PLANNING OPTIMUM INVESTMENT IN WATER-BASED RECREATION THROUGH YEAR 2000 FOR LAKE FORT GIBSON IN OKLAHOMA

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INTRODUCTION

Background

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 32,000,000 (Table I). The Navigation System in its present state includes 6 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.

A study by Badger, Schreiner and Presley (1977) analyzed expenditures 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 visitor day trip expenditures averaged $6.01 and the visitor day annual 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

TABLE I

VISITOR DAYS RECREATION ATTENDANCE BY LAKE AND AREA, McCLELLAN-KERR ARKANSAS RIVER NAVIGATION SYSTEM 1950-1984 (FIGURES IN 1,000)

Year	Keyston	F. Gibson	Eufaula	Tenkiller	Oolagah	Oklahoma Main Channel	Arkansas Above Little Rock	Arkansas Below Little Rock	Total
1950	0	195	0	45	0	0	0	0	240
1951	0	489	0	93	0	0	0	0	582
1952	0	780	0	67	0	0	0	0	847
1953	0	1,287	0	552	0	0	0	0	1,839
1954	0	2,163	0	1,155	0	0	0	0	3,138
1955	0	2,746	0	1,413	0	0	0	0	4,159
1956	0	3,707	0	1,866	0	0	0	0	5,573
1957	0	3,988	0	2,130	0	0	0	0	6,128
1958	0	4,178	0	2,298	0	0	0	0	6,476
1959	0	4,213	0	2,398	0	0	0	0	6,611
1960	0	3,782	0	2,284	0	0	0	0	6,066
1961	0	3,512	0	1,627	0	0	0	0	5,139
1962	0	3,736	0	1,841	0	0	0	0	5,577
1963	0	2,479	0	1,663	324	0	0	0	4,466
1964	479	2,806	168	1,636	719	0	0	0	5,808
1965	1,582	2,466	2,305	1,782	1,148	0	1,589[n]	0	10,872
1966	2,001	2,427	2,158	1,842	937	0	1,318	0	10,683
1967	1,794	2,112	2,002	1,373	1,178	0	1,217	0	9,676
1968	1,833	2,406	2,313	1,466	1,093	0	1,034	0	10,145
1969	2,152	2,672	2,766	1,804	1,057	0	1,277	1,027	12,755
1970	2,440	2,937	3,215	2,311	966	0	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

TABLE I (Continued)

Year	Keyston	F. Gibson	Eufaula	Tenkiller	Oolagah	Oklahoma Main Channel	Arkansas Above Little Rock	Arkansas Below Little Rock	Total
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	39,198
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
1982	3,051	4,484	4,561	3,088	3,088	2,432	9,606	3,144	33,656
1983	3,105	3,544	4,059	2,134	2,524	2,688	9,150	3,290	30,494
1984	2,627	3,882	4,163	2,066	3,033	3,088	9,517	3,420	31,766

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

[a]Beginning 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

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 (1979) 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 study shows the linkages the Navigation System has with the rest of the economy through recreation activities. The study does not directly show the benefits to society from the demand for recreation. The recommended procedure (Water Resources Council, December, 1979) measures benefits in terms of willingness-to-pay for each increment of supply provided.

The primary objective of a second study by Schreiner, Willett and Badger (1983) was to estimate recreation benefits for the McClellan-Kerr Arkansas River Navigation System by the travel cost method using data from the 1974-1975 survey. The study used weighted least squares regression to estimate recreation demand functions categorized by regional lakes and local lakes. Local lakes were defined as accounting 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 were defined as having 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 was given as $50,000,000 for the Navigation System as a whole.

Problem Statement

The above studies are an analysis of the current status of recreation development in Eastern Oklahoma. However, they do not tell the policy maker what will be or should be the level of development of this major economic activity. U.S. Army Corps of Engineers maintains a facilities and site development plan for each project or lake which is referred to as the Master Plan. The Master Plan generally provides information on the historical development of the project, the current status of the project, and what is proposed for long term development of the project.

Hence, the Master Plan is a document prepared and used by the U.S. Army Corps for purposes of long term development of a particular project (lake). This study proposes to provide elements of a planning methodology useful to Project Engineers in developing a Master Plan. Application is made to Lake Fort Gibson as one project in the total McClellan-Kerr Oklahoma River Navigation System. A planning period of 25 years (1975 to 2000) is chosen to correspond with the base year of the early survey work and the end of the development period contained in the Lake Fort Gibson Master Plan (U.S. Army Corps of Engineers Master Plan for Lake Fort Gibson, 1978).

Integrating Elements of a Planning Methodology

Three factors need to be given particular consideration in the planning of recreation services in Eastern Oklahoma: 1) growth in demand for recreation, 2) cost of supplying recreation facilities and services, and 3) charges (prices) assessed for using recreation facilities and services. These factors are briefly discussed and then the need for an integrated approach to planning recreation services is presented.

Growth in demand. Growth in population and real per capita income are major factors in projecting demand for water-based recreation. Schreiner, Willett and Badger (1983) estimated demand functions using travel cost methodology for all lakes in the McClellan-Kerr Arkansas River Navigation System. That study serves as a basis for projecting recreation demand for Fort Gibson to the year 2000.

Costs of supplying recreation services. Costs of supplying recreation services include private travel costs, operation and maintenance costs, and capital costs of building new facilities and maintaining existing facilities. Travel costs provide a dual role in recreation studies. They act as a surrogate for price in estimating the demand for recreation using the travel cost methodology. However, travel costs also enter in determining the costs of supplying recreation. Hence, as travel costs increase, due in part to an increase in energy costs, the quantity of recreation services demanded should decrease.

Operation and maintenance costs are directly influenced by the number of people visiting a facility. Trash must be picked up and removed, bath houses and restrooms must be cleaned and serviced, and areas must be patrolled and safety regulations enforced. Project Engineers have a good idea of what it costs to operate and maintain their projects.

Projects are designed and built to handle a certain capacity of recreationists. The number of recreationists visiting a project is not a smooth continuous flow each day of the year or recreation season, rather, there are peak demand periods such as Memorial Day, Fourth of July and Labor Day weekends. Long term development costs must consider the possibility of maintaining existing capacity and/or increasing capacity. Although O&M costs handle routine maintenance, Project Engineers plan to refurbish recreation areas about every 15 years. These costs include such things as repairing or replacing picnic tables and camp site equipment, regrading and surfacing roads, and replacing other equipment and facilities that have deteriorated. Without a periodic refurbishing of recreation areas, the capacity of a project would decrease.

Charges for recreation. The McClellan-Kerr Arkansas River Navigation System is a multi-purpose facility but recreation is basically a secondary purpose. The system, or some variant to the current system, would not have been built on the basis of recreation only. Recreation, however, can be evaluated on the basis of separable costs and separable benefits. Development of the level of recreation services found at the Navigation System requires additional costs over and above the costs in supplying the other system purposes. The question becomes one of who will pay for these separable costs and how will the assessment of these costs affect the quantity of recreation services demanded.

The tremendous growth in recreation visitor days at the Navigation System (Table 1) has significantly increased the financial burden of maintaining the facilities and increasing the capacity of the projects to handle more visitor days. Until 1965 the costs of providing recreation services at the Navigation System by-in-large were the responsibility of the Federal government, specifically the U.S. Army Corps of Engineers. Beginning in 1971 charges or fees were assessed at some locations for overnight camping and use of certain facilities. Currently, gate attendants are hired and placed at specified locations for purposes of collecting entrance fees and assessing charges for using certain facilities.

The Federal Water Project Recreation Act of 1965 provides that construction agencies, such as the U.S. Army Corps of Engineers, should encourage non-federal agencies to operate, maintain and replace recreational facilities. The federal agency would provide one-half the cost of constructing and refurbishing the project, while the state and/or private recreationist would provide the other half, as well as all the costs of operation, maintenance and replacement.

Several consequences may result depending on the policy governing charges assessed the recreationist. Policy makers will feel pressure from groups for the following reasons:

1. Since recreation at the Navigation System is not an inferior good, the less recreationists pay for services the more they will demand and the greater will be their derived benefits. Recreationists will agitate to keep charges as low as possible.

2. State and local governments will encourage as many visitor days as possible because of the perceived multiplier benefits of recreation expenditures. If required to share in costs of constructing and maintaining additional facilities, state and local government will weigh these costs against the perceived benefits of increased economic activity. An alternative will be to pass on as much of the facility cost to the recreationist as is possible.

3. The federal government will try to reduce treasury costs as much as possible by a) charging the recreationist as much as possible, b) requiring state and local governments to cost share, or c) keeping the number of visitor days as low as possible and thus minimizing their costs.

4. Society as a whole will strive for efficiency in resource use by supplying the number of visitor days that equates the marginal social benefits derived from recreation with the marginal social costs of supplying recreation services.

There are various options that policy makers may use in charging for the use of recreation facilities. One option is to charge the full cost of supplying the recreation services and facilities. A second option is for recreationists to pay private (travel costs) plus O&M costs; the rest of the costs will be paid by the federal government. A third option is for recreationists to pay only private costs; all other costs are incurred by the government. A fourth option is based on the use of the policy guidelines in the Federal Water Project Recreation Act of 1965 where the recreationist may be asked to pay all but 50 percent of capital costs for facilities.

Integrating. The need for a consistent planning methodology becomes apparent. The demand for recreation is changing over time and must be projected over the planning period. Costs of supplying recreation services must be estimated. The equilibrium between the demand for recreation and the supply of recreation services is dynamic and must be traced out over time. Furthermore, this equilibrium is dependent upon what the recreationist is charged for services. This study will seek to provide such an integrated planning methodology.

Results of the Planning Model

Before stating the specific objectives covered in this study it might be well to state the specific results that should come out of a planning methodology as discussed above:

1. The level of development of recreation services should be a primary output of the planning methodology. This is interpreted by the time path of visitor days in attendance over the planning period. It should state the needed capacity in recreation facilities to handle the projected visitor days. This in turn will determine the level and timing of investments to build the needed capacity.

2. Since the level of development is dependent upon economic and social criteria of resource use, these criteria should be specified in the planning methodology.

3. And since social criteria of resource use in public projects such as recreation development are seldom specified without

arbitration, policy options should be presented to decision makers with the attendant measurements of such variables as private benefits, private costs, public benefits and public costs including welfare loss.

Application to Lake Fort Gibson

The choice of a lake for application within the Arkansas Navigation System was somewhat arbitrary but the following factors were considered:

1. Only lakes within the Navigation System were considered since recent recreation demand functions were estimated for those lakes.

2. Fort Gibson was catagorized as a local lake as defined by Schreiner, Willett and Badger (1983) and thus represented a more limited market area and hence reduced data requirements in estimating recreation benefits.

3. Preliminary investigation indicated data were available from the Tulsa District Corps of Engineers on costs of supplying recreation services for the lake.

4. Lake Fort Gibson had a recent updated Master Plan which could be used to check against the results of this study.

5. Finally, the planning methodology developed and applied to Lake Fort Gibson is assumed applicable to any other lake in the Navigation System.

Fort Gibson Dam is located on the Grand (Neosho) River in Wagoner and Cherokee counties, about 5 miles northeast of historic Fort Gibson, Oklahoma, from which it draws its name. Figure 1 shows the

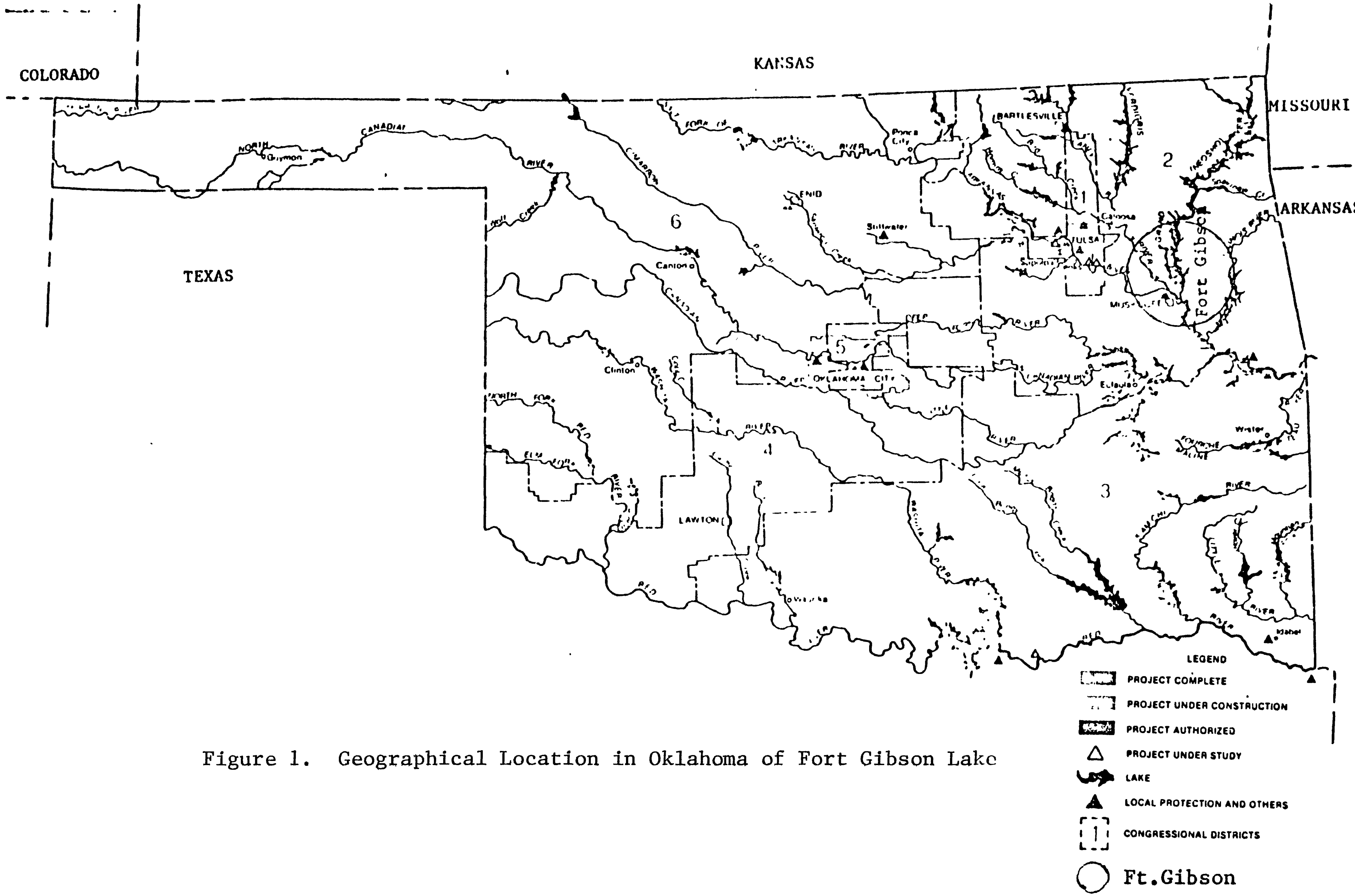

Figure 1. Geographical Location in Oklahoma of Fort Gibson Lake

geographical location in Oklahoma of Lake Fort Gibson. The Fort Gibson project was authorized by the Flood Control Act of 1941 and was incorporated into the Arkansas River multiple-purpose plan by the River and Harbor Act of July, 1946. Designed and built by the Tulsa District Corps of Engineers, the project was started in 1942, suspended during World War II, and completed in September 1953, at a cost of $42,535,000.

The recreation plan was adopted in 1946 after a joint study by the National Parks Service and the U.S. Army Corps of Engineers. The federal government authorized the corps to construct, maintain and operate public parks and recreation facilities in reservoir areas and to grant lease and license for lands, including facilities, preferable to federal, state or local government agencies (U.S. Army Corps of Engineers Master Plan for Lake Fort Gibson, 1978). The Master Plan for Lake Fort Gibson (1978) has set the development of the lake until the year 2000, which provides a comparative base for this study.

Objectives of the Study

The general objective of this study is to determine the optimal facility development for water-based recreation at Lake Fort Gibson. Specific objectives include:

1. To develop a planning methodology for recreation development at Lake Fort Gibson.

2. To project the demand for water-based recreation at Lake Fort Gibson to the year 2000.

3. To estimate the unit costs of operating, maintaining and expanding water-based recreation facilities at Lake Fort Gibson.

4. To determine the optimal facility development for water-based recreation at Lake Fort Gibson to the year 2000 based on alternative policy options concerning assessment of costs to recreationists.

5. To evaluate alternative policy options and provide guidelines for water-based recreation management at Lake Fort Gibson.

Plan of Presentation

A Proposed planning methodology for recreation facility development is presented in Chapter II. A brief discussion of the efficiency criteria for investments in recreation is given. The criteria is then used to show effects of policy options in assessing charges for recreation on efficiency of resource use and distribution of benefits and costs to the private and public sectors. Finally, elements of a mathematical programming model are presented for determining optimum facility development.

The demand relationships for recreation at Lake Fort Gibson are presented in Chapter III and factors demand are projected to the year 2000. Cost relationships are presented in Chapter IV and results of various empirical studies reviewed. Selection of cost estimates for supplying recreation services is made.

The investment programming model is formulated in Chapter V and the model components and data are assembled.

Results of the investment analyses for recreation facility development are presented in Chapter VI. Comparisons of policy options are made and comparisons with the Master Plan are highlighted.

The last chapter presents a summary and conclusions of the entire study. Limitations of the study are also mentioned and further research suggestions are proposed.

CHAPTER II

PROCEDURES FOR DETERMINING OPTIMAL RECREATION FACILITY DEVELOPMENT

Introduction

The purpose of this chapter is to develop a planning methodology for recreation facility development. Succeeding chapters will apply the planning methodology to facility development at Lake Fort Gibson. The first section briefly presents the economic efficiency criteria for determining optimum investment in recreation development by means of maximizing net social benefits. This criteria is relaxed for purposes of evaluating different policy options for assessing costs of recreation. The distribution of recreation benefits and costs are determined under the various options.

The second section presents a mathematical programming model for purposes of determining optimal recreation facility development. The last section presents a brief listing of the expected results of the analysis.

Investments in Recreation

Maximizing Net Social Benefits

The basic question to be answered is, How much investment should be made in recreation facility development? Water-based recreation would be q_o visitor days. This is the point of maximum social benefits or the point where marginal social benefits is equal to marginal social costs. To supply fewer visitor days of recreation services would be giving up some net benefits society would like to have. To supply more visitor days of recreation services, the gain in benefits to society is less than the costs to society of supplying those additional visitor days. Clearly, then, net social benefits are a maximum when q_o visitor days are supplied.

The supply of recreation visitor days can be considered for a year or for a long term planning period. For short run (annual) analysis, facility development must be considered fixed. To extend the analysis to a planning period with possible facility development requires maximizing present value of net social benefits where future benefits and costs are discounted at the social discount rate. Since the purpose of the present study is to assist Project Engineers in determining long term facility development for purposes of presenting a Master Plan, emphasis is placed on maximizing present value of net social benefits.

