85° +)

(1.04) Mode of Travel to Mountain Fork River

1. Car
2. Pick-up
3. Camper
4. Van
5. Motor Home
6. Motorcycle
7. Bicycle
8. Walking
9. Other ______________ Specify

(1.05) What is the one-way distance from your permanent residence to the Mountain Fork fishing area? _________miles

*(1.06) You stated on the postcard ______ hours away from home, ______ hours spent trout fishing, and ______ hours travel time. This leaves ______ hours unaccounted for (if zero, go to 2.01). Was this strictly a recreation trip or did it include business as well?

1. Recreation only (go to 1.08). 2. Recreation and business.

(1.07) What percent of this unaccounted time was for business and what percent was for other recreation activities?

1. _______ % business 2. _______ % other recreation. (If 100% business go to 2.01).

(1.08) Did you spend some time fishing at other locations in addition to Mountain Fork River? 1. Yes 2. No (go to 1.10).

(1.09) If yes, what locations and about how many hours per location?

	Location (Name)	Hours
#1	________________	_____
#2	________________	_____
#3	________________	_____

(1.10) What other recreation or leisure activities did you engage in besides fishing?

Activities: ______________ ______________ ______________

______________ ______________ ______________ ______________

Section 2 Fishing Information This Trip

*(2.01) You stated on the postcard ____ hours were spent trout fishing on this trip. If this was over more than one day, how many days did it include? _____ days.

(2.02) Did you spend time fishing for other species on the Mountain Fork?
_____ Yes _____ No (if no, go to 2.04).

(2.03) If yes, how many hours were spent fishing for other species? _______ hours.

*(2.04) You stated on the postcard _______ additional person(s) came with you in the same vehicle (If 0 go to 2.07). Did these people trout fish?
1. Yes 2. No (go to 2.06)

*(2.05) If yes, did this(ese) person(s) fish ______ more, ______ less, ______ about the same amount of time as you? If more (less) time, approximately what percent? ______ Percent (go to 2.07).

(2.06) If no, how many did trout fish? ________ No.

*(2.07) How many trout did (you) (your group travelling in the same vehicel) catch, release, and keep on this trip? 1. Catch ____ 2. Release ____ 3. Keep ____.

(2.08) On a scale of 1 to 10 (10 being the best) how would you rate the quality of this fishing trip? ______

(2.09) Did you increase or decrease the amount of time you originally planned to trout fish on this trip? ___ Increase ___ Decrease (go to 2.11) ___Neither (go to 2.12).

(2.10) If increase, what was the single most important contributing factor?
__________________________________ (go to 2.12).

(2.11) If decrease, what was the single most important contributing factor?

____

(2.12) If you had not made this trout fishing trip to Mountain Fork, in what other recreational or pleasurable activity would you probably have participated?
1. Fishing at other location
2. A home-based recreation activity (e.g. watching TV, gardening)
3. A community-based recreation activity (e.g. attending a movie, attending ballgame)
4. Other (Specify) ____

(2.13) How much more valuable (in terms of dollars) do you consider this trout fishing trip in comparison to the other recreation or pleasurable activity mentioned above? $________.

Section 3 Fishing Information about Mountain Fork

(3.01) How many fishing trips did you make to Mountain Fork River between January 1, 1989 and February 28, 1989? _________ No.

(3.02) Did you spend about the same amount of time trout fishing during each trip as you did during this trip? ____ Yes (go to 3.04) ____ No.

(3.03) If no, did you spend less or more time? _____ Less _____ More.
What percent less (or more) time? ________ percent.

(3.04) Approximately how many fishing trips do you expect to make to Mountain Fork between March 1, 1989 and May 31, 1989 (three month period)? ______ No.

(3.05) When did you first learn about trout fishing on the Mountain Fork River?
_____ Month _____ Year.

(3.06) How did you first learn about trout fishing on the Mountain Fork River?
1. Another person 2. Newspaper 3. Radio
4. Television 5. Brochure from Beaver's Bend State Park
6. Other (Specify)____

(3.07) Is Mountain Fork the first place you have trout fished?
_____ Yes (go to 3.13) _____ No.

(3.08) If no, what other locations within Oklahoma have you trout fished?
_____ Blue River _____ Watonga Lake _____ Lower Illinois
_____ Lake Altus _____ Other (specify) ___________________

(3.09) What percent of the total time you trout fish in Oklahoma is at Mountain Fork River? ______ Percent.

