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Recreation Benefits Measured By Travel Cost Method for the McClellan-Kerr Arkansas River Navigation System and Application to Other Selected Corps Lakes

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The primary objective of this study was to estimate recreation benefits for the McClellan-Kerr Arkansas River Navigation System by the travel cost method using data from a 1974-1975 survey. A secondary objective was to develop generalized relationships for estimating recreation benefits and to apply those relationships to a sample of other Corps projects.

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RECREATION BENEFITS MEASURED BY TRAVEL COST METHOD FOR THE McCLELLAN-KERR ARKANSAS RIVER NAVIGATION SYSTEM AND APPLICATION TO OTHER SELECTED CORPS LAKES

Support Agreement WRC-IA-81-20
for
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FOREWARD

This study was designed with two objectives. First, to estimate what recreational users would be "willing to pay" through admission fees to use the Corps project, the travel cost method was utilized to estimate the user benefits. Second, the regional estimator model, derived from McClellan-Kerr Arkansas River Navigation System data was applied to several reservoirs outside the study area to test their predictive ability. The analysis used data gathered in a survey conducted during 1974 and 1975. The original purpose of this survey was to develop a data base on recreational expenditure for various activities across the McClellan-Kerr Arkansas River System. That data base (from about 3,000 interviews) remains as one of the richest sources of recreational user information ever gathered.

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RECREATION BENEFITS MEASURED BY TRAVEL COST METHOD FOR THE McKELLEN-KERR ARKANSAS RIVER NAVIGATION SYSTEM--AND APPLICATION TO OTHER SELECTED CORPS LAKES

Abstract

The primary objective of this study was to estimate recreation benefits for the McClellan-Kerr Arkansas River Navigation System by the travel cost method using data from a 1974-1975 survey. A secondary objective was to develop generalized relationships for estimating recreation benefits and to apply those relationships to a sample of other Corps projects.

Visitor day attendance is currently about 35,000,000 at the six major lakes and 17 locks and dams in the Arkansas River Basin of Oklahoma and Arkansas. Earlier studies based on the 1974-1975 survey estimate annual recreation expenditures of $224,000,000 and associated direct and indirect annual income of $390,000,000. The current study uses weighted least squares regression techniques to estimate recreation demand functions categorized by regional lakes and local lakes. Local lakes account for 80 percent or more of their visitor days coming from households located within a radius of 100 miles of the lake whereas regional lakes have a radius in excess of 100 miles for 80 percent of their visitor days.

Price, income and population elasticities of demand were estimated individually for the regional and local lakes. Price elasticities varied from a low of -0.86 to a high of -1.12. Population elasticities, based on aggregate county data serving as observations for concentric zones around a lake, varied from a low of 0.31 to a high of 0.68. Income elasticities of demand in general, lacked statistical significance. Estimated visitor day benefits ranged from $1.20 to $3.68. A conservative estimate of annual recreation benefits in 1975 dollars is given as $50,000,000 for the Navigation System as a whole.

Typical recreation parameter data derived from the McClellan-Kerr System were combined with information obtained from Division Engineers for a sample of 15 lakes outside the study area to estimate recreation benefits for the sample lakes. Results show estimated visitor day benefits two to three times larger for the sample lakes, on the average, than estimated for the lakes in the study area. Further analysis is needed to correlate characteristics of sample lakes with study area lakes, reduce potential bias of data obtained for sample lakes, and in adaptation of models to fit sample lakes.

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SUMMARY

Background and Objectives

Water and related land-based recreation is a major activity of the McClellan-Kerr Arkansas River Navigation System. Visitor day attendance has increased from 240,000 in 1950 to a high of 39,198,000 in 1978 and a present visitor day attendance of about 35,000,000 (Table 2). The Navigation System in its present state includes six major lakes and 17 locks and dams in the Arkansas River Basin of the states of Oklahoma and Arkansas. The Navigation System is a multiple purpose system providing transportation, hydroelectric power, municipal and industrial water, soil and water conservation, flood control, scenic beauty, and recreation and wildlife benefits.

What are the social benefits of such a massive and magnificant Navigation System? What are the methodologies and procedures for estimating social benefits of such projects? Economists, engineers, politicians and others have discussed and debated these questions for decades. The approved procedures for evaluating national economic development benefits and costs for federal multiple purpose water resources projects have been detailed in the <u>Federal Register</u>, December 14, 1979 [1]. But what are the estimated social benefits of the McClellan-Kerr Arkansas River Navigation System for water and related land-based recreation activities following these approved procedures? The major objective of this study was to provide an estimate of the annual social benefits.

This study was possible because it builds on the primary data base of an earlier study by the same authors [26].The earlier study analyzed <u>expenditures</u> by recreationists for recreational activities at all of the lakes and locks and dams in the Navigation System. Basis for the analysis was personal interviews with over 2,200 recreational groups in the summers of 1974 and 1975. Results of that study show that for 1975 the estimated <u>visitor day</u> trip expenditures averaged $6.01 and the visitor day <u>annual</u> expenditures averaged $3.53 for a total of $9.54 per visitor day. Estimated aggregate recreation expenditures taking place over the entire navigation system equalled $224,000,000 for 1975. These expenditures were classified in the framework of input-output sectors for purposes of linking recreation activities to the total economic system both inside the Arkansas River Basin region and outside the region. Such a framework permits analysis of linkages of recreation expenditures to regional and interregional sector output, employment and income. Antle [27] has estimated that these recreation expenditures were associated directly and indirectly with an annual income of $390 million both within the region and outside the region.

The above studies show the linkages the Navigation System has with the rest of the economy through recreation activities. The studies do not directly show the benefits to society from the demand for recreation. The recommended procedure [1] measures benefits in terms of willingness-to-pay for each increment of supply provided. This study provides estimates of the willingness-to-pay and estimates social benefits from recreation based on consumers surplus. The 1975 survey cited above [26] provided the primary data needed to estimate willingness-to-pay by consumers of recreation services at the Navigation System.

A secondary objective of this study was to adapt the quantitative models developed for this system to other selected Corps of Engineer lakes throughout the United States in an effort to estimate recreation benefits for those lakes.

Procedures

Willingness-to-pay for recreation benefits is estimated in this study by the travel cost method (see Part II). The travel cost method is based on the premise that the use of a recreational resource will decrease as both the out-of-pocket outlays and travel time cost increase. First, demand functions were estimated for the six major lakes in the Navigation System by relating recreation use (visitor days) to travel and time costs as proxies for price, and income. Second, consumers surplus (recreation benefits) is computed as the area under the demand curve minus the distance and time costs of traveling to the lake.

The use of the travel cost method is valid only under the assumption that travel distance and time are proxies for prices in determining frequency of use. The travel cost method is not valid for users that base their decision on factors other than travel distance and time such as the planned overnight stop on a vacation trip or on an infrequent family reunion with the resource serving as an approximate central location for all family members. To reduce the likelihood of including the occasional user whose decision to use the lake is not based on travel distance and time, the origin of all sample visitor days were plotted on maps relative to the lake at which they were interviewed. By inspection of the data, it was determined that about 80 percent of the sample visitor days followed a pattern of location that could be considered a definition of the market area for a lake. These sample data were aggregated to the county unit and used in estimating the demand functions for recreation. Area under the demand curve was computed for all counties in the 80 percent market area and summed. Average benefit per visitor day was computed by dividing total consumers surplus by the total estimated visitor days using the sample information. Average benefit per visitor day was then used to estimate benefits for the population of visitor days.

Variables in the demand models were formulated in such a manner that data are readily available and thus do not require special survey results for application to other lakes. Data information inputs required to transfer demand models for prediction of visitor day demand from the study lakes in the Navigation System to lakes outside the system include: (1) an approximate market area radius for a lake accounting for about 80 percent of visitor days; (2) travel and time cost from a concentric zone location (county) to the lake; (3) county population; and (4) county per capita income. The first variable, approximate 80 percent market area, was assumed to be available from Division Engineers and based on staff knowledge concerning origin of visitors to a lake. Data were obtained by a letter questionnaire to Division Engineers for lakes outside the study region and through survey data for lakes in the study region. Travel and time cost data were constructed based on distance measurements from the county seat to the dam or lock site (see Part III). Three different measurements of the price (travel and time cost) variable were made based on hypothesized decision criteria of recreationists to visit a lake and these included: (a) round trip cost irrespective of the recreation group size or length of stay; (b) round trip cost distributed over number of individuals in the group and (c) round trip cost per visitor day for the group. Choice of the appropriate price variable was left for empirical testing based on goodness of fit in the estimation procedure. To use price measurements (b) and (c) required two new variables that must be available for application to lakes outside the study region: average size recreation group and average length of stay. These data were available for a sample of lakes. County population and county per capita income were readily available from the Corps of Engineers Construction Engineering Research Laboratory's Economic Impact Forecast System [22] for the year 1975.

Results

Market Area

Lakes in the Navigation System were classified as either local lakes or regional lakes based on the size of their 80 percent market area. The assumption is made that a lake which is small or has fewer developed recreation facilities will draw recreationists mainly from the immediate area while a larger lake and/or one that offers greater recreation amenities will attract visitors from more distant locations. Lakes Oologah, Fort Gibson and Keystone were classified as local lakes since 80 percent or more of their visitor days came from within a radius of less than 100 miles. The exact radii for these lakes are 30 miles for Oologah, 50 miles for Fort Gibson and 70 miles for Keystone.

Lakes Dardanelle, Eufaula and Tenkiller were classified as regional lakes since 80 percent or more of their visitor days came from a radius of more than 100 miles. Lake Dardanelle has an estimated radius of 110 miles, Lake Eufaula has a radius of 130 miles and Lake Tenkiller has a radius of 140 miles. These estimates are all based on sample survey results.

Demand Functions

Weighted least squares regression was used as the estimation procedure. Several forms of the model were tried with the double log form consistently giving superior results. The dependent variable was county sample visitor days recorded at a lake. Independent variables were county population, per capita county income and travel cost. Separate models were run for money cost alone as the price variable and then as money plus time cost as the price variable. Results with the price measurement as round trip cost per visitor day were consistently superior to the measurements of cost per trip and costs per individual. All further results were based on price as round trip cost per visitor day.

Results of the estimated demand functions for the money cost model are reported in Table 10 for the six lakes of the Navigation System. The coefficients of determination, R^2, ranged from a low of 0.64 for Lake Tenkiller to a high of 0.80 for Lake Oologah. All variables had the expected sign except per capita income for Lake Dardanelle. It was consistently negative and statistically nonsignificant and hence was dropped from the estimation.

The estimated price elasticities of demand were all statistically different from zero at the five percent probability level and ranged from a low of -0.86 to a high of -1.12 indicating close to unitary elasticity. The regional lakes, in general, had lower price elasticities than the local lakes. One argument for regional lakes being more price inelastic is that travel costs are less important relative to the amenities provided by such lakes.

The estimated regression coefficients for income per capita lacked statistical significance for three of the six lakes and the size of the income elasticities varied considerably. The range of the elasticity was from 0.18 to 2.73 with no logical explanation for the variation. The method of measurement of the income variable is assumed to be the major cause of insignificance and variation in size. Because of the need to adapt measurement of this variable to data available for lakes outside the study region, secondary data on county per capita income were used in the estimation procedure. Presumably, if sample data were used in measuring per capita income the results would be superior.

The range of the population elasticity was from 0.31 to 0.68 with all coefficients significant at five percent probability level except for Lakes Dardanelle and Keystone. This result is consistent with the literature where population size has less than unitary elasticity. Less than unitary elasticity could be explained by counties with larger populations having larger central cities with more recreation alternatives which compete with water-based recreation at the lakes.

Results of the estimated demand functions for the money plus time cost model are reported in Table 11. Statistical significance and size of the elasticities varied little from the money cost model. The major difference occurred in the location of the demand curves with all lakes showing an outward shift in the curve.

Recreation Benefits for the Navigation System

Visitor day benefits were estimated for each lake in the Navigation System (Tables 12 and 13). For the money cost model the estimated visitor day benefits ranged from \$1.20 for Lake Keystone to \$3.12 for Lake

Dardanelle. The general result shows that regional lakes have higher benefits per visitor day than the local lakes. Lake Oologah appears to be atypical but this result may be influenced by small sample size.

Results of the money plus time cost model show higher visitor day benefits than for the money cost alone. This is consistent with theory and the literature. The range of visitor day benefits with this model was from $1.22 for Lake Keystone to $3.68 for Lake Tenkiller. Lake Oologah had an estimated visitor day benefit of $7.71 but this is considered atypical when compared with all other results.

The authors estimated aggregate benefits for the entire Navigation System at $50,800,000 using the money cost model and $68,215,000 using the money plus time cost model. Approximately 60 percent of these benefits are estimated as coming from the regional lakes of Eufaula, Tenkiller and Dardanelle. The remaining 40 percent are from the local lakes and the locks and dams. The specific assumptions used to estimate aggregate benefits are given in Part IV of the report. A conservative estimate in 1975 dollars is given by the authors as $50 million annual benefits for the Navigation System as a whole.

Application to Other Lakes

A sample of 15 lakes outside the study area was chosen to apply the estimated parameters of recreation demand for purposes of estimating visitor day benefits and aggregate benefits (Part V). Lakes were classified as local or regional on the basis of estimated market area radius provided by Division Engineers. Local lakes included Grapevine, Lavon, Stillhouse Hollow, Canyon and Proctor in the Fort Worth District; Arkabutla and Grenada in the Vicksburg District; Carlyle in the St. Louis District; John Martin in the Albuquerque District; and Nimrod in the Little Rock District. Regional lakes included Rend in the St. Louis District; Conchas in the Albuquerque District; Clearwater and Table Rock in the Little Rock District; and Wappapello in the Memphis District.

Typical parameter data were used from the estimated demand functions of the McClellan-Kerr System for local and regional lakes in application to estimating visitor day benefits for the sample of lakes outside the study region. Results of the application show estimated visitor day benefits two to three times larger for the sample lakes on the average than estimated for the lakes in the study area. Various reasons may be given for the wide difference in estimated visitor day benefits. First, average group size and average length of stay are important in estimating travel cost per visitor day. Lakes in the study area averaged significantly higher values for these variables than for the sample of lakes. The sample of lakes included a higher proportion of lakes with day visitors and thus higher travel costs per visitor day. This seems to be correlated with higher benefits per visitor day.

Second, size of the market area influences size of average benefit per visitor day. The larger the market area the higher the average benefit per visitor day (Tables 20 and 21). If there is a bias in estimating size of the market area by the Division Engineers towards larger areas, this will increase the average benefit per visitor day.

Conclusions

1. Application of approved procedures for evaluating national economic development benefits at the McClellan-Kerr Arkansas River Navigation System shows substantial benefits arising out of recreation activities. These annual benefits are in excess of $50 million in 1975 dollars.

2. Adapting recreation demand parameters estimated for the study area lakes to lakes outside the study area requires further analysis before confidence can be placed in using the estimated visitor day benefits. Further analysis is needed to correlate characteristics of lakes and adaptation of models.

PART I: INTRODUCTION

Water and related land-based recreation has become increasingly important as a multiple purpose use at Corps of Engineers lakes and other federal agency lakes in the 1960's and 1970's. The rapid annual increases in recreation visits have been slowed by the oil embargo of 1973 and its impacts into 1974, by the doubling of oil (gas) prices in 1978 and by the depressed economic conditions from 1980-82. However, the basic demand for water based recreation is still strong and many urban residents have boats, skiing and fishing equipment and camping equipment high on their list of goals as soon as the economy improves and more people return to full time jobs. Thus, there is still a strong unfilled demand for water-based recreation.

Economists, engineers and various other federal agency planners have made noble attempts to estimate the recreation expenditure impacts and/or the benefits generated in both the regional and national economy by the high levels of recreation use at public lakes. Arguments and counterarguments and voluminous amounts of data have been generated to prove that provision of outdoor recreation facilities and services either: (1) makes a significant contribution to national employment (jobs created), increases in income and in output of goods and services; or (2) are of little significance nationally and make only minor and/or seasonal contributions to local and regional economies.

This study is a further attempt to measure some of these recreation related impacts, utilizing a primary data base heretofore unavailable for such analysis.

This study builds on an earlier research project which used input-output analysis to estimate the economc impacts of outdoor recreation at Corps of Engineers locks and dams and lakes which are part of the McClellan-Kerr Arkansas River Navigation System. The Navigation System covers six major lakes and 17 locks and dams in the Arkansas River Basin in Oklahoma and Arkansas. The earlier project generated primary data through personal interviews with over 2,100 recreational groups or parties in the summers of 1974 and 1975.

In mid-1981, the Institute for Water Resources requested researchers in the Department of Agricultural Economics at Oklahoma State University to take the data generated by the 1092 personal surveys of recreationists in 1975 and estimate recreation benefits utilizing the travel cost method for the McClellan-Kerr Arkansas River Navigation System. A second objective was to adapt the quantitative models developed for this system to other selected Corps of Engineer lakes throughout the United States, in an effort to estimate recreation benefits for those lakes.

Specifically, the scope of work identified the task as estimating the "willingness-to-pay" recreation benefits by Travel Cost Method from McClellan-Kerr Survey Data (1974 and 1975) and develop generalized relationships between recreation use and socio-economic factors.

The specific objectives of the study were:

1. Estimate recreation benefits for the McClellan-Kerr Arkansas River Navigation System (mainstream and Eufaula, Keystone and Oologah Lakes) by travel cost method from existing data base generated in 1974-1975 survey.

2. Develop generalized relationships between household income, occupation of head of household, distance and: (a) recreational participation rate; (b) distance to competing public use areas; and (c) investment in recreational equipment.

3. Test predictive ability of generalized relationships on a sample of other Corps projects.

After preliminary model building and testing of the 1974 and 1975 survey data, it was decided by both the researchers and the Corps of Engineers project coordinator to concentrate on the survey data from 1975, since it was slightly more refined (more statistically valid) than the 1974 survey data.

The number of personal interviews of recreationists at the lakes and locks and dams is presented in Table 1. The interviews taken at each lake in 1975 generally were based on the visitor days reported by the Corps of Engineers for the May through August period in 1974. This weighting method allowed relating recreation use of the lake to total expenditure impact.