Seldom can all of the benefits and costs of society be identified for a particular project and frequently not all of the identified social benefits and costs can be quantified. This should not, however, prevent identifying and quantifying as many of the social benefits and costs of recreation services as possible and using this information in assisting Project Engineers in developing their Master Plan.

projects are generally public projects and the question is then one of determining how much investment should be made in developing recreation facilities at a particular project. Particular application of this study is to determine the optimal recreation facility development at Fort Gibson.

Economic theory would state that recreation facility development should take place up to the point where the marginal social benefits derived from recreation is equal to the marginal social costs of supplying recreation (Herfindahl and Kneese, 1974, Chapters II and V in particular). If all of the social benefits and social costs of recreation at a particular project can be identified and quantified as depicted in Figure 2 then the optimal recreation facility development

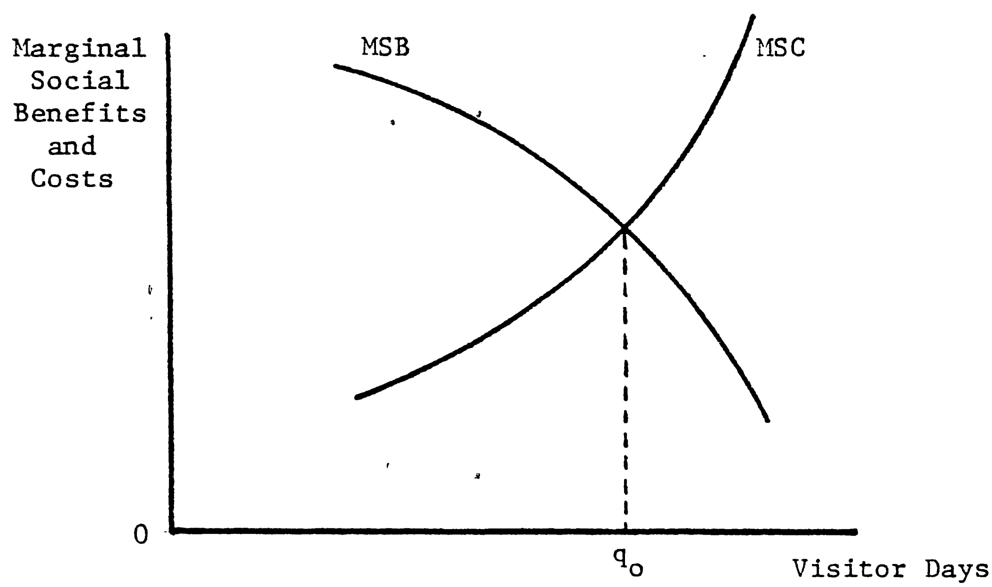

Figure 2. Marginal Social Benefit and Marginal Social Cost of Recreation Facility Development

Policy Options for Assessing Costs of Recreation

Total benefits are equated with total willingness-to-pay for recreation or the area under the demand curve for recreation. Since the area under the marginal social benefit curve (Figure 2) is also equal to total benefits, then the MSB curve is comparable to the demand curve for recreation (Herfindahl and Kneese 1974, pp 189-191). As a surrogate for marginal social benefits this study proposes to substitute benefits derived by people participating in recreation activities at Lake Fort Gibson or what might be called the private demand for recreation. This is identified as the marginal benefit (MB) or private demand curve for recreation in Figure 3. The important factor to recognize here is that this MB curve represents private benefits or only those benefits attributed to recreationists utilizing recreation services at the project. There may be additional benefits enjoyed by society from these recreation services but such benefits have not been identified or quantified.

Costs of supplying recreation services are broken down into several component parts. MTC in Figure 3 represents the marginal travel costs recreationists must pay out to participate in recreation activities at the project. The MTC curve is upward sloping since recreationists live at varying distances from the project. Presumably, those recreationists living next to the project have zero travel costs but as you move away from the project more visitor days are supplied but at a higher marginal travel cost. In application, and with delineated travel zones, the MTC is a step increase function

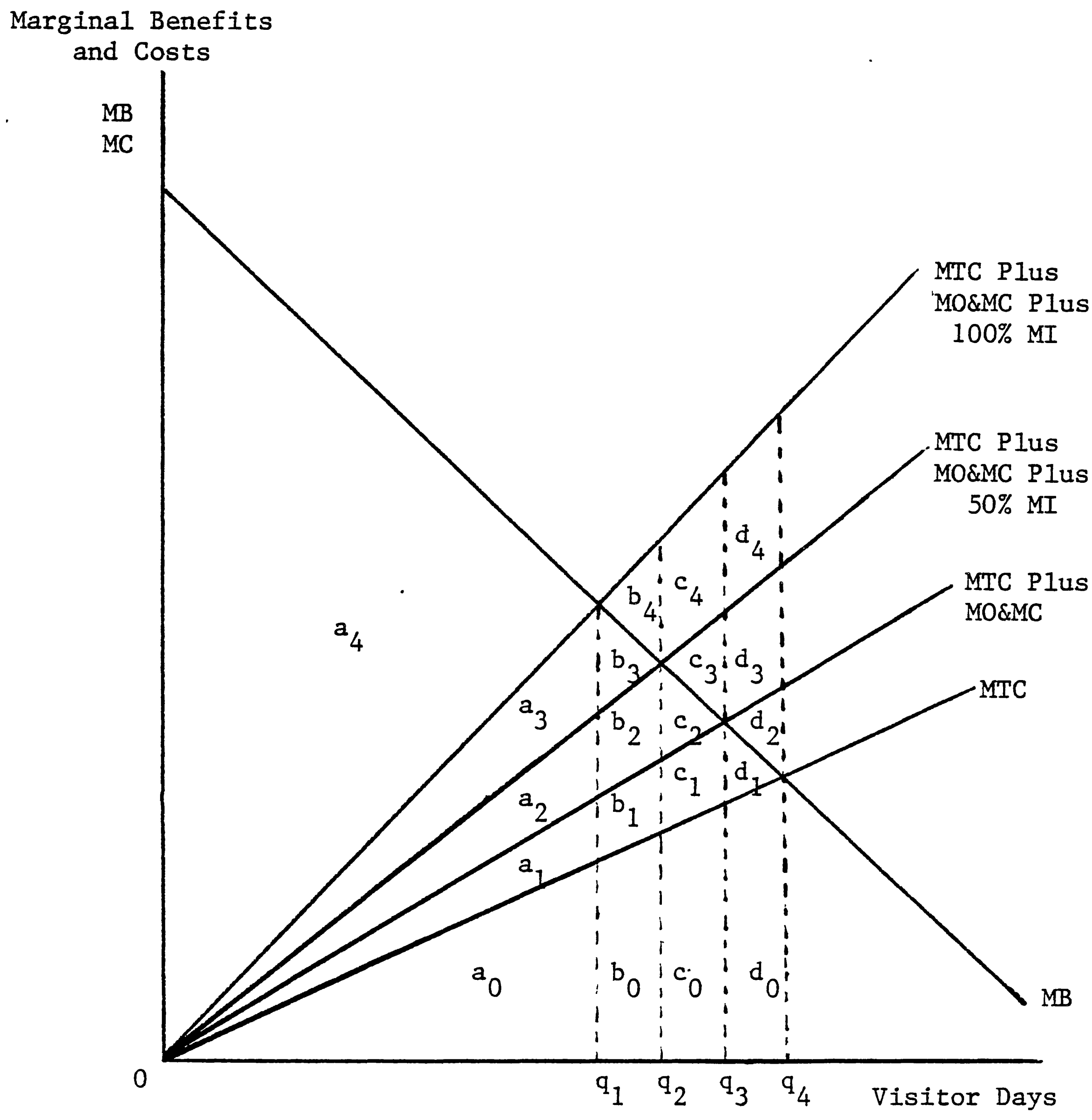

Figure 3. Identified Marginal Benefits and Marginal Costs of Recreation Facility Development

but for expository purposes it is represented here as a continously increasing function.

A second component of social cost is the cost of operation and maintenance (O&M). If O&M cost is assumed constant per visitor day (Chapter IV for estimation of O&M costs) then the marginal travel cost plus marginal O&M cost function is a fixed proportion of the MTC curve. This is identified as the "MTC Plus MO&MC" curve in Figure 3.

Costs to maintain or increase capacity is another component of the total costs of supplying recreation services. These costs are further discussed and estimated in Chapter IV. It is sufficient here to indicate that to maintain the level of capacity that currently exists at the project or to increase capacity requires additional investment. Two marginal investment cost functions are added to the MTC Plus MO&MC curve in Figure 3. The first is the "MTC Plus MO&MC Plus 50% MI" curve which includes all previously discussed costs plus 50 percent of the marginal investment costs. Past investments prior to the beginning of the current planning period are fixed and assumed not to effect current decisions on facility development. If a policy decision is made to recoup part or all of past investments in recreation services, and these costs are passed on to recreationists in the form of entrance fees, then past investments can have an effect on current decisions to use recreation facilities. However, because no entrance fees were charged before 1971 it is assumed for this study that investments in recreation facilities prior to this date are not to be recovered.

The purpose for having a curve showing a 50 percent marginal investment cost is in keeping with the guidelines of the Federal Water

Project Recreation Act of 1965 that encourages state and local participation by a 50-50 cost sharing basis of new capital expenditures. The final cost curve of Figure 3, the "MTC Plus MO&MC Plus 100% MI" curve, captures 100 percent of the marginal investment costs in addition to the marginal travel costs and the marginal O&M costs. It is this curve that comes closest to the MSC curve in Figure 2 since it identifies all of the known costs that appear in the private account of the recreationists and in the accounts of the Project Engineer. As is the case with social benefits, there may be some social costs that have not been captured. One such cost may be the cost of increased traffic on local roads leading to the project.

Assessing charges is sometimes a problem in water-based recreation. Traditionally, water-based recreation was provided free of charge to recreationists by the federal government since recreation was considered a secondary purpose to the major purpose of water projects such as flood control or navigation. With a tightening of budgets, an increased perception of large untapped recreation benefits, and a changing attitude toward public goods by the Congress, the Water Recreation Act of 1965 implies a more formal policy of charging local sectors who benefit from water-based recreation projects. However, because charging users is not yet standarized, there is ambiquity in public and private attitudes toward who should pay for water-based recreation projects.

In order to understand all aspects of the issue of pricing, four scenarios are introduced here for analysis purposes. Scenario 1 is termed the full cost model, Scenario 2 represents the Water Recreation Act of 1965 policy guideline pricing model, Scenario 3 is the O&M and private travel cost model, and Scenario 4 represents the private travel cost model. A discussion of the proposed scenarios and their pricing consequences is the following:

Scenario 1. The full cost model is the extreme case of pricing where all identified costs incurred by the recreation activity are paid in full by private recreationists. The fact that the marginal cost curves are all sloping upward implies perfect discrimination in assessing exact marginal costs to individual recreationists. In fact, this is the case. Private travel costs do discriminate individual recreationists according to distance from the project. For all practical purposes, all other costs are equal on a per visitor day basis implying marginal cost equal to average cost.

As noted earlier, there is no such project yet in water-based recreation typified by the full cost model since the view of public policy is still not totally in this direction. In this scenario it is assumed the federal government paid for all facility development up to the current planning period. But the recreationists will determine what facility development should occur over the planning period by equating their marginal benefit with the total marginal cost of supplying recreation services. In this case, private costs equal total costs. There is no public cost. The amount of recreation services provided is q_1, in Figure 3. This also reflects the closest level of output to q_0 in Figure 2.

Scenario 2. The policy guideline model (Water Recreation Act of 1965) is based on the federal government sharing in 50 percent of the new investment and refurbishing costs. The rest of the costs (i.e., the other 50 percent of new investment and refurbishing costs, O&M cost and private travel cost) are borne by the recreationists. The quantity of visitor days at the lake will be greater than under Scenario 1, since the price to the recreationists will be lower than Scenario 1. The amount of recreation services provided is q_2 in Figure 3.

Scenario 3. The O&M plus travel cost pricing model indicates that q_3 visitor days will be provided. The price that recreationists pay is equal to O&M cost and, of course, the travel cost to and from the recreation lake. The federal, state and local governments share in the costs of refurbishing and new investment.

Scenario 4. This is the other extreme case of pricing where the private sector pays only the travel cost. This has been the traditional way of pricing water-based recreation. The costs of new investment, refurbishing, and O&M are borne by the federal and/or local and state governments. The private sector or recreationists pay only their travel costs to and from the lake. This lower price increases the number of visitor days supplied to q_4 in Figure 3. Since private costs are lower, the number of visitor days tends to rise relative to the other scenarios and public costs tend to increase.

Distribution of Recreation Benefits and Costs

The four scenarios as discussed above can be compared relative to the distribution of benefits and costs between the private recreationists and the public or society as a whole. The distribution of benefits and costs are summarized in Table II and are classified according to private benefits, private costs, net private benefits, public costs, welfare loss and net social benefits. For the moment only consider the information presented in block form in Table II. These blocks correspond to the pricing policies discussed in the descriptions of the scenarios and the information contained in the blocks represents areas presented in Figure 3. That is, for Scenario 1 which corresponds with the recreationists paying full costs of recreation, the private benefits is the area $a_0 + a_1 + a_2 + a_3 + a_4$ of Figure 3. The recreationists' private costs equal the area $a_0 + a_1 + a_2 + a_3$ and hence their net private benefits are equal to a_4. For this scenario there are no public costs, no welfare loss and the net social benefit is equal to area a_4 which is the same as the area for net private benefit.

For Scenario 2 the recreationists are charged less, quantity of recreation services increases, net private benefits increase, public costs are equal to the difference between total costs and private costs, welfare loss equals area b_4, and net social benefits are reduced from the level of Scenario 1 by the amount of welfare loss.

The same trend holds for Scenarios 3 and 4: net private benefits increase; public costs increase; welfare losses increase and net social benefits decrease. It should be noted that welfare losses represent the opportunity costs of too many resources allocated to recreation relative to the returns those resources would enjoy in production of goods and services elsewhere in the economy. That is, area b_4 represents the difference in the total cost of expanding

TABLE II

DISTRIBUTION OF RECREATION BENEFITS AND COSTS BASED ON
POLICY OPTIONS OF ASSESSING RECREATION COSTS

Distribution of Benefits and Costs	Charges Made to Recreationists: Travel Cost			
	Travel Cost	Travel Cost Plus O&M Cost	Travel Cost Plus O&M Cost Plus 50% Invest.	Travel Cost Plus O&M Cost Plus 100% Invest.
	(1)	(2)	(3)	(4)
Scenario 1				
Private Benefits	$a_0+a_1+a_2+a_3+a_4$	$a_0+a_1+a_2+a_3+a_4$	$a_0+a_1+a_2+a_3+a_4$	$a_0+a_1+a_2+a_3+a_4$
Private Costs	a_0	a_0+a_1	$a_0+a_1+a_2$	$a_0+a_1+a_2+a_3$
Net Private Benefit	$a_1+a_2+a_3+a_4$	$a_2+a_3+a_4$	a_3+a_4	a_4
Public Costs	$a_1+a_2+a_3$	a_2+a_3	a_3	None
Welfare Loss	None	None	None	None
Net Social Benefit	a_4	a_4	a_4	a_4
Scenario 2				
Private Benefits	$a_0+a_1+a_2+a_3+a_4+b_0$ $+b_1+b_2+b_3$	$a_0+a_1+a_2+a_3+a_4+b_0$ $+b_1+b_2+b_3$	$a_0+a_1+a_2+a_3+a_4+b_0$ $+b_1+b_2+b_3$	
Private Costs	a_0+b_0	$a_0+a_1+b_0+b_1$	$a_0+a_1+a_2+b_0+b_1+b_2$	
Net Private Benefit	$a_1+a_2+a_3+a_4+b_1+b_2$ $+b_3$	$a_1+a_2+a_3+b_1+b_2+b_3$	$a_3+a_4+b_3$	

TABLE II (Continued)

Distribution of Benefits and Costs	Charges Made to Recreationists: Travel Cost	Travel Cost Plus O&M Cost	Travel Cost Plus O&M Cost Plus 50% Invest.	Travel Cost Plus O&M Cost Plus 100% Invest.
	(1)	(2)	(3)	(4)
Public Costs	$a_1+a_2+a_3+b_1+b_2+b_3+b_4$	$a_2+a_3+b_2+b_3+b_4$	$a_3+b_3+b_4$	
Welfare Loss	b_4	b_4	b_4	
Net Social Benefit	a_4-b_4	a_4-b_4	a_4-b_4	
Scenario 3				
Private Benefits	$a_0+a_1+a_2+a_3+a_4+b_0$ $+b_1+b_2+b_3+c_0+c_1+c_2$	$a_0+a_1+a_2+a_3+a_4+b_0$ $+b_1+b_2+b_3+c_0+c_1+c_2$		
Private Costs	$a_0+b_0+c_0$	$a_0+a_1+b_0+b_1+c_0+c_1$		
Net Private Benefit	$a_1+a_2+a_3+a_4+b_1+b_2$ $+b_3+c_1+c_2$	$a_2+a_3+a_4+b_2+b_3+c_2$		
Public Costs	$a_1+a_2+a_3+b_1+b_2+b_3$ $+b_4+c_1+c_2+c_3+c_4$	$a_2+a_3+b_2+b_3+c_2+c_3$ $+c_4$		
Welfare Loss	$b_4+c_3+c_4$	$b_4+c_3+c_4$		
Net Social Benefit	$a_4-b_4-c_3-c_4$	$a_4-b_4-c_3-c_4$		

TABLE II (Continued)

Distribution of Benefits and Costs	Charges Made to Recreationists			
	Travel Cost	Travel Cost Plus O&M Cost	Travel Cost Plus O&M Cost Plus 50% Invest.	Travel Cost Plus O&M Cost Plus 100% Invest.
	(1)	(2)	(3)	(4)
<u>Scenario 4</u>				
Private Benefits	$a_0+a_1+a_2+a_3+a_4$ $+b_0+b_1+b_2+b_3+c_0+c_1$ $+c_2+d_0+d_1$			
Private Costs	$a_0+b_0+c_0+d_0$			
Net Private Benefit	$a_1+a_2+a_3+a_4+b_1+b_2$ $+b_3+c_1+c_2+d_1$			
Public Costs	$a_1+a_2+a_3+b_1+b_2+b_3$ $+b_4+c_1+c_2+c_3+c_4+d_1$ $+d_2+d_3+d_4$			
Welfare Loss	$b_4+c_3+c_4+d_2+d_3+d_4$			
Net Social Benefit	$a_4-b_4-c_3-c_4-d_2-d_3-d_4$			

recreation from q_1 to q_2 and the total benefit of the increased recreation services. Since this difference is negative there is a welfare loss from those resources being allocated to recreation services instead of the production of alternative goods and services.