(3.10) In what states outside of Oklahoma have you trout fished? ______________
____

(3.11) Which locations (in Oklahoma and other states) would you classify as superior to Mountain Fork? ____

(3.12) Which locations would you classify as inferior to Mountain Fork?
____

(3.13) Did you fish on the Mountain Fork River before January 1, 1989?
_______ Yes _______ No (go to 4.01).

(3.14) If yes, approximately how many times per year did you fish the Mountain Fork River? ______ No.

Section 4 Information About Alternative Fishing Places

(4.01) Do you fish at locations other than Mountain Fork River?

_____ Yes _____ No. (If no, go to 4.06).

(4.02) Approximately how many days in a year do you fish excluding Mountain Fork?

_________ days

(4.03) At what locations other than Mountain Fork River do you fish?

Location (Name)	Distance From Home (Miles)	Percent of Fishing Days or	Number of Fishing Days (see 4.02)
#1			
#2			
#3			
#4			
#5			
		100	

(4.04) Do you expect the number of days you fish per year at other locations to decrease or remain the same now that there is trout fishing on the Mountain Fork River? 1. Decrease 2. Remain the same (go to 4.06)

(4.05) If decrease, which of the locations do you expect to decrease and by what amount?

Location (Name)	Percent Decrease or	Number of Days Decrease
#1		
#2		
#3		
#4		
#5		

(4.06) On a scale of 1 to 10 (10 being the highest) how would you rate the quality of the fishing locations?

Location (Name)	Quality of Location (1 - 10)
#1 ____________	______
#2 ____________	______
#3 ____________	______
#4 ____________	______
#5 ____________	______
Mountain Fork River	______

(4.07) How many days do you expect to fish on the Mountain Fork River per year?

______ No.

(4.08) What are the game fish of Oklahoma that you have eaten? How would you rank the eating quality of these game fish, starting with 1 as the best quality and highest rank?

	Game Fish	Rank (1 highest)
1.	____________	______
2.	____________	______
3.	____________	______
4.	____________	______
5.	____________	______
6.	____________	______
7.	____________	______
8.	____________	______
9.	____________	______
10.	____________	______

Section 5 Socioeconomic Data

(5.01) Sex of respondent: ____ Male ____ Female

(5.02) Age of respondent: ____

*(5.03) You stated on your postcard that _______ (if 0 go to 5.04) additional persons travelled together in one vehicle to the Mountain Fork River. What are the approximate ages of these persons? _____ _____ _____ _____ _____ _____ _____

(5.04) Principal occupation of respondent:

1. Professional
2. Manager or administrator
3. Sales or clerical
4. Craftsman
5. Laborer or Operative
6. Service worker
7. Farmer or farm worker
8. Retired
9. Not employed
10. Other (Specify) ____

(5.05) Do you have a secondary occupation or part time job (e. g. you may be retired but you work part time)? _____ Yes _____ No. (If no, go to 6.01).

(5.06) If yes, what is the occupational category of this secondary occupation?

1. Professional
2. Manager or administrator
3. Sales or clerical
4. Craftsman
5. Laborer or Operative
6. Service worker
7. Farmer or farm worker
8. Other (Specify) ______________________

Section 6 Expenditures

*(6.01) You estimated your proportion of total expenditures for this trip was $_______.

How would you distribute this amount in dollars or percentages among the following categories:

	$	or	Percent
1. Lodging (e. g. motel, cabins, camping fees)	______		______
2. Food and beverages (e. g. restaurants, groceries)	______		______
3. Transportation (e. g. gas, oil, car rental)	______		______
4. Purchased items (e. g. bait, tackle, insect repellent, souvenirs)	______		______
5. Purchased services (e. g. canoe rental, putt-putt)	______		______
6. Other (Specify) __________________________	______		______
*Total			100

*(6.02) How would you distribute these expenditures as purchases made in the following areas:

	$	or	Percent
1. In Beavers Bend State Park	______		______
2. Outside Beavers Bend State Park but at local areas within a radius of 25 miles of Mountain Fork River	______		______
3. Outside of the local areas (outside radius of 25 miles) but within the state of Oklahoma	______		______
4. Outside the state of Oklahoma	______		______
*Total			100

*(6.03) You stated on the postcard your proportion of total expenditures for this trip was $ ______. What would have been your estimated expenditures if you had not made this trip to Mountain Fork River but instead had participated in the other recreation or pleasurable activity identified earlier (2.12)?