The 1970-81 total annual visitation for the lakes and locks and dams in the Navigation System are presented in Table 2. The base year for estimating recreation benefits, 1975, had the highest annual recreation visits up to that time. As indicated earlier, water and related land based recreation on the Navigation System lakes continued to increase in popularity for several years, reaching a peak of 39.2 million units in 1978. Due to higher gas prices, but more important, due to a lagging economy, recreation

Table 1

Number of Recreation Groups Surveyed by Lake or Area and Total McClellan-Kerr Arkansas River Navigation System, 1975

Lake or Area	1975
Keystone	151
Fort Gibson	146
Eufaula	150
Tenkiller	193
Oologah	88
Oklahoma Main Channel[a]	65
Arkansas Above Little Rock[b]	181
Arkansas Below Little Rock[c]	118
Total	1092

[a]Oklahoma Main Channel includes Newt Graham L & D, Choteau L & D in the Verdigris River and Robert S. Kerr Lake and Webber Falls Lake and W. D. Mayo L & D on the Arkansas River.

[b]Arkansas above Little Rock includes L & D 13, Ozark Lake; Dardanelle Lake, L & D 9; Toadsuck Ferry L & D and Murray L & D on the Arkansas River.

[c]Arkansas below Little Rock includes David D. Terry L & D, L & D 5, L & D 4, L & D 3 and L & D 2 on the Arkansas River and Norrell L & D on the White River.

Table 2

Visitor Days Recreation Attendance by Lake and Area, McClellan-Kerr Arkansas River Navigation System, 1950-1981 (Figures in 1,000)

Year	Keystone	Ft. Gibson	Eufaula	Tenkiller	Oologah	Oklahoma Main Channel	Arkansas Above Little Rock	Arkansas Below Little Rock	Total
1950	-	195	-	45	-	-	-	-	240
1951	-	489	-	93	-	-	-	-	582
1952	-	780	-	67	-	-	-	-	847
1953	-	1,287	-	552	-	-	-	-	1,839
1954	-	2,163	-	1,155	-	-	-	-	3,318
1955	-	2,746	-	1,413	-	-	-	-	4,159
1956	-	3,707	-	1,866	-	-	-	-	5,573
1957	-	3,998	-	2,130	-	-	-	-	6,128
1958	-	4,178	-	2,298	-	-	-	-	6,476
1959	-	4,213	-	2,398	-	-	-	-	6,611
1960	-	3,782	-	2,284	-	-	-	-	6,066
1961	-	3,512	-	1,627	-	-	-	-	5,139
1962	-	3,736	-	1,841	-	-	-	-	5,577
1963	-	2,479	-	1,663	324	-	-	-	4,466
1964	479	2,806	168	1,636	719	-	-	-	5,808
1965	1,582	2,466	2,305	1,782	1,148	-	1,589[a]	-	10,872
1966	2,001	2,427	2,158	1,842	937	-	1,318	-	10,683
1967	1,794	2,112	2,002	1,373	1,178	-	1,217	-	9,676
1968	1,833	2,406	2,313	1,466	1,093	-	1,034	-	10,145
1969	2,152	2,672	2,766	1,804	1,057	-	1,277	1,027	12,755
1970	2,440	2,937	3,215	2,311	966	-	1,559	1,266	14,694
1971	2,585	3,116	3,982	2,361	884	304[c]	2,693[b]	1,874	17,799
1972	2,893	4,419	4,602	3,096	1,103	1,093[d]	2,811	2,417	22,434
1973	3,138	4,008	4,522	4,055	1,326	1,172	3,413	2,462	24,096
1974	3,674	4,083	4,562	5,002	1,219	1,317	3,729	2,080	25,666
1975	3,022	4,110	4,695	5,226	1,421	2,128	4,330	2,348	27,280
1976	4,051	3,571	5,387	5,669	1,782	3,133	5,931	2,630	32,154
1977	4,236	6,790	6,550	6,575	1,842	3,774	6,592	2,696	39,055
1978	4,180	7,228	7,242	4,064	1,801	4,552	7,303	2,828	39,158
1979	4,156	4,451	6,455	4,595	2,145	3,717	7,552	2,537	35,608
1980	3,357	2,352	3,463	3,127	1,611	3,115	10,825	3,359	31,209
1981	4,602	4,404	4,115	3,493	3,630	3,651	8,191	2,410	34,496

Source: These visitation data were obtained from the Tulsa and Little Rock Districts of the U.S. Army Corps of Engineers.

[a] Beginning of Lake Dardanelle

[b] Beginning of Ozark Lake, L & D #13, L & D #9, Toadsuck Ferry L & D, Murray L & D

[c] Beginning of Robert S. Kerr Lake and W.D. Mayo Lock and Dam

[d] Beginning of Webbers Falls Lake, Newt Graham L & D and Chouteau L & D

visits declined in 1979 and 1980, but then increased to 34.5 million in 1981. Thus, even a depressed economy has failed to hem in the pent up demand for water based recreation for very long periods of time. Even when families are short of money, they still need an outlet.

PART II: TRAVEL COST METHODOLOGIES

Recreation Benefit Evaluation Procedures

The Water Resource Council (WRC) developed and recommended a set of procedures to evaluate national recreation benefits of federal water resource projects. Both the recommendations and procedures were published in the December 1979 issue of the Federal Register [1]. In essence, travel cost behavior and user and/or perceived use surveys are suggested as methods to gather information on willingness-to-pay for recreation benefits from federal multipurpose water projects. Three acceptable benefit evaluation methods were cited: (1) travel cost, (2) contingent valuation and (3) unit day value. Each is discussed in the ensuing subsections.

Travel Cost Method

The theoretical foundation of the travel cost method was conceived by Hotelling [2] and further developed by Clawson [3]. The initial empirical work was performed by Clawson in concert with Knetsch [4]. Thus, one finds the travel cost method and the Hotelling-Clawson-Knetsch method used interchangeably in the literature.

The travel cost method is based on the premise that the use of a recreational resource will decrease as both the out-of-pocket outlays and travel time cost increase. First, demand for the recreational activity is estimated from models that relate use to travel distance and time as proxies for price, socioeconomic factors and, in some cases, alternative sites. Here, distance and travel time are converted to dollars. Second, recreational resource demand curves are derived by applying the parameters obtained from the recreational use models to incremental changes in travel distance and time or more specifically travel prices. The aggregation of survey data by counties appears to be the most widely employed procedure for developing recreational demand models with counties forming the concentric zones around a lake.

In most empirical studies, only money cost has been used (i.e., distance converted to dollars) since travel distance and travel time are usually highly correlated. This has lead several researchers, such as Cesario and Knetsch [5], to criticize the travel cost method as being biased since models with money cost alone suggest that an increase in price for a county closer to a recreational area will result in the same lower level of demand as a county with an equivalent price before the price change. The problem reduces to finding a means for including both money and time costs in a single travel cost model. Cesario [6] has suggested several money and time cost combinations to remove the bias in the estimates owing to money cost alone. One of the suggestions will be adapted in a subsequent section when discussing the models.

Contingent Valuation

Individuals are directly asked the dollar value they place on a recreational resource when the contingent valuation method is employed. The term contingent means these values are obtained from conditional circumstances in the absence of markets. Here, an individual may be presented with a hypothetical situation that requires a change in one's welfare and then asked once or iteratively one's dollar valuation of the change.

Direct questioning is one way of employing the contingent valuation method. The question may be phrased as to determine how much travel expenses one would be willing to incur before making the decision to no longer visit the recreational area. The approach would be open-ended if the respondent were not asked a certain dollar amount and closed ended otherwise. The open-ended approach is viewed less favorably from the argument that consumers seldom set the price in an economic transaction. Iterative questioning is an approach whereby the respondent is first confronted with a low price and subsequently higher prices until converging on ones highest willingness-to-pay.

Contingent valuation methods are advantageous since the demand curve for the recreational resource is directly derived from an individual's willingness to pay responses. Inadequacies revolve around how well the hypothetical markets depict the real world and if individuals behave similarly as compared to real markets.

Unit Day Value

Unit day values are approximations which in themselves are built from a specific range of recreation monetary values and user day estimates. Neither of the latter values are site specific but evolve from studies of other sites with similar quality characteristics. Thus, unit day values approximate willlingness-to-pay using subjective judgment and in the process require a systematic system or range of values within a quality characteristic to justify the value selected. Usually, abundant water resource activities are given low monetary values and vice versa for scarce water resource opportunities. By comparison, the unit day value method is less preferable to the travel cost and contingent valuation methods.

Use of the Travel Cost Method

From the inception of the travel cost method by Hotelling to the early applications by Clawson and Knetsch in estimating the demand for recreational resources, numerous extensions of the technique have evolved. As is apparent from the literature, the aggregation of survey data by counties appears to be the most widely employed procedure for analyzing recreational demand models with counties forming concentric zones around the facility. Recent studies by Smith [7], Smith and Kopp [8], and Sutherland [9] have addressed the spatial limits to develop more accurately the size of the surrounding market area. The absolute level of use versus a per capita ratio have been questioned by Flegg [10] along with Bowes and Loomis [11] on the basis of the most appropriate specification of the dependent variable. Concomitant with this issue is forcing the population elasticity of demand to one. Several researchers such as Cesario and Knetsch [12], Sinden [13], Smith [14], Ziemer, Musser and Hill [15], and Sutherland have focused attention on the correct functional form of the demand model. Additionally, Cesario and Knetsch, Burt and Brewer [16] and Moncur [17] have expanded the H-C-K travel cost model to include competition among recreational areas on the premise that single site evaluations are biased upward.

One subject lacking in the recreational literature, however, is the specification of the price variable with respect to travel cost alone. In the present study this problem is analyzed along with the recreational resource's market area. Two assumptions are given as succinct statements of the problems discussed above: (1) a lake that offers a wide range of amenties will draw recreationists from further distances than one with limited amenities; and (2) recreationists traveling individually or as a group base their decisions on visiting a site and the length of stay on either: (a) the round trip cost irrespective of the group size or length of stay, (b) the round trip cost distributed over individuals in the group, or (c) the round trip cost per visitor day for the group or the individual recreationist traveling alone. Different functional forms of the model and different specifications of the dependent variable are addressed in this study.

Market Area Defined

The use of the travel cost method for estimating demand for a recreational resource is valid only under the assumption that travel distance and time are proxies for prices in determining frequency of use. The travel cost method is not valid for the occasional user of a recreational resource that bases their decision on location of the resource relative to an interstate highway and the planned overnight stop on a vacation trip or on an infrequent family reunion with the resource serving as an approximate central location for all family members. Under these conditions the travel cost is of secondary importance and not a valid measure of willingness-to-pay for the recreational resource. To reduce the likelihood of including the occasional user from our sample of visitors to the McClellan-Kerr Navigation System, the origin of all sample visitors were plotted relative to the lake at which they were interviewed. By inspection of the mapping of the data it was determined that about 80 percent of the sample visitor days followed a pattern of location that could be considered a definition of the market area for that lake. On the basis of this criteria the approximate 80 percent market area was deliniated for each lake in the system.

In terms of the market area associated with any lake, the following assumption is made:

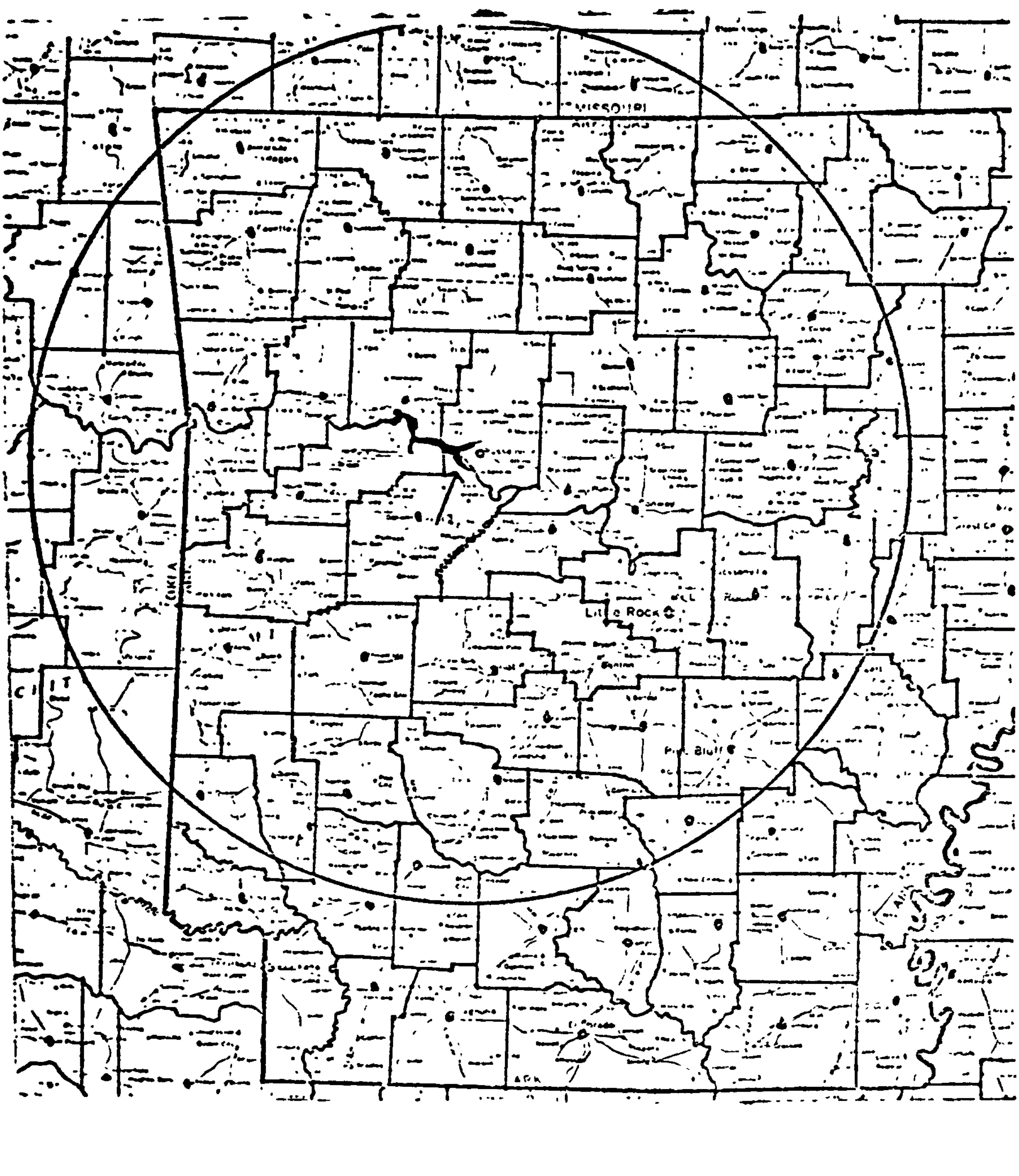
> A lake is viewed as being encompassed by a market area that extends a fixed radius from a representative point within its boundaries and this radius is more than likely longer in length if the lake is large and/or offers greater amenities.

This assumption implies that a lake which is small or has less developed facilities will draw recreationists mainly from the immediate area while a larger lake and/or one that offers greater ammenities will attract recreationists from more distant locations. To provide a foundation for this assumption, the data were aggregated from the survey to the county level and, using state maps, concentric circles were drawn of ten mile increments with the dam site as the centroid up to the distance where approximately 80 percent of the observations were concentrated. Location of the county seat was used to identify which concentric zone a county was assigned. For counties having two county seats, the one having the larger population and/or concentration of population surrounding it was used to find the zone in which the county was located. This was the case for several counties in Arkansas. The 80 percent level was chosen from inspecting the data and noting that approximately this proportion of the recreational groups were clustered around a lake while the remaining 20 percent came from much further distances within the same state where the lake was located, or from nearby states and even some from much distant states. By using this technique, the radius of the outer circle was found and interpreted as the radial distance measure of the lake's drawing power. The county seat was also used when computing the overall driving distance from a county to each of the lakes. This will be discussed in greater detail in the next section.