Six additional policy options have been introduced in Table 2. These policy options arise out of Scenarios 1, 2 and 3 and assume that the quantity of visitor days remains the same as in the original option but that recreationists are assessed fees less than the amount equaling their marginal benefits. As an example, assume Scenario 1 with q_1 visitor days of recreation services supplied. But instead of the recreationist being assessed costs equal to the area a_0 + a_1 + a_2 + a_3 they are assessed something less than full costs. In the above example, if the recreationists pay their individual travel costs (which discriminates among recreationists) and the O&M costs then they are assessed the areas a_0 + a_1 but the public picks up the costs corresponding to areas a_2 + a_3.

A practical problem arises, however, if the quantity of visitor days is fixed but the fee assessed recreationists is less than the amount equal to their marginal benefit. With the example above, if the recreationist is assessed only private travel cost plus O&M cost, the quantity of visitor days demanded is greater than q_1. Clearly, if only q_1 days are supplied, the Project Engineer must ration the visitor days.

The idea of rationing visitor days is not that strange to Project Engineers. During peak demand periods (i.e. Memorial Day, 4th of July and Labor Day) recreationists must arrive early to obtain the choice sites and some may decide not to stay if conditions are not suitable.

It is logical to assume that the lower the fees the greater will be the quantity of visitor days demanded and, with a fixed supply of visitor days, the more rationing of sites will have to occur.

In Table II there are three pricing options for Scenario 1 in addition to the full cost option. In each option the recreationist pays less than the full cost option and public costs increase by the amount of the reduced private costs. None of the additional options for Scenario 1, however, induces a welfare loss or changes net social benefit. As the fees assessed recreationists are reduced the more rationing of visitor days must occur. If the recreationists pay only their own private travel costs and no entrance fees, the number of visitor days demanded that must be reduced through rationing is equal to $q_4 - q_1$.

Another way of analyzing the policy options is to look down a column in Table II. Assume that the policy option is to charge no fees and the recreationists pay only their travel costs (column one in Table II). As you move from Scenario 1 to Scenario 4, the following occurs: 1) more visitor days are supplied, 2) private net benefits increase, 3) public costs increase, 4) welfare losses increase, and 5) net social benefits decrease.

Programming Optimum Recreation Facility Development

Mathematical programming is used as the analytical tool for choosing that combination of recreation facility development which maximizes present value of net recreation benefits over a planning period. Even though some of the model solutions could be obtained using classical optimization of continuous functions, approximation results from mathematical programming is chosen because of the ease in handling multiple time periods and multiple travel zones. This section discusses the planning period, discount rate, decision time unit and model formulation.

Planning Period

The 25-year planning period of 1975 to 2000 is assumed for application purposes. Several reasons are stated for this choice.

1. The year 1975 corresponds with the year surveys were taken at the Navigation System and for which demand functions were estimated.

2. The updated Master Plan for Lake Fort Gibson is to the year 2000. This document provides data for estimation of investment costs and provides a comparative base for results of this study.

3. Investments for creating new capacity are assumed to have a 25-year life. The life of such facilities can be extended if investments in refurbishing occur.

4. Assumptions on constant tastes and preferences, recreation technologies and relative prices seem more appropriate for a shorter planning period of 25 years than for a longer period.

Discount Rate

A constant 5 percent discount rate is assumed for the planning period. This rate is less than 6 and one-eighth percent used by the Water Resource Council (1975) in evaluating government multiple purpose water projects but is slightly more than the real rate of return to investments in such sectors as manufacturing and agriculture.

Decision Time Unit

To reduce the size of the programming model and to approach more realistic decision time units for adding capacity or letting of contracts for refurbishing existing capacity, 5 year decision units are assumed and the average annual result for data inputs for the 5 year decision units are entered in the program. This means that capacity can be added only once every 5 years either through refurbishing or new investment.

The Benefit Function

The benefit associated with a given consumption of recreation at Lake Fort Gibson is measured by the consumers' willingness-to-pay which is the area under the demand curve up to a specific quantity demand level. The demand for recreation at Lake Fort Gibson is a set of nonlinear functions representing the twelve counties within a 50-mile radius of Lake Fort Gibson (Chapter III).

Exogenous factors of recreation demand are projected for each county to year t in the planning period (t=1,...,25). The "willingness-to-pay" benefit function for county c is equal to:

$$f_{ct}\ (Q_{ct}) = \int_{o}^{Q_{ct}} P_c\ (Q_{ct})\ d\ Q_{ct} \qquad (2.1)$$

where Q_{ct} is the quantity of visitor days for county c in year t and $P_c\ (Q_{ct})$ is the inverse recreation demand function for county c. The annual benefit functions are discounted and summed over the planning period and over all counties to obtain total present value of gross benefits. Because of the 5 year decision time unit only one out of 5 years is counted and this 1 year represents the average of the decision time unit. Therefore, the total present value of gross benefits for the entire planning period is equal to:

$$GB = 5 \sum_{\tau=1}^{5} \sum_{c=1}^{12} \bar{\alpha}_\tau f_{c\tau}(Q_{c\tau}) \qquad (2.2)$$

where

$\bar{\alpha}_\tau$ = average annual discount factor for decision time unit τ

and is equal to $\sum_{t=(\tau-1)5+1}^{5\tau} \alpha_\tau/5$ where α_τ is the annual

discount rate for year t

$f_{c\tau}(Q_{c\tau})$ = average annual benefit function for decision time unit τ for county c

τ = 1,2,3,4,5 and represents the decision time unit periods over the 25-year planning period.

Separable programming as illustrated by Duloy and Norton (1975) is used to approximate the nonlinear concave benefit functions and to render the optimization model compatible with generally available computer techniques.

The Cost of Recreation Services

The identified costs of recreation services were presented in Figure 3 and discussed in a previous section. The general form in which costs enter the programming model are presented here with greater detail available in succeeding chapters.

Private Travel Costs. Travel costs vary by county of origination of those recreating at a project. Total travel costs for the planning period in present value is equal to the following:

$$TTC = 5 \sum_{\tau=1}^{5} \sum_{c=1}^{12} \bar{\alpha}_{\tau} \quad a_c \quad Q_{c\tau} \tag{2.3}$$

where

$\bar{\alpha}_{\tau}$ = average annual discount factor for decision time unit τ

a_c = travel cost per visitor day from county c

$Q_{c\tau}$ = average annual quantity of visitor days for decision time unit τ for county c.

Travel costs per visitor day are constant for a county but vary between counties due to varying distances.

O&M Cost. Operation and maintenance costs are assumed to be a linear function of quantity of total recreation visitor days (Q_{τ}) at the project. Present value of total O&M costs for the planning period are equal to:

$$TO = 5 \sum_{\tau=1}^{5} \sum_{c=1}^{12} \bar{\alpha}_{\tau} \cdot bQ_{c\tau} \tag{2.4}$$

where

b = cost of operation and maintenance per visitor day.

Refurbishing Cost. Recreation facilities need to be refurbished every 15 years on the average. The assumption is made in this study, however, that new facilities will last 25 years before refurbishing is required. It is further assumed that capacity of existing facilities at Lake Fort Gibson in 1975 will decrease by one-fifth in each decision time unit unless those facilities are refurbished. The programming model then can either choose to refurbish existing facilities at the assumed rate of deterioration and maintain 1975 capacity or to let capacity decrease. Costs are assumed a constant amount per visitor day of capacity refurbished. These costs are annualized and then discounted to the present for the period from the time of refurbishing to the end of the planning period.

Present value of total annualized refurbishing costs for the planning period equal:

$$TRF = 5 \sum_{j=1}^{5} \beta d R_j \sum_{\tau=j}^{5} \bar{\alpha}_\tau \tag{2.5}$$

where

β = capital recovery factor at a given discount rate for fifteen years

d = cost of refurbishing per visitor day capacity

R_j = quantity of visitor day capacity refurbished in decision time unit j.

<u>New Investment Cost</u>. Capacity to handle more visitor days at the project can increase with additional investment in recreation facilities. The expected life of new facilities is assumed to be 25 years at which time continued use is possible with refurbishing. Investment costs are annualized over the expected life of the facilities using the appropriate capital recovery factor and then discounted to the present for the period from the time of construction

to the end of the planning period. Present value of total annualized new investment costs for the planning period equals:

$$TIN = 5 \sum_{j=1}^{5} \beta e S_j \sum_{\tau=j}^{5} \bar{\alpha}_\tau \qquad (2.6)$$

where

β = capital recovery factor at a given discount rate for 25 years

e = investment cost per visitor day of additional capacity

S_j = quantity of visitor day additional capacity in decision time unit j.

Maximizing Present Value of Net Benefits

Solutions to the programming model are variations to the following objective function depending on the Scenario:

$$\text{Max } PVNB = GB - TTC - TO - TRF - TIN \qquad (2.7)$$

where

PVNB = present value of net benefits for the planning period

GB = present value of gross benefits for the planning period

TTC = present value of total travel costs for the planning period

TO = present value of total O&M costs for the planning period

TRF = present value of total annualized refurbishing costs for the planning period

TIN = present value of total annualized new investment costs for the planning period.

Objective functions for the specific Scenarios are the following:

Scenario 1

$$\text{Max PVNB} = GB - TTC - TO - (TRF + TIN) \quad (2.8)$$

Scenario 2

$$\text{Max PVNB} = GB - TTC - TO - 0.5\,(TRF + TIN) \quad (2.9)$$

Scenario 3

$$\text{Max PVNB} = GB - TTC - TO \quad (2.10)$$

Scenario 4

$$\text{Max PVNB} = GB - TTC \quad (2.11)$$

Constraints to the model are the following:

1. Recreation Supply = Recreation Demand

$$-Q_\tau + \sum_{c=1}^{12} Q_{c\tau} \leq 0 \quad (2.12)$$

where

Q_τ = quantity of visitor days supplied in time unit τ

$Q_{c\tau}$ = quantity of visitor days demanded in county c in time unit τ.

2. Recreation Capacity

$$Q_\tau - \sum_{j=1}^{\tau} R_j - \sum_{j=1}^{\tau} S_j \leq V_\tau \quad (2.13)$$

where

$\sum_{j=1}^{\tau} R_j$ = total quantity of visitor day capacity refurbished up to time unit τ

$\sum_{j=1}^{\tau} S_j$ = total quantity of visitor day capacity added up to time unit τ

V_τ = visitor day capacity in time period τ assuming no refurbishing of the 1975 capacity.

3. Maximum Refurbishing

$$\sum_{j=1}^{\tau} R_j \leq V - V_\tau \qquad (2.14)$$

where

V = visitor day capacity in 1975.

Expected Results of the Analysis

Results of the preceeding analysis should provide information useful to Project Engineers in preparing their Master Plan and in management decisions. The following are types of information made available:

1. Optimum level of facility development - the programming models provide information on the optimum timing and level of investment for refurbishing existing recreation facilities and for constructing new facilities. These results are dependent upon the Scenario assumed for assessing costs of recreation.

2. Net benefits of recreation - results of the analysis provide information on total visitor days by time period, costs of supplying total visitor days and net benefits of recreation. These results again are based upon specific Scenarios.

3. Distribution of benefits and costs - policy makers will have information on private benefits, private costs, public costs, welfare losses and net social benefits for each of the stated Scenarios. This information should be helpful in choosing among the policy options as represented by the different scenarios.

CHAPTER III

DEMAND FOR WATER-BASED RECREATION AT LAKE FORT GIBSON

This chapter sets a framework for estimating the demand for water-based recreation at Lake Fort Gibson. The method was formulated in a previous study by Schreiner, Willet and Badger (1983). The results of that study are summarized here and the estimated parameters are used to project recreation demand to the year 2000 for Lake Fort Gibson. Projected demand for recreation is then used in a mathematical programming model for purposes of obtaining optimum investment levels for recreation and in providing guidelines for managing recreation services.

Recreation Demand Based on Travel Cost Methodology

After the publication of the Federal Register on December 14, 1979 (U.S. Government, Water Resources Council, 1979), the travel cost method became a standard for estimating recreation demand and is based on the concept of willingness-to-pay for recreation benefits from federal multipurpose water projects. The travel cost method is based on early work done by Hotelling (1949) and Clawson and Knetsch (1966).

The travel cost method is based on the premise that the use of recreation facilities will decrease as out-of-pocket outlay and travel cost increases. Schreiner, Willett and Badger (1983) used this method in estimating demand for recreation at the various lakes and locks and dams on the McClellan-Kerr Arkansas River Navigation System. On the basis of these estimated demand functions, social benefits from recreation were estimated for the navigation system.

The use of the travel cost method is valid under the assumption that travel and time costs are proxies for price in determining frequency of use. The travel cost method is not valid for users who base their decisions on factors other than travel and time costs, the origin of all sample visitor days were plotted on maps relative to the lake at which they were interviewed. The data shows 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 function for recreation and is represented as the following:

$$VDAY_c = f(P_c, Pop_c, Y_c) \quad (3.1)$$

where

$VDAY_c$ = sample visitor days recorded from the 1975 sample survey at a lake for county c

P_c = price of recreation for county c and is taken as the travel per visitor for recreationists of arriving at the lake (round trip) from county c (1975 dollars)

POP_c = population of county c (1975 in 1,000)

Y_c = per capita income for county c ($1,000 in 1975).

Least squares regression was used to estimate the parameters. The double log form of the model gave the best fit to the data.

Application of Recreation Demand Estimation to Lake Fort Gibson

A survey of recreationists at Lake Fort Gibson during the period of May to August 1975 served as the basis of the demand study. A total of 146 recreation groups were interviewed at the lake. The market area for Lake Fort Gibson was determined to have a 50-mile radius from the dam site. Approximately 86 percent of the recreationists came from within the 50-mile radius and 14 percent came from outside this market area. Twelve Oklahoma counties are included in the 50-mile radius market area: Adair, Cherokee, Creek, Haskell, McIntosh, Mayes, Muskogee, Okmulgee, Rogers, Sequoyah, Tulsa and Wagoner. The estimated demand for recreation at Lake Fort Gibson based on the money cost model is the following:

$$\ln(VDAY_c) = -1.3 - 1.09\ln(P_c) + 0.54\ \ln(POP_c) + 1.56\ \ln(Y_c) \tag{3.2}$$

where

$\ln(VDAY_c)$ = natural log of the 1975 sample of visitor days recorded at Lake Fort Gibson for county c

$\ln(P_c)$ = natural log of the price of recreation (round trip travel cost per visitor day) from county c (1975 dollars)

$\ln(POP_c)$ = natural log of the population of county c (1,000 in 1975)

$\ln(Y_c)$ = natural log of per capita income for county c ($1,000 in 1975).

These results indicate that for Lake Fort Gibson the price elasticity of demand is -1.09, the income elasticity of demand is 1.56, and the population elasticity of demand is 0.54. The regression coefficients are statistically significant from zero at the 5 percent probability level or better. For further evaluation of the estimated demand function see Schreiner, Willet and Badger (1983).

Two results of the estimated demand for recreation at Lake Fort Gibson are important for the current analysis. First, equation (3.2) represents a series of demand functions for the lake: a demand function for each of the 12 counties representing the market area for Lake Fort Gibson. As population and per capita income changes for a county, and as price of recreation (i.e., energy costs) changes for a county, the demand for recreation at Lake Fort Gibson from that county will change.

Second, the demand function of (3.2) was estimated with sample data. These results must be adjusted to represent the total population of visitor days recorded for Lake Fort Gibson for 1975. Sample and total population visitor days for Lake Fort Gibson are presented in Table III. The assumption is that the population of visitor days is distributed in proportion to the sample of visitor days, both for the recreation season of May through August and for the off-season of September through April. The population to sample ratio is 1,889 and thus the results obtained using the sample data can be put on the population basis by multiplying by this factor.

TABLE III

SAMPLE AND POPULATION VISITOR DAYS AT
LAKE FORT GIBSON, 1975

County	Sample Visitor Days	Population of Visitor Days by Recreation Period[a] May-August	September-April	Total
1. Adair	10	11,565	6,739	18,304
2. Cherokee	221	263,945	153,805	417,750
3. Creek	104	124,548	72,576	197,124
4. Haskell	30	36,267	21,134	57,401
5. McIntosh	45	53,553	31,206	84,759
6. Mayes	25	30,059	17,516	47,575
7. Muskogee	403	481,689	280,689	762,378
8. Okmulgee	31	36,491	21,264	57,755
9. Rogers	88	104,984	61,177	166,161
10. Sequoyah	46	54,312	31,649	85,961
11. Tulsa	803	958,747	558,678	1,517,425
12. Wagoner	65	77,092	44,923	122,015
Total in Market Area	1,871	2,233,252	1,301,356	3,534,608
Outside Market Area	305	363,548	211,844	575,392
TOTAL	2,176	2,596,800	1,513,200	4,110,000

[a]Total visitor days for the recreation periods are from the Tulsa District of the U.S. Army Corps of Engineers.

Projection of Recreation Demand for Lake Fort Gibson

The next step is to project recreation demand. Growth of demand is crucial for purposes of planning recreation services. The next sections discuss the projection period, the projection model and the projection results.

Projection Period

The planning investment model in this study is for a 25-year period, and so is the projection of the demand for recreation. The base year is 1975 and extends till the year 2000. Five-year intervals are used to separate the decision periods of this analysis.

Projection Model

The growth in demand is influenced by three factors: population, income, and changes in price (cost) of recreation. To project recreation demand consider the following projection model:

$$VDAY_t = VDAY_o \, e^{vt} \tag{3.3}$$

where

$VDAY_t$ = visitor days at Lake Fort Gibson in time period t

$VDAY_o$ = visitor days for the base period 1975

e^{vt} = the exponential growth of visitor days where e is the base of the natural logarithm.

Therefore, the rate of growth of visitor days is equal to:

$$\frac{dVDAY}{d\,t}\,\frac{1}{VDAY} = VDAY_o \, e^{vt} \, \frac{v}{VDAY} = v \tag{3.4}$$

hence

v = rate of growth of visitor days.