$ __________.

Section 7 Preferences and Facility Developments

(7.01) How do you perceive the overall Mountain Fork River trout fishing activity?

1. Adequate and should be maintained as is.
2. Adequate but needs to be improved.
3. Inadequate and should be discontinued.
4. Inadequate but with significant changes could be continued.

(7.02) How would you classify the following as being a problem or not a problem to you:

	Problem	No Problem
1. Catch rate	______	______
2. Size of trout caught	______	______
3. Catch limit	______	______
4. Size of stream	______	______
5. Water swiftness during electricity generation	______	______
6. Number of anglers	______	______
7. Walking access trails to river	______	______
8. Road access to river	______	______
9. Parking facilities	______	______
10. Sanitary facilities	______	______
11. Other (Specify) ______	______	______
12. ______	______	______

Section 8 Family Income Data

(8.01) How many persons in addition to yourself are in your household? ______ No.

(8.02) How many of these persons are wage earners? _______ No.

(8.03) What is your total household income per year (household income includes income from all sources and all wage earners for the most current year)?

01. Under $5,000	08. $35,000 - $39,999
02. $5,000 - $9,999	09. $40,000 - $44,999
03. $10,000 - $14,999	10. $45,000 - $49,999
04. $15,000 - $19,999	11. $50,000 - $54,999
05. $20,000 - $24,999	12. $55,000 - $59,999
06. $25,000 - $29,999	13. $60,000 and over
07. $30,000 - $34,999	14. Not sure/refuse

(8.04) This is the end of the survey. We appreciate the time you have spent with us on the survey. If we have additional questions may we call you again in the future? 1. Yes 2. No

Good fishing at Mountain Fork in the future!

CONFIDENTIAL

1990 MOUNTAIN FORK RIVER TROUT FISHING TELEPHONE SURVEY

Department of Agricultural Economics
Oklahoma State University
Stillwater, OK 74078

Section 0 Identification

*(0.01) Fishing Quarter ______ 19_90_ River Section __________

*(0.02) No. __________ Sample ____________ Replacement __________

*(0.03) Place of Residence __________ City __________ County ________ State ________ Zip

Miles from MFR __________

*(0.04 Telephone No. (____) ______ - ________

*(0.05) Interview Schedule:

First Call:

Date __________ Time __________ Interviewer__________ Result __________

Second Call:

Date __________ Time __________ Interviewer__________ Result __________

Third Call:

Date __________ Time __________ Interviewer__________ Result __________

Fourth Call:

Date __________ Time __________ Interviewer__________ Result __________

Fifth Call:

Date __________ Time __________ Interviewer__________ Result __________

CONFIDENTIAL

Section 1 Trip Information

*(1.01) Date of Trip: Month ____ Day ____, Year 19 _90_, WE ____, WD ____

(1.02) Mode of Travel to Mountain Fork River

1. Car
2. Pick-up
3. Camper
4. Van
5. Motor Home
6. Motorcycle
7. Bicycle
8. Walking
9. Other ____________ Specify

(1.03) Was the purpose of this trip specifically for trout fishing?
______ Yes (go to 1.05) ______ No

(1.04) What percent of this trip would you associate with the trout fishing activity?
______%.

(1.05) On the day you answered the creel survey (______ Day ______ Month) you started fishing at _______ (a.m.) (p.m.). How long a period did you actually fish?
____ hr. _____ minutes.

(1.06) Was this a one day fishing trip? ______ Yes (go to 1.07) ______ No.
If more than one day, what was the total number of days? _______ Number.
How many days on this trip did you trout fish? _______ Number.
Did you fish the same amount of time each day as reported in (1.05)?
_______ Yes (go to 1.07) ______ No.
What was the total amount of time you actually spent trout fishing this trip?
______ hr. ______ minutes.

(1.07) On a scale of 1 to 10 (10 being the best) how would you rate the quality of <u>this</u> fishing trip? ____________

(1.08) If you had not made this trout fishing trip to Mountain Fork, in what other recreational or pleasurable activity would you probably have participated?