There are problems associated with using the dam site as the reference point of a lake when determining its market area. First, the dam site is generally located at the extreme end of a lake and thereby may be remote from other bodies or branches of the lake. Thus, the radial distance may be under or over estimated given the geographical direction of the county to the lake's dam site. The second problem is associated with the first in that recreationists may opt to recreate at areas other than the dam site and when this is true the average distance from their home county would also be miscalculated for lakes that are extensive in length and/or width. Figures 1 to 6 pictorially demonstrate the location of Lakes Dardanelle, Eufaula, Fort Gibson, Keystone, Oologah and Tenkiller, respectively, in terms of their market areas. The arrow in each figure points to the location of the dam site. One may easily recognize from Figure 1 that Lake Dardanelle is elongated and in Figure 2 that Lake Eufaula is even more so in addition to being

Figure 1

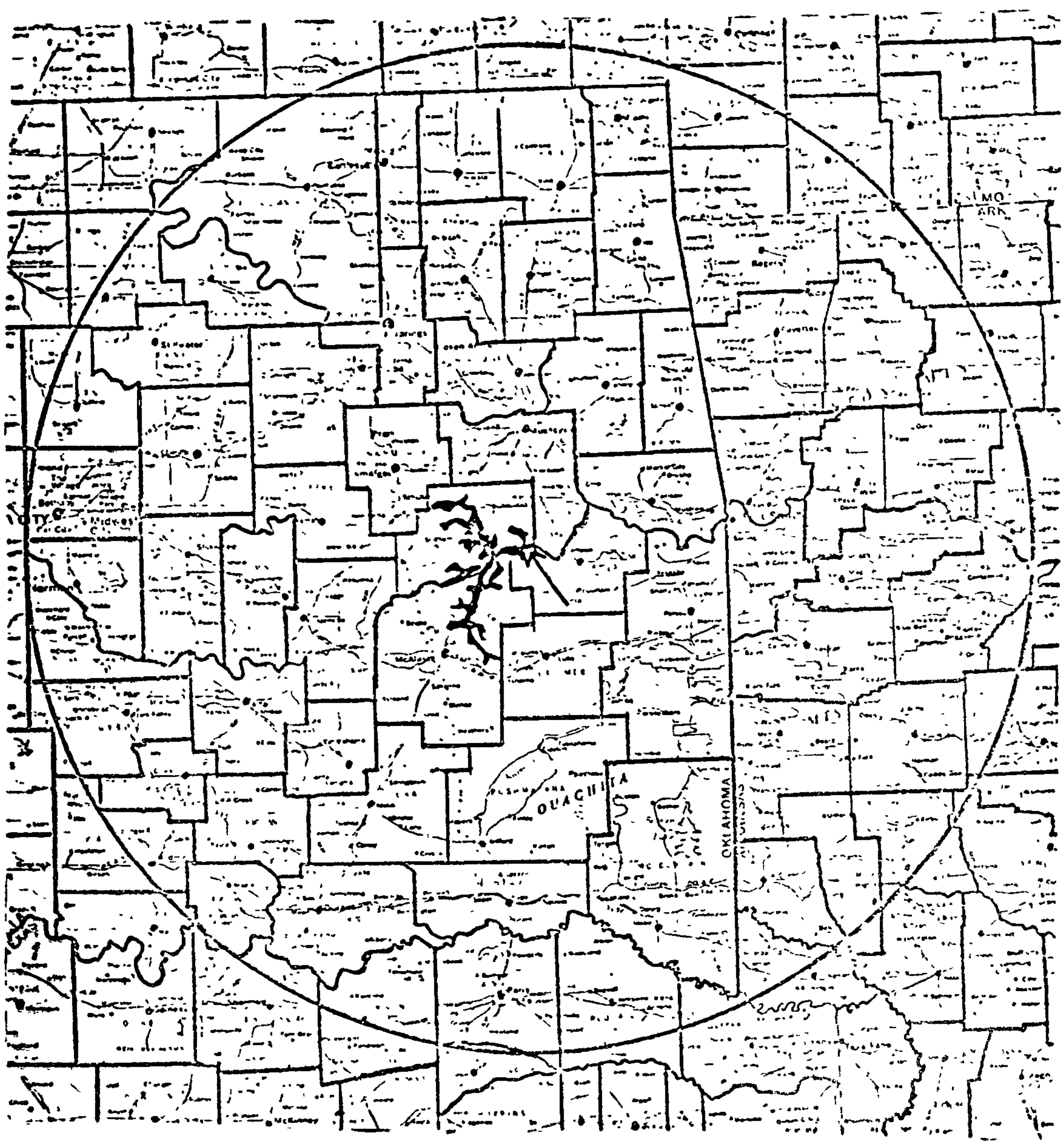
Market Area for Lake Dardanelle



Radial distance = 110 miles

Figure 2

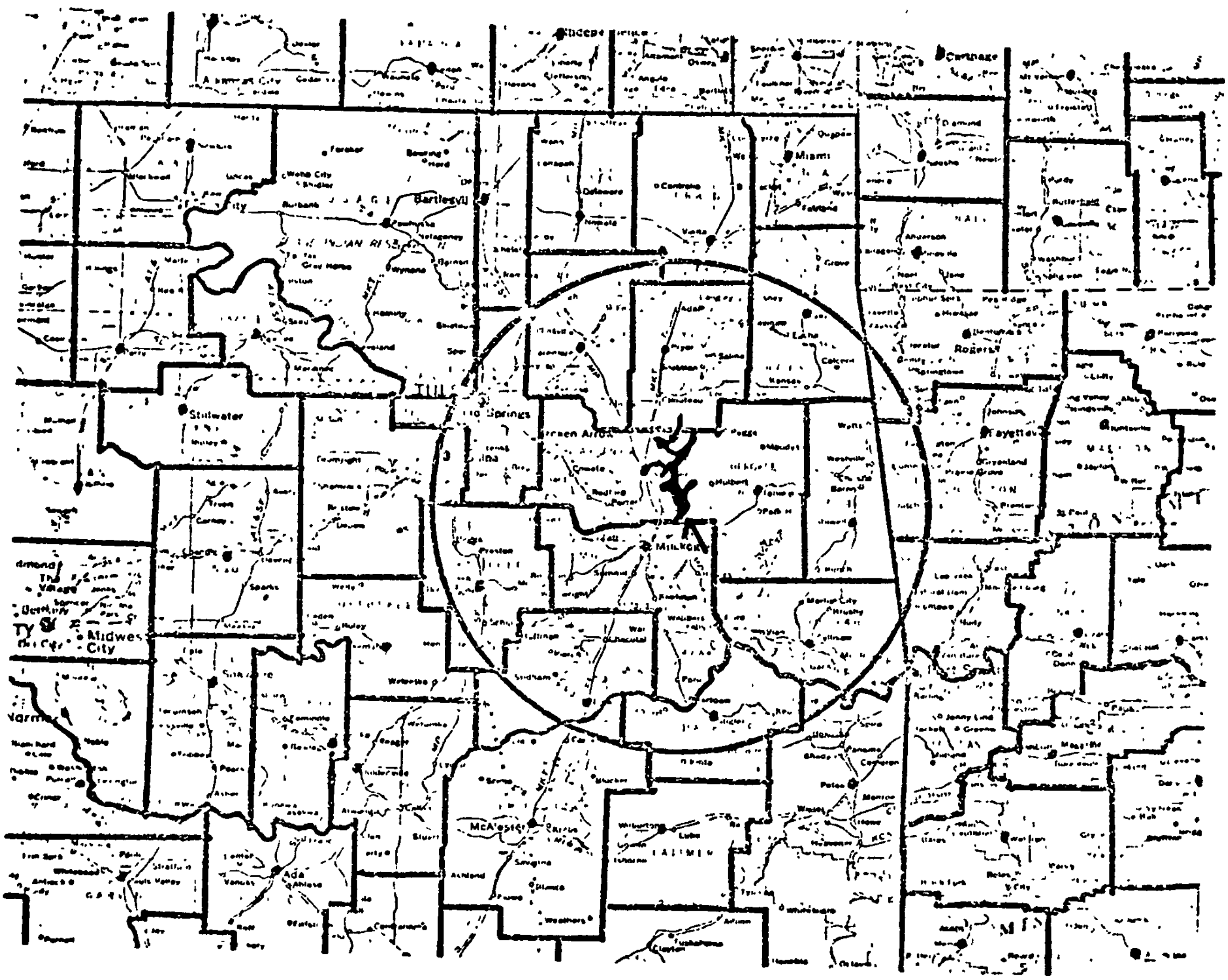
Market Area for Lake Eufaula



Radial distance = 130 miles

Figure 3

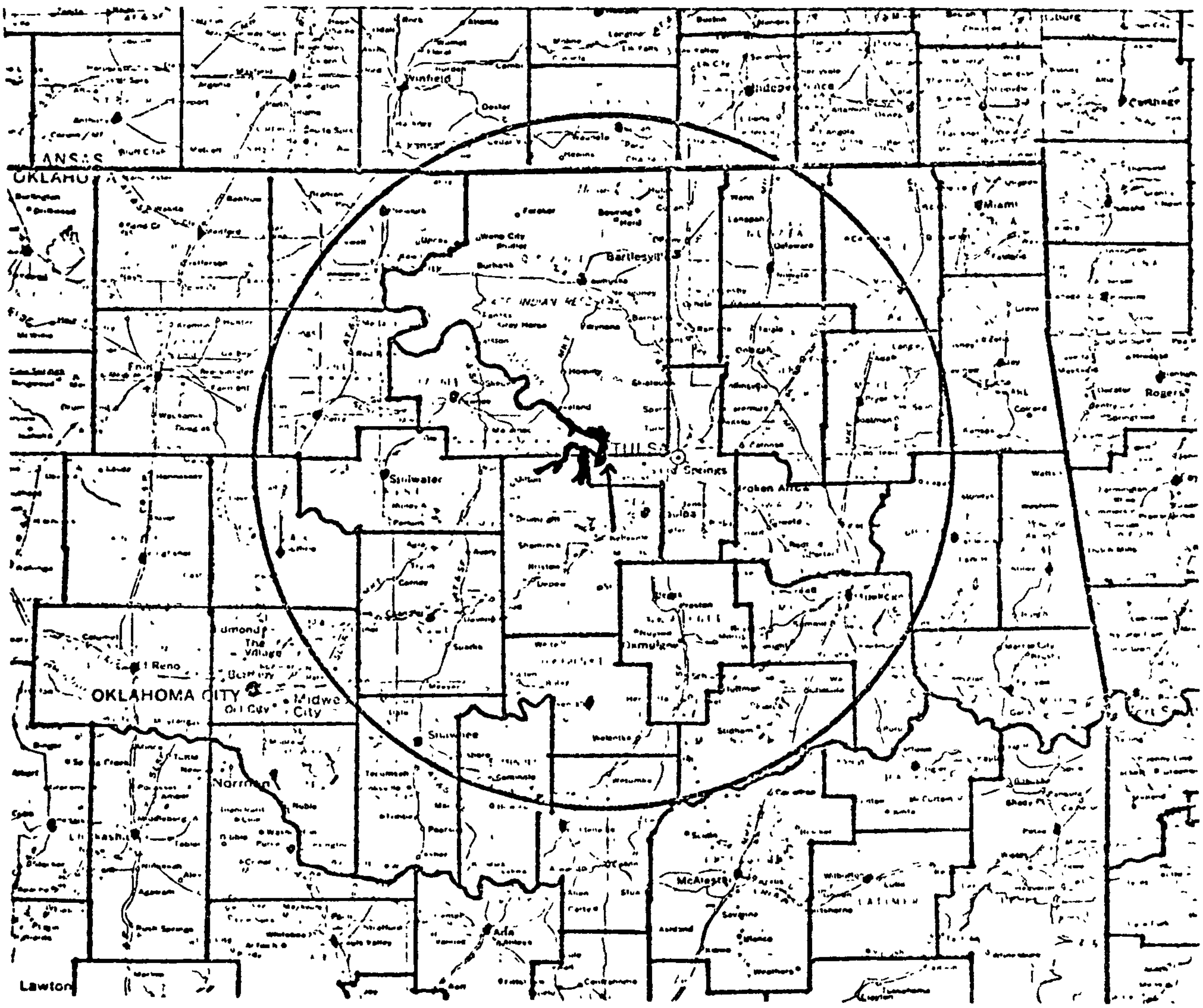
Market Area for Fort Gibson



Radial distance = 50 miles

Figure 4

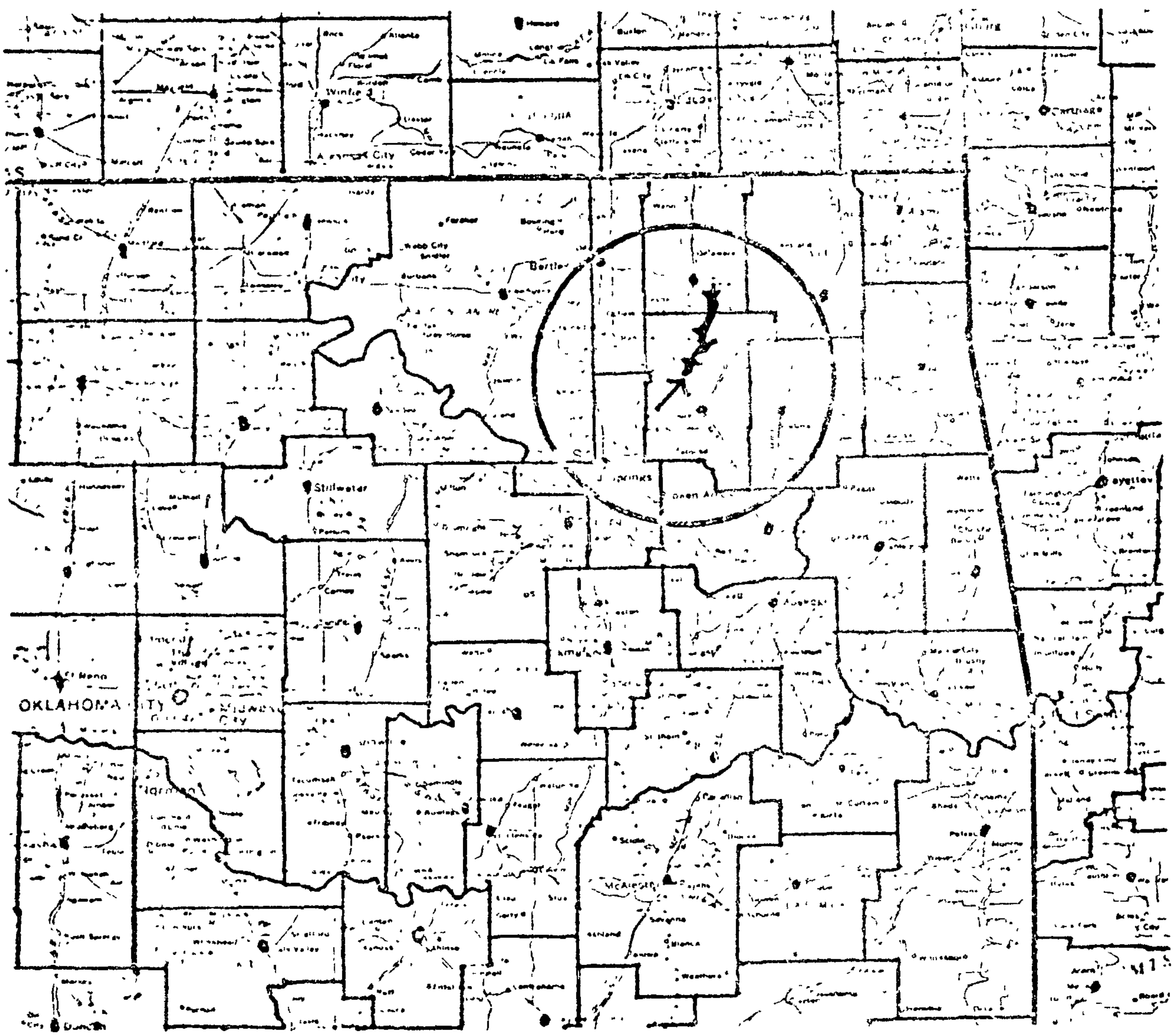
Market Area for Lake Keystone



Radial distance = 70 miles

Figure 5

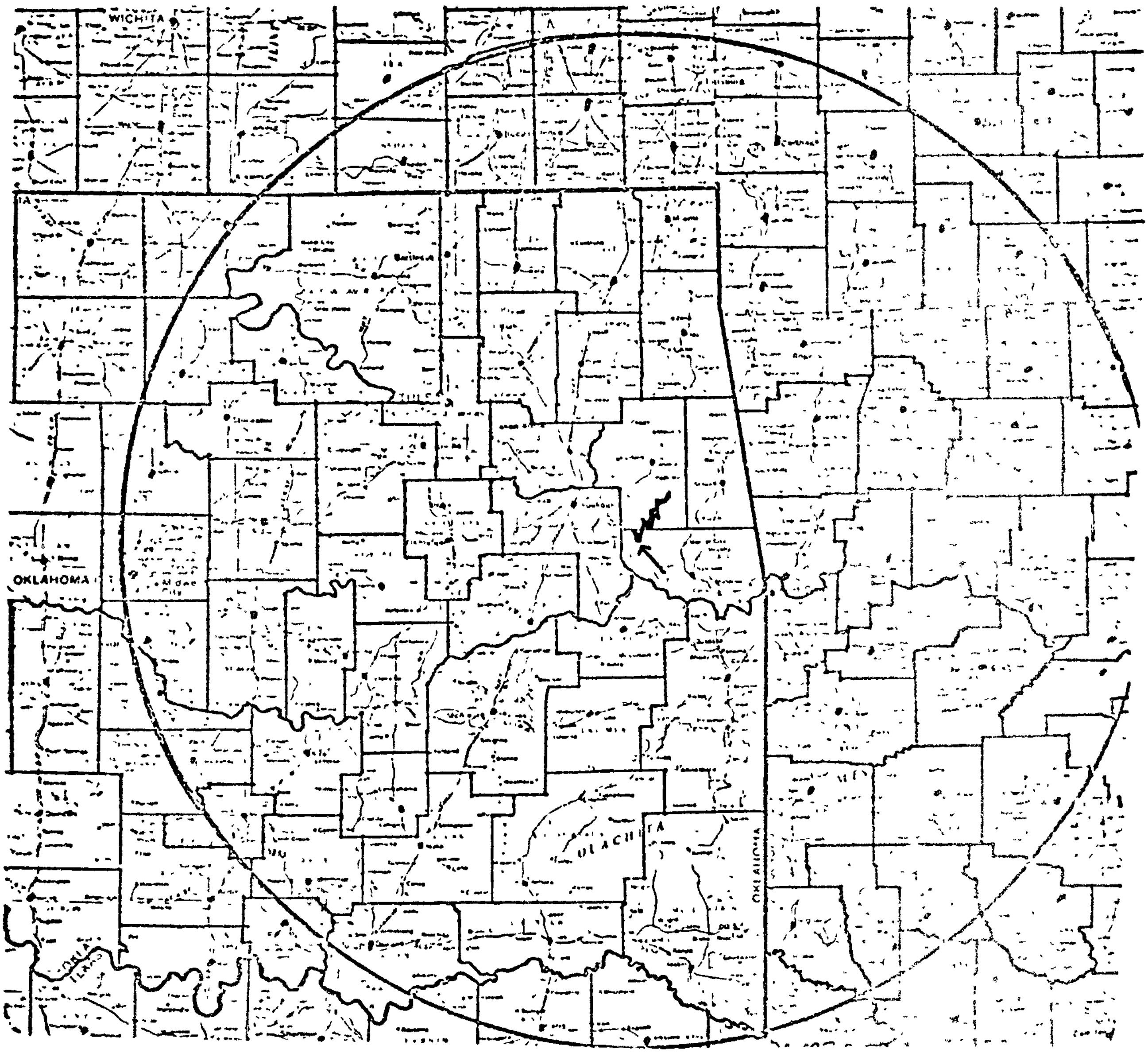
Market Area for Lake Oologah



Radial distance = 30 miles

Figure 6

Market Area for Lake Tenkiller



Radial distance = 140 miles

greatly segmented. By contrast, Lake Keystone's shape has a curvature with a few large branches as shown in Figure 4. By weighing factors such as the limitation of readily available information on each lake in relation to their focal points and the time limits of this study, it was decided that the dam site could adequately serve as the reference point when determining the lakes market area while keeping in mind the problems associated with this choice.