Using the result of equation (3.4) and the factors of recreation demand as expressed in equation (3.2), the rate of growth in recreation demand is the following:

$$\frac{dVDAY}{d\,t}\,\frac{1}{VDAY} = \left[\frac{\partial VDAY}{\partial P}\cdot\frac{dP}{dt} + \frac{\partial VDAY}{\partial POP}\cdot\frac{dPOP}{d\,t} + \frac{\partial VDAY}{\partial Y}\cdot\frac{dY}{dt}\right]\frac{1}{VDAY}$$

$$= \frac{\partial VDAY}{\partial P}\cdot\frac{P}{VDAY}\cdot\frac{dP}{dt}\cdot\frac{1}{P} + \frac{\partial VDAY}{\partial POP}\cdot\frac{POP}{VDAY}\cdot\frac{dPOP}{dt}\cdot\frac{1}{POP}$$

$$+ \frac{\partial VDAY}{\partial Y}\cdot\frac{Y}{VDAY}\cdot\frac{dY}{dt}\,\frac{1}{Y} \qquad (3.5)$$

The following substitutions are made for equation (3.5):

$\frac{dVDAY}{dt}\,\frac{1}{VDAY}$ = v = rate of growth of recreation demand

$\frac{\partial VDAY}{\partial P}\cdot\frac{P}{VDAY}$ = -1.09 = price elasticity of recreation demand

$\frac{dP}{dt}\cdot\frac{1}{P} = p_r$ = rate of change (growth) in price of recreation

$\frac{\partial VDAY}{\partial POP}\cdot\frac{POP}{VDAY}$ = 0.54 = population elasticity of recreation demand

$\frac{dPOP}{dt}\cdot\frac{1}{POP} = p_o$ = rate of growth of population

$\frac{\partial VDAY}{\partial Y}\cdot\frac{Y}{VDAY}$ = 1.56 = income elasticity of recreation demand

$\frac{dY}{dt}\,\frac{1}{Y}$ = y = rate of growth of per capita income

thus, the following equation results:

$$v = -1.09\ p_r + 0.54\ p_o + 1.56\ y \qquad (3.6)$$

Substituting (3.6) into (3.3) gives the following:

$$VDAY_t = VDAY_o \, e^{(-1.09\ p_r + 0.54\ p_o + 1.56\ y)t} \qquad (3.7)$$

Projection Results

Once the population and income growth rates are determined for each county in the market area for Lake Fort Gibson, the growth in recreation demand for that county can be determined.

Population Growth

Population projections by county are taken from the Oklahoma Employment Security Commission (1976). These data were smoothed into an annual growth rate from 1975 to 2000 and are presented in Table IV.

Income Growth

The per capital real income growth is computed from the state of Oklahoma and assumed for the Lake Fort Gibson market area. The growth function in exponential form is the following:

$$Y_t = e^{a_o} \, e^{yt} \qquad (3.8)$$

where Y_t is per capita real income and Y_t is the rate of income growth. Taking the natural log of equation (3.8) results in the following equation which can be estimated using ordinary least squares:

$$\ln Y_t = a_o \ln e + yt \ln e \qquad (3.9)$$

TABLE IV

POPULATION GROWTH RATE BY COUNTY FOR LAKE FORT GIBSON MARKET AREA, 1975-2000

County	Population Growth Rate (P_o) (Percent)
1. Adair	1.06
2. Cherokee	2.15
3. Creek	1.04
4. Haskell	0.86
5. McIntosh	0.93
6. Mayes	2.43
7. Muskogee	0.94
8. Okmulgee	0.84
9. Rogers	1.04
10. Sequoyah	1.10
11. Tulsa	0.98
12. Wagoner	2.03

Time series data for per capita real income for the state of Oklahoma from 1969 to 1981 was used to estimate equation (3.9). The following result was obtained:

$$Y_t = e^{8.24} e^{1.91t} \quad (3.10)$$

The growth rate per capita real income is 1.91 percent per annum and this rate is assumed for all counties in the market area.

Growth in Recreation Demand

Equation (3.7) can now be used to project the level of recreation demand by county or equation (3.6) can be used to compute the growth in recreation demand by county. If it is assumed that p_r = o and y = 1.91, then the rate of growth in recreation demand by county can be computed from the following:

$$v_c = 0.54\ P_{oc} + 1.56\ (1.91) \quad (3.11)$$

where

v_c = rate of growth of recreation demand for county c

p_{oc} = rate of growth of population for county c.

The rate of growth of recreation demand by county is given in Table V.

Summary

The demand for recreation at Lake Fort Gibson is based upon the empirical results of the study by Schreiner, Willett and Badger (1983). Survey data for recreationist behavior in 1975 were used in that study. Growth in demand for the 12 counties in the Lake Fort

TABLE V

RATE OF GROWTH IN DEMAND FOR RECREATION BY COUNTY FOR LAKE FORT GIBSON MARKET AREA

	County	Growth in Demand (V_c) (Percent)
1.	Adair	3.55
2.	Cherokee	4.14
3.	Creek	3.54
4.	Haskell	3.44
5.	McIntosh	3.48
6.	Mayes	4.29
7.	Muskogee	3.49
8.	Okmulgee	3.43
9.	Rogers	3.54
10.	Sequoyah	3.57
11.	Tulsa	3.51
12.	Wagoner	4.08

Gibson market area was calculated for purposes of projecting demand through the year 2000. Results of the projected growth in county demand is important for the investment programming model used in the following chapter.

CHAPTER IV

ANALYSIS OF RECREATION COSTS AT LAKE FORT GIBSON

Introduction

This chapter presents the framework for analysis of recreation costs at Lake Fort Gibson. Costs of recreation consist of private costs, operation and maintenance costs (O&M), refurbishing costs, and new investment costs. Each of the cost categories is described and methods and procedures for estimation and analysis are presented. Survey results for 1975 are the basis for estimating private costs. Annual O&M and refurbishing costs are taken from various reports of the U.S. Army Corps of Engineer's Office in Tulsa, Oklahoma. The investment cost data are taken from the Master Plan for Lake Fort Gibson (U.S. Corps of Engineeers, 1978).

Private Costs of Recreation

Travel cost was defined as a proxy for price in estimating the demand for recreation. It is also used as the private cost for the recreationists in this study. Private costs are derived from the travel cost for recreationists originating from different points in the market area and traveling to Lake Fort Gibson.

Cost per visitor day is presented in Schreiner, Willett and Badger (1983) and is computed for Lake Fort Gibson from the following equations:

$$CVD_c = (CT_c)/AVD_c \tag{4.1}$$

$$CT_c = (D_c \; 0.069) \, . \, 2 \tag{4.2}$$

where

CVD_c = cost per visitor day for the sample of recreationists interviewed at Lake Fort Gibson from county c

CT_c = cost per trip for those recreating at Lake Fort Gibson from county c

AVD_c = average number of visitor days per trip for the sample of recreationists interviewed at Lake Fort Gibson from county c

D_c = distance in miles from county c to the dam site at Lake Fort Gibson

The variable D_c in equation (4.2) refers to the number of road miles from the county seat to the dam site at Lake Fort Gibson. The value 0.069 is the per mile cost of operating an automobile in 1975 as reported by the Department of Transportation for the following items: gas, oil, maintenance, accessories, parts, tires, and state and federal taxes. The unit mile cost is multiplied by two to obtain the round trip travel cost.

The estimated costs per visitor day are presented in Table VI. Travel costs are different for each county due to differences in distance to the lake as well as differences in average number of visitor days per trip for the sample of recreationists.

TABLE VI

PRIVATE TRAVEL COSTS PER VISITOR DAY FOR SAMPLE OF RECREATIONISTS AT LAKE FORT GIBSON, 1975

	County	Distance to Dam Site (miles)	Travel Cost Per Visitor Day ($)
1.	Adair	46	1.59
2.	Cherokee	13	0.13
3.	Creek	56	0.59
4.	Haskell	57	0.59
5.	McIntosh	49	0.45
6.	Mayes	42	1.45
7.	Muskogee	13	0.22
8.	Okmulgee	53	1.22
9.	Rogers	54	0.57
10.	Sequoyah	57	0.59
11.	Tulsa	54	0.47
12.	Wagoner	19	0.52

Operation and Maintenance (O&M) Costs

Operation and maintenance costs refer to all current year costs for direct labor, equipment, vehicles, supplies, utilities, fuel, administrative overhead, and other operating expenses needed to provide recreation services. The O&M cost is generally assumed to vary in a direct relationship to the number of visitor days. Four studies or sources of data are reviewed for estimates of O&M costs.

Reiling and Anderson (1983) estimated that O&M costs constituted about 72 percent of total costs of campground operations and 69 percent of total costs of day use facilities. O&M costs averaged about $425 per campsite per year or $1.44 per visitor day. The main categories for O&M costs were as follows:

1. Personal services

   Permanent regular salary

   Seasonal regular salary

   Overtime

   Health insurance and retirement

   Clothing and telephone allowance

2. Other O&M costs

   Professional services

   Travel

   Gasoline and oil

   Miscellaneous vehicle expenses

   Telephone and electricity

   Repairs

   General operating, postage and office supplies

Other supplies

Workmen's compensation

The second study on water-based recreation facility costs is for the U.S. Army Corps of Engineers' lakes of Kaw and Keystone and estimated by Jordan, Badger and Schreiner (1976). O&M costs were estimated at $0.13 per visitor day.

A third source of data for annual O&M costs was provided by private communication with the Tulsa District of the U.S. Army Corps of Engineers for Lake Fort Gibson and for the 1983 fiscal budget year. The summary of O&M costs is as follows:

Categories	Cost
Labor, materials and supplies, vehicles, equipment, administrative costs	$498,500
Cleaning contract (parks only)	55,000
Mowing contract (parks only)	19,500
Gate attendant contracts (some parks)	32,000
Total	$605,000

The average O&M cost for 1983 is computed at $0.14 per visitor day.

The fourth study reviewed for O&M costs was the Master Plan (U.S. Corps of Engineers, 1978) for Lake Fort Gibson. The annual operation and maintenance cost in 1978 prices was $580,000. An implicit price deflator was used to adjust O&M costs from the Master Plan back to the base period of 1975. The O&M cost in 1975 prices is about $0.12 per visitor day. It is this value that is taken as representative of O&M costs for Lake Fort Gibson per visitor day for 1975.

Refurbishing Cost

Recreation public use areas are refurbished periodically to repair damages, improve roads, replace worn equipment and upgrade facilities. Refurbishing costs are normal costs but do not appear in the annual operation and maintenance budget. To maintain facilities at the designed capacity, however, refurbishing must be done on a periodic basis.

The data for cost of refurbishing were not provided separately from investment costs in the Fort Gibson Master Plan. An estimate is made based on 1983 figures from the Corps of Engineers that show refurbishing is done every 15 years at a cost of about $1,000 per campsite. When deflated to 1975 prices, the result for refurbishing costs for Fort Gibson is $836.24 per campsite.

In 1975 there were 559 campsites operating at the lake. In the same year, total visitor days was 4,100,000. Therefore, an average number of visitor days per campsite is 7,335. The costs of refurbishing per visitor day is estimated at about $0.11 in 1975 prices. Since the Corps of Engineers estimates that refurbishing lasts for an average of 15 years, the unamortized cost per year is about $0.0076 per visitor day. The amortized cost per visitor day at 5 percent discount rate is $0.010984 (the capital recovery factor used for 15 years at 5 percent is 0.096342).

New Investment for Increasing Capacity

The 1978 Master Plan for Lake Fort Gibson indicates that an investment cost of $4,751,000 is necessary to support the increase from 4.1 million visitor days in 1975 to 6.5 million in 2000. In 1975 prices, this is equal to $3,972,967.

If it is assumed that the cost per year per visitor day to keep the 4.1 million capacity refurbished is $0.0076 (see previous section) then the total refurbishing costs are 4.1 million x $0.0076 x 25 years = $779,000. The amount remaining is assumed available for new facilities:

Master Plan Investment	$3,972,967
Minus estimated refurbishing cost	779,000
Investment for new facilities	$3,193,967

Since the projected increased capacity is 2.4 million visitor days, the investment cost per visitor day capacity is $1.33 ($3,193,967 - 2,400,000 = $1.33). Assuming a 25 year life for investment in new facilities, amortized cost at 5 percent discount rate is $0.094366 per visitor day.

Investment costs for increasing capacity as derived from the 1978 Master Plan for Fort Gibson is compared to recent investments in public use areas for Big Hill Lake at Big Hill Creek, Kansas. The project in 1980 called for facilities that included 147 picnic units or campsites. The government cost estimate was $3,420,761 or an average of $23,270 per site. The lowest private contract bid was $2,987,720 or an average of $20,325 per site. If we assume the average number of visitor days per site as existed at Fort Gibson for 1975 (7,335) this would equal an investment cost of $3.17 per visitor day for the government bid and $2.77 per visitor day for the lowest bid price. This equals $2.26 and $1.97, respectively, as the investment cost per site in 1975 prices.

The visitor day investment cost of $1.33 as derived from the 1978 Master Plan is used in further development of this study.

Summary

There are four major cost components in supplying recreation services: 1) private or travel cost, 2) operation and maintenance cost, 3) refurbishing cost, and 4) new investment cost. The empirical results of private cost for each county is shown in Table VI. The private cost ranges from $0.13 for Cherokee County to $1.59 for Adair County. These estimates are based on survey results developed in a previous study. O&M cost are reviewed from four different studies. Data from the Master Plan for Lake Fort Gibson are used as the basis for calculating the O&M cost and in terms of 1975 prices these costs are equal to $0.12 per visitor day. The refurbishing cost is calculated using information from the U.S. Army Corps of Engineers about frequency of refurbishing and cost of refurbishing per campsite. The amortized refurbishing cost is calculated at $0.011 per visitor day per year. The amortized cost for investment in new capacity is calculated at $0.094 per visitor day per year. These cost per visitor day components are used in the succeeding chapter in formalizing the investment programming model.

CHAPTER V

INVESTMENT MODEL FORMULATION

Introduction

This chapter is intended to accomplish two main purposes: 1) to present the model components and data for the programming models as outlined in Chapter II, and 2) to formulate the programming model. The succeeding chapter presents an analysis of the programming results and a discussion of policy and management guidelines for recreation development at Lake Fort Gibson.

Model Components and Data

This section contains the data for the recreation benefit and cost functions as they are used in the model. The following section contains the model formulation.

The Benefit Functions

As explained in Chapter II, the benefits associated with a given consumption of recreation are measured by the consumers' willingness-to-pay or the area under the demand curve for recreation. The demand for recreation from county c at Lake Fort Gibson is the following (Chapter III):

$$VDAY_c = 2.491 \; e^{-1.30} \; P_c^{-1.09} \; Y_c^{1.56} \; POP_c^{0.54} \qquad (5.1)$$

where

$VDAY_c$ = sample visitor days demanded at Lake Fort Gibson for county c

e = natural logarithim

P_c = price of recreation (as round trip travel cost per visitor day from county c (1975 dollars)

Y_c = per capita income for county c ($1,000 in 1975)

POP_c = population of county c (1,000 in 1975)

2.491 = a correction factor used in the prediction model to assure that the sum of the predicted sample observations equals the sum of the actual observations (See Schreiner, Willett and Badger, 1983 page 56). For further discussion concerning the prediction bias with logarithmic dependent variable, see Kennedy (1983).

-1.30 = intercept value

-1.09 = price elasticity of recreation demand

1.56 = income elasticity of recreation demand

0.54 = population elasticity of recreation demand

Two factors should be noted for the recreation demand function given in equation (5.1). First, this function is representative of the sample of visitor days. It must be multiplied by 1,889 to represent the population of visitor days (Table III of Chapter III). Second, this function is representative of each of the twelve counties making up the market area for Lake Fort Gibson and for any particular time period.

Using the information from Chapter III, the growth in recreation demand for any particular county can be represented as in Figure 4. $VDAY_{co}$ represents the demand function for the base period (1975) and growth shifts the function to the right for each additional decision time unit until $VDAY_{c5}$ represents average annual demand for the period 1995-2000.

Following Chapter II, the benefit function can be expressed in present value as the following:

$$f_{c\tau}\ (VDAY_{c\tau}) = \bar{\alpha}_{\tau} \int_{o}^{VDAY_{c\tau}} P_c\ (VDAY_{c\tau})\ d\ VDAY_{c\tau} \qquad (5.2)$$

where

$f_{c\tau}(VDAY_{c\tau})$ = present value of recreation benefits for county c in decision time unit τ

$\bar{\alpha}_{\tau}$ = average annual discount factor for decision time unit τ

$P_c\ (VDAY_{c\tau})$ = inverse recreation demand function for county c in decision time unit τ

Two factors need to be noted for the benefit function (5.2): 1) the exponential function of equation (5.1) is undefined at $VDAY_{c\tau} = 0$ and hence equation (5.2) is not differentiable, and 2) the solution of equation (5.2) is dependent upon the level of visitor days ($VDAY_c$) and hence becomes a nonlinear element in the objective function of the linear programming model.