____

Possible answers:

a. Fishing at other location
b. A home-based recreation activity (e.g., watching TV, gardening)
c. A community-based recreation activity (e.g., attending a movie, attending a ballgame)
d. Other (specify) ______________________________

CONFIDENTIAL

Section 2 Fishing Information about Mountain Fork and Alternative Sites

(2.01) How many trout fishing trips did you take to the Mountain Fork River during the period December 1, 1989 to February 28, 1990? ______ trips.

March 1, 1990 to May 31, 1990 ______ trips.

June 1, 1990 to August 31, 1990 ______ trips.

Sept. 1, 1990 to Nov. 30, 1990 ______ trips.

(2.02) Did you fish at locations other than Mountain Fork River during the season (Sept.-Nov.)?

_______ Yes ______ No. (If no, go to 3.01)

(2.03) Approximately how many fishing trips to other locations excluding Mountain Fork and farm ponds did you make during the season (Sept.-Nov.)?

________ trips.

(2.04) What were these locations?

Location (Name	Distance From Home (Miles)	Percent of Fishing Trips	or	Number of Fishing Trips (see 2.03)
#1 ______	______	______		______
#2 ______	______	______		______
#3 ______	______	______		______
#4 ______	______	______		______
#5 ______	______	______		______
		100		______

(2.05) On a scale of 1 to 10 (10 being the highest) how would you rate the quality of these locations with that of the Mountain Fork River during this season?

Location (Name)	Quality of Location (1 - 10)
Mountain Fork River	______ (see 1.07)
#1 ______	______
#2 ______	______
#3 ______	______
#4 ______	______
#5 ______	______

Section 3 Expenditures

(3.01) The number of anglers in your party was reported in the creel survey as ______. What was the estimated cost of this trip for you including transportation, food, accommodations, and other expenses? (For example, if you travelled with a party of 3 and total cost was $45, your cost was $15) $ ________.

(3.02) (Look at question 1.03. If marked yes, go to 3.03). You indicated earlier that only _______ % (see 1.04) of this trip was associated with trout fishing. What percent of your expenditures was associated with trout fishing? _____ %.

(3.03) How would you distribute this amount in dollars or percentages among the following categories:

		$	or	Percent
1.	Lodging (e.g. motel, cabins, camping fees)	________		________
2.	Food and beverages (e. g. restaurants, groceries)	________		________
3.	Transportation (e.g. gas, oil, car rental)	________		________
4.	Purchased items (e. g. bait, tackle, insect repellent, souvenirs)	________		________
5.	Purchased services (e. g. canoe rental, putt-putt)	________		________
6.	Other (Specify) __________________	________		________
	Total	________ (see 3.01)		100

(3.04) How would you distribute these expenditures as purchases made in the following areas:

	$	Percent
1. Local areas within a 25 mile radius of Mountain Fork River	______	______
2. Outside of the local area (outside radius of 25 miles but within Oklahoma)	______	______
3. Outside the state of Oklahoma	______	______
Total	______ (see 3.01)	100

(3.05) Your expenditure for this trip was (see 3.01) $ ________. What would have been your estimated expenditure if you had not made this trip to Mountain Fork River but instead had participated in the other recreation or pleasurable activity identified earlier (1.08)? $ ___________.

(3.06) In a previous question you identified other locations where you fished during the season (Sept.-Nov.) (see 2.04). What were your typical (personal) expenditures per trip at these locations?

	Location (Name)	Average Expenditure per trip ($)
#1	______________________	____________
#2	______________________	____________
#3	______________________	____________
#4	______________________	____________
#5	______________________	____________

Section 4 Family Income Data

(4.01) What is your total household income per year (household income includes income from all sources and all wage earners for the most current year)?

$ ________

01.	Under $5,000	08.	$35,000 - $39,999
02.	$5,000 - $9,999	09.	$40,000 - $44,999
03.	$10,000 - $14,999	10.	$45,000 - $49,999
04.	$15,000 - $19,999	11.	$50,000 - $54,999
05.	$20,000 - $24,999	12.	$55,000 - $59,999
06.	$25,000 - $29,999	13.	$60,000 and over
07.	$30,000 - $34,999	14.	Not sure/refuse

(4.02) Are you retired or were you unemployed during this period? ___Yes ____No.

(4.03) This is the end of the survey. We appreciate the time you have spent with us on the survey. If we have additional questions may we call you again in the future? 1. Yes 2. No

Good fishing at Mountain Fork in the future!