The radial distances are presented in Table 3 along with the corresponding percent level of recreational groups for each lake in the study area. Tables 4 to 9 contain information on Lakes Dardanelle, Eufaula, Fort Gibson, Keystone, Oologah and Tenkiller, respectively, by county in terms of the incremental distance zones that make up each lake's market area and the distance in miles from the county seat to its dam site. These tables are the numerical companions to Figures 1 to 6. From Table 3, the percentage of recreationists accounted for among the lakes differ somewhat from the 80 percent level since radial increments were limited to 10 miles. It was found, as an example, that for Lake Eufaula, 81 percent of the recreational groups resided within a 130 mile radius of the lake. By contrast, 86 percent of the visitors come from within a 50 mile radius for Lake Fort Gibson. Lakes Dardanelle, Eufaula and Tenkiller are basically regarded as regional lakes and are mainly characterized as such from their inherent attributes and extensive drawing power. This statement is consistent with the assumption on the market area associated with a lake. In support of this assumption, our radial distance measure indicates, as seen in Table 9, that Lake Tenkiller's market area includes counties from

Table 3

Radial Distance and Number of Recreational Groups Identified by

80 Percent Market Area

Lake	Radial Distance (miles)	Groups		
		Total Interviewed	In Market Area	
			Number	Percent
Dardanelle	110	129	100	78
Eufaula	130	150	122	81
Fort Gibson	50	146	125	86
Keystone	70	151	125	83
Oologah	30	88	71	81
Tenkiller	140	193	163	85

Table 4

Distance in Miles from County Seat to Dam Site for Counties

in Market Area of Lake Dardanelle

Observed County	State[1]	Distance	Distance Zone	Unobserved County	State[1]	Distance	Distance Zone
Pope	AR	6	10	Perry	AR	35	30
Conway	AR	22	30	Newton	AR	66	60
Yell	AR	23	10	Van Buren	AR	68	50
Johnson	AR	32	30	Montgomery	AR	71	60
Faulkner	AR	52	50	Cleburne	AR	76	70
Franklin	AR	53	50	Boone	AR	90	70
Logan	AR	61	40	Hot Spring	AR	90	70
Scott	AR	68	60	Saline	AR	94	60
Garland	AR	69	60	Searcy	AR	98	60
Pulaski	AR	70	82	Madison	AR	99	70
Crawford	AR	86	80	Lonoke	AR	100	90
Sebastian	AR	87	80	Clark	AR	105	80
Marion	AR	115	80	Stone	AR	106	80
Grant	AR	119	80	Sequoyah	OK	109	100
Washington	AR	124	90	Polk	AR	110	80
Arkansas[2]	AR	131	130	Pike	AR	117	90
White	AR	137	90	Carroll	AR	123	90
Jefferson	AR	161	100	Independence	MO	123	100
Crittenden[2]	AR	205	180	Prairie	AR	127	100
				Izard	AR	133	100
				Nevada	AR	134	110
				Howard	AR	135	100
				Adair	OK	137	100
				Baxter	AR	137	90
				Taney	MO	140	100
				Dallas	AR	142	110
				Le Flore	OK	145	90

Table 4 (Continued)

Observed County	State[1]	Distance	Distance Zone	Unobserved County	State[1]	Distance	Distance Zone
				Ozark	MO	146	110
				Haskell	OK	147	110
				Benton	AR	149	100
				Sevier	AR	155	110
				Cherokee	OK	156	110
				Woodruff	AR	159	110
				Fulton	AR	175	110
				Harry	MO	177	110
				Cleveland	AR	185	110

[1] AR -- Arkansas
MO -- Missouri
OK -- Oklahoma

[2] County lies outside the market area but is included in the analysis as in-state outlier.

Table 5

Distance in Miles from County Seat to Dam Site for Counties

in Market Area of Lake Eufaula

Observed County	State[1]	Distance	Distance Zone	Unobserved County	State[1]	Distance	Distance Zone
Haskell	OK	20	10	Sequoyah	OK	47	30
Mc Intosh	OK	20	20	Wagoner	OK	53	50
Muskogee	OK	36	40	Cherokee	OK	66	50
Latimer	OK	37	30	Crawford	AR	72	60
Pittsburg	OK	42	40	Adair	OK	75	50
Le Flore	OK	57	40	Mayes	OK	77	70
Okmulgee	OK	66	50	Atoka	OK	82	80
Sebastian	AR	68	50	Coal	OK	87	80
Okfuskee	OK	73	60	Pushmataha	OK	103	80
Hughes	OK	79	70	Logan	AR	107	80
Tulsa	OK	86	70	Franklin	AR	108	90
Rogers	OK	93	80	Bryan	OK	114	110
Creek	OK	99	70	Delaware	OK	116	90
Pottowatomie	OK	106	90	Scott	AR	118	70
Seminole	OK	109	80	Craig	OK	120	100
Pontotoc	OK	114	90	Johnston	OK	121	110
Lincoln	OK	129	100	Washington	OK	122	110
Cleveland	OK	133	120	Choctaw	OK	124	90
Oklahoma	OK	141	130	Pawnee	OK	125	110
Mc Clain	OK	145	120	Nowata	OK	126	100
Garvin	OK	148	120	Johnson	AR	127	110
Grady[2]	OK	164	140	Washington	AR	130	90
Canadian[2]	OK	169	150	Marshall	OK	133	120
Logan	OK	170	130	Osage	OK	138	110
Kay[2]	OK	196	150	Ottawa	OK	144	120

Table 5 (Continued)

Observed County	State[1]	Distance	Distance Zone
Comanche[2]	OK	210	190
Jackson[2]	OK	262	240

Unobserved County	State[1]	Distance	Distance Zone
Mc Donald	MO	145	100
Newton	MO	148	120
Polk	AR	150	80
Murray	OK	152	110
Pope	AR	152	120
Lamar	TX	152	130
Montgomery	AR	156	110
Madison	AR	157	100
Benton	AR	158	100
Labette	KS	159	130
Payne	OK	164	120
Mc Curtain	OK	167	100
Noble	OK	176	130
Yell	AR	178	110
Barry	MO	183	120
Red River	TX	183	120
Carter	OK	189	130
Fannin	TX	189	130
Sevier	AR	196	100
Carroll	AR	197	120
Newton	AR	212	130
Pike	AR	216	130
Howard	AR	219	130
Little River	AR	230	130

[1] AR -- Arkansas
MO -- Missouri
OK -- Oklahoma
TX -- Texas

[2] County lies outside the market area but is included in the analysis as an in-State outlier.

Table 6.

Distance in Miles from County Seat to Dam Site for Counties

in Market Area of Lake Fort Gibson

Observed County	State[1]	Distance	Distance Zone
Muskogee	OK	13	10
Wagoner	OK	19	20
Mayes	OK	42	40
Adair	OK	46	40
Mc Intosh	OK	49	40
Okmulgee	OK	53	40
Rogers	OK	54	50
Tulsa	OK	54	50
Creek	OK	56	50
Craig[2]	OK	69	60
Washington[2]	OK	78	80
Lincoln[2]	OK	107	100
Osage[2]	OK	107	90
Payne[2]	OK	118	110
Oklahoma[2]	OK	153	130
Cleveland[2]	OK	158	130
Canadian[2]	OK	177	150
Kiowa[2]	OK	264	230

Unobserved County	State[1]	Distance	Distance Zone
Cherokee	OK	13	20
Haskell	OK	57	40
Sequoyah	OK	57	40

[1]OK — Oklahoma

[2]County lies outside the market area but is included in the analysis as an in-State outlier.

Table 7

Distance in Miles from County Seat to Dam Site for Counties in Market Area of Lake Keystone

Observed County	State[1]	Distance	Distance Zone
Tulsa	OK	14	20
Creek	OK	16	20
Rogers	OK	41	40
Pawnee	OK	44	40
Lincoln	OK	47	50
Payne	OK	48	50
Osage	OK	52	40
Wagoner	OK	56	60
Washington	OK	64	50
Seminole	OK	69	70
Noble	OK	72	60
Oklahoma[2]	OK	95	90
Kay	OK	97	70
Garfield[2]	OK	112	100
Alfalfa[2]	OK	163	130
Woods[2]	OK	178	150
Woodward[2]	OK	192	180

Unobserved County	State[1]	Distance	Distance Zone
Okfuskee	OK	47	50
Okmulgee	OK	49	40
Mayes	OK	58	60
Nowata	OK	63	60
Muskogee	OK	67	60
Logan	OK	73	60
Pottowatom	OK	73	70
Craig	OK	76	70
Chautauqua	KS	80	70
Mc Intosh	OK	92	70

[1]KS -- Kansas
OK -- Oklahoma

[2]County lies outside the market area but is included in the analysis as an in-State outlier.

Table 8

Distance in Miles from County Seat to Dam Site for Counties in Market Area of Lake Oologah

Observed County	State	Distance	Distance Zone
Rogers	OK	10	20
Nowata	OK	22	20
Mayes	OK	27	30
Tulsa	OK	32	30
Washington	OK	42	30
Creek[2]	OK	45	40
Osage[2]	OK	53	40
Okmulgee[2]	OK	60	60
Kay[2]	OK	109	80
Oklahoma[2]	OK	146	130

[1]OK -- Oklahoma

[2]County lies outside the market area but is included in the analysis as an in-State outlier.

Table 9

Distance in Miles from County Seat to Dam Site for Counties

in Market Area of Lake Tenkiller

Observed County	State[1]	Distance	Distance Zone	Unobserved County	State[1]	Distance	Distance Zone
Sequoyah	OK	22	20	Haskell	OK	46	30
Muskogee	OK	26	30	Mc Intosh	OK	53	40
Cherokee	OK	31	30	Latimer	OK	73	50
Adair	OK	33	30	Rogers	OK	81	60
Sebastian	AR	43	40	Okfuskee	OK	85	80
Wagoner	OK	46	40	Montgomery	AR	91	110
Le Flore	OK	58	50	Craig	OK	92	80
Okmulgee	OK	58	60	Logan	AR	102	80
Mayes	OK	67	60	Mc Donald	MO	103	80
Crawford	AR	68	50	Franklin	AR	104	70
Delaware	OK	72	70	Ottawa	OK	106	100
Washington	AR	76	70	Madison	AR	107	90
Pittsburg	OK	81	70	Nowata	AR	113	90
Tulsa	OK	82	70	Scott	AR	115	80
Creek	OK	84	70	Newton	MO	120	100
Benton	AR	102	80	Johnson	AR	123	100
Hughes	OK	111	90	Coal	OK	125	110
Seminole	OK	117	100	Atoka	OK	126	110
Pottowatomie	OK	124	110	Cherokee	KS	129	120
Washington	OK	126	100	Barry	MO	129	110
Osage	OK	134	110	Pushmataha	OK	131	110
Payne	OK	146	120	Labette	KS	131	120
Oklahoma	OK	157	140	Lincoln	OK	135	110
Cleveland	OK	162	140	Pawnee	OK	136	120
Logan	OK	163	140	Pontotoc	OK	142	100
Noble	OK	164	140	Conway	AR	142	140

Table 9 (Continued)

Observed County	State[1]	Distance	Distance Zone
Canadian[2]	OK	184	170
Kingfisher[2]	OK	185	170
Kay[2]	OK	190	150
Grady[2]	OK	195	170
Stephens[2]	OK	233	190
Major[2]	OK	239	200
Custer[2]	OK	244	230
Cimarron[2]	OK	469	430

Unobserved County	State[1]	Distance	Distance Zone
Polk	AR	146	90
Pope	AR	148	110
Jasper	MO	148	120
Choctaw	OK	151	120
Carroll	AR	152	100
Perry	AR	152	140
Crawford	KS	153	140
Yell	AR	154	110
Bryan	OK	157	140
Stone	MO	160	130
Johnston	OK	165	140
Mc Curtain	OK	165	130
Neosho	KS	168	140
Barton	MO	168	140
Lawrence	MO	169	130
Chautauqua	KS	170	130
Garland	AR	171	140
Montgomery	KS	171	130
Mc Clain	OK	172	140
Murray	OK	173	140
Garvin	OK	174	140
Boone	AR	175	120
Lamar	TX	179	140
Newton	AR	188	110
Sevier	AR	191	120
Pike	AR	193	140

Table 9 (Continued)

Observed County	State[1]	Distance	Distance Zone	Unobserved County	State[1]	Distance	Distance Zone
				Taney	MO	202	130
				Red River	TX	210	140
				Howard	AR	215	140
				Searcy	AR	218	140
				Marion	AR	225	140

[1] AR -- Arkansas
KS -- Kansas
MO -- Missouri
OK -- Oklahoma
TX -- Texas

[2] County lies outside the market area but is included in the analysis as an in-State outlier.

Arkansas, Kansas, Missouri, Oklahoma and Texas. Lake Eufaula draws recreationists from the same states excluding Missouri. The states represented by the other lakes are Arkansas, Missouri and Oklahoma for Lake Dardanelle; and only Oklahoma for Lakes Fort Gibson, Keystone and Oologah. The latter three lakes are either smaller or offer less recreational opportunities than the regional lakes and can be labeled as local in terms of drawing power.

The present discussion has addressed both the counties from where recreationists were interviewed, and the remaining counties in a lake's market area from which recreationists were not interviewed due to sampling phenomenon. These latter counties were identified and recorded since later in the study they will become important constructs when estimating the recreation benefits. What needs to be emphasized at this time is that when analyzing the models to be presented later, (1) an observation refers to a county and (2) the number of observations equals the number of counties represented. Additionally, counties were included as observations that were situated relatively close but outside the 80 percent zone and from which recreationsists were interviewed.

These are referred to as in-state outlying counties and are noted as such in Tables 4 to 9. The rationale for retaining them in the analysis is a judgement that they do respond to travel distance and time. In general these people are expected to have a lower participation rate than those that reside within the market area. This also allowed a larger sample of observations to be used in the estimated models.

PART III: RECREATION DEMAND AND BENEFIT ESTIMATION PROCEDURES

Introduction

In this chapter, the general famework is presented for estimating average visitor day demand and recreation benefit at any of the study lakes with recreational facilities based on the Hotelling-Clawson-Knetsch travel cost method. As presented in the previous part, the travel cost method is based on the premise that the use of a recreational site will decrease as both the out-of-pocket outlay and travel time cost increase. First, demand for the recreational activity is estimated from models that relate use to travel distance and time as proxies for price, socioeconomic factors and in some cases alternative sites. Here, distance and travel time are converted to dollars. Next, the recreational resource demand curves are derived by applying the parameters obtained from the recreation use models to incremental changes in travel distance and time or, more specifically, travel prices. The final step is to convert the recreation demand functions into benefit functions and estimate the net social benefits from recreation. The aggregation of survey data by counties appears to be the most widely employed procedure for developing recreational demand models with counties forming the concentric zones around a lake. This is also the convention followed in this study as indicated in Part II in the discussion on the market area.

Recreation Demand Models

The basic theoretical models state demand as a function of the explanatory variables population, income per capita and price. Three empirically adaptable models are developed from the basic model with each differing in terms of the formulation of the price variable. A log linear mathetical form is used throughout. In the first model, price is defined as the cost per trip and in the second and third as the cost per individual and cost per visitor day, respectively. It is implicit in each model that a recreational group travels to a lake in one vehicle.

Since an individual is likely to experience a time cost in addition to money cost when in transit, price is expanded in the three previous models to include opportunity cost as a measure of the value of time when traveling to and from a lake. The derivation is shown for measuring the opportunity cost per hour associated with each county where recreationists originated and recreated at a particular lake.

Estimating Average Demand Using the Money Cost Model

As implied in the introduction, economic models are used to estimate the demand for recreation at each of the lakes in the McCellan-Kerr Naviagtion System. These are economic models since price is explicitly included in the demand fucntion. Thus, it is inherent in the basic theoretical model and the ensuing empirically adaptable models that travel cost, in the absence of a market price (e.g., entrance fee), can be used as a proxy for an individual's willingness-to-pay for a recreation resource such as found at one of the lakes in the study area. Mathematically, the basic model is:

$$VD_{jk} = f_k(P_j, (Y/P)_j, C_{jk}) \qquad \text{Eq. 1}$$

where: VD_{jk} = number of visitor days at lake k from county j

P_j = 1975 population of county j divided by 1,000

$(Y/P)_j$ = 1975 per capita personal income of county j divided by 1,000

C_{jk} = 1975 cost in dollars associated with lake k with respect to county j.

Recall that the above model can be altered in one of three ways by respecifying the price variable C_{jk}. That is, each model is similar in that the total number of visitor days is the dependent variable but differs in the price variable. The first model is specified in terms of the round trip cost with the second and third differing by round trip cost per individual and round trip cost per visitor day, respectively. The following assumption is given as a succinct statement of the arguments for incorporating any of the three cost variables into the basic model:

> Recreationists traveling individually or as a group base their decisions on visiting a site and length of stay on either (a) the round trip cost irrespective of the group size or length of stay, (b) the round trip cost distributed over individuals in the group or (c) the round trip cost per visitor day for the group or the individual recreationist traveling alone.

These assumptions can be incorporated into Eq. 1 by replacing C_{jk} with one of the following price equations:

$$CT_{jk} = (D_{jk}0.069)2 \qquad \text{Eq. 2}$$

$$CI_{jk} = (CT_{jk}G_{jk})/I_{jk} \qquad \text{Eq. 3}$$

$$CVD_{jk} = (CT_{jk}G_{jk})/VD_{jk} \qquad \text{Eq. 4}$$

where: CT_{jk} = cost per trip to lake k from county j

D_{jk} = distance in miles to lake k from the county seat of county j

CI_{jk} = cost per individual to lake k from county j

G_{jk} = number of recreational groups at lake k from county j

I_{jk} = number of individuals at lake k from county j

CVD_{jk} = cost per visitor day at lake k as related to county j.

The variable D_{jk} in Eq. 2 always refers to the number of road miles from the jth county seat to lake k. The value 0.069 is the per mile cost of operating an automobile for 1975. This was obtained by using the values reported by the Department of Transportation [18, 19] for the following items: gas, oil, maintenance, accessories, parts, tires, and state and federal taxes. In Eq. 2, the unit mile cost (i.e., D_{jk} times 0.069) is multiplied by two to obtain the round trip travel cost.

Estimating Time Cost

Cesario and Knetsch [5], among others, have emphasized that travel cost should include the opportunity cost of travel time in addition to money cost. An empirical study by Keith and Workman

[20] shows that the cost of travel time is a significant determinant in an individual's decision to recreate. As a whole, these authors conclude willingness-to-pay for a recreational resource would be underestimated when travel time cost is excluded from the estimation procedure. Harrison [21] has indicated that a valuation can be placed on travel time for all individuals (i.e., adults and children and among them wage earners and nonwage-earners). In his view, he finds it reasonable to use a single average value of 25 percent of the relevant wage rate for wage earners and one-third of this value for nonwage-earners. These are regarded as preferential figures when considering the broad ranges of time expending experiences and thus are applicable to commuting as well as recreation; the latter which is the focus of Harrison's discussions.