First, consider the undefined nature of equations (5.2) for $VDAY_{c\tau} = 0$. An arbitrary decision rule is proposed to solve the integral of equation (5.2). The observed prices (P_c) for the twelve

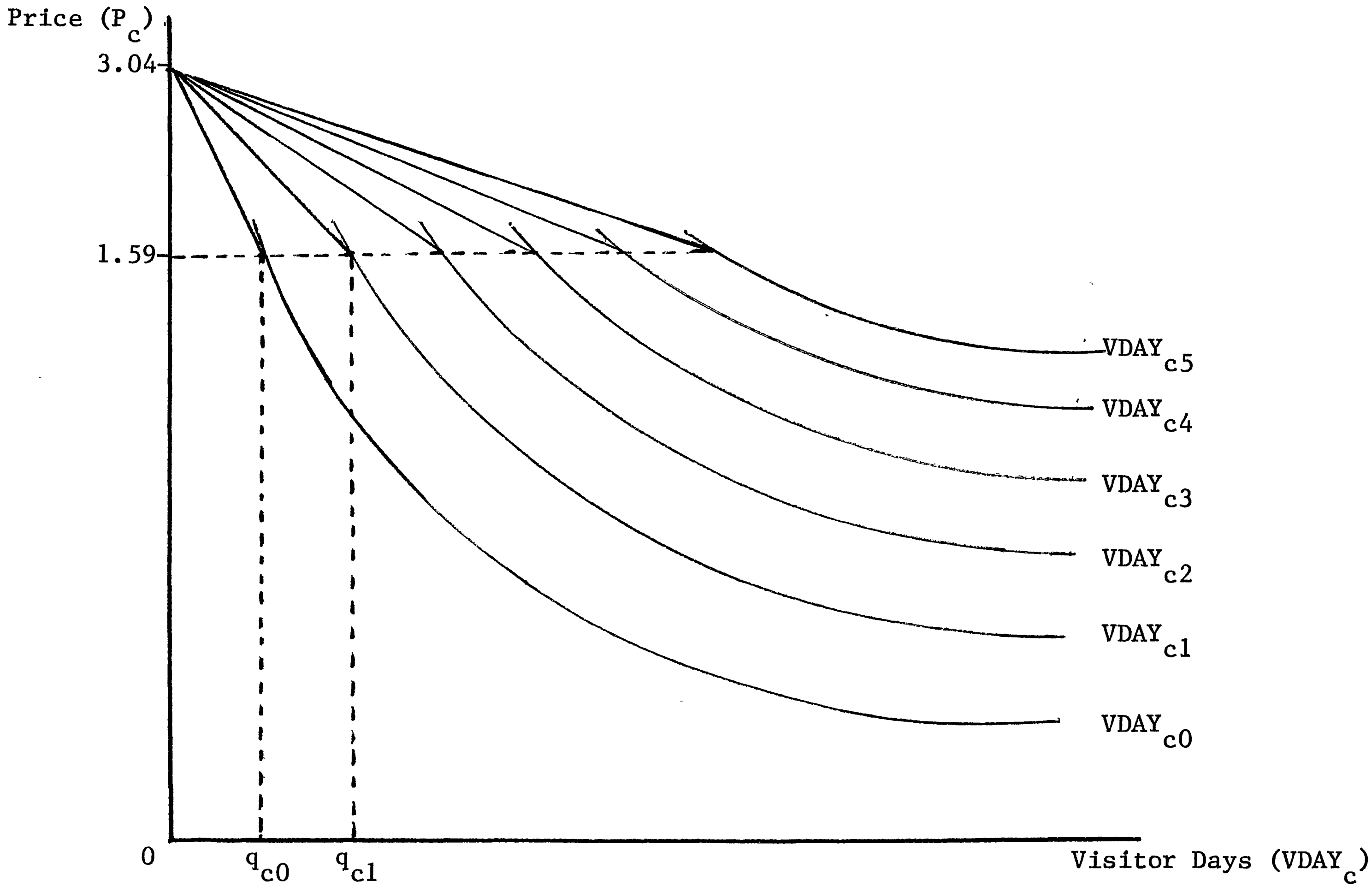

Figure 4. Recreation Demand for County c at Lake Fort Gibson

counties are given in Table VI of Chapter IV. The range is from $0.13 for Cherokee county to $1.59 for Adair county. This might be interpreted as the relevant range of the demand function. If at the price of $1.59 the slope of the demand function is determined and then the intercept of this slope solved on the P_c axis, a two stage integration process can be used to determine the area under the demand curve. This procedure has been completed in Figure 4 and the intercept price computed at $3.04. Equation (5.2) can be replaced with the following equation:

$$f'_{c\tau}\ (VDAY_{c\tau}) = \bar{\alpha}_\tau \Big\{ [1.59\ q_{c\tau} + 0.5\ (3.04 - 1.59)\ q_{c\tau}] + \int_{q_{c\tau}}^{VDAY_{c\tau}} P_c\ (VDAY_{c\tau})\ d\ VDAY_{c\tau} \Big\} \quad (5.3)$$

Consider the sample demand function for Cherokee county in the base period 1975:

$$VDAY_o = 2.491\ e^{-130}\ P_o^{-1.09}\ Y_o^{1.56}\ POP_o^{0.54} \quad (5.4)$$

and since $Y_o = 3.267$ and $POP_o = 25.41$ in 1975, equation (5.4) becomes:

$$VDAY_o = 24.689\ P_o^{-1.09} \quad (5.5)$$

When $P_o = 1.59$ as proposed above, $VDAY_o = 14.923$ which is the same as q_{co} in Figure 4. The inverse demand function from equation (5.5) is equal to:

$$P_o = 18.946\ VDAY_o^{-0.917} \quad (5.6)$$

The solution to the benefit function of equation (5.3) for the base year for Cherokee county is equal to:

$$f_o'(VDAY_o) = [1.59\ (14.923) + 0.5\ (3.04 - 1.59)\ (14.923)] + \int_{14.923}^{VDAY_o} 18.946\ VDAY_o^{-0.917}\ d\ VDAY_o = 229.454\ VDAY_o^{0.08257} - 252.293 \qquad (5.7)$$

Clearly, equation (5.7) shows that the benefit function is nonlinear and is increasing at a decreasing rate.

The second consideration is how to formulate the benefit function to render the optimization model compatible with currently available computer techniques. Piecewise or grid linearization is proposed following Duloy and Norton (1975). Grid linearization requires prior specification of a relevant range of values of the demand curve and the use of variable interpolation weights on the grid point. The interpolation weights become variables in the model and their values are jointly constrained by a set of convex combination constraints.

The procedure is applied to Cherokee county for purposes of exposition. The relevant range of the demand curve for Cherokee county in the base year is shown in Figure 5. The relevant range of the demand curve is from a price of \$1.59 per visitor day down to \$0.13 which is the travel cost for Cherokee county (Table V of Chapter IV). The corresponding sample visitor days are 14.92 and 221.01, respectively.

The relevant range of the demand curve is partitioned into 11 segments by evenly dividing the difference between the quantity of

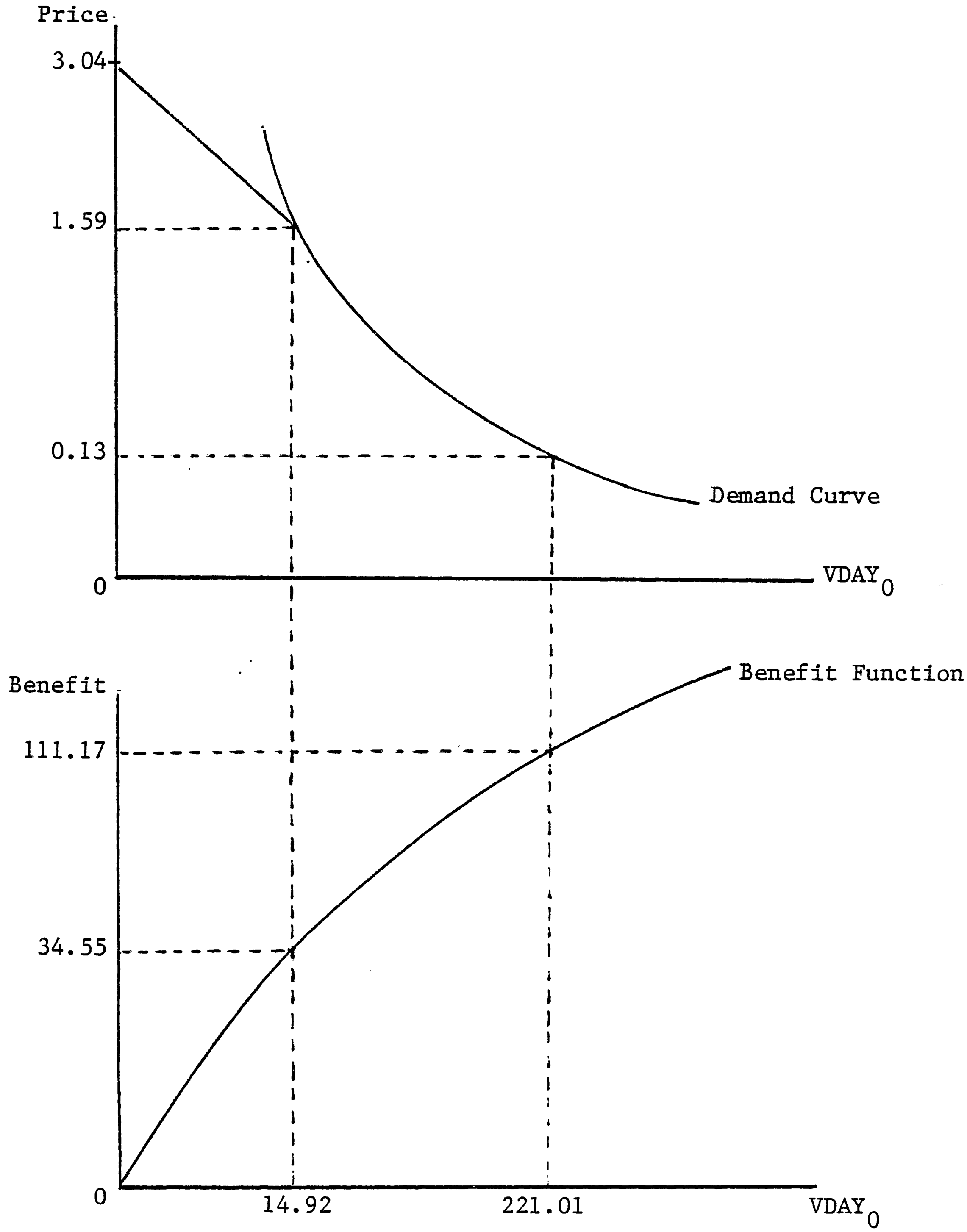

Figure 5. Recreation Demand and Benefit Functions for Cherokee County in Base year

visitor days at a price of $0.13 and the quantity at a price of $1.59 into 10 parts. The quantity of visitor days for each segment is given in Column (1) of Table VII. For each segment end point the cumulative area under the demand curve is computed and recorded in Column (1) of Table VII. Hence, for segment 1, the quantity of sample visitor days is 14.92 and the benefit is 34.55 whereas for segment 11, the quantity of sample visitor days is 221.01 and the benefit is 116.17.

The quantity of visitor days and the total area under the demand curve can be expressed as a weighted combination of the segments:

$$Q = \sum_{s=1}^{11} Q_s W_s$$

$$B = \sum_{s=1}^{11} B_s W_s$$

where W_s is a weight variable such that $\sum_{s=1}^{11} W_s \leq 1$. Duloy and Norton show that no more than 2 consecutive points on the quantity (VDAY) axis will enter the optimal basis.

A similar set of segments are computed for the projected demands in each of the decision time units. These segments in terms of quantity of visitor days and discounted benefits are presented for Cherokee county in Table VII. Similar tables for the other 11 counties are presented in the Appendix. It should be noted that the benefits are all presented in present value by applying the appropriate discount factor for each decision time unit.

The Cost Functions

Cost of recreation services have been identified to include: 1) private travel costs, 2) O&M costs, 3) refurbishing costs, and 4) new

TABLE VII

QUANTITY AND DISCOUNTED BENEFIT OF SEGMENTED DEMAND FOR CHEROKEE COUNTY BY DECISION TIME UNIT

Segment	Quantity (Q) Benefit (B)	Decision Time Units 1975	1975-1980	1980-1985	1985-1990	1990-1995	1995-2000
		(1)	(2)	(3)	(4)	(5)	(6)
1	Q (VDAY)	14.92	16.88	20.75	25.46	31.28	38.43
	B ($)	34.55	33.84	35.58	31.33	30.16	29.04
2	Q	35.53	40.20	49.40	60.62	74.47	91.51
	B	55.85	54.71	52.67	50.65	48.75	46.94
3	Q	56.14	63.52	78.05	95.78	117.66	144.58
	B	67.71	66.33	63.86	61.60	59.10	56.91
4	Q	76.75	86.83	106.70	130.94	160.85	197.65
	B	76.08	74.55	71.75	68.99	66.41	63.94
5	Q	97.36	110.15	135.35	166.10	204.04	250.73
		82.59	80.93	77.90	74.90	72.09	69.42
6	Q	117.97	133.46	164.00	201.25	247.23	303.80
	B	87.94	86.17	82.94	79.75	76.76	73.92
7	Q	138.97	156.78	192.25	236.41	290.42	356.88
	B	92.49	90.64	87.24	87.88	80.74	77.74
8	Q	159.18	180.10	221.30	271.57	333.62	409.95
	B	96.46	94.52	90.98	87.48	84.20	81.80
9	Q	179.79	203.41	249.95	306.73	376.81	463.02
	B	99.99	97.48	94.31	90.68	87.28	84.04
10	Q	200.40	226.73	278.60	341.89	463.19	516.10
	B	108.28	101.08	97.29	93.55	90.05	86.70
11	Q	221.01	250.04	307.25	377.05	463.19	569.17
	B	116.17	103.91	100.02	96.17	92.56	89.13

investment costs. In addition, fixed costs of past recreation development must be considered in the context of constraints to current capacity.

Fixed Costs. Recreation development that occured prior to 1975 is fixed. Two assumptions are made relative to these fixed costs. First, it is assumed that the recreation facilities in existence in 1975 were used at their capacity and this capacity is measured by the number of recreation visitor days in 1975. This would mean that recreation capacity for Lake Fort Gibson at the beginning of the planning period was 4,100,000 visitor days. Supporting evidence of this assumption is the fact that the Master Plan of 1978 recommends additional investments in recreation facility development. As explained earlier, more visitor days can always be handled in nonpeak demand periods but direct observation would show that during peak periods most lakes in Eastern Oklahoma were crowded during the holiday weekends at this period of time.

The second assumption pertains to the need for refurbishing of existing facilities and the reduction in capacity if such refurbishing does not take place. No information is available on the need for refurbishing at Lake Fort Gibson other than the indirect knowledge that facilities should be refurbished on the average every fifteen years. The assumption is made here that the original capacity of 4,100,000 visitor days will show a straight line decay function from the beginning of the planning period to the end of the planning period. Hence, if no refurbishing took place during the planning period, by the year 2000, capacity at Lake Fort Gibson would be zero visitor days.

Capacity constraints by decision time unit are presented in Table VIII. A straight line decay function is represented by column (2) of Table VIII. Column (3) shows the amount of capacity used by the market area and is equal to 86 percent of column (2). This column represents the V_τ constraint given in equation (2.12). Column (4) represents the maximum refurbishing that can take place to reestablish capacity for the market area. This column represents the $(V-V_\tau)$ constraint in equation (2.13).

Private Travel Costs. Travel costs by county and by decision time unit are presented in Table IX. The base period travel costs are from Table VI. These costs are discounted to present value for each of the decision time units. These costs are comparable to the $\bar{\alpha}_\tau\ a_c$ values as expressed in equation (2.2).

O&M Costs. O&M costs are defined for the lake and apply to all visitor days. The present value of O&M costs are given in column (2) of Table X and compare with the values of $\bar{\alpha}_\tau\ b$ as presented in equation (2.3).

Refurbishing Costs. Refurbishing costs by decision time unit are presented in column (2) of Table X and compare with the values of $\beta d \sum_{\tau=j}^{5} \bar{\alpha}_\tau$ as given in equation (2.4). The refurbishing cost of $0.03 for the decision time unit 1975-1980 is interpreted as the present value of the annualized cost for refurbishing one visitor day during this time unit and that this visitor day capacity is retained for the rest of the planning period. This value, however, represents

TABLE VIII

CAPACITY CONSTRAINTS BY DECISION TIME UNIT FOR LAKE FORT GIBSON (VISITOR DAYS)

Decision Time Unit	Capacity	Utilized by Market Area (V_τ)	Maximum Refurbishing Market Area ($V-V_\tau$)
(1)	(2)	(3)	(4)
1975 (Base)	4,100,100	3,526,000	--
1975-1980	3,690,000	3,173,400	352,600
1980-1985	2,870,000	2,468,000	705,200
1985-1990	2,050,000	1,763,000	705,200
1990-1995	1,230,000	1,057,800	705,200
1995-2000	410,000	352,600	705,200

TABLE IX

PRESENT VALUE OF TRAVEL COSTS PER VISITOR DAY BY DECISION TIME UNIT AND BY COUNTY (DOLLARS)

County	Decision Time Units					
	1975	1975-1980	1980-1985	1985-1990	1990-1995	1995-2000
1. Adair	1.59	1.38	1.08	0.85	0.66	0.52
2. Cherokee	0.13	0.11	0.09	0.07	0.05	0.04
3. Creek	0.59	0.51	0.40	0.31	0.25	0.19
4. Huskell	0.59	0.51	0.40	0.31	0.25	0.19
5. McIntosh	0.45	0.39	0.31	0.24	0.19	0.15
6. Mayes	1.45	1.26	0.98	0.77	0.60	0.47
7. Muskogee	0.22	0.19	0.15	0.12	0.09	0.07
8. Okmulgee	1.22	1.06	0.83	0.65	0.51	0.40
9. Rogers	0.57	0.49	0.39	0.30	0.24	0.19
10. Sequoyah	0.59	0.51	0.40	0.31	0.25	0.19
11. Tulsa	0.47	0.41	0.32	0.25	0.20	0.15
12. Wagoner	0.52	0.45	0.35	0.28	0.22	0.17

TABLE X

PRESENT VALUE OF O&M, REFURBISHING AND NEW INVESTMENT COSTS PER VISITOR DAY AND BY DECISION TIME UNIT (DOLLARS)

Decision Time Unit τ	O&M Cost $\alpha_\tau b$	Refurbishing Cost $\beta d \sum_{\tau=j}^{5} \bar{\alpha}_\tau$	New Investment $\beta e \sum_{\tau=j}^{5} \bar{\alpha}_\tau$
(1)	(2)	(3)	(4)
1975 (Base)	0.12	0.00	0.00
1975-1980	0.10	0.03	0.27
1980-1985	0.08	0.02	0.18
1985-1990	0.06	0.01	0.12
1990-1995	0.05	0.008	0.07
1995-2000	0.04	0.004	0.03

only one-fifth of the cost for the planning period since only 1 out of 5 years is counted.

New Investment Costs. Capacity beyond the 4,100,000 visitor days is added through new investment in recreation facilities. The present value of annualized cost of new investment during any decision time unit is given in column (4) of Table X. These values compare with the $\beta e \sum_{\tau=j}^{5} \bar{\alpha}_{\tau}$ given in equation (2.5).

Model Formulation

The linear programming model is summarized in this section. The assumptions of the model are first stated and then the equational form of the model is presented.

Assumptions

1. Recreation demand in year t is a function of price in that year and no other period.

2. The price elasticity of demand is assumed constant throughout the relevant range of the demand function.

3. Demand segments enter as linear approximations and are expanded by a sample to population factor of 1889.

4. Five year decision time units are assumed and model results are assumed representative of the mid-year of the decision time unit.

5. All costs and benefits are assumed to occur as a lump sum for the representative mid-year of the decision time unit.

6. There are no economies of scale in O&M, refurbishing and investment costs. Travel costs are constant per visitor day within a county but vary between counties.

7. An annual social discount rate of five percent is used and is assumed constant over the planning period.

8. Inflation effects on benefits and costs are not considered. All values are expressed in present value of 1975 dollars.

9. The planning period is chosen as 25 years and is assumed to be the life time of new investments before refurbishing needs to take place.