CONFIDENTIAL

1991 MOUNTAIN FORK RIVER TROUT FISHING TELEPHONE SURVEY

Department of Agricultural Economics
Oklahoma State University
Stillwater, OK 74078

Section 0 Identification

*(0.01) Fishing Quarter _______ 19____ River Section ___________

*(0.02) Creel No. __________ Sample __________ Replacement ___________

*(0.03) Place of Residence ____________ ____________ __________ __________
City County State Zip

*(0.04) Miles from MFR ___________

*(0.05) Telephone No. (____) _______ - _________

*(0.06) Interview Schedule:

First Call:

Date __________ Time __________ Interviewer__________ Result ____________

Second Call:

Date __________ Time __________ Interviewer__________ Result ____________

Third Call:

Date __________ Time __________ Interviewer__________ Result ____________

Fourth Call:

Date __________ Time __________ Interviewer__________ Result ____________

Fifth Call:

Date __________ Time __________ Interviewer__________ Result ____________

Section 1 Trip Information

*(1.01) Date of Trip: Month ____ Day ____, Year 19 ____, WE ____, WD ____

(1.02) Mode of Travel to Mountain Fork River

1. Car
2. Pick-up
3. Camper
4. Van
5. Motor Home
6. Motorcycle
7. Bicycle
8. Walking
9. Other ____________ Specify

(1.03) Approximately what is the one-way driving time to the Mountain Fork River from your place of residence? ______ hrs. ______ minutes

(1.04) Was the purpose of this trip specifically for trout fishing? ______ Yes (go to 1.07) ______ No

(1.05) What were the other purposes of this trip? ____________________________

____

(1.06) What percent of this trip would you associate with the trout fishing activity? ______%. (Not limited to time.)

(1.07) On the day you answered the creel survey (______ ______) approximately
day month
how long did you fish that day? _______ hrs. _______ min.

(1.08) Was this a one day or part of one day trip? ____ yes (go to 1.11)
(Did not spend the night) ____ no (go to 1.09).

CONFIDENTIAL

(1.09) How many days was this trip? __________ days

(1.10) On the average, how many hours and minutes did you spend trout fishing each day? __________ hrs. __________ minutes.
(Example: On a two day trip, the first day you fished 5 hours and the second day you did not fish. Average fishing time per day is 2 hours and 30 minutes.)

(1.11) How would you evaluate the quality of <u>this</u> fishing trip to the Mountain Fork River?

1. Definitely Poor 2. Poor 3. Average 4. Good 5. Definitely Good

(1.12) What major positive factor and major negative factor did you consider in making your quality evaluation?

Positive factor - ______________________________

Negative factor - ______________________________

(1.13) If you had not made this trout fishing trip to the Mountain Fork River, what would you have done with this time?

a. Fished at an alternative location. (Specify location) ______________________

b. Engaged in other activities. (Specify) ______________________

Section 2 Fishing Information about Mountain Fork and Alternative Sites

(2.01) Approximately (or exactly) how many trout fishing trips did you make to the Mountain Fork River in Calendar year 1990 (last year)?

_________ trips.

(2.02) Approximately (or exactly) how many other fishing trips (excluding Mountain Fork and farm pond trips) did you make in Calendar year 1990 (last year)?

_________ trips.

(2.03) Approximately (or exactly) how many trout fishing trips did you make to the Mountain Fork River during the period September 1, 1991 through November 31, 1991?

_________ trips.

(2.04) Approximately (or exactly) how many other fishing trips (excluding Mountain Fork and farm pond trips) did you make during the period September 1, 1991 through November 31, 1991?

_________ trips.

Section 3 Expenditures

(3.01) The number of anglers in your party was reported in the creel survey as ______. What was the estimated cost of this trip for <u>you</u> including transportation, food, accommodations, and other expenses? $ ________.
(For example, if you travelled with a party of 3 and total cost was $45, your cost was $15)

(3.02) (Look at question 1.04. If marked yes, go to 3.03). You indicated earlier that only _______ % (see 1.06) of this trip was associated with trout fishing. What percent of your <u>expenditures</u> would you associate with the other purpose of your trip? _____ %.