It is necessary to determine the opportunity cost per hour before developing the opportunity cost of the entire time in transit. These derivations are shown below and are by county in terms of a specific lake as was the case in the money cost models. When considering the first part of the problem, the following model was developed:

$$\begin{aligned} OCH_{jk} = w_s v_1 \, [v_2 I_{1j} &+ r_{1s} I_{2j} \\ &+ v_2(1-r_{1s}) I_{2j} \\ &+ r_{2s} I_{3j} + v_2(1-r_{2s}) I_{3j}] \end{aligned} \qquad \text{Eq. 5}$$

where: OCH_{jk} = Opportunity cost per hour of travel time associated with lake k with respect to county j

I_{1j} = Average number of persons age 0-19 in recreational groups from county j

I_{2j} = Average number of persons age 20-59 in recreational groups from county j

I_{3j} = Average number of persons age 60 or greater in recreational groups from county j

r_{1s} = Labor force participation rate of all persons age 20-59 from State s

r_{2s} = Labor force participation rate of all persons age 60 or greater from State s

w_s = Average annual hourly wage rate of State s

v_1 = Proportion of wage rate measured as opportunity cost for persons working

v_2 = Proportion of v_1 measured as opportunity cost for persons not working.

$j = 1,\ldots,n_k$
$k = 1,\ldots,6$
$s = 1,\ldots,S$
$v_1 = 0.25$
$v_2 = 0.33$

The I_{1j}, I_{2j} and I_{3j} were aggregated as such in order to correspond with the available wage data and statistics on labor force participation rates. The terms v_1 and v_2 are from Harrison. It is important to note that in Eq. 5, all persons in a recreational group are accounted for.

Equation 5 can be used to develop the opportunity cost of travel time with reference to the cost per (1) round trip, (2) individual or (3) visitor day. This is shown below in Eq. 6 to 8.

$$OCT_{jk} = V(D_{jk}OCH_{jk})2 \qquad \text{Eq. 6}$$

$$OCI_{jk} = OCT_{jk}/\overline{GSZ}_k \qquad \text{Eq. 7}$$

$$OCVD_{jk} = OCI_{jk}/\overline{VD}_k \qquad \text{Eq. 8}$$

where: OCT_{jk} = Opportunity cost per trip associated with lake k with respect to county j

V = Constant for the inverse of the rate of travel

OCI_{jk} = Opportunity cost per individual to lake k from county j

$\overline{GSZ}_k$ = Average group size at lake k

$OCVD_{jk}$ = Opportunity cost per visitor day at lake k as related to county j

$\overline{VD}_k$ = Average number of visitor days per group at lake k.

$V = 1/45.$

It is important to note in Eqs. 7 and 8 that the terms $\overline{GSZ}_k$ and $\overline{VD}_k$ are average values in reference to lake k. Also, when substituting the right-hand side of Eq. 7 into the right-hand side of Eq. 8, the denominator is easily seen as the total average number of visitor days associated with lake k. The value two in Eq. 6 has the same use as in Eq. 2, that is, it inflates D_{jk} to the round trip number of miles. The inverse of the rate of travel (V) is assumed to be an average value when considering such factors as secondary roads, congestion on the highway and hauling recreational equipment.

Estimating Average Demand Using the Money Cost Plus Time Cost Model

The problem now reduces to incorporating Eqs. 6 to 8 into Eqs. 2 to 4, respectively, whereby models can be obtained for expressing either money plus time cost per trip, money plus time cost per individual or money plus time cost per visitor day into the basic demand model as shown in Eq. 1. Thus, C_{jk} in Eq. 1 can be rewritten as C^*_{jk} when adding opportunity cost to the model. The general specification for the basic demand model with money and time cost becomes:

$$VD_{jk} = g_k(P_j, (Y/P)_j, C^*_{jk}) \qquad \text{Eq. 9}$$

where: C^*_{jk} = monetary cost plus opportunity cost associated with lake k with respect to county j.

In terms of the Eqs. 2 to 4, they are rewritten in terms of both money and time cost in the following manner:

$$TMCT_{jk} = CT_{jk} + OCT_{jk} \qquad \text{Eq. 10}$$

$$TMCI_{jk} = CI_{jk} + OCI_{jk} \qquad \text{Eq. 11}$$

$$TMCVD_{jk} = CVD_{jk} + OCVD_{jk} \qquad \text{Eq. 12}$$

where: $TMCT_{jk}$ = money plus time cost per trip to lake k from county j

$TMCI_{jk}$ = money plus time cost per individual to lake k from county j

$TMCVD_{jk}$ = money plus time cost per visitor day at lake k as related to county j.

Recreation Benefit Models

Net social benefits from recreation are computed on the basis of the difference between what people are willing to pay for a visitor day of recreation and what they actually pay. This is what economists refer to as the consumer's surplus. Consider the demand for recreation in county j at lake k as expressed in Figure 7.

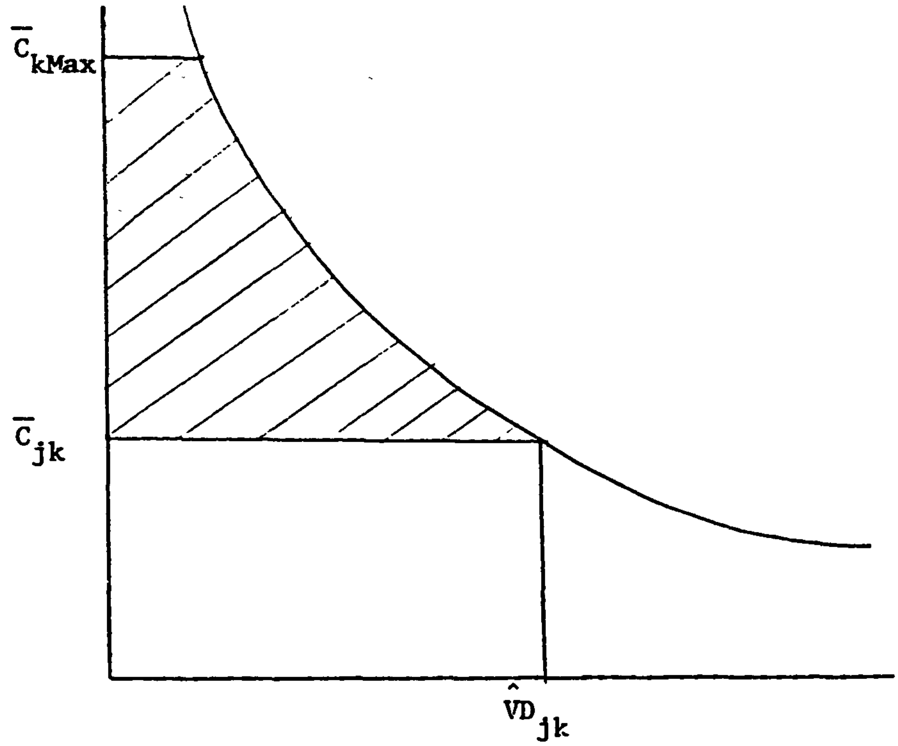


Figure 7. Demand for Recreation in County j at Lake k and Consumer's Surplus

The demand curve is estimated according to the travel cost method as explained above. For county j the demand for recreation in terms of visitor days can be traced out by varying the price (C_{jk}) in Eq. 1 for a constant (actual) level of county population, P_j, and per capita income, $(Y/P)_j$. The travel cost from county j to lake k used in estimating the demand function can be considered as the average price paid by recreationists in that county for recreating at lake k. This price is denoted as $\overline{C}_{jk}$ in Figure 7. The expected visitor days, $\hat{VD}_{jk}$, can be computed from the estimated demand function corresponding to Eq. 1.

Consumer's surplus for the expected visitor days from county j at lake k is the total shaded area under the demand curve of Figure 7. To compute this value requires integrating the demand function from $\overline{C}_{jk}$ to C_{kMax} and is the following:

$$CS_{jk} = \int_{\overline{C}_{jk}}^{C_{kMax}} \hat{VD}_{jk} \, dC_{jk} \qquad \text{Eq. 13}$$

Total consumer's surplus is computed when C_{kMax} equals the value at $\hat{VD}_{jk}=0$. However, if the equational form of the demand function is such that $\hat{VD}_{jk}$ never equals zero, an approximate value for consumer's surplus can be computed by setting $\hat{VD}_{jk}$ equal to a small value and solving for C_{kMax}.

Summing the consumer's surpluses for those counties in the 80 percent market area gives a measure of recreation benefits for lake k corresponding to 80 percent of the recorded visitor days. Since the procedures described so far are based on sample information, summation of consumer's surplus is sample summation and not population summation. However, average benefit per visitor day can be computed from the sample data and is equal to total sample consumer's surplus divided by total sample visitor days:

$$\overline{CS}_k = \frac{\sum_{j=1}^{n_k} CS_{jk}}{\sum_{j=1}^{n_k} \hat{VD}_{jk}} \qquad \text{Eq. 14}$$

where

$\overline{CS}_k$ = average visitor day consumer's surplus for lake k

$\sum_{j=1}^{n_k} CS_{jk}$ = total sample consumer's surplus for lake k in the 80 percent market area

$\sum_{j=1}^{n_k} \hat{VD}_{jk}$ = total sample predicted visitor days for lake k in the 80 percent market area

Total recreation benefits can be estimated by applying the per visitor day estimate to reported Corps of Engineers visitor days adjusted for the 80 percent market area:

$$TCS_k = \overline{CS}_k \cdot TVD_k \cdot MKTGP_k \qquad \text{Eq. 15}$$

where: TCS_k = estimated total recreation benefits for lake k in the 80 percent market area

TVD_k = total Corps of Engineers visitor days reported for lake k

$MKTGP_k$ = the exact percentage of market area visitor days reported from the sample for lake k.

PART IV: EMPIRICAL RESULTS AND ANALYSES OF RECREATION DEMAND

Introduction

This chapter provides a discussion on the statistical results obtained from empirically analyzing the demand models presented in the previous chapter. Here, the objective is to examine how well the models statistically predict the demand for recreation at each of the lakes in the study area given the explanatory variables from the survey and additional data sources. The demand functions are then used to empirically estimate recreation benefits for the 80 percent market area of each lake. Before proceeding to the statistical results, the composition of each variable used in the equations will be discussed in addition to the data. Two pertinent points warrant attention before proceeding to the subsequent section. One, an observation from the survey is analogous to a recreational group. By contrast, a county and an observation are one and the same in the data set used for analyzing the travel cost models. Thus, reference will be made to the former in terms of developing the latter throughout the following discussions. Rather than mentioning each lake individually at all times, the index k is adopted as a general notation.

Explanatory Variables

The variable visitor days (VD_{jk}) was computed from information in the survey by first multiplying the number of persons in a group times the length of stay reported by the group's respondent. Next, this product was summed by a group's county of residence to give the number of visitor days at lake k from county j.

County population (P_{jk}) was obtained from the Corps of Engineers Construction Engineering Research Laboratory's (CERL) Economic Impact Forecast System [22] and is relevant for the year 1975. For ease of working with the numbers, the actual level was changed to population in thousands.

Per capita personal income [$(Y/P)_j$] is a derived variable and was found by dividing the jth county personal income by the jth county population. Personal income[1], itself, was obtained from the same data base as population and includes returns from all sources. The ratio was converted to thousands of dollars.

Distance (D_{jk}) is the number of road miles from the county seat of county j to lake k. As noted in Part II, the county seat with the greater population level and/or surrounding population concentration was selected as the representative location for counties with two county seats. This choice had to be made for several counties in Arkansas. In Oklahoma, as in Arkansas, populations seem to be centered around the county seat(s) which facilitated the decision to use them as a central point. State highway maps were used to determine the number of road miles from the county seat to the lake. In some cases, distances were noted

[1]The 1975 level of personal income was not reported for Somervell, Texas. In order to derive an income value for this year, the annual rates of increase were computed from 1972 to 1974 and found to be fairly constant at around 14.5 percent. Personal income in 1975 was thereby found by inflating the 1974 level of income by 1.145.

from mileage tables as to the road miles from county seat to a major town near each lake. Miles were either added or subtracted from these figures depending on the county seat's geographic location to that of the lake in order to obtain the distance in miles between the two points. At other times, the most direct route was selected and the distances between major intersections recorded on the maps and summed.

The unit mile cost ($0.069) is the average variable cost of operating an automobile in 1975. This dollar value was found by averaging the 1974 and 1976 figures reported by the U.S. Department of Transportation [18, 19] over the following items: gas, oil, maintenance, accessories, parts, tires, state and federal taxes.

The variable G_{jk} is the sum of recreational groups at lake k from county j. As previously described, G_{jk} equals the number of observations in the data set for lake k. The number of individuals at lake k from county j (I_{jk}) is the same variable used from the survey to compute visitor days. It is derived by summing the number of individuals across recreational groups for a county.

Two sources were used to derive the States' average annual wage rate (w_s). For Oklahoma, average weekly earnings were divided by a forty hour work-week factor with the former value coming from the 1975 county employment and wage data reported by the Oklahoma Employment Security Commission [23]. Arkansas, Kansas, Mississippi, Missouri and Texas are the other five states where recreationists orginated and counties appeared in one or more lake's market area. Average annual wage values were obtained for each state from the Office of Business and Economic Research at Oklahoma State University. These values were divided by 2080 (i.e., a fifty-two week work-year times a forty hour work-week) which lead to the average hourly wage rate. The previous section discussed the proportion of the wage rate measured as opportunity cost for those persons working and those not working (v_1 and v_2).

The breakdown in age categories (I_{1jk}, I_{2jk} and I_{3jk}) is the number of persons ages 0-19, 20-59 and 60 or greater sampled at lake k from county j. These categories match the available information on labor force participation by state. The latter is for 1970 and comes from data on the distribution of workers by age in the 1970 Census of Population [24]. Ages 20-59 and 60 or greater labor force participation rates (r_{1s} and r_{2s}) were derived for each state by dividing its population into the value for the appropriate labor force participation age category.

Average group size at lake k ($\overline{GSZ_k}$) was derived by dividing the sum over j of I_{jk} by the sum over j of G_{jk}. Lastly, average visitor days per individual at lake k ($\overline{VD_k}$) comes from dividing the sum over j of VD_{jk} by the sum over j of G_{jk}. Recall, that I_{jk}, G_{jk} and VD_{jk} originated from the sample.

Results of the Money Cost Model

The statistical results using the money cost model are presented in this section. The results represent the double log formulation transformed to log-linear and estimated by a multiple regression procedure. Linear, quadratic and semi-log formulations were tried and subsequently rejected in favor of the double log formulation based on the goodness of fit criteria. Ziemer, et. al. [15] support the choice of the double log formulation over other forms. Implicit in the double log model is the constant elasticity of each independent variable at all levels associated with visitor days.

Weighted least squares (WLS) was utilized as the regression procedure as opposed to ordinary least squares (OLS) since the latter was found inapropriate due to heteroskedasticity introduced by the highly unequal population variable. When analyzing the residuals from the OLS regressions, the error term was found to be proportional to the log of the population variable. Thus, the OLS estimators (coefficients) were unbiased but inefficient. Bowes and Loomis [11] experienced this phenomenon but with visits per capita as the dependent variable. Here, the heteroskedasticity problem breaks down to the variance of the natural log of visitor days related to the inverse of the natural log of population such that for the ith observation:

$$\mathrm{Var}\,[\ln\,(VD_i)] = \sigma^{-2}\,[\ln(POP)_i] \qquad \text{Eq. 16}$$

By weighting the ith observation by the natural log of the inverse of the square root of the ith population, $[\sqrt{\frac{1}{\ln(POP)_i}}]$, the variance of the ith observation becomes:

$$\mathrm{Var}\,\{\sqrt{\frac{1}{\ln(POP)_i}}\;\ln\,(VD_i)\} = (\frac{1}{\ln(POP_i)})\;\{(\mathrm{Var}\,\ln\,(VD_i)\} \qquad \text{Eq. 17}$$

This simple data manipulation resulted in WLS efficient estimators (i.e., estimators that satisfy the least squares minimum variance property).

As a final note, the conventional model of visitor days per capita was used as the dependent variable and was found to be unsatisfactory. These findings resolved the question of forcing a unitary elasticity of visitor days with respect to the county population variable.

The WLS regression results for the six lakes using the three price specifications are summarized in Table 10. A priori, little can be said about what price variable recreationists base their decisions on to recreate at a lake. When analyzing the regression results in terms of the coefficients of determination, however, a higher R^2 is found for five of the lakes when price is specified as cost per visitor day. The one exception is Lake Oologah where the R^2 is similar in size for each demand equation. Only two immediate explanations can be given for this with one relating to the other. First, Lake Oologah can be characterized as the most "local" of the six lakes as indicated by its radial distance, and secondly it has less recreational facilities relative to the other lakes in this study. Setting aside this one inconsistency in the findings, it is reasonable to conclude that cost per visitor day is the superior specification for price when attempting to explain total visitor days. The ensuing discussion will be in reference to this price specification equation unless stated otherwise.