The Model Equations

Solutions to the model vary by the assumed Scenarios as discussed in Chapter II. Each Scenario varies only by the objective function. The most general objective function is the following:

$$\text{Max PVNB} = 5\left\{\left[\underbrace{\sum_{t=1}^{5}\sum_{c=1}^{12}\sum_{s=1}^{11}\bar{\alpha}_\tau B_{sc\tau} X_{sc\tau}}_{\text{Gross Benefit}} \underbrace{-\sum_{t=1}^{5}\sum_{c=1}^{12}\bar{\alpha}_\tau a_c Q_{c\tau}}_{\text{Travel Cost}} \underbrace{-\sum_{t=1}^{5}\sum_{c=1}^{12}\bar{\alpha}_\tau b Q_{c\tau}}_{\text{O\&M Cost}}\right] - \left[\underbrace{\sum_{j=1}\beta_r d R_j \sum_{\tau=1}^{5}\alpha_\tau}_{\text{Refurbishing Cost}} + \underbrace{\sum_{j=1}^{5}\beta_s e S_j \sum_{\tau=j}^{5}\bar{\alpha}_\tau}_{\text{New Investment Cost}}\right]\right\} \tag{5.10}$$

subject to

1. Recreation demand and supply equilibrium

$$-\sum_{c=1}^{12} Q_{c\tau} + \sum_{c=1}^{11}\sum_{s=1}^{11} X_{sc\tau} \leq 0 \tag{5.11}$$

2. Recreation capacity

$$\sum_{c=1}^{12} Q_{c\tau} - \sum_{j=1}^{\tau} R_j - \sum_{j=1}^{\tau} S_j \leq V_\tau \qquad (5.12)$$

3. Maximum refurbishing

$$\sum_{c=1}^{\tau} R_j \leq V - V_\tau \qquad (5.13)$$

4. Convex combination constraint

$$\sum_{s=1}^{11} X_{sc\tau} \leq H \qquad (5.14)$$

Definition of Variables

$X_{sc\tau}$ = demand segment weight variables by county and decision time unit

$Q_{c\tau}$ = quantity of recreation visitor days by county and decision time unit

R_j = refurbishing activity in visitor day capacity in decision time unit one and through the planning period ($j=\tau=1,2,3,4,5$)

S_j = new investment activity in visitor day capacity in decision time unit one and through the planning period ($j=\tau=1,2,3,4,5$)

Definition of Parameters

$\bar{\alpha}_\tau$ = average annual discount factor at 5 percent for decision time unit τ

β_r = capital recovery factor for 15 years at 5 percent discount rate

β_s = capital recovery factor for 25 years at 5 percent discount rate

$B_{sc\tau}$ = benefit for demand segment s of county c in decision time unit τ (1975 dollars)

a_c = travel cost per visitor day for county c (1975 dollars)

b = O&M cost per visitor day (1975 dollars)

d = cost of refurbishing per visitor day capacity (1975 dollars)

e = investment cost per visitor day of new capacity (1975 dollars)

V_τ = visitor day capacity in time period τ assuming no refurbishing of the 1975 capacity for market area

V = visitor day capacity in 1975 for market area

H = population to sample ratio and is equal to 1889

τ = decision time unit and equals 1,2,3,4,5

c = county and equals 1,2,...,12

s = demand and benefit segments and equals 1,2,...,11

j = activity index and equals 1,2,3,4,5

CHAPTER VI

OPTIMUM RECREATION FACILITY DEVELOPMENT

Introduction

Results and analysis of the recreation investment programming models are presented in this chapter. The first section contains a summary analysis of each of the 4 Scenarios and provides results on total visitor days, additions to capacity, total gross benefits, total private costs, total public costs, net private and social benefits, and net benefits per visitor day. The results are presented in undiscounted form for the market area and as annual averages for the five decision time units.

The second section presents the investment budget for each Scenario. Timing of the facility development is shown by decision time unit. The last section presents an analysis of policy options based on alternative recreation charges or fees. These results are presented in discounted form and for the entire 25-year planning period and for total recreation visitor days (market area plus outside market area). A comparative analysis of policy options is given on the basis of recreation gross benefits, total private costs, net private benefit, total public cost, welfare loss, and net social benefit.

Results of the Investment Programming Models

Chapter II ended with a statement that this study should provide information useful to Project Engineers in preparing their Master Plan and in management decisions. That information should pertain to 1) optimum level of facility development, 2) net benefits of recreation, and 3) distribution of benefits and costs from alternative policy options. This section presents information on 1) and 2). The last section presents information on 3).

Results of the investment programming models are presented by Scenario with the Full-Cost Scenario presented first. Results are presented for total visitor days accounted for in the market area. Since the market area accounts for 86 percent of total visitor days, an expansion to 100 percent visitor days could be done on the assumption that gross benefit per visitor day for those coming from outside the market area is equal to the average gross benefit of those in the market area. The value data on benefits and costs are presented in undiscounted form for ease in making comparative analysis between decision time units and between Scenarios. All data are presented as annual averages for the decision time units with the exception of additions to capacity which is in terms of the additions put into place during a decision time unit.

Scenario 1 - Full Cost Model

Scenario 1 is the extreme case of pricing where all identified marginal costs incurred by the recreation activity are paid in full by private recreationists. The full objective function of equation

(5.10) is used in obtaining these results. Results have been summarized in Table XI.

The obvious result is a reduction in visitor days from what existed in the base year of 1975. Visitor days decreased from 3,526,000 in the market area in 1975 to 2,861,255 in the period 1975-1980. It is not until the fourth decision time unit of 1990-1995 before visitor days increase beyond the 1975 level. In that decision time unit capacity was increased by 390,223 visitor days to serve the increased demand from the market area. In the final decision time unit capacity was increased by 801,346 visitor days for a total increase of 1,191,569 visitor day capacity for the planning period.

Note that the results call for refurbishing of the maximum visitor days in decision time unit one of 352,600 visitor days even though the capacity was not needed during that period. It was preferable to maintain existing capacity through refurbishing than to let facilities deteriorate and rebuild in later periods. In all of the model results for all Scenarios it has been preferable, less costly, to maintain existing facilities in anticipation of future growth in demand than to let facilities deteriorate and rebuild in a later period.

Gross benefits increase from $4,326,960 in decision time unit one to $7,153,650 in the last time unit. This is a 63 percent increase in gross benefits even though recreationists are paying their full marginal costs. Total costs to the recreationists increased by 80 percent during the same period although 76 percent of these costs in the last decision time unit are private travel costs.

TABLE XI

RESULTS OF THE RECREATION INVESTMENT PROGRAMMING MODEL FOR THE MARKET AREA BY DECISION TIME UNIT, SCENARIO 1

	Unit	1975-1980	1980-1985	1985-1990	1990-1995	1995-2000
Visitor Days (annual)	VDAY	2,861,255	3,419,438	3,526,000	3,916,223	4,717,569
Additions to Capacity	VDAY					
Refurbishing		352,600	705,200	705,200	705,200	705,200
New Capacity		0	0	0	390,223	801,346
TOTAL		352,600	705,200	705,200	1,095,423	1,506,546
Gross Benefits (annual)	$1,000	4,326.96	4,514.21	5,111.79	5,889.84	7,153.65
Private Costs (annual)	$1,000					
Travel Costs		1,286.71	1,536.23	1,649.11	1,847.68	2,223.37
O&M Costs		337.05	403.21	417.88	460.73	563.79
Refurbishing		3.87	11.72	19.36	27.11	34.86
New Investment		0.00	0.00	0.00	36.82	112.44
TOTAL		1,627.64	1,951.17	2,086.35	72.35	934.45
Public Costs (annual)	$1,000					
O&M Costs		0.00	0.00	0.00	0.00	0.00
Refurbishing		0.00	0.00	0.00	0.00	0.00
New Investment		0.00	0.00	0.00	0.00	0.00
TOTAL		0.00	0.00	0.00	0.00	0.00

TABLE XI (Continued)

	Unit	1975-1980	1980-1985	1985-1990	1990-1995	1995-2000
Net Benefits (annual)	$1,000					
Private		2,699.32	2,563.04	3,025.44	3,517.49	4,219.20
Social		2,699.32	2,563.04	3,025.44	3,517.49	4,219.20
Net Benefits Per Visitor Day	$					
Private		0.943	0.750	0.858	0.898	0.894
Social		0.943	0.750	0.858	0.898	0.894

Net private benefits are equal to net social benefits in this Scenario since recreationists are paying all marginal costs. Net benefits for those recreationists within the market area increased from $2,699,320 in time unit one to $4,219,200 in the last time unit for a 56 percent increase. Clearly, on the basis of the benefit and cost components contained in this analysis it is privately and socially beneficial to increase recreation activities at Lake Fort Gibson.

Net benefits per visitor day are highest in the first decision time unit for this Scenario and all other Scenarios. This is consistent with the fact that recreationists early in the planning period are living on past investments. In particular, this Scenario has little investment costs to recoup in the first time unit -- most costs are associated only with travel and O&M.

Scenario 2 - Policy Guidelines Model

This Scenario is based on the federal government sharing in 50 percent of the additional investments for recreational facility development. It is assumed that the recreationists pay the other 50 percent of additional investments plus all O&M and private travel costs. The objective function in equation (5.10) is modified to include only half of the last two components on refurbishing and new investment costs. The results of the model for the market area are presented in Table XII.

Visitor days for this Scenario are the same as Scenario 1 for the first two decision time units. Beginning in time unit three visitor days increase for Scenario 2 relative to Scenario 1 since recreationists are only charged half of new capacity investment costs.

TABLE XII

RESULTS OF THE RECREATION INVESTMENT PROGRAMMING MODEL FOR THE MARKET AREA BY DECISION TIME UNIT, SCENARIO 2

	Unit	1975-1980	1980-1985	1985-1990	1990-1995	1995-2000
Visitor Days (annual)	VDAY	2,861,255	3,419,438	3,691,690	4,399,804	5,263,189
Additions to Capacity	VDAY					
Refurbishing		352,600	705,200	705,200	705,200	705,200
New Capacity		0	0	165,690	708,114	863,385
TOTAL		352,600	705,200	870,890	1,413,314	1,568,585
Gross Benefits (annual)	$1,000	4,326.96	4,514.21	5,186.72	6,160.83	7,452.01
Private Costs (annual)	$1,000					
Travel Costs		1,286.71	1,536.23	1,649.35	2,024.27	2,415.53
O&M Costs		337.05	403.21	437.52	517.61	628.96
Refurbishing		1.94	5.86	9.68	13.56	17.43
New Investment		0.00	0.00	7.82	41.23	81.97
TOTAL		1,625.70	1,945.29	2,149.37	2,596.64	3,143.89
Public Costs (annual)	$1,000					
O&M Costs		0.00	0.00	0.00	0.00	0.00
Refurbishing		1.94	5.86	9.68	13.56	17.43
New Investment		0.00	0.00	7.82	41.23	81.97
TOTAL		1.94	5.86	17.50	54.79	99.40

TABLE XII (Continued)

	Unit	1975-1980	1980-1985	1985-1990	1990-1995	1995-2000
Net Benefits (annual)	$1,000					
Private		2,701.26	2,568.92	3,037.35	3,564.19	4,308.12
Social		2,699.32	2,563.06	3,019.85	3,509.40	4,208.72
Net Benefits Per Visitor Day	$					
Private		0.944	0.751	0.823	0.810	0.819
Social		0.943	0.750	0.818	0.798	0.800

By the last decision time unit visitor days for Scenario 2 equals 5,263,189 for the market area versus 4,717,569 for Scenario 1. This is about a 12 percent increase in visitor days for Scenario 2 over Scenario 1.

As in Scenario 1, Scenario 2 refurbishing brings capacity back up to the original level in all decision time units. New capacity increases for Scenario 2 over Scenario 1 by 165,690 visitor days in time unit three, by 317,891 visitor days in time unit four, and by 62,039 visitor days in time unit five. This is a total increase in visitor day capacity for Scenario 2 of 1,737,189 visitor days for the planning period or 545,620 visitor days more than in Scenario 1. This is about a 46 percent increase in new capacity for Scenario 2 over Scenario 1. It also represents a 49 percent increase in capacity for Scenario 2 by the end of the planning period over what existed in the base period of 1975.

Gross benefits increase only marginally for Scenario 2 over Scenario 1. In the last decision time unit, annual gross benefits are only about 4 percent more for Scenario 2 than for Scenario 1. Total private costs are marginally less for Scenario 2 over Scenario 1 for the first two time units and then increase, primarily because of more visitor days for Scenario 2 in later time units. Net private benefits are marginally greater for Scenario 2 than for Scenario 1 because recreationists are paying marginally less and because visitor days increase toward the end of the planning period. Social net benefits are marginally less for Scenario 2 than for Scenario 1 because of the increase in public costs. Public costs for Scenario 2 which is the Policy Guidelines Model are rather minimal during the early part of the planning period and increase to an annual amortized cost of $99,400 during the final decision time unit.

Net benefits per visitor day are marginally lower for Scenario 2 compared to Scenario 1. This result is consistent throughout the analysis as visitor days increase, marginal benefits decrease, marginal costs increase and net benefits per visitor day decrease.

Scenario 3 - O&M Plus Travel Cost Model

Recreationists pay none of the marginal investment costs under this Scenario but pay all O&M plus travel costs. Results of this model would be consistent with the Policy Guidelines Model if state and/or local government paid 50 percent of additional facility development costs and the federal government paid 50 percent as in the case of Scenario 2. Results of the model are presented in Table XIII.

Visitor days again do not change from Scenarios 1 and 2 for the first two decision time units. In time unit three Scenario 3 has 390,873 more visitor days than Scenario 2, 486,508 more visitor days in time unit four, and 581,158 more visitor days in time unit five. This means that more capacity must be added under Scenario 3 than under Scenario 2. This increase in capacity for the planning period is 581,158 visitor days over Scenario 2 and 1,126,778 more visitor day capacity than Scenario 1. The total increase in capacity for Scenario 3 over what existed in base period 1975 for the market area is 2,318,347 visitor days or a 66 percent increase.

Gross benefits increase by about 3.9 percent in the last decision time unit over Scenario 2 and by 8.2 percent over Scenario 1. This corresponds to an 11.0 percent increase in visitor days over Scenario

TABLE XIII

RESULTS OF THE RECREATION INVESMENT PROGRAMMING MODEL FOR
THE MARKET AREA BY DECISION TIME UNIT, SCENARIO 3

	Unit	1975-1980	1980-1985	1985-1990	1990-1995	1995-2000
Visitor Days (annual)	VDAY	2,861,255	3,419,438	4,082,563	4,886,312	5,844,347
Additions to Capacity	VDAY					
Refurbishing		352,600	705,200	705,200	705,200	705,200
New Capacity		0	0	556,563	803,749	958,035
TOTAL		352,600	705,200	1,261,763	1,508,949	1,663,235
Gross Benefits (annual)	$1,000	4,326.96	4,514.21	5,381.46	6,405.07	7,742.56
Private Costs (annual)	$1,000					
Travel Costs		1,286.71	1,536.23	1,834.67	2,201.29	2,624.72
O&M Costs		337.05	403.21	483.84	574.85	698.43
Refurbishing		0.00	0.00	0.00	0.00	0.00
New Investment		0.00	0.00	0.00	0.00	0.00
TOTAL		1,623.76	1,939.45	2,318.50	2,776.14	3,323.15
Public Costs (annual)	$1,000					
O&M Costs		0.00	0.00	0.00	0.00	0.00
Refurbishing		3.87	11.72	19.36	27.11	34.86
New Investment		0.00	0.00	52.52	128.37	218.77
TOTAL		3.87	11.72	71.88	155.48	253.63

TABLE XIII (Continued)

	Unit	1975-1980	1980-1985	1985-1990	1990-1995	1995-2000
Net Benefits (annual)	$1,000					
Private		2,703.19	2,574.76	3,062.96	3,628.94	4,419.41
Social		2,699.33	2,563.04	2,991.08	3,473.45	4,165.78
Net Benefits Per Visitor Day	$					
Private		0.945	0.753	0.750	0.743	0.756
Social		0.943	0.750	0.733	0.711	0.713

2 and a 23.9 percent increase over Scenario 1 for the last decision time unit. Total private costs decrease for Scenario 3 over Scenarios 1 and 2 for the first two time units since visitor days remain the same and recreationists are not charged the marginal investment costs. However, private costs increase in time unit three because of increased visitor days and by the last time unit total private costs are 5.7 percent more than Scenario 2 and 13.2 percent more than Scenario 1. Even at that, visitor days increased by 11.0 percent and 23.9 percent, respectively, which is significantly more than the increase in private costs.

Public costs in the form of annualized investment costs go from zero in decision time unit one for Scenario 1 to $1,940 for Scenario 2 to $3,870 for Scenario 3. This changes by the last decision time unit when public costs are zero for Scenario 1, $9,400 for Scenario 2, and $253,630 for Scenario 3. The next section discusses the investment budget for each Scenario whereas the investment costs presented in the tables here only pertain to the annualized investment costs for refurbishing and new capacity.

Net private benefits increase marginally by 2.6 percent over Scenario 2 and 4.7 percent over Scenario 1 for the last time unit. Private benefits are 6.1 percent greater than social benefits during the last decision time unit for Scenario 3. This compares to a 2.4 percent difference for Scenario 2 and, of course, no difference for Scenario 1. Net benefits, both private and social, per visitor day are less for Scenario 3 compared to Scenario 2 for the reason explained above under the discussion of Scenario 2. The divergence between private net benefits per visitor day and social net benefits per visitor day increase from Scenario 2 to Scenario 3 and from the beginning of the planning period to the end of the planning period. The difference in private and social net benefits for decision time unit one for Scenario 3 is 0.5 percent but increases to 6.0 percent for the last time unit. The reason for this is because of increased public costs for maintaining facilities and adding new capacity.

Scenario 4 - Travel Cost Model

This is the extreme case where recreationists pay none of the marginal investment costs and none of the O&M costs. Their only cost is to travel to the lake and back again to their residence. The only components that enter the objective function of equation (5.10) is gross benefits and travel costs. Although recreationists may agitate for this pricing Scenario, Lake Fort Gibson and other lakes in Eastern Oklahoma do not typify this Scenario. Results of the model are presented in Table XIV.

Visitor days in the market area increased for Scenario 4 for the first decision time unit by 387,597 visitor days beyond the base period level of 1975. This is the only Scenario that shows an increase in visitor days for the first time unit. The reason, of course, is the reduced cost (price) of recreation and an increase in the quantity of visitor days demanded. Visitor days increase significantly for each decision time unit with annual visitor days equalling 8,029,824 for the last time unit. This is a 128 percent increase over the base period of 1975. This compares to a 65.8 percent increase for Scenario 3, a 61.6 percent increase for Scenario 2, and a 33.8 percent increase for for Scenario 1.