(3.03) How would you distribute this amount in dollars <u>or</u> percentages among the following categories:

		$	or	Percent
1.	Lodging (e.g. motel, cabins, camping fees)	________		________
2.	Food and beverages (e.g. restaurants, groceries)	________		________
3.	Transportation (e.g. gas, oil, car rental)	________		________
4.	Purchased items (e.g. bait, tackle, insect repellent, souvenirs)	________		________
5.	Purchased services (e.g. canoe rental, putt-putt)	________		________
6.	Other (Specify) __________________	________		________
	Total	________ (see 3.01)		100

(3.04) How would you distribute these expenditures as purchases made in the following areas:

		$	or	Percent
1.	Local areas within a 25 mile radius of Mountain Fork River	________		________
2.	Outside of the local area (outside radius of 25 miles but within Oklahoma)	________		________
3.	Outside the state of Oklahoma	________		________
	Total	________ (see 3.01)		100

Section 4 Family Income Data

(4.01) What is your total household income per year (household income includes income from all sources and all wage earners for the most current year)?

$ ________

01.	Under $5,000	08.	$35,000 - $39,999
02.	$5,000 - $9,999	09.	$40,000 - $44,999
03.	$10,000 - $14,999	10.	$45,000 - $49,999
04.	$15,000 - $19,999	11.	$50,000 - $54,999
05.	$20,000 - $24,999	12.	$55,000 - $59,999
06.	$25,000 - $29,999	13.	$60,000 and over
07.	$30,000 - $34,999	14.	Not sure/refuse

(4.02) Were you retired during this period? ___Yes ____No.

(4.03) This is the end of the survey. We appreciate the time you have spent with us on the survey. If we have additional questions may we call you again in the future? 1. Yes 2. No

Good fishing at Mountain Fork in the future!

APPENDIX B

ESTIMATION OF AVERAGE HOURS OF FISHING AND TOTAL NUMBER OF TRIPS WINTER, 1990

STATE	100ZIP	AVGQ	AVGTCFt	AVGHRF	FREQ	WGT1	WGT2
LA	717	1	45.673	3	1	0.0027	0.0081
AR	718	1	100	8	3	0.0081	0.065
OK	730	2.3333	74.751	4.167	9	0.0244	0.1016
OK	731	1	115.46	7.333	6	0.0163	0.1192
OK	741	3.5	18.57	4.25	5	0.0136	0.0576
OK	744	1	167.48	8	1	0.0027	0.0217
OK	745	2	22.564	3.75	14	0.0379	0.1423
OK	BROKEN BOW	19	15.267	2.966	173	0.4688	1.3906
OK	IDABEL	13.857	33.183	4.643	24	0.065	0.302
OK	OTHER Mc.	16.222	18.865	2.806	29	0.0786	0.2205
OK	747	11.25	45.041	3.25	14	0.0379	0.1233
OK	748	2	60.828	7	9	0.0244	0.1707
OK	749	1	66.026	6	9	0.0244	0.1463
TX	750	2	113.62	13	22	0.0596	0.7751
TX	752	1.5	145.12	10	10	0.0271	0.271
TX	754	7.2	183.48	15.2	14	0.0379	0.5767
TX	755	11	16.993	4.5	10	0.0271	0.122
TX	756	8	94.318	7.625	7	0.019	0.1446
TX	757	1	36.655	7	3	0.0081	0.0569
TX	760	1	179.32	12	5	0.0136	0.1626
TX	782	2	150	11.5	1	0.0027	0.0312
					369	1	5.0091

The Total Creel Survey: 385

AVGHRF: Group(by 100 unit ZIP) Average Hours of Fishing Per Trip

FREQ: Number of Observations in the Telephone Survey

WGT1: FREQ / 369

WGT2: AVGHRF * WGT1

Total Pressure Hour: 16181 hrs

Average Hour of Fishing: 5.009 hr / trip / angler

Total Number of Trips: 16181 / 5.01 = 3230

Source: Schreiner et al. (1989).