In terms of the explanatory variables, some general results can be discussed relative to their effects on total visitor days. A striking result is the relative consistency of the cost per visitor day variable for all six lakes. The estimated coefficient is statistically significant for each lake (at the one percent

Table 10

Regression Coefficients (WLS), Double Log Form, for Total Visitor Days Under Three Different Travel Cost Assumptions for Six Lakes in Eastern Oklahoma and Western Arkansas

Lake		Cost Per Trip					Cost Per Individual					Cost per Visitor Day					Number of Observation
		Intercept	LNP	LN(Y/P)	LNCT	R^2	Intercept	LNP	LN(Y/P)	LNCI	R^2	Intercept	LNP	LN(Y/P)	LNCVD	R^2	
Dardanelle	1	2.54	0.73		-0.78	.31	2.10	0.61		-0.97	.59	2.23	0.31		-0.98	.75	19
	2		(2.07)		(-2.08)			(2.34)		(-4.27)			(1.47)		(-6.35)		
Eufaula	1	4.45	0.66	-1.27	-0.55	.15	2.63	0.75	-0.58	-0.83	.36	0.69	0.68	0.18	-0.99	.62	27
	2		(1.57)	(-0.57)	(-1.31)			(2.05)	(-0.31)	(-3.14)			(2.40)	(0.13)	(-5.61)		
Fort Gibson	1	-0.74	0.43	2.79	(-0.79)	.55	-0.96	0.26	2.74	-0.75	.59	-1.30	0.54	1.56	-1.09	.76	18
	2		(1.53)	(2.50)	(-2.38)			(0.92)	(2.66)	(-2.79)			(2.71)	(2.15)	(-4.83)		
Keystone	1	0.72	0.79	-0.10	-0.12	.34	0.41	0.63	0.54	-0.43	.40	-0.59	0.31	1.48	-1.12	.78	17
	2		(2.01)	(-0.06)	(-0.20)			(1.73)	(0.33)	(-1.14)			(1.47)	(1.55)	(-5.11)		
Oologah	1	-1.79	0.77	2.24	-0.80	.82	-3.00	0.71	2.40	-0.72	.73	-3.84	0.59	2.73	-0.90	.80	10
	2		(3.25)	(2.36)	(-2.56)			(2.47)	(2.01)	(-1.58)			(2.53)	(2.60)	(-2.35)		
Tenkiller	1	0.89	0.57	1.31	-0.52	.38	0.40	0.48	1.41	-0.53	.42	-0.61	0.43	1.64	-0.86	.64	34
	2		(2.97)	(1.47)	(-1.50)			(2.43)	(1.82)	(-2.08)			(3.01)	(1.14)	(-4.98)		

1 ---- coefficient
2 ---- t value

probability level for each lake except Oologah which is significant at the five percent level). The range of the coefficient is from -0.86 to -1.12 indicating close to unitary price elasticity. The regional lakes (Dardanelle, Eufaula and Tenkiller), in general, have the lower price elasticities with the more local lakes having higher elasticities. Keystone is more of an intermediate local-to-regional lake (radial distance of 70 miles) and is in the upper range of the price elasticity.

One argument that can be used for regional lakes being more price inelastic is that travel costs are less important relative to the amenities provided by such lakes and the sizeable investments recreationists have in equipment. Recreationists interested in higher quality water and facilities are willing to travel greater distances to reach lakes providing such amenities. It may also be that they stay longer at the regional lakes and thus have a lower travel cost per visitor day.

Income per capita was not consistent among lakes in explaining total visitor days. The estimated regression coefficients lacked statistical significance for Lakes Eufaula and Keystone. The coefficient for Dardanelle remained negative and statistically insignificant for all three models and hence was dropped. The range of the elasticity was from 0.18 to 2.73 with no logical explanation for the variation. Measurement of the income variable is assumed to be the major cause of the insignificance and variation in the income coefficient. Per capita county income was used as the income measurement for the county concentric zones. Little variation occurs among counties in this income measurement as the extreme values are $2900 and $8200 but 53 percent of the observations are concentrated between $3800 and $5800 for all counties used in the analysis. A different result would be expected if observations on individuals or groups were used in explaining recreation participation and individual or group income measurements were available.

Population size, in general, was significant in explaining total county visitor days (all coefficients were statistically significant at the five percent level except for Lakes Dardanelle and Keystone). The range of the population elasticity was from 0.31 to 0.68. Consistency among the regional and local lakes is not apparent except that two of the three local lakes have a similar population elasticity but the third has the lowest elasticity. The important result, however, is that the total visitor days coefficient has an elasticity substantially less than unitary with respect to county population size. This result supports the literature that per capita county visitor days is a less desirable dependent variable since, in the absence of a further explanatory variable related to population base, the latter specification would assume the result of unitary elasticity for population. Less than unitary elasticity could be explained by the fact that larger county populations in general mean larger central city size. Larger central cities could mean more recreation alternatives which compete with water-based recreation at the lakes. Hence, an increase in size of popultion base leads to a less than proportional increase in total visitor days.

Th intercept term is an important factor in the double log form for locating the demand curve when plotting the price (travel cost) and quantity (visitor days) variables. The intercept term acts as a shifter of demand since its impact on visitor days is proportional to the travel cost. We can view this by fixing the levels of population and per capita income and varying only travel cost and the size of the intercept. The demand function is reduced to the following:

$$VD_{jk} = e^{a_k} A \ (CVD)_{jk}^{b_k} \qquad \text{Eq. 18}$$

where: VD_{jk} = visitor days at lake k for county j

e = base of the natural log

a_k = intercept value for lake k

A = a constant term for population and per capita income effects

$(CVD)_{jk}$ = cost per visitor day at lake k for county j

b_k = cost per visitor day (price) elasticity coefficient for lake k

Assuming similar price elasticities, the demand curve will shift out or in depending on the size of the intercept term. Higher values of a_k will shift the demand curve further to the right. To compare these shift factors among lakes, the antilog of the intercept values taken from Table 10 are given below:

Lake	Antilog of Intercept
Dardanelle	9.30
Eufaula	1.99
Fort Gibson	0.27
Keystone	0.55
Oologah	0.02
Tenkiller	0.54

The two local lakes (Oologah and Fort Gibson) have demand curves furthest to the left. Tenkiller and Keystone have similar demand curve positions whereas Dardanelle and Eufaula have demand curves located furthest to the right.

Results of the Money Plus Time Cost Model

The WLS regression results are given in Table 11 with price inclusive of money and time costs. The additional cost in terms of time causes very little change in either the R^2 measure, regression coefficients or t values. The R^2 increases marginally for Lakes Dardanelle, Keystone and Oologah and decreases marginally for Lakes Eufaula, Fort Gibson and Tenkiller in comparison to the basic model. The price elasticities increased for four lakes (Dardanelle, Eufaula, Keystone and Tenkiller) and decreased marginally for two lakes (Fort Gibson and Oologah) in comparison with the basic model. The per capita income elasticities increased for four lakes (Eufaula, Fort Gibson, Keystone and Tenkiller) and decreased for one lake (Oologah). Population elasticities increased for three lakes (Fort Gibson, Oologah and Tenkiller), remained the same for one lake (Dardanelle) and decreased for two lakes (Eufaula and Keystone).

Significant changes in the intercept terms occurred among the lakes. The antilog values for the money cost and money plus time cost models are given below for comparison purposes:

Table 11

Regression Coefficients (WLS), Double Log Form, for Total Visitor Days with Money and Time Cost Included in Cost Per Visitor Day

Lake		Cost Per Visitor Day				
		Intercept	LNP	LN(Y/P)	LNCVD	R^2
Dardanelle	1	2.73	0.31		-1.12	.76
	2		(1.49)		(-6.47)	
Eufaula	1	1.16	0.62	0.38	-1.06	.57
	2		(2.06)	(0.25)	(-5.04)	
Fort Gibson	1	-1.21	0.63	1.58	-1.05	.73
	2		(2.96)	(2.06)	(-4.40)	
Keystone	1	0.13	0.25	1.52	-1.31	.80
	2		(1.20)	(1.66)	(-5.44)	
Oologah	1	-3.10	0.62	2.51	-0.81	.81
	2		(2.69)	(2.51)	(-2.44)	
Tenkiller	1	-0.35	0.46	1.67	-0.89	.63
	2		(3.24)	(3.12)	(-4.84)	

1 --- coefficient
2 --- t value

Lake	Antilog of Intercept	
	Money Cost Model	Money Plus Time Cost Model
Dardanelle	9.30	15.33
Eufaula	1.99	3.19
Fort Gibson	0.27	0.30
Keystone	0.55	1.14
Oologah	0.02	0.05
Tenkiller	0.54	0.70

The demand curve shifts outward for all lakes.

The hypothesis that money and time costs are highly correlated is reflected by the negligible differences between the models in terms of R^2 and size and significance level of the variable coefficients. The major differences occurred in the location of the demand curves with all lakes showing an outward shift in the curve.

Recreation Benefits Per Visitor Day and Per Lake

Recreation benefits are computed as the consumer's surplus. First, visitor days were predicted for all counties in the market area using the estimated sample data demand functions and summed for a lake. A correction factor was used in the prediction model to assure that the sum of the predicted sample observations equal the sum of the actual observations (see Appendix A).

Second, consumer's surplus was calculated for each county according to Eq. 13 and summed for all counties in the market area. This sum corresponds to consumer's surplus for sample data. Maximum price (C_{kMax}) was calculated from the demand function by setting county population and per capita income equal to the average for the market area and equating county visitor days to one. This was necessary since in the double log form recreation demand never reaches zero or the vertical axis no matter how high the price. The value of one chosen for recreation visitor days (VD_k) was arbitrary. This procedure provides an operational way of solving the integration problem but it also can bias the results since the smaller the value, the greater is total consumer's surplus.

Third, the average consumer's surplus per visitor day is computed using Eq. 14. This is a weighted average based on consumer's surplus estimated for all counties in the market area using the sample data demand function. The data at this point has not been expanded to the total population level.

Fourth, total recreation benefits are estimated by multiplying the reported visitor days by the average consumer's surplus per visitor day. Reported visitor days are limited to the recreation period of May through August. This is the period for which the sample data are valid. Total visitor days are further reduced to the percentage contained in the market area as explained in Part II of this report. The equations and parameter data used for the following results are contained in Appendix A.

Basic Money Cost Model

Estimated recreation benefits and supporting data are presented in Table 12 for the basic money cost model. Predicted visitor days for the market area are given in column (2). These predictions are based on the money cost per visitor day demand functions presented in Table 10. The computed maximum price per visitor day for each lake is given in column (3). This can be interpreted as the assumed maximum price recreationists in the sampled population are willing to pay for the first visitor day in each county of the market area for a given lake. The range in the maximum price is from $20.23 to $89.15 per visitor day. The lowest price is for Lake Keystone and the highest is for Lake Tenkiller.

Table 12

Estimated Recreation Benefits and Supporting Data for the Basic Model for Six Lakes in Eastern Oklahoma and Western Arkansas, 1975

	Sample Data for 80 Percent Market Area				Total		
Lake k	Predicted Visitor Days $\hat{VD}_k$	Maximum Price (\$) C_{kMax}	Recreation Benefits (\$) CS_k	Average Benefit per Visitor Day (\$) $\overline{CS}_k$	Reported Visitor Days May-Aug. (1,000) TVD_k	Percent in Market Area $MKTGP_k$	Estimated Recreation Benefits for Market Area (\$1,000) TSB_k
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dardanelle	1,658	34.01	5,170	3.12	1,151.8	78	2,803
Eufaula	4,237	48.39	11,722	2.77	2,849.3	81	6,393
Fort Gibson	1,870	40.53	2,882	1.54	2,596.8	86	3,439
Keystone	1,466	20.23	1,764	1.20	1,916.8	83	1,909
Oologah	557	71.50	1,715	3.08	862.5	81	2,152
Tenkiller	8,520	89.15	26,502	3.11	3,556.5	85	9,402

Total recreation benefits for the sample data are given in column (4). This is equal to total consumer's surplus minus the money cost of travelling to the lake. Average benefit (consumer's surplus) per visitor day is given in column (5) and is equal to column (4) divided by column (2). The average benefit per visitor day ranges from $1.20 for Lake Keystone to $3.12 for Lake Dardanelle. Excluding Lake Oologah, the general result shows that regional lakes (Dardanelle, Eufaula and Tenkiller) have higher benefits per visitor day than the local lakes (Fort Gibson and Keystone). Lake Oologah appears to be atypical with no apparent reasoning. Since it is the smallest lake in terms of reported visitor days, these results may be influenced by sampling error.

The last three columns of Table 12 expand the data to the total lake population. In column (6) the Corps of Engineers reported visitor days are given for the months of May, June, July and August for 1975. Column (7) gives the exact percentage of the visitor days in the market area as contained in the sample data. Hence, for Lake Dardanelle 78 percent of the visitor days sampled were in the 110 mile radial distance of the lake and included 53 counties. In column (8) the estimated recreation benefits for the market area of each lake is presented and is derived by multiplying column (6) by column (7) and then multiplying this product by the average benefit per visitor day given in column (5).

Lakes Tenkiller and Eufaula show the greatest recreation benefits of the six lakes for 1975. About $9.4 million is the estimated benefits for Lake Tenkiller and $6.4 million for Lake Eufaula. These estimates are limited to the months of May through

August and for the 80 percent market area. If the average benefit per visitor day estimate is felt representative for the visitor days during other months of the year, total benefits could be expanded to include these reported visits. Similarly, if it is felt that the average benefit is a minimum for visitor days represented by individuals outside of the market area, then total benefits could be expanded using this average visitor day estimate.

Money Plus Time Cost Model

Recreation benefits estimated from the money plus time cost model are presented in Table 13. These recreation benefits were calculated in the same manner as with the basic money cost model but using the demand functions given in Table 11. The value of travel time has been included in the estimated money plus time cost demand functions. Maximum price increased for four lakes (Eufaula, Fort Gibson, Oologah and Keystone) and decreased for two lakes (Dardanelle and Keystone). Average benefit per visitor day increased for all lakes although the increase was only marginal for Lakes Dardanelle and Keystone. Lake Oologah shows an abnormal increase in average benefit per visitor day, increasing from $3.08 for the money cost model to $7.71 for the money plus time cost model. Results for this lake appear to be abnormal when compared with the relatively consistent results obtained for the other five lakes.

Excluding Lake Oologah, average benefit per visitor day ranged from a low of $1.22 for Lake Keystone to a high of $3.68 for Lake Tenkiller. Total recreation benefits ranged from $1.9 million for

Table 13

Estimated Recreation Benefits and Supporting Data for the Money Plus Time Cost Model for the Six Lakes in Eastern Oklahoma and Western Arkansas, 1975

Lake k	Sample Data for 80 Percent Market Area: Predicted Visitor Days $\widehat{VD}_k$	Maximum Price (\$) C_{kMax}	Recreation Benefits (\$) CS_k	Average Benefit per Visitor Day (\$) $\overline{CS}_k$	Total: Reported Visitor Days May-Aug. (1,000) TVD_k	Percent in Market Area $MKTGP_k$	Estimated Recreation Benefits for Market Area (\$1,000) TSB_k
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dardanelle	1,883	33.80	5,952	3.16	1,151.8	78	2,839
Eufaula	5,346	65.49	18,332	3.43	2,849.3	81	7,916
Fort Gibson	1,938	71.83	5,142	2.65	2,596.8	86	5,918
Keystone	1,595	18.88	1,941	1.22	1,916.8	83	1,941
Oologah	562	212.35	4,335	7.71	862.5	81	5,386
Tenkiller	10,807	123.51	39,790	3.68	3,556.5	85	11,125

Lake Keystone to $11.1 million for Lake Tenkiller. These estimates are all larger than those estimated from the money cost models. Theoretically, the money plus time cost model is superior to the model with only money cost.

Estimated Recreation Benefits for McClellan-Kerr Arkansas River Navigation System

Results of the estimated recreation benefits per visitor day are used to estimate an aggregated value of benefits for the entire McClellan-Kerr Arkansas River Navigation System. A number of assumptions are necessary to expand the results from the previous section to cover the entire Navigation System but in general a conservative view is taken of the estimated recreation benefit. Following are the assumptions:

1. Off-season (September to April) recreation benefits per visitor day are assumed at 60 percent of benefits during recreation period May to August. The original sample of visitor days covered only the recreation period of May to August, hence the estimated demand functions are assumed representative only of this same time period.

2. Demand functions were not estimated for visitor days recorded at the locks and dams along the Oklahoma Main channel and along the Arkansas portion of the Navigation System. These visitor day benefits are assumed representative of the local lakes and are estimated at $1.50 for the money cost model and $2.00 for the money plus time cost model.

3. Average visitor day benefit is assumed for those visitor days recorded outside the 80 percent market area. Little is known about how to estimate the demand function for these visitor days, at least using the travel cost method. The average visitor day benefit is assumed representative of these visitor days.

Recreation benefits for the entire Navigation System are presented in Tables 14 and 15 based on the money cost and money plus time cost models, respectively. Total visitor days for 1975 are recorded in column (1). This total is shown for the period May to August in column (2) and September to April in column (5). Average benefit per visitor day for the period May to August is recorded in column (3) and comes from Tables 12 and 13. Total estimated benefits for the May to August period is recorded in column (4) and for the September to April period in column (7). Aggregate benefits over both periods and by lake or area are recorded in column (8).

Aggregate benefits in 1975 for the Navigation System are estimated at $50,800,000 using the money cost model and $68,215,000 using the money plus time cost model. Approximately 60 percent of these benefits are estimaed as coming from the regional lakes of Eufaula, Tenkiller and Dardanelle. The remaining 40 percent are from the local lakes and the locks and dams.

The authors best estimate of recreation benefits for the entire Navigation System is $50 million annually.

Table 14

Estimated Recreation Benefits Based on Money Cost Model for McClellan-Kerr Arkansas River Navigation System, 1975

Lake and Area	Total Visitor Days 1975 (1,000)	Recreation Period May-August: Visitor Days 1975 (1,000)	Recreation Period May-August: Average[a] Benefit Per Visitor Day ($)	Recreation Period May-August: Estimated Benefits ($1,000)	Recreation Period Sept.-April: Visitor Days 1975 (1,000)	Recreation Period Sept.-April: Average[c] Benefit Per Visitor Day ($)	Recreation Period Sept.-April: Estimated Benefits ($1,000)	Total Estimated Benefits ($1,000)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Keystone	3,022	1,916.8	1.20	2,300	1,105.2	0.72	796	3,096
Ft. Gibson	4,110	2,596.8	1.54	3,999	1,513.2	0.92	1,392	5,391
Eufaula	4,695	2,849.3	2.77	7,893	1,845.7	1.66	3,064	10,957
Tenkiller	5,226	3,556.5	3.11	11,061	1,669.5	1.87	3,122	14,183
Oologah	1,421	862.5	3.08	2,656	558.5	1.85	1,033	3,689
Oklahoma Main Channel	2,128	1,117.2	1.50[b]	1,676	1,010.8	0.90	910	2,586
Dardanelle	2,218	1,151.8	3.12	3,594	1,066.2	1.87	1,994	5,588
Arkansas Above Little Rock (Excluding Dardanelle)	2,112	953.0	1.50[b]	1,430	1,159.0	0.90	1,043	2,473
Arkansas Below Little Rock	2,348	1,206.9	1.50[b]	1,810	1,141.1	0.90	1,027	2,837
TOTAL	27,280	16,210.8	NA	36,419	11,069.2	NA	14,381	50,800

NOTES: [a]The same benefit per visitor day was assumed for visitor days outside the market area as for inside the market area (see text).