TABLE XIV

RESULTS OF THE RECREATION INVESMENT PROGRAMMING MODEL FOR THE MARKET AREA BY DECISION TIME UNIT, SCENARIO 4

	Unit	1975-1980	1980-1985	1985-1990	1990-1995	1995-2000
Visitor Days (annual)	VDAY	3,913,597	4,689,092	5,598,667	6,343,200	8,029,824
Additions to Capacity	VDAY					
Refurbishing		352,600	705,200	705,200	705,200	705,200
New Capacity		387,597	775,495	909,575	774,533	1,686,624
TOTAL		352,600	705,200	1,261,763	1,508,949	6,663,235
Gross Benefits (annual)	$1,000	4,747.17	5,017.12	5,975.89	6,979.68	8,553.60
Private Costs (annual)	$1,000					
Travel Costs		1,652.73	1,974.50	2,359.70	2,690.71	3,380.67
O&M Costs		0.00	0.00	0.00	0.00	0.00
Refurbishing		0.00	0.00	0.00	0.00	0.00
New Investment		0.00	0.00	0.00	0.00	0.00
TOTAL		1,652.73	1,974.50	2,359.70	2,690.71	3,380.67
Public Costs (annual)	$1,000					
O&M		461.01	552.92	663.53	746.25	959.59
Refurbishing		3.87	11.72	19.36	27.11	34.86
New Investment		36.58	109.76	195.59	265.85	425.01
TOTAL		501.46	674.40	878.48	1,039.21	1,419.46

TABLE XIV (Continued)

	Unit	1975-1980	1980-1985	1985-1990	1990-1995	1995-2000
Net Benefits (annual)	$1,000					
Private		3,094.44	3,042.62	3,616.19	4,288.97	5,172.93
Social		2,592.98	2,368.22	2,737.71	3,249.76	3,753.47
Net Benefits Per Visitor Day	$					
Private		0.791	0.649	0.646	0.676	0.644
Social		0.663	0.505	0.489	0.512	0.467

Both private costs and public costs increase for Scenario 4 over Scenario 3. Private costs increase just because of the significant increase in visitor days and the associated travel costs. Public costs increase substantially because more of the costs are borne by the public sector and there are many more visitor days. For the last decision time unit, the public sector pays 29.6 percent of total costs for Scenario 4 compared to 7.1 percent for Scenario 3, 3.1 percent for Scenario 2, and zero percent for Scenario 1.

The annual costs for the market area under Scenario 4 equals $1,419,460 during the last time unit versus $253,630 for Scenario 3 and $99,400 for Scenario 2.

Private net benefits increase by 17.1 percent for Scenario 4 over Scenario 3 versus a 1.7 percent increase in private costs and a 460 percent increase in public costs for the last decision time unit. Clearly, the private recreationists are the gainers under Scenario 4 compared to all other Scenarios. Social net benefits decrease by 11.0 percent during the same time unit, Scenario 4 over Scenario 3 and by 12.4 percent Scenario 4 over Scenario 1.

Net private benefits per visitor day for Scenario 4 are 72 percent of the same benefits in Scenario 1 for the last decision time unit. Net social benefits per visitor day are even less, 52 percent. As explained in a latter section, the net social benefits consider the welfare loss due to committing too many resources to recreational services at Lake Fort Gibson. To reiterate from above, as the number of visitor days expands beyond the quantity in Scenario 1, the marginal benefit per visitor day decreases and the marginal cost increases. As costs are shifted from the private recreationists to the public sector, net private benefit per visitor day increases and net social benefit decreases.

Investment Budget for Facility Development

In this section the investment budget is presented and summarized for each of the Scenarios. The data are given in Table XV. The data and results of the programming model are in terms of discounted annualized costs for refurbishing and investment in new capacity. The results in Table XV are presented by decision time unit, in terms of the total investment budget or contract amount, and in undiscounted 1975 dollars.

Refurbishing costs are taken from Chapter IV and equal $0.11 per visitor day. The number of visitor days refurbished are from the programming models and appear in Tables XI - XIV. The only modification is that those visitor days refurbished in the 1975-1980 time unit must be refurbished again in the 1990-1995 period and hence the investment cost is repeated again for that period. The same is true for the time unit 1980-1985 which must be repeated again in 1995-2000.

New capacity costs $1.33 per visitor day and the number of visitor days of new capacity comes from the programming models and Tables XI - XIV. No economies of scale were permitted in the programming model which may be somewhat unrealistic when viewing the investment amounts in Table XV. That is, the contract price for refurbishing 352,600 visitor days or about 48 campsites is $38,786 for the first decision time unit. When this is doubled to 705,200 visitor

TABLE XV

INVESTMENT BUDGET FOR WATER-BASED RECREATION FACILITY DEVELOPMENT AT LAKE FORT GIBSON BY SCENARIO AND DECISION TIME UNIT (1975 DOLLARS)

Investment Category	1975-1980	1980-1985	1985-1990	1990-1995	1995-2000	Total
			Scenario 1			
Refurbishing	38,786	77,572	77,572	116,358	155,144	465,432
New Capacity	--	--	--	518,997	1,065,790	1,584,787
TOTAL	38,786	77,572	77,572	635,355	1,220,934	2,050,219
			Scenario 2			
Refurbishing	38,786	77,572	77,572	116,358	155,144	465,432
New Capacity	--	--	220,368	941,792	1,148,302	2,310,462
TOTAL	38,786	77,572	297,940	1,058,150	1,303,446	2,775,894
			Scenario 3			
Refurbishing	38,786	77,572	77,572	116,358	155,144	465,432
New Capacity	--	--	740,229	1,068,986	1,274,187	3,083,402
TOTAL	38,786	77,572	817,801	1,185,344	1,429,331	3,548,834

TABLE XV (Continued)

Investment Category	1975-1980	1980-1985	1985-1990	1990-1995	1995-2000	Total
			Scenario 4			
Refurbishing	38,786	77,572	77,572	116,358	155,144	465,432
New Capacity	515,504	1,031,408	1,209,735	990,229	2,243,210	5,990,086
TOTAL	554,290	1,108,980	1,287,307	1,106,587	2,398,354	6,455,518

days or about 48 campsites in $38,786 for the first decision time unit. When this is doubled to 705,200 visitor days or about 96 campsites the cost is also doubled to $77,572 for decision time units two and three. For time units four and five this is again increased by 50 percent to 144 campsites and a contract price of $116,358. This assumption needs to be verified or changed.

The total investment budget for the market area by Scenario for the 25-year planning period is given in the last column of Table XV. Since the market area accounts for only 86 percent of total visitor days there would need to be an upward adjustment in the investment budgets. The adjustment would be less than proportional since Scenarios 1, 2, and 3 have excess capacity in one or more of the decision time units. For Scenario 4 the investment in new capacity would need to be increased by a factor of 1.163 to account for visitor day capacity needed for those outside the market area.

The investment budget for Scenario 1 is about $2,050,219. Scenario 2 would require about a 35 percent increase in the investment budget, Scenario 3 a 73 percent increase, and Scenario 4 a 215 percent increase. Scenario 4 requires a 132 percent increase in the investment budget over the Policy Guidelines Scenario (Scenario 2) and an 82 percent increase over Scenario 3 which could assume state and/or local government cost sharing with the federal government.

If the federal and state and/or local governments shared investment costs of Scenario 3, the federal government share would be $1,774,417 and the state and/or local government share would also be $1,774,417. This public cost would have to be weighed against expected public or social benefits derived from increased recreational activity in the region or from some other socially derived benefits.

Under Scenario 1 the assumption is that recreationists will pay the investment costs as well as O&M and travel costs. Therefore, entrance fees or user charges must be established not only for O&M but for facility use. To be equitable among recreationists, variable fees would need to be established according to usage of facilities such as campsites, electrical hook-ups, dump stations, boat ramps, etc.

Comparative Analysis of Policy Options

In Figure 3 and Table II, a set of policy options were proposed and discussed for the four different Scenarios. The Scenarios are based on the economic rationale that recreationists equate their marginal benefit with their marginal cost. Differences exist among the four Scenarios because recreationists are presumed to be assessed different proportions of the total marginal costs. Additional policy options arise if after the quantity of visitor days are fixed, based upon the different Scenarios, recreationists are not charged the presumed marginal cost but some lesser amount. These options require a certain amount of rationing of visitor days, either directly by limiting the number of user permits or indirectly by discouraging recreationists through crowding on weekends and special holidays. A summary of the policy options is as follows:

Scenario I - Full Cost Model

- Recreationists pay full marginal cost.
- Recreationists pay travel plus O&M plus 50 percent investment cost.

- Recreationists pay travel plus O&M cost.
- Recreationists pay travel cost.

Scenario 2 - Policy Guideline Model

- Recreationists pay travel plus O&M plus 50 percent investment cost.
- Recreationists pay travel plus O&M cost.
- Recreationists pay travel cost.

Scenario 3 - O&M Plus Travel Cost Model

- Recreationists pay travel plus O&M cost.
- Recreationists pay travel cost.

Scenario 4 - Travel Cost Model

- Recreationists pays travel cost.

The various policy options are summarized in Table XVI with respect to the following variables: gross benefit, private cost, net private benefit, public cost, welfare loss and net social benefit. Results of the variables are in present value of 1975 dollars for the entire planning period (1975-2000) and for visitor days in the market area plus outside the market area. A simple proportional expansion of the programming model results for the market area was made to include the visitor days accounted for outside the market area. This basically assumes that visitor days outside the market area have a gross benefit equal to the average for visitor days within the market area. Similarly, costs are assumed to be the same for visitor days outside the market area as for visitor days inside the market area.

TABLE XVI

LEVEL AND DISTRIBUTION OF RECREATION BENEFITS AND COSTS UNDER ALTERNATIVE POLICY OPTIONS FOR DEVELOPMENT OF RECREATION FACILITIES AT LAKE FORT GIBSON, PLANNING PERIOD 1975-2000 (PRESENT VALUE IN 1975 DOLLARS)

Variable	Policy Option: Recreationists Pay			
	Travel Cost (1)	Travel Plus O&M Cost (2)	Travel Plus O&M Plus 50% Investment Cost (3)	Travel Plus O&M Plus 100% Investment Cost (4)
	Scenario 1 - Full-Cost Model			
Gross Benefit	83,223,591	83,223,591	83,223,591	83,223,591
Private Cost	26,326,945	33,091,020	33,372,816	33,654,619
Net Private Benefit	56,896,646	50,132,571	49,850,775	49,850,775
Public Cost	7,327,680	563,605	281,808	None
Welfare Loss	None	None	None	None
Net Private Benefit	49,568,972	49,568,972	49,568,972	49,568,972
	Scenario 2 - Policy Guidelines Model			
Gross Benefit	84,677,527	84,677,527	84,677,527	
Private	27,258,974	34,345,212	34,753,450	
Net Private Benefit	57,418,553	50,332,315	49,924,077	

TABLE XVI (Continued)

Variable	Travel Cost (1)	Travel Plus O&M Cost (2)	Travel Plus O&M Plus 50% Investment Cost (3)	Travel Plus O&M Plus 100% Investment Cost (4)
	Policy Option: Recreationists Pay			
Public Cost	7,902,715	816,477	408,238	
Welfare Cost	53,134	53,134	53,134	
Net Social Benefit	49,515,838	49,515,838	49,515,838	
		Scenario 3 - O&M Plus Travel Cost Model		
Gross Benefit	86,422,120	86,422,120		
Private Cost	28,518,125	36,017,909		
Net Private Benefit	57,903,995	50,404,211		
Public Cost	8,648,214	1,148,430		
Welfare Loss	313,192	313,192		
Net Social Benefit	49,255,780	49,255,780		
		Scenario 4 - Travel Cost Model		
Gross Benefit	95,288,747			
Private Cost	36,331,659			
Net Social Benefit	58,957,088			

TABLE XVI (Continued)

Variable	Policy Option: Recreationists Pay			
	Travel Cost (1)	Travel Plus O&M Cost (2)	Travel Plus O&M Plus 50% Investment Cost (3)	Travel Plus O&M Plus 100% Investment Cost (4)
Public Cost	13,111,242			
Welfare Loss	3,723,128			
Net Private Benefit	45,845,844			

These assumptions tend to underestimate costs but may also tend to underestimate gross benefits. The results of Table XVI represent the empirical counterpart to those in Table II.

Scenario 1 is the most socially efficient of the four Scenarios. It has the highest net social benefit and no welfare loss. If recreational facility development took place at Lake Fort Gibson that was consistent with Scenario 1 the expected present value of net social benefits would be $49,568,972 or close to 50 million dollars. At this level of facility development there are four policy options available:

Option (4) - Recreationists pay full cost and public costs are zero. Under this option net social benefits are equal to net private benefits.

Option (3) - Recreationists pay all but 50 percent of the investment costs. The present value of public costs are equal to $281,808.

Option (2) - Recreationists pay none of the marginal investment costs but all of the travel and O&M costs. Public costs increase to a present value of $563,605.

Option (1) - Recreationists pay no costs at the lake and only their private travel costs. Public costs increase significantly due to shifting of O&M costs from the recreationists to the public. The public costs equal a present value of $7,327,680. Under this policy option, a considerable rationing of visitor days would have to occur.

Scenario 2 is consistent with the currently proposed level of facility development where the federal government pays half of the marginal investment costs. The quantity of visitor days under this

Scenario is consistent with the recreationists being charged the other half of the marginal investment cost. Two additional policy options are available, however, in charging the recreationists. Net social benefits are only marginally lower for Scenario 2 compared to Scenario 1. Welfare loss is minimal at a present value of only $53,134. This compares to a difference in net private benefits between the two Scenarios ranging from $73,302 for policy option (3) to $521,907 for policy option (1).

Scenario 3 is the level of facility development consistent with the recreationist paying travel plus O&M costs. This Scenario would also be consistent with the Federal Policy Guidelines if the state and/or local governments picked up the 50 percent share of marginal investment costs instead of the recreationists. This arrangement would be consistent with policy option (2) under Scenario 3. Welfare loss increases under Scenario 3 to the level of present value $313,192. Public costs increase to a present value of $1,148,430 for policy option (2) which would be $574,215 as the federal share and an equal amount for state and/or local governments. Public costs under policy option (1) increases significantly to a present value of $8,648,214.

Scenario 4 has the lowest net social benefit, highest welfare loss, highest public cost and highest net private benefit. However, it pays to compare this policy option, as the only policy option for Scenario 4, with the similar policy option for the other three Scenarios. Welfare loss equals a present value of $3,723,128 for Scenario 4 compared to $313,192 for Scenario 3, $53,134 for Scenario 2, and zero welfare loss for Scenario 1. In comparing policy option

(1) of Scenario 4 with Scenario 1, net social benefits decreased by 7.5 percent and net private benefits increased by only 3.6 percent. Public cost for Scenario 4 increased by 51.6 percent over Scenario 3 and by 78.9 percent over Scenario 1. In contrast net private benefit for Scenario 4 increased by only 1.8 percent over Scenario 3 and by 3.6 percent over Scenario 1. Clearly, one would have to ask whether the marginally small increases in net private benefits are worth the sizeable increases in public costs.

Comparison of Programming Results With Master Plan

The overall objective of this study was to develop and apply a planning methodology to assist Project Engineers in completing a Master Plan for facility development. In this section the results of the study are compared to the existing Master Plan for recreation facility development at Lake Fort Gibson. Comparisons of the various Scenarios with the Master Plan are presented in Table XVII. Data were not available in the Master Plan to compare all variables but the important variables of projected visitor days and investment budget were available.

Results of the programming models were expanded to include visitor days outside the market area. Investment costs were increased proportionally to the increase in visitor days outside the market area. For some Scenarios this would be a slight overestimation of investment costs in the first decision time units because of the higher weighting needed for new capacity relative to refurbishing existing capacity. The effects of this assumption would modestly

TABLE XVII

COMPARISON OF RECREATION FACILITY DEVELOPMENT RESULTS
BY SCENARIO WITH MASTER PLAN FOR LAKE FORT GIBSON,
MARKET AREA PLUS OUTSIDE MARKET AREA

Variable	Unit	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Master Plan
Visitor Days	(Annual)					
1975 Base		4,100,000	4,100,000	4,100,000	4,100,000	4,100,000
1975-1980		3,327,041	3,327,041	3,327,041	4,550,694	5,230,000
1980-1985		3,976,091	3,976,091	3,976,091	5,452,433	3,733,200
1985-1990		4,100,000	4,292,663	4,747,166	6,510,078	N/A[a]
1990-1995		4,553,748	5,116,051	5,681,758	7,375,814	N/A
1995-2000		5,485,545	6,119,987	6,795,752	9,337,005	6,500,000[b]
Investment Costs	($1975)	2,383,976	3,227,784	4,126,551	7,506,416	3,972,967
Average Visitor Day Net Benefit	($)					
Private		0.869	0.824	0.777	0.672	N/A
Social		0.869	0.815	0.753	0.515	N/A
Present Value of Marginal Gross Benefits	($1975)	83,223,591	84,677,527	86,422,120	95,288,747	N/A
Present Value of Marginal Total Costs	($1975)	33,654,619	35,161,688	37,166,339	49,442,901	N/A

TABLE XVII (Continued)

Variable	Unit	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Master Plan
Present Value of Marginal Net Social Benefits	($1975)	49,503,972	49,515,839	49,255,781	45,845,846	N/A
Marginal Social B/C		2.47	2.41	2.33	1.93	N/A

[a]N/A - Not available

[b]For year 2000

overestimate investment costs of Scenarios 1, 2, and 3 and underestimate costs of Scenario 4. This proportionality assumption would also modestly effect costs and net benefits in a similar manner. Benefits, however, may be undervalued for visitor days outside the market area. The problem stems from not having a demand function, and subsequently a benefit function, for those visitor days outside the market area.

The column for Master Plan in Table XVII shows the number of visitor days in the base period and the average annual visitor days for the 1975-1979 period and the 1980-1984 period using the data from Table I. Reported visitor days increases from 4,100,000 to 5,230,000 in the 1975-1979 period and decreases to 3,733,200 in the 1980-1984 period. One must be a little skeptical about the accuracy of visitor day counts when viewing some of the reported data. However, the overall trend for Eastern Oklahoma was a buildup of visitor days during the early to later part of the 1970s, a change in trend during the latter years of the 1970s, and early 1980s, and then an increasing trend again in the more current years.

The direction of these trends is consistent with the changes in energy costs and the changes in policies for user charges and entrance fees. Although energy costs are assumed constant at the 1975 level, Scenarios 1, 2, and 3 would be a reflection of changes in policies on user fees. Scenario 4 would reflect a continuation of early policies of no charges for facility use.

Projection of visitor days in the Master Plan of 6.5 million for the year 2000 would put the result somewhere between Scenario 2 and Scenario 3 of the programming results. This is encouraging in terms of validation of the planning methodolgy and data used for the programming models. The policies assumed for the Master Plan in terms of charges made to recreationists would be somewhere around Scenarios 2 and 3. Recreationists are expected to pay more than only their travel costs as in Scenario 4 and less than full cost as in Scenario 1. In fact, the 6.5 million visitor days of the Master Plan is very close to the Policy Guidelines Model of Scenario 2 when the results of the latter are for the year 2000 instead of the midpoint of the decision time unit of 1995-2000.

Investment costs given in the Master Plan again compare very favorably with Scenarios 2 and 3 of the programming results. Since investment costs on a per visitor day basis were estimated from the Master Plan and used as data in the programming models, one would expect that if visitor day results are close to one Scenario then the investment costs would also be close to that Scenario.

The Master Plan does not have information on recreation beneftis so the variables of average visitor day net benefit, present value of marginal gross benefits, present value of marginal total costs, present value of marginal net social benefits and marginal social benefit-cost ratio are not available for comparative purposes. However, since there is close agreement between the Master Plan and Scenarios 2 and 3 on visitor days and investment costs, one can infer results of these other variables as likely results of policy choices by decision makers on recreation facility development for Lake Fort Gibson.