APPENDIX C

ESTIMATION OF CONSUMER SURPLUS
(ANGLER BENEFITS)
WINTER, 1990

TCFt	OBS	EST.TR	TOT.TR	WGT1	WGT2	NO.AGR	CS/AGRS	TOT.CS
349	1	0.378	0.378	0.0007	2.3044	6.089		
300	1	0.59	0.59	0.0011	3.591	6.089		
220	1	1.218	1.218	0.0023	7.4144	6.089		
205.1	1	1.394	1.394	0.0026	8.4886	6.089		
179.3	1	1.761	1.761	0.0033	10.72	6.089		
167.5	1	1.96	1.96	0.0037	11.934	6.089		
150	1	2.296	2.296	0.0043	13.982	6.089	2.286	13.919
145.3	1	2.397	2.397	0.0045	14.593	6.089	13.361	81.352
141.4	1	2.482	2.482	0.0047	15.111	6.089	22.742	138.47
123.3	1	2.925	2.925	0.0055	17.808	6.089	71.625	436.11
118.2	1	3.064	3.064	0.0058	18.656	6.089	86.977	529.59
115.8	1	3.131	3.131	0.0059	19.064	6.089	94.378	574.65
104.9	1	3.456	3.456	0.0065	21.043	6.089	130.24	793
103.7	1	3.494	3.494	0.0066	21.277	6.089	134.49	818.9
100	1	3.613	3.613	0.0068	21.997	6.089	147.54	898.33
84.97	1	4.14	4.14	0.0078	25.208	6.089	205.73	1252.6
81.96	1	4.254	4.254	0.008	25.905	6.089	218.35	1329.5
80	1	4.331	4.331	0.0082	26.368	6.089	226.75	1380.7
77.66	1	4.424	4.424	0.0083	26.934	6.089	237.01	1443.1
72.63	1	4.63	4.63	0.0087	28.189	6.089	259.74	1581.5
71.62	1	4.672	4.672	0.0088	28.449	6.089	264.46	1610.2
67.48	1	4.851	4.851	0.0091	29.536	6.089	284.16	1730.2
67.25	1	4.861	4.861	0.0092	29.597	6.089	285.26	1736.9
66.03	1	4.915	4.915	0.0093	29.928	6.089	291.27	1773.5
62.73	1	5.064	5.064	0.0095	30.836	6.089	307.73	1873.7
62.44	1	5.078	5.078	0.0096	30.918	6.089	309.2	1882.7
60.83	1	5.152	5.152	0.0097	31.372	6.089	317.43	1932.8
59.14	1	5.232	5.232	0.0099	31.856	6.089	326.21	1986.2
52.12	1	5.575	5.575	0.0105	33.947	6.089	364.11	2217
45.67	1	5.911	5.911	0.0111	35.99	6.089	401.13	2442.4
45.52	1	5.919	5.919	0.0112	36.041	6.089	402.05	2448
45	1	5.947	5.947	0.0112	36.21	6.089	405.12	2466.7
40.17	1	6.213	6.213	0.0117	37.829	6.089	434.45	2645.3
40	1	6.223	6.223	0.0117	37.889	6.089	435.54	2651.9