[b]This rate was assumed representative of local visitor day benefits.

[c]Average benefit per visitor day was assumed at 60 percent of benefit during recreation period May-August.

Table 15

Estimated Recreation Benefits Based on Money Plus Time Cost Model for

McClellan-Kerr Arkansas River Navigation System, 1975

Lake and Area	Total Visitor Days 1975 (1,000)	Recreation Period May-August: Visitor Days 1975 (1,000)	Average[a] Benefit Per Visitor Day ($)	Estimated Benefits ($1,000)	Recreation Period Sept.-April: Visitor Days 1975 (1,000)	Average[c] Benefit Per Visitor Day ($)	Estimated Benefits ($1,000)	Total Estimated Benefits ($1,000)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Keystone	3,022	1,916.8	1.22	2,338	1,105.2	0.73	807	3,145
Ft. Gibson	4,110	2,596.8	2.65	6,882	1,513.2	1.59	2,406	9,288
Eufaula	4,695	2,849.3	3.43	9,773	1,845.7	2.06	3,802	13,575
Tenkiller	5,226	3,556.5	3.68	13,088	1,669.6	2.21	3,690	16,778
Oologah	1,421	862.5	7.71	6,650	558.5	4.63	2,586	9,236
Oklahoma Main Channel	2,128	1,117.2	2.00	2,234	1,010.8	1.20	1,213	3,447
Dardanelle	2,218	1,151.8	3.16	3,640	1,066.2	1.90	2,026	5,666
Arkansas Above Little Rock (Excluding Dardanelle)	2,112	953.0	2.00	1,906	1,159.0	1.20	1,391	3,297
Arkansas Below Little Rock	2,348	1,206.9	2.00	2,414	1,141.1	1.20	1,369	3,783
TOTAL	27,280	16,210.8	NA	48,925	11,069.2	NA	19,290	68,215

NOTES: [a]The same benefit per visitor day was assumed for visitor days outside the market area as for inside the market area (see text).

[b]This rate was assumed representative of local visitor day benefits.

[c]Average benefit per visitor day was assumed at 60 percent of benefit during recreation period May-August.

PART V: SIMULATED RECREATION BENEFITS

The general framework is presented here for utilizing the regression coefficients to simulate visitor days and recreation benefits over a sample of Corps of Engineers lakes outside the study area. First a brief discussion is provided on these projects in terms of their selection as candidates for simulation. The process in which the candidates were narrowed down to 15 lakes is also discussed. Next, the physical site characteristics utilized to make comparisons among these 15 lakes with those in the study area are introduced. Lastly, the simulation methodology is addressed and followed by the simulation results.

Selection of Lakes

Initially, 45 projects from the eight divisions of the Corps of Engineers were recommended by the Institute for Water Resources (IWR), as candidates to simulate visitor days using the coefficients estimated over the lakes in the McClellan-Kerr Navigation System. Their selection was communicated as not being random but based on a wide representation in supply and demand characteristics. The next step was to determine if information was available on three essential factors in incorporating each lake into the simulation analysis. Thus, a questionnaire was distributed among the Division of Engineers soliciting answers on: (1) the market area, (2) average recreational group size and (3) average length of stay during the period May through August, 1975 for the lakes in question. Item one requested information on the radial distance (miles) from which a lake drew 80 to 85 percent of its recreationists in 1975. The size of the market area is used in the first stage to distinguish between regional and local lakes. The latter two items are used in constructing the cost per visitor day values needed in the simulation procedure.

Limited records were kept on recreational visitation in the mid-seventies thus reducing the number of lakes with reasonable estimates on the characteristics cited above. Responses were obtained from 15 of the 45 Corps projects initially recommended. However, the final set represented a wide range in terms of the size of the market areas reported.

Lake Characteristics

The original intent was to pair each of the lakes outside the study area to a lake within the study area based on similar characteristics. However, because of limited time a thorough analysis and correlation of lake characteristics was not possible. Furthermore, a preliminary grouping of lakes by market area did not reveal any consistency among groups for a limited number of characteristics. Grouping of lakes by market area is given in Table 16 along with characteristics of reported visitor days (May through August), water surface area, number of campsites, average group size and average length of stay. Data are from the sample survey and the IWR's Recreation Resource Management System.

Table 16

Lake Characteristics

Market Area Radial Distance and Lake	District	State	Reported Visitor Days May-Aug. 1975 (1,000)	Water Surface Area (Acres)	Camp-sites (Number)	Average Group Size (Persons per Group)	Average Length of Stay (Days per Group)
			(1)	(2)	(3)	(4)	(5)
Local Lakes							
30 Miles							
Oolagah[a]	Tulsa	Oklahoma	862.5	29,500	252	3.95	2.30
Grapevine[b]	Fort Worth	Texas	2,541.0	7,380	36	2.80	1.00
Lavon[b]	Fort Worth	Texas	614.4	11,080	251	2.80	2.00
40 Miles							
Stillhouse Hollow[b]	Fort Worth	Texas	651.2	9,827	23	2.70	3.00
Arkabutla[b]	Vicksburg	Mississippi	672.4	11,870	293	3.80	2.20
50 Miles							
Fort Gibson[a]	Tulsa	Oklahoma	2,596.8	19,900	559	3.83	3.50
Canyon[b]	Fort Worth	Texas	984.3	8,240	176	3.30	3.00
70 Miles							
Keystone[a]	Tulsa	Oklahoma	1,916.8	24,500	394	3.47	3.05
Carlyle[b]	St. Louis	Illinois	1,323.9	26,000	708	—	—
100 Miles							
John Martin[b]	Albuquerque	Colorado	68.5	—	41	4.50	3.00
Proctor[b]	Fort Worth	Texas	464.7	4,610	113	3.10	3.00
Nimrod[b]	Little Rock	Arkansas	298.5	3,600	105	2.90	2.00
Grenada[b]	Vicksburg	Mississippi	1,051.7	34,310	300	3.40	2.40
Regional Lakes							
110 Miles							
Dardanelle[a]	Little Rock	Arkansas	1,151.8	34,300	243	3.70	2.86
130 Miles							
Eufaula[a]	Tulsa	Oklahoma	2,849.3	102,500	652	4.96	4.13
Rend[b]	St. Louis	Illinois	629.7	18,900	760	2.95	3.19
140 Miles							
Tenkiller[a]	Tulsa	Oklahoma	3,556.5	12,650	891	3.96	4.32
Conchas[b]	Albuquerque	New Mexico	129.5	6,240	158	3.00	4.00
Clearwater[b]	Little Rock	Missouri	662.2	1,650	350	3.40	2.00
Table Rock[b]	Little Rock	Missouri	3,767.4	43,100	1417	3.40	2.00
Wappapello[b]	Memphis	Missouri	1,290.2	8,400	316	6.00	5.00

[a]Estimated from sample data.

[b]Estimated by Division Engineers.

Lakes Oologah, Grapevine and Lavon have a reported 30 mile market radius. For Oologah, the market radius came from the 1975 sample survey. For Lakes Grapevine and Lavon, the market radius information came from Division Engineers. Visitor days for these three lakes ranged from 614,400 for Lavon to 2,541,000 for Grapevine. Grapevine, with the highest number of visitor days, had the smallest water surface area and the lowest number of campsites. Water surface area ranged from 7,380 acres for Grapevine to 29,500 acres for Oologah. The number of campsites ranged from 36 at Grapevine to 252 at Oologah. The average length of stay by visitors was one day at Grapevine and 2.3 days at Oologah.

Diversity among lake characteristics is evident when viewing all lakes. Lake Conchas is classified in the group with the highest market area radius but has the second lowest number of visitor days for all lakes. Lake Clearwater is in the same market area group but has the smallest water surface area of all lakes.

The point to be made is that pairing lakes outside the study area with lakes in the study area for purposes of using the demand parameters in predicting recreation benefits may be inappropriate if only market area is used in the pairing process. Therefore, an alternative procedure of classifying lakes as local or regional was used and typical demand parameter data were specified for only these two divisions. Lakes with an 80 percent market area radius of 100 miles or less are classified as local lakes and those lakes with an 80 percent market area radius greater than 100 miles are classified as regional lakes.

Parameter data from the recreation demand analysis given previously is summarized in Table 17 along with the values assumed

Table 17

Classification of Lakes and Recreation Demand

Parameter Data Used for Simulation of

Recreation Benefits

	Estimated Parameters			
		Elasticities		
	Antilog of Intercept	Population	Per Capita Income	Money Cost
Local Lakes				
Fort Gibson	0.27	0.54	1.56	-1.09
Keystone	0.55	0.31	1.48	-1.12
Oologah	0.02	0.59	2.73	-0.90
Regional Lakes				
Dardanelle	9.30	0.31	--	-0.98
Eufaula	1.99	0.68	0.18	-0.99
Tenkiller	0.54	0.43	1.64	-0.86
	Simulation Parameters			
Local Lakes	0.50	0.50	1.75	-1.00
Grapevine				
Lavon				
Stillhouse Hollow				
Arkabutla				
Canyon				
Carlyle				
John Martin				
Proctor				
Nimrod				
Grenada				
Regional Lakes	3.00	0.50	1.00	-0.95
Rend				
Conchas				
Clearwater				
Table Rock				
Wappapello				

for simulating recreation benefits for the sample of lakes outside the study area. The analysis presented here is limited to the money cost model. The population elasticity is assumed the same for both local and regional lakes at 0.50. The per capita income elasticities are assumed at 1.75 for local lakes and 1.00 for regional lakes. Price (money cost) elasticities of demand are very similar for both groups of lakes but slightly higher for local lakes (-1.00) compared to regional lakes (-0.95). The major difference is in location of the demand curve (antilog of the intercept term of the demand fucntion) which is correlated with the radial distance of the market area. For local lakes this parameter is assumed at 0.50 and for regional lakes it is assumed at 3.00.

Simulation Procedure

Average Visitor Day Benefits

Counties were identified by ten mile increments for all 15 lakes up to the 80 percent market area estimated by the Division Engineers. Distance was next calculated in road miles from the county seat to the dam site using the same process described previously for lakes in the McClellan-Kerr Navigation System. Cost per visitor day associated with each county in a lake's market area was calculated from the information provided by the Division Engineers on average group size and average length of stay. The formula used to derive the jth county cost per visitor day in relationship to the mth lake is given below:

$$CVD_{jm} = \frac{(D_{jm} \times 0.069)2}{(\overline{GSZ}_m)\ (\overline{LS}_m)} \qquad \text{Eq. 19}$$

where:

CVD_{jm} = cost per visitor day at lake m from county j

D_{jm} = distance in miles to lake m from county seat of county j

$\overline{GSZ}_m$ = average group size reported for lake m

$\overline{LS}_m$ = average length of stay reported for lake m.

County population and personal income are additional data needed in the simulation analysis. These variables are defined in the same manner as in the models for the McClellan-Kerr analyses.

Average benefit per visitor day for the 80 percent market area of each of the 15 sample lakes was computed using the procedure outlined in Appendix A. The parameter data for estimating recreation demand were taken from Table 17. Results of the simulated average benefit per visitor day for the sample of local and regional lakes are presented in Tables 18 and 19, respectively.

For Grapevine, the average benefit per visitor day is simulated at $7.74 (Table 18). For Lavon the value is $3.95. Rend Lake has a simulated value of $7.10 for each visitor day in the reported market area (Table 19).

Additional simulations were carried out for smaller market areas than reported by the Division Engineers. For example, using the same parameter data for Grapevine but assuming a 20 mile market area radius the simulated average recreation benefit per visitor day is $5.61. This is a lower value than the $7.74 simulated for the 30 mile market area radius. Lake Conchas varies in simulated visitor day benefits from $6.01 for a market area radius of 100 miles to $6.86 for a radius of 120 miles to $8.52 for a radius of 140 miles.

Table 18

Simulated Average Recreation Benefit Per Visitor Day

For Sample of Local Lakes, 1975 (Dollars)

Lake	Radius of 80 Percent Market Area in Miles								
	20	30	40	50	60	70	80	90	100
Grapevine	5.61	7.74[a]							
Lavon	1.97	3.95[a]							
Stillhouse Hollow		0.57	0.91[a]						
Arkabutla		3.20	3.09[a]						
Canyon		1.65	2.63	1.91[a]					
Carlyle					2.08	2.34[a]			
John Martin							2.33	3.30	3.36[a]
Proctor							2.97	3.79	4.75[a]
Nimrod							5.13	5.51	6.08[a]
Grenada							2.55	2.99	3.63[a]

[a]Corresponds with the 80 percent market area reported by Division Engineers.

Table 19

Simulated Average Recreation Benefit Per Visitor Day

For Sample of Regional Lakes, 1975 (Dollars)

Lake	Radius of 80 Percent Market Area in Miles				
	100	110	120	130	140
Rend		6.43	6.72	7.10[a]	
Conchas	6.01		6.86		8.52[a]
Clearwater	8.96		11.37		12.34[a]
Table Rock	7.07		8.15		9.38[a]
Wappapello	2.60		3.20		3.41[a]

[a]Corresponds with the 80 percent market area reported by Division Engineer.

Analysis of the procedures for obtaining the results for different size market areas of the same lake reveals a disturbing fact. Differences in the simulated visitor day benefits are due to: (1) mix of counties by market area relative to the demand variables of population, per capita income and travel cost (price) per visitor day; and (2) an assumed rule for integration of the benefit function. The first factor is of no concern since it is expected the demand for recreation (and subsequent benefit) will vary by county depending on the county's population size, per capita income and travel cost. Data by market area for each lake given in Appendix B does reveal that, in general, average county population and average county per capita income tends to increase as size of market area increases. This has the tendency to increase average benefit per visitor day. On the other hand, increasing the size of the market area tends to increase the average travel cost by county which should tend to decrease the average benefit per visitor day.

The second factor causes concern since it is based on an arbitrary assumption necessary for purposes of integrating the benefit function. Figure 7 and Eq. 13 show that consumer's surplus depends on the upper limit assumed for travel cost. The double log form of the recreation demand function does not allow for zero visitor days at a maximum price (travel cost). Hence, an arbitrary rule was used to set visitor days equal to a small number and solve for the maximum price. The arbitrary rule used was to set visitor days equal to one and solve for maximum price. To assure the same maximum price for all county observation of a particular lake, the price was calculated using the average county population and the average county per capita income. The result of this arbitrary assumption is a consistently higher maximum price as market size increases (see data in Appendix B). This, in turn, tends to increase average visitor day benefit as market size increases. As an example of the bias introduced from this arbitrary assumption, average visitor day benefit for Lake Conchas was computed for the 120 mile market area radius with the maximum price used for the 140 mile market area radius. Average benefit per visitor day was computed at \$7.56 versus the \$6.86 reported in Table 19 using a different maximum price. These results indicate that the difference in average visitor day benefits for the different size market area equaled \$0.96 (\$8.52-\$7.56=\$0.96) due to mix of counties and \$0.70 (\$7.56-\$6.86=\$0.70) due to the assumed integration rule. This shows that average visitor day benefit can be influenced significantly by the assumptions used for integration. The higher the cut off value for maximum travel cost (price) the higher will be consumer's surplus and the higher will be average benefits.

A second concern of the results in Tables 18 and 19 is the generally large average benefits for the simulated lakes relative to the average benefits computed for lakes in the McClellan-Kerr Navigation System. Average benefits in the McClellan-Kerr System range from \$1.20 to \$3.12 per visitor day (Table 12). For the simulated lakes average benefits range from \$0.91 to \$7.74 for the local lakes (Table 18) using the Division Engineer's estimate of market area and from \$3.41 to \$12.34 for the regional lakes (Table 19). Using the smaller market area radius the benefits ranged from \$0.57 to \$5.61 for the local lakes and \$2.60 to \$8.96 for the regional lakes.

Several factors may be responsible for the larger simulated visitor day benefits. First, the parameter data used to specify recreation demand may not be representative for all of the simulated lakes, particularly location of the demand curve as interpreted by the intercept value. Even if one has confidence in the estimated elasticities, if location of the demand curve is not correct, the estimation of recreation benefits can be highly biased. A different form of the model may be more appropriate where the elasticities are used to measure county differences from an average visitor benefit.

Second, average group size and average length of stay are important in estimating travel cost per visitor day. This information came from survey results for the McClellan-Kerr System but came from the IWR Recreation Resource Management System for the sample of simulated lakes. The product of group size and length of stay is important in computing travel cost per visitor day since distance times cost per mile is divided by this product. The larger the group size or length of stay, the lower is the travel cost per visitor day. The product of these two variables (columns (4) times (5) in Table 16) range from 10.6 to 20.5 for the regional lakes of Dardanelle, Eufaula and Tenkiller with an average of 16.1 for the three. The range of this same product for the simulated regional lakes is 6.8 to 30.0 with an average of 13.0. It is apparent that the higher the product of these two variables, the greater are average visitor day benefits. Clearwater and Table Rock have the lowest product and the highest visitor day benefits. Wappapello has by far the largest product of these two variables and the lowest visitor day benefit.

Total Benefits

Total benefits for the recreation period May through August were calculated for the sample of lakes using the reported visitor days given in Table 16 and the average visitor day benefits given in Tables 18 and 19. Results for the sample of local and regional lakes are presented in Tables 20 and 21, respectively. Results are given for the same range of market area radius as used in Tables 18 and 19. As an example, estimated benefits for the reported visitor days May through August of 1975 for Lake Grapevine equaled \$19,667,000. This assumes the 80 percent market area with a 30 mile radius as reported by the Division Engineer. If the 80 percent market area was reduced to a radius of 20 miles, the total recreation benefits are estimated at \$14,255,000. This is based on an estimated average benefit per visitor day of \$7.74 for the 30 mile radius and \$5.61 for the 20 mile radius (Table 18). These average benefit per visitor day values are two to four times larger than those reported for the local lakes in the McClellan-Kerr Navigation System (Table 13). Fort Gibson with approximately the same number of visitor days but a 50 mile radius has estimated benefits of \$5,918,000 for the same period.

For the sample of regional lakes total benefits range from \$1,103,000 for Lake Conchas with only 129,500 visitor days to \$35,338,000 for Lake Table Rock with a total of 3,767,400 visitor days. Table Rock has about 200,000 more visitor days than Lake Tènkiller but over three times the value of total recreation benefits.

Table 20

Simulated Total Recreation Benefits for Sample of Local Lakes, 1975 ($1,000)

Lake	Visitor Days May-Aug 1975 (1,000)	Radius of 80 Percent Market Area in Miles: 20	30	40	50	60	70	80	90	100
Grapevine	2,541.0	14,255	19,667[a]							
Lavon	614.4	1,210	2,427[a]							
Stillhouse Hollow	651.2		371	593[a]						
Arkabutla	672.4		2,152	2,078[a]						
Canyon	984.3		1,624	2,589	2,914[a]					
Carlyle	1,323.9				2,529	2,754	3,098[a]			
John Martin	68.5							160	226	230[a]
Proctor	464.7							1,380	1,761	2,207[a]
Nimrod	298.5							1,531	1,645	1,815[a]
Grenada	1,051.7							2,682	3,145	3,818[a]

[a]Corresponds with the 80 percent market area reported by Division Engineers.

Table 21

Simulated Total Recreation Benefits for Sample of Regional Lakes, 1975 ($1,000)

Lake	Visitor Days May-Aug 1975 (1,000)	Radius of 80 Percent Market Area in Miles				
		100	110	120	130	140
Rend	629.7		4,049	4,232	4,471[a]	
Conchas	129.5	778		888		1,103[a]
Clearwater	662.2	5,933		7,529		8,172[a]
Table Rock	3,767.4	26,636		30,704		35,338[a]
Wappapello	1,290.2	3,355		4,129		4,400[a]

[a]Corresponds with the 80 percent market area reported by Division Engineer.

REFERENCES

1. Water Resources Council. "Part IX: Procedures for Evaluation of National Economic Development (NED) Benefits and Costs in Water Resources Planning (Level C); Final Rule." Federal Register. December 14, 1979.

2. Hotelling, H. A Letter quoted by Roy E. Prewitt in An Economic Study of the Monetary Evaluation of Recreation in the National Parks. U.S. Department of Interior, National Park Service, Washington, 1949.

3. Clawson, M. Methods of Measuring the Demand for and Value of Outdoor Recreation. Resources for the Future, Washington, 1959.

4. Clawson, M. and Knetsch, J. Economics of Outdoor Recreation. Johns Hopkins Press, Baltimore, 1966.

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

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

7. Smith, Robert J. "The Evaluation of Recreation Benefits: The Clawson Method in Practice." Urban Studies. 8(1971): 89-102.

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

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

10. Flegg, A.T. "Methodological Problems in Estimating Recreational Demand Functions and Evaluating Recreational Benefits." Regional Studies. 10(1976): 353-62.

11. Bowes, Michael D. and Loomis, John B. "A Note on the Use of Travel Cost Methods with Unequal Zonal Populations" Land Economics. 56(1980): 467-70.

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

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

14. Smith, V.K. "Travel Cost Demand Models for Wilderness Recreation: A Problem of Non-Nested Hypotheses." Land Economics. 51(1975): 104-111.

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

16. Burt, O. and Brewer, D. "Estimation of Net Social Benefits from Outdoor Recreation." Econometrica. Vol. 39(1971): 813-827.

17. Moncur, J.E. "Estimating the Value of Alternative Outdoor Recreation Fcilities within a Small Area." Journal of Leisure. Vol. 7 (1975): 301-311.

18. U.S. Department of Transportation, Federal Highway Administration. Cost of Owning and Operating An Automobile-1974. Washington, D.C.

19. ___________. Cost of Owning and Operating an Automobile-1976. Washington, D.C.

20. Keith, J. and Workman, J.P. "Opportunity Cost of Time in Demand Estimates for Nonmarket Resources." Journal of Leisure Research. Vol. 7, No. 2, 121-127.

21. Harrison, A.J. The Economics of Transport Appraisal. John Wiley and Sons, New York.

22. Hamilton, J.W. and Webster, R.D. Economic Impact Forecast System, Version 2.,0: User's Manual. U.S. Army Corps of Engineers Construction Research Laboratory, Technical Report N-69, July 1979.

23. Oklahoma State Employment Security Commission and Oklahoma State Employment Service, Research and Planning Division. County Employment and Wage Data, Oklahoma 1975. Oklahoma City, November 1976.

24. U.S. Department of Commerce, Bureau of Census. 1970 Census of Population, Detailed Characteristics (by State: Arkansas, Kansas, Mississippi, Missouri, Oklahoma and Texas), Washington, D.C. Table 174, September, 1972.

25. U.S. Army Corps of Engineers, Oklahoma. Water Resources Development in Oklahoma 1981. Tulsa District, 1981.

26. Badger, Daniel D., Dean F. Schreiner, Ronald W. Presley. Analysis of Expenditures for Outdoor Recreation at the McClellan-Kerr Arkansas River Navigation System. U.S. Army Engineer Institute for Water Resources, IWR Contract Report 77-4, 1977.

27. Antle, Lloyd G. "Recreation at the McClellan-Kerr Arkansas River Navigation System." Water Resources Bulletin. 15 (1979): 1408-1417.

APPENDIX A

PROCEDURES AND PARAMETER DATA FOR COMPUTING RECREATION BENEFITS OF McCLELLAN-KERR NAVIGATION SYSTEM

1. Recreation Demand Function

$$\hat{VD}_{jk} = c_k e^{a_{1k}} \; P_j^{a_{2k}} \; (Y/P)_j^{a_{3k}} \; (CVD)^{a_{4k}}$$

where

j = county

k = lake

$\hat{VD}_{jk}$ = predicted number of sample visitor days at lake k from county j

e = base of the natural log

P_j = 1975 population of county j divided by 1,000

$(Y/P)_j$ = 1975 per capita personal income of county j divided by 1,000

$(CVD)_{jk}$ = cost per visitor day to lake k from county j

c_k = correction factor for underestimation of double log form and is equal to:

$$\sum_{j=1}^{n_k} VD_{jk} \Big/ \sum_{j=1}^{n_k} \hat{VD}_{jk}$$

a. Money cost model

Dardanelle = 1	Eufaula = 2	Fort Gibson = 3
a_{11} = 2.23	a_{12} = 0.69	a_{13} = -1.30
a_{21} = 0.31	a_{22} = 0.68	a_{23} = 0.54
a_{31} = 0.0	a_{32} = 0.18	a_{33} = 1.56
a_{41} = -0.98	a_{42} = -0.99	a_{43} = -1.09
c_1 = 1.201	c_2 = 1.505	c_3 = 2.491

Keystone = 4	Oologah = 5	Tenkiller = 6
a_{14} = -0.59	a_{15} = -3.84	a_{16} = -0.61
a_{24} = 0.31	a_{25} = 0.59	a_{26} = 0.43
a_{34} = 1.48	a_{35} = 2.73	a_{36} = 1.64
a_{44} = -1.12	a_{45} = -0.90	a_{46} = -0.86
c_4 = 1.616	c_5 = 1.274	c_6 = 1.898

b. Money plus time cost model

Dardanelle = 1	Eufaula = 2	Fort Gibson = 3
$a_{11} = 2.73$	$a_{12} = 1.16$	$a_{13} = -1.21$
$a_{21} = 0.31$	$a_{22} = 0.62$	$a_{23} = 0.63$
$a_{31} = 0.0$	$a_{32} = 0.38$	$a_{33} = 1.58$
$a_{41} = -1.12$	$a_{42} = -1.06$	$a_{43} = -1.05$
$c_1 = 1.185$	$c_2 = 1.60$	$c_3 = 2.402$

Keystone = 4	Oologah = 5	Tenkiller = 6
$a_{14} = 0.13$	$a_{15} = -3.10$	$a_{16} = -0.35$
$a_{24} = 0.25$	$a_{25} = 0.62$	$a_{26} = 0.46$
$a_{34} = 1.52$	$a_{35} = 2.51$	$a_{36} = 1.67$
$a_{44} = -1.31$	$a_{45} = -0.81$	$a_{46} = -0.89$
$c_4 = 1.506$	$c_5 = 1.269$	$c_6 = 1.845$

2. Compute the Sample Visitor Days for the 80 Percent Market Area

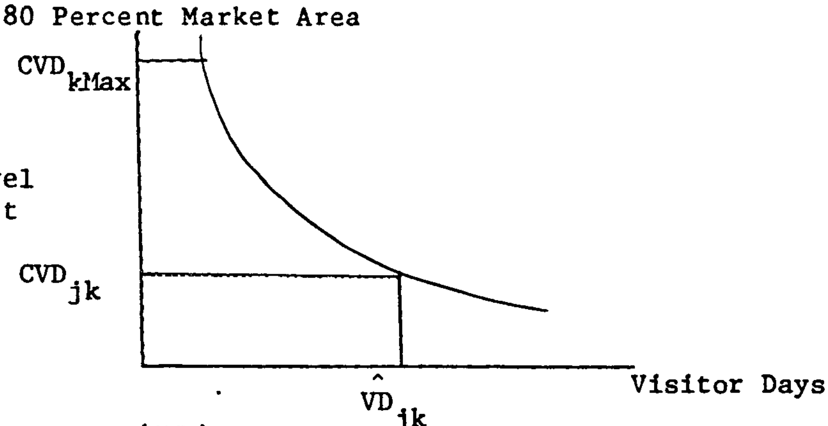
$$\hat{VD}_k = c_k \sum_{j=1}^{n_k} \hat{VD}_{jk} = c_k e^{a_{1k}} \sum_{j=1}^{n_k} \left[P_j^{a_{2k}} (Y/P)_j^{a_{3k}} (CVD)_{jk}^{a_{4k}}\right]$$

where

$\hat{VD}_k$ = predicted sample visitor days for lake k

n_k = number of counties in the 80 percent market area for lake k

3. Compute the Recreation Benefits for the Sample Visitor Days for the 80 Percent Market Area



$$CS_{jk} = \int_{(CVD)_{jk}}^{(CVD)_{kMax}} \hat{VD}_{jk} \, d\,(CVD)_{jk}$$

where

CS_{jk} = consumer surplus for sample visitor days at lake k from county j

$(CVD)_{kMax}$ = upper limit on travel cost and is computed by (1) setting the county population and county per capita income variables equal to the average for lake k and (2) setting $\hat{VD}_{jk} = 1.0$ which represents a small value.

Thus:

$$(CVD)_{kMax} = c_k^{-\frac{1}{a_{4k}}} e^{-\frac{a_{1k}}{a_{4k}}} (\bar{P})_k^{-\frac{a_{2k}}{a_{4k}}} (\overline{Y/P})_k^{-\frac{a_{3k}}{a_{4k}}}$$

where

$(\bar{P})_k$ = average county population for lake k

$(\overline{Y/P})_k$ = average county per capita income for lake k

Therefore:

$$CS_{jk} = \int_{(CVD)_{jk}}^{(CVD)_{kMax}} \left[c_k e^{a_{1k}} P_j^{a_{2k}} (Y/P)_j^{a_{3k}} (CVD)_{jk}^{a_{4k}} \right] d(CVD)_{jk}$$

Let,

$$a^o_{jk} = c_k e^{a_{1k}} P_j^{a_{2k}} (Y/P)_j^{a_{3k}}$$

Then,

$$CS_{jk} = \frac{a^o_{jk}}{a_{4k} + 1} \left[(CVD)_{kMax}^{a_{4k}+1} - (CVD)_{jk}^{a_{4k}+1} \right]$$

4. Aggregate Sample Consumers Surplus for Lake k in 80 Percent Market Area

$$CS_k = \sum_{j=1}^{n_k} CS_{jk}$$

5. Compute Average Benefit (Consumers Surplus) Per Visitor Day

$$\overline{CS}_k = CS_k / \hat{VD}_k$$

6. Expand Recreation Benefits to the Reported Corps of Engineers Visitor Days for the 80 Percent Market Area for Lake k

$$TCS_k = \overline{CS}_k \cdot TVD_k \cdot MKTGP_k$$

where

TCS_k = estimated recreation benefits for the 80 percent market area of lake k ($1,000)

TVD_k = total visitor days reported by Corps of Engineeers for lake k during months of May, June, July and August (1,000)

$MKTGP_k$ = exact market area percent of visitor days for lake k computed from sample (Table 3)

$TVD_1 = 0.78$	$MKTGP_1 = 1,151.8$
$TVD_2 = 0.81$	$MKTGP_2 = 2,849.3$
$TVD_3 = 0.86$	$MKTGP_3 = 2,596.8$
$TVD_4 = 0.83$	$MKTGP_4 = 1,916.8$
$TVD_5 = 0.81$	$MKTGP_5 = 862.5$
$TVD_6 = 0.85$	$MKTGP_6 = 3,556.5$

APPENDIX B

PROCEDURES AND PARAMETER DATA FOR SIMULATING VISITOR DAYS AND RECREATION BENEFITS FOR SAMPLE OF LAKES

1. Parameter Data for Simulating Visitor Days

$$\hat{VD}_{jm} = c_m e^{a_{1m}} P_j^{a_{2m}} (Y/P)_j^{a_{3m}} (CVD)_{jm}^{a_{4m}}$$

a. Local Lakes: Grapevine
Lavon
Stillhouse Hollow
Arkabutla
Canyon
Carlyle
John Martin
Proctor
Nimrod
Grenada

a_{1m} = -0.69315
a_{2m} = 0.50
a_{3m} = 1.75
a_{4m} = -1.00
c_m = 1.794 (taken as the average value for Lakes Fort Gibson, Keystone and Oologah)

b. Regional Lakes: Rend
Conchas
Clearwater
Table Rock
Wappapello

a_{1m} = 1.0986
a_{2m} = 0.50
a_{3m} = 1.00
a_{4m} = -0.95
c_m = 1.535 (taken as the average value for Lakes Dardanelle, Eufaula and Tenkiller)

2. Parameter Data by Radius of Market Area

$\overline{P}$ = average county population (1,000)

$\overline{Y/P}$ = average county per capita income (\$1,000)

$\overline{CVD}$ = average county travel (money) cost per visitor day (\$)

CVD_{Max} = maximum travel cost per visitor day (\$)

$\overline{CS}$ = average benefit per visitor day (\$)

Lake	Radius of Market Area					
	20	30	40	50	60	70
Grapevine						
$\overline{P}$	101.117	746.524				
$\overline{Y/P}$	5.163	6.069				
$\overline{CVD}$	1.130	1.260				
CVD_{Max}	159.480	575.130				
$\overline{CS}$	5.610	7.740				
Lavon						
$\overline{P}$	50.921	387.708				
$\overline{Y/P}$	5.808	5.798				
$\overline{CVD}$	0.310	0.490				
CVD_{Max}	139.080	382.580				
$\overline{CS}$	1.970	3.950				
Stillhouse Hollow						
$\overline{P}$		105.258	75.286			
$\overline{Y/P}$		4.699	4.599			
$\overline{CVD}$		0.380	0.610			
CVD_{Max}		136.500	112.410			
$\overline{CS}$		0.570	0.910			
Arkabutla						
$\overline{P}$		206.192	108.089			
$\overline{Y/P}$		4.554	3.939			
$\overline{CVD}$		0.460	0.700			
CVD_{Max}		182.840	102.690			
$\overline{CS}$		3.200	3.090			
Canyon						
$\overline{P}$		34.071	149.595	175.822		
$\overline{Y/P}$		4.483	4.625	4.720		
$\overline{CVD}$		0.320	0.470	0.510		
CVD_{Max}		72.320	160.030	179.770		
$\overline{CS}$		1.650	2.630	2.960		
Carlyle						
$\overline{P}$				126.345	90.230	76.788
$\overline{Y/P}$				5.347	5.283	5.360
$\overline{CVD}$				0.430	0.550	0.650
CVD_{Max}				189.570	156.870	148.420
$\overline{CS}$				1.910	2.080	2.340

Lake	Radius of Market Area		
	80	90	100
John Martin			
$\overline{P}$	6.356	12.330	11.810
$\overline{Y/P}$	6.593	6.855	6.629
$\overline{CVD}$	0.680	0.900	0.940
CVD_{Max}	61.340	91.460	84.430
$\overline{CS}$	2.330	3.330	3.360
Proctor			
$\overline{P}$	16.939	25.445	48.091
$\overline{Y/P}$	4.554	4.713	4.942
$\overline{CVD}$	0.930	1.070	1.170
CVD_{Max}	52.400	68.210	101.880
$\overline{CS}$	2.970	3.790	4.750
Nimrod			
$\overline{P}$	35.833	33.286	31.804
$\overline{Y/P}$	3.918	3.919	4.117
$\overline{CVD}$	1.680	1.970	2.190
CVD_{Max}	58.590	56.480	60.190
$\overline{CS}$	5.130	5.510	6.080
Grenada			
$\overline{P}$	23.668	24.558	38.457
$\overline{Y/P}$	3.538	3.625	3.673
$\overline{CVD}$	1.120	1.330	1.450
CVD_{Max}	39.819	42.330	54.220
$\overline{CS}$	2.550	2.990	3.630

Lake	Radius of Market Area				
	100	110	120	130	140
Rend					
$\overline{P}$		43.187	40.065	40.667	
$\overline{Y/P}$		4.945	4.915	4.938	
$\overline{CVD}$		1.420	1.560	1.650	
CVD_{Max}		194.780	185.050	188.430	
$\overline{CS}$		6.430	6.720	7.100	
Conchas					
$\overline{P}$	15.637		14.070		29.669
$\overline{Y/P}$	5.283		5.786		5.861
$\overline{CVD}$	1.250		1.450		1.650
CVD_{Max}	122.330		127.350		191.180
$\overline{CS}$	6.010		6.860		8.520
Clearwater					
$\overline{P}$	23.360		40.479		40.606
$\overline{Y/P}$	4.062		4.257		4.281
$\overline{CVD}$	2.180		2.590		3.000
CVD_{Max}	114.580		160.790		162.020
$\overline{CS}$	8.960		11.370		12.340
Table Rock					
$\overline{P}$	22.959		23.725		25.984
$\overline{Y/P}$	3.758		3.867		3.979
$\overline{CVD}$	2.010		2.350		2.730
CVD_{Max}	104.640		109.700		118.590
$\overline{CS}$	7.070		8.150		9.380
Wappapello					
$\overline{P}$	24.249		37.818		43.902
$\overline{Y/P}$	4.120		4.246		4.285
$\overline{CVD}$	0.450		0.530		0.560
CVD_{Max}	118.630		154.710		168.990
$\overline{CS}$	2.600		3.200		3.410