38.5	1	6.308	6.308	0.0119	38.409	6.089	444.96	2709.3
36.66	1	6.414	6.414	0.0121	39.055	6.089	456.67	2780.6
35.54	1	6.48	6.48	0.0122	39.453	6.089	463.89	2824.5
33.64	1	6.592	6.592	0.0124	40.136	6.089	476.26	2899.9
30.24	1	6.798	6.798	0.0128	41.391	6.089	499.01	3038.4
25.13	1	7.121	7.121	0.0134	43.355	6.089	534.61	3255.1
25	1	7.129	7.129	0.0134	43.406	6.089	535.52	3260.7
23.99	1	7.195	7.195	0.0136	43.807	6.089	542.78	3304.9
22.03	1	7.324	7.324	0.0138	44.592	6.089	557.01	3391.5
21.99	1	7.326	7.326	0.0138	44.605	6.089	557.25	3393
21.52	1	7.358	7.358	0.0139	44.799	6.089	560.76	3414.4
20.82	1	7.404	7.404	0.014	45.083	6.089	565.92	3445.8
20	3	7.459	22.38	0.0422	136.25	18.27	571.98	10448
19.73	1	7.477	7.477	0.0141	45.527	6.089	573.96	3494.8
19.37	1	7.502	7.502	0.0141	45.678	6.089	576.69	3511.4
18.79	1	7.542	7.542	0.0142	45.92	6.089	581.08	3538.1
17.45	1	7.634	7.634	0.0144	46.481	6.089	591.25	3600
17.1	1	7.658	7.658	0.0144	46.628	6.089	593.92	3616.3
15.83	1	7.747	7.747	0.0146	47.168	6.089	603.7	3675.8
15.11	1	7.797	7.797	0.0147	47.474	6.089	609.25	3709.6
15	1	7.805	7.805	0.0147	47.523	6.089	610.14	3715
14.2	1	7.862	7.862	0.0148	47.871	6.089	616.44	3753.4
12.8	2	7.962	15.92	0.03	96.963	12.18	627.5	7641.5
12.44	1	7.988	7.988	0.0151	48.64	6.089	630.39	3838.3
12.37	1	7.993	7.993	0.0151	48.669	6.089	630.91	3841.5
12.31	1	7.998	7.998	0.0151	48.697	6.089	631.41	3844.5
10.87	1	8.102	8.102	0.0153	49.334	6.089	642.95	3914.8
10	5	8.167	40.83	0.077	248.63	30.44	650.06	19791
9.846	1	8.178	8.178	0.0154	49.795	6.089	651.32	3965.8
9.329	1	8.217	8.217	0.0155	50.03	6.089	655.56	3991.6
8.914	1	8.248	8.248	0.0155	50.218	6.089	658.98	4012.4
8.106	1	8.308	8.308	0.0157	50.587	6.089	665.66	4053.1
8	1	8.316	8.316	0.0157	50.636	6.089	666.54	4058.5
7.564	1	8.349	8.349	0.0157	50.836	6.089	670.18	4080.6
7.282	1	8.37	8.37	0.0158	50.966	6.089	672.53	4094.9
6.399	1	8.438	8.438	0.0159	51.376	6.089	679.96	4140.1
5.573	1	8.501	8.501	0.016	51.761	6.089	686.95	4182.7
5	4	8.545	34.18	0.0644	208.12	24.36	691.83	16850
3.699	1	8.647	8.647	0.0163	52.648	6.089	703.02	4280.5
3	1	8.702	8.702	0.0164	52.983	6.089	709.08	4317.5
1.916	1	8.788	8.788	0.0166	53.506	6.089	718.56	4375.2
	85	449.3	530.5	1	3230	517.5	31446	230724

Demand Equation:

$$LnQ = 1.3367 - 0.0090624\ TCFt - 0.015543\ TCOt - 0.0020321\ SUB + 0.0146974\ Y + 0.076763\ T$$

Demand Curve:

$$LnQ = 2.1907 - 0.0090624\ TCFt$$

$$\ln Q = a + bP$$

$$Q = Exp(a+bP)$$

$$CS = \int_{p}^{ph} Exp(a+bP)\ dP$$

$$CS = \frac{Exp(a)}{b} (Exp(b^{*}Ph) - Exp(bP))$$

a=	2.1907
b=	-0.0090624
EXP(a)=	8.94146995
EXP(a)/b=	-986.65585
EXP(b*Ph)=	0.25450816

TCFt: Observed Travel Costs in the Sample

OBS: Number of Observations for Each Travel Cost Level

EST.TRIP: Estimated Travel Demand for Each Travel Cost Level

TOT.TRIP: OBS * EST.TRIP

WGT1: TOT.TRIP / 530.48 (Summation of TOT.TRIP)

WGT2: WGT1 * 3230

NO.AGRS: Estimated Number of Anglers With Observed Travel Cost (WGT2 / EST.TRIP)

CS/AGRS: Annual Consumer Surplus Per Angler

TOT.CS: Total Consumer Surplus (CS/AGRS * NO.AGRS)

Source: Schreiner et al. (1989).

VITA

Se-Hyun Choi

Candidate for the Degree of

Doctor of Philosophy

Thesis: ECONOMIC ANALYSIS OF THE MOUNTAIN FORK RIVER TROUT FISHERY IN SOUTHEASTERN OKLAHOMA USING TRAVEL COST METHOD.

Major Field: Agricultural Economics

Biographical:

Personal Data: Born in Taegu, Korea, June 22, 1961, the son of Jae-Man Choi and Soon-Ja Chun.

Education: Graduated from Young-Shin High School, Taegu, Korea in February 1980; received Bachelor of Science Degree in Agricultural Economics at Korea University, Seoul in February 1985; received Master of Science Degree in Agricultural Economics from Oklahoma State University in May 1989; completed requirements for the Doctor of Philosophy Degree from Oklahoma State University May, 1993.

Professional Experience: Research Assistant, Department of Agricultural Economics, Oklahoma State University, July, 1989 to present.