The direction of the Master Plan implies an average visitor day net benefit between $0.75 and $0.82. The present value of marginal gross benefits at a 5 percent discount rate for the entire planning period is around $85,000,000, the present value of marginal total costs is about $36,000,000, and the present value of net social benefits is about $49,000,000. The marginal social benefit-cost ratio is estimated to be between 2.3 and 2.4. Clearly, the direction of recreation facility development at Lake Fort Gibson is one of providing what society desires and is close to the level of optimum resource use.

CHAPTER VII

SUMMARY AND CONCLUSIONS

This chapter contains a summary of the entire study including the problem statement, objectives, procedures used and results of the analyses. Some specific conclusions are stated and some general policy guidelines proposed. The last section discusses limitations of the study and suggestions for further research.

Summary

Problem Statement

Water-based recreation in Eastern Oklahoma has proven to be a major bonanza to the development of that part of the state and has increased the welfare of millions of recreationists in the region, the state and the nation as a whole. Several past studies have focused on issues of economic impact, demand for recreation and benefits of recreation. However, a systematic and rigorous procedure has not been developed and applied to determine what is the optimum level of recreation facility development for the region.

Resource economics shows that recreation facility development should take place up to the point where the marginal social benefits derived from recreation are equal to the marginal social costs of supplying recreation. At such a level of facility development, net social benefits will be a maximum. This, however, is an analytical result. There needs to be an empirical counterpart in determining a proposed (optimum) level of facility development. Such empirical results would be most useful to Project Engineers in establishing the Master Plan for a project.

Three major components of an empirically based planning methodology are necessary in determining optimum level of recreation facility development. First, an estimate of the benefits of recreation is necessary. The empirical counterpart is an estimate of the willingness-to-pay for recreation which is the area under the demand curve for recreation. Costs of supplying recreation is the second necessary component. All social costs of supplying recreation perhaps can not be identified and quantified but certain costs can be and they include private costs of the individual recreationists, operation and maintenance costs of recreation services at the lake and investment costs of recreation facility development. Charges made to recreationists is the third component. Policy options exist on how much of the costs of supplying recreation will be charged to the recreationists. If the demand curve for recreation is an interpretation of the private benefits of recreation, then the policy option on how much of the costs of supplying recreation is charged to the recreationists becomes important in determining level of recreation facility development.

Objectives

Although the need for determining the optimum level of recreation facility development applies to much of Eastern Oklahoma, and specifically to the McClellan-Kerr Arkansas River Navigation System, this study is limited in application to one lake in the System, Lake Fort Gibson. The overall objective of this study was to determine the optimal facility development for water-based recreation at Lake Fort Gibson. Specific objectives were to develop a planning methodology for recreation facility development for the 25-year period 1975-2000; project demand for recreation over the planning period; estimate unit costs of operating, maintaining and expanding recreation services; determine optimal level of recreation facility development based an alternative policy options on charges for recreation; and evaluate the policy options on the basis of gross benefits of recreation, private and public costs of recreation, net benefits and welfare loss.

Procedures

The U.S. Army Corps of Engineers developed a Master Plan for Lake Fort Gibson that carries through the year 2000. A major recreation survey was conducted at the McClellan-Kerr System including Lake Fort Gibson in 1975. Therefore the 1975-2000 period was chosen as the planning period for determining optimum recreation facility development. The Master Plan provided a comparative base and the 1975 survey provided a data base period.

Recreation facility development up to 1975 was assumed fixed and capacity for recreation was assumed equal to the recorded visitor days for that year. During the following 25-year planning period, additional recreation facility development becomes a variable and the objective, then, is to develop recreation services to the point where the present value of net benefits is a maximum. A 5 percent discount rate is assumed for purposes of discounting future benefits and costs.

Twelve counties around Lake Fort Gibson were identified in an earlier study as comprising the lake's market area for recreation services. Demand for recreation from these 12 counties was estimated based on the travel cost methodology and projected to the year 2000. The rate of growth in demand varied from a low of 3.43 percent annually to a high of 4.29 percent.

Costs of supplying recreation services were estimated for private travel costs, operation and maintenance, refurbishing of existing facilities and construction of facilities for creating additional capacity. Travel costs by county assume 1975 Department of Transportation per mile estimated costs and round trip mileage from the county seat to the dam site. Travel costs per visitor day range from a low of $0.13 for Cherokee county to a high of $1.59 for Adair county. Operation and maintenance costs for recreation services at the lake were estimated at $0.12 per visitor day. Refurbishing costs were estimated at $0.11 per visitor day and new capacity costs were estimated at $1.33 per visitor day.

An investment programming model was constructed to maximize present value of net benefits of recreation facility development for the planning period. To reduce the size of the programming model, 5 year decision time units were defined in place of annual time units. The objective function contains benefit functions derived for the 12 county market area. The objective function also contains costs of supplying recreation services including travel costs, O&M costs, refurbishing costs and costs of increasing recreation capacity at the lake. Since the benefit functions introduce nonlinear elements into the objective function, piecewise or grid linearization was used to the optimization model compatible with currently available computer techniques.

Constraints to the investment programming model were limited to:

1. Equilibrium between recreation demand from the market area and supply of recreation services at the lake.

2. Recreation capacity which was interpreted as amount of capacity at the beginning of the planning period plus the amount added from refurbishing existing facilities and adding new facilities.

3. Maximum refurbishing during any one decision time unit equal to an assumed decay function for recreation capacity that existed in the base period 1975.

4. A set of convex combination constraints defined for purposes of choosing linear segments on the demand and benefit functions.

Policy options on the charges made to recreationists were defined by variations to the objective function. Scenario 1 assumed the recreationists were charged all marginal costs and this model was called the Full Cost Model. Results are the closest to the defined equilibrium of marginal social benefits equalling marginal social costs. Scenario 2, called the Policy Guidelines Model, assumed the proposed policies of the Water Recreation Act of 1965 and is based on the federal government sharing in 50 percent of investment costs and the remainder of all other costs sustained by the recreationists. Scenario 3 is called the O&M Plus Travel Cost Model and assumes all investment costs are paid by federal and state and/or local governments. Recreationists pay O&M costs plus private travel costs. Scenario 4 is the Travel Cost Model and assumes recreationists pay no costs for participating in recreation at the lake but pay only their individual costs of travelling to the lake.

Results of the Analyses

Scenario 1 is the most restrictive to recreationists and Scenario 4 is the least restrictive. Visitor days for the market area for the last decision time unit (1995-2000) varied form 4,717,569 for Scenario 1 to 8,029,824 for Scenario 4. Gross benefits for the market area increase from $7,153,650 annually for Scenario 1 to $8,553,600 for Scenario 4 for the last time unit, all values expressed in undiscounted 1975 dollars. Public costs are zero for Scenario 1 but increase to $1,419,460 annually during the last time unit for Scenario 4. Annual net private and social benefits are estimated at $4,219,200 for the last time unit for Scenario 1. Net social benefits on a comparable basis decrease to $3,753,470 for Scenario 4 but net private benefits increase to $5,172,930. Net benefits per visitor day vary from a low of $0.47 to a high of $0.94 depending on Scenario, decision time unit, and whether the measurement is private or social net benefit.

Recreation visitor days increased for all Scenarios form the base period to the end of the planning period. However, Scenarios 1, 2 and 3 had excess capacity in recreation facilities for the first two or three decision time units. Visitor days increased over the planning period by 33.8 percent for Scenario 1 and by 128 percent for Scenario 4.

Investment budgets were computed for each of the Scenarios. Investment was considered in terms of refurbishing existing capacity or creating new capacity. The investment budget for Scenario 1 amounted to $2,050,219 in 1975 dollars. For Scenario 4, with a much greater demand for visitor days, the investment increased to $6,455,518. The Policy Guidelines Model, Scenario 2, requires an investment budget of $2,775,894 which would be shared 50 percent by the federal government and 50 percent by the recreationists. Scenario 3 requires an investment budget of $3,548,834 which would be shared 50 percent by the federal government and 50 percent by the state and/or local governments.

Various policy options by Scenarios were compared by such variables as gross benefit, private cost, net private benefit, public cost, welfare loss and net social benefit. Scenario 1 had the greatest present value of net social benefit at $49,568,972. Because the other Scenarios expand recreation beyond the level where marginal social benefits equal marginal social costs, net social benefits decrease. For Scenario 4, net social benefits are 92.5 percent of Scenario 1. This means a loss of welfare equal to $3,723,128 or that this amount of welfare could have been gained by allocating the additional resources elsewhere in the economy. The data under these policy options were expanded to include recreationists outside the market areas as well as those in the market area.

Other policy options were considered by holding the visitor days at the optimum for the Scenario but charging the recreationists less than their marginal cost. This option would require a certain amount of rationing of visitor days. For instance, if under Scenario 1 recreationists instead of being charged full costs they were not charged any costs at the lake, public costs would increase over the planning period from zero dollars to $7,327,680 in terms of present value. With an expansion in visitor days to the amount as in Scenario 4, the same policy of not charging recreationists any costs at the lake would increase public costs to $13,111,242 or a 78.9 percent increase.

Finally, the various Scenarios were compared to the Master Plan as constructed for Lake Fort Gibson. The Master Plan projected visitor day attendance to 6,500,000 by the year 2000 and an investment budget of $3,972,967 in 1975 dollars. This result falls between the results for Scenarios 2 and 3 using the investment programming model. This would imply an average visitor day benefit between $0.75 and $0.82; a present value of marginal net social benefit equal to about $49,500,000 at a 5 percent discount rate; and a marginal social benefit-cost ratio between 2.3 and 2.4.

Conclusions and Policy Guidelines

This section briefly states some conclusions and policy guidelines that are a result of the investment analysis of recreation facility development at Lake Fort Gibson.

Conclusions

1. Continued investment in recreation facility development at Lake Fort Gibson is in the best interests of society. If recreationists are charged all of the identified marginal costs of recreation facility development, the present value of marginal net benefits increase by about $49,500,000 in 1975 dollars.

2. Recreationists are price responsive to increases in charges for recreation services. If recreationists are charged less than

their full marginal costs they will demand more recreation, investment costs will be greater and society will suffer a welfare loss. By the end of the planning period, assuming the results of Scenario 1 versus Scenario 4, recreation demand will increase from 5,485,545 visitor days under the full cost model to 9,337,005 visitor days under the policy option of recreationists paying none of the costs at the lake.

3. Use of an investment programming model similar to the one presented here is practical and feasible in developing a Master Plan for a project. The major data components needed include demand or benefit functions for recreation, estimates of costs of supplying recreation services, and proposed charges for recreation. The results are in terms of projected visitor days, an investment budget, distribution of benefits and costs between the private and public sectors, level of present value of marginal net benefits, and an estimate of the marginal social benefit-cost ratio.

Policy Guidelines

1. The most efficient use of resources for society as a whole comes about when recreationists are charged their full marginal costs and, in turn, recreationists are able to equate their marginal costs with the marginal benefits they derive from the recreation services. The planning methodology used in this study shows how such results can be approximated.

2. The real change in results comes when recreationists are charged at least the O&M costs of supplying recreation services. This is depicted by the comparison of Scenario 4 with Scenario 3 and Scenario 1 with Scenario 3. Charging recreationists their O&M costs

reduces visitor days by 27 percent, reduces investment costs by 45 percent, increases present value of the marginal net social benefit by 7.4 percent and increases the marginal social benefit-cost ratio from 1.9 to 2.3. Charging recreationists their marginal investment costs in addition to their O&M costs (comparing Scenario 1 with Scenario 3) reduces visitor days by only 19.3 percent, reduces investment costs by 42 percent, increases present value of the marginal net social benefit by 0.6 percent and increases the marginal social benefit-cost ratio from 2.33 to 2.47.

3. The difference between the results for the most efficient use of society resources (Scenario 1) and what is proposed as Policy Guidelines for recreation projects (Scenario 2) is minimal for Lake Fort Gibson. Annual visitor days for the last decision time unit changes by only 634,442, investment costs increase by only $843,808 and the marginal social benefit-cost ratio changes minimally from 2.47 to 2.41. It doesn't cost the federal government much in the way of investment costs for society to gain close to $84,000,000 gross benefits over the planning period.

4. Because state and/or local governments can shift 50 percent of the investment costs on to the federal government, it may be advisable to consider Scenario 3 over Scenario 4. For about $870,000 in investment costs to state and/or local governments, visitor days increase by about 1.3 million annually and present value of marginal gross benefits increase by $3,200,000.

Limitations and Further Research

Finally, limitations of the study are discussed and further research areas are proposed.

Limitations

The results, conclusions and policy guidelines of this study are limited by the accuracy of the data and assumptions used. Projections of demand for recreation are based on assumptions of constant 1975 travel costs and constant tastes and preferences. Competition from other lakes in Eastern Oklahoma on the demand for recreation at Lake Fort Gibson was not considered.

Estimates of costs of supplying recreation services at Fort Gibson used in this study should be considered as first approximations. More definitive research should be done on estimating O&M costs, refurbishing costs and additional capacity costs. Economies and diseconomies of scale in supplying recreation services should be tested. Effects of crowding at the lake on costs of services should be considered.

Methodology on how to include visitor days outside the market area in the analysis should be improved. Specifically, a benefit function for those visitor days should be more fully developed.

Further Research

First consideration to further research is improvement on the limitations expressed above. Estimates of costs of supplying recreation services could be improved upon by further interaction with

Project Engineers and using cross section data from several different projects or lakes.

Seasonality factors and peak demand period problems should be addressed in any further work on methodologies for estimating demand, estimating cost and investment planning.

Realistic methods for assessing charges and costs of collecting fees should be investigated and integrated in the analyses on effects of policy options. This would include analysis of assessing specific charges for use of specific services.

Competition between a local lake and a regional lake could be studied for use of limited investment resources or limited budgets for supplying recreation services. Cross price effects on competing demands for recreation at a local lake and a regional lake could be built into an improved investment programming model.

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TABLE XVIII

QUANTITY AND DISCOUNTED BENEFIT OF SEGMENTED DEMAND FOR ADAIR COUNTY BY DECISION TIME UNIT

Segment	Quantity (Q) Benefit (B)	Decision Time Units 1975	1975-1980	1980-1985	1985-1990	1990-1995	1995-2000
		(1)	(2)	(3)	(4)	(5)	(6)
1	Q (VDAY)	0	0	0	0	0	0
	B ($)	0	0	0	0	0	0
2	Q	0.97	1.08	1.28	1.53	1.83	2.18
	B	2.88	2.77	2.59	2.42	2.26	2.11
3	Q	1.94	2.15	2.57	3.06	3.65	4.36
	B	5.61	5.40	5.05	4.72	4.41	4.12
4	Q	2.91	3.23	3.85	4.59	5.49	6.54
	B	8.21	7.89	7.39	6.90	6.45	6.03
5	Q	3.87	4.30	5.14	6.12	7.31	8.72
	B	10.66	10.25	9.60	8.56	8.37	7.83
6	Q	4.84	5.38	6.42	7.66	9.13	10.90
	B	12.97	12.48	11.68	10.90	10.19	9.53
7	Q	5.81	6.45	7.71	9.19	10.96	13.08
	B	15.14	14.57	13.63	12.73	11.89	11.12
8	Q	6.78	7.53	8.99	10.72	12.78	15.25
	B	17.17	16.52	15.46	14.43	13.49	12.61
9	Q	7.75	8.61	10.28	12.25	14.61	17.43
	B	19.06	18.33	17.16	16.02	14.97	14.00
10	Q	8.72	9.68	11.56	13.78	16.44	19.61
	B	20.81	20.02	18.73	17.49	16.35	15.28
11	Q	9.68	10.76	12.85	15.31	18.26	21.79
	B	22.42	21.56	20.18	18.84	17.61	16.46

TABLE XIX

QUANTITY AND DISCOUNTED BENEFIT OF SEGMENTED DEMAND FOR CREEK COUNTY BY DECISION TIME UNIT

Segment	Quantity (Q) Benefit (B)	Decision Time Units 1975	1975-1980	1980-1985	1985-1990	1990-1995	1995-2000
		(1)	(2)	(3)	(4)	(5)	(6)
1	Q (VDAY)	35.75	39.10	47.21	56.14	66.78	79.51
	B ($)	82.77	78.38	74.15	69.08	64.40	60.07
2	Q	42.60	46.60	56.26	66.89	79.58	94.74
	B	93.07	87.86	88.72	77.45	72.19	69.46
3	Q	49.46	54.10	65.31	77.65	92.38	109.98
	B	101.71	96.05	96.42	84.66	78.91	75.73
4	Q	56.31	61.61	74.35	88.41	105.17	125.21
	B	109.31	103.26	103.19	91.00	84.82	81.24
5	Q	63.16	69.11	83.40	99.17	117.97	140.44
	B	116.10	109.70	109.25	99.86	90.11	86.17
6	Q	70.01	76.61	92.45	109.92	130.77	155.68
	B	122.26	115.52	114.73	105.00	94.90	90.64
7	Q	76.86	84.11	101.49	120.68	143.57	170.91
	B	127.88	120.85	119.84	109.69	99.27	94.72
8	Q	83.71	91.61	110.54	131.44	156.36	186.15
	B	133.05	125.76	124.36	114.01	99.90	98.48
9	Q	90.56	99.11	119.58	142.19	169.16	201.38
	B	137.86	130.31	128.64	118.02	107.67	101.96
10	Q	97.41	106.61	128.63	152.95	181.96	216.62
	B	142.35	134.55	132.63	121.76	111.15	105.21
11	Q	104.27	114.02	137.68	163.71	194.75	231.85
	B	145.55	138.49	136.38	125.26	114.42	108.26

TABLE XX

QUANTITY AND DISCOUNTED BENEFIT OF SEGMENTED DEMAND FOR HASKELL COUNTY BY DECISION TIME UNIT

Segment	Quantity (Q) Benefit (B)	Decision Time Units 1975	1975–1980	1980–1985	1985–1990	1990–1995	1995–2000
		(1)	(2)	(3)	(4)	(5)	(6)
1	Q (VDAY)	10.27	11.38	13.51	16.01	19.00	22.55
	B ($)	23.77	22.80	21.22	19.70	18.32	17.04
2	Q	12.28	13.60	16.15	19.14	22.72	26.96
	B	26.71	25.62	23.83	22.23	20.58	19.14
3	Q	14.29	15.83	18.80	22.28	26.44	31.37
	B	29.23	28.04	26.08	24.02	22.53	20.95
4	Q	16.30	18.06	21.44	25.41	30.16	35.79
	B	31.45	30.16	28.06	25.59	24.23	22.53
5	Q	18.31	20.28	24.08	28.54	33.87	40.20
	B	33.43	32.06	29.83	27.00	25.76	23.95
6	Q	20.32	22.51	26.73	31.68	37.59	44.61
	B	35.22	33.78	31.42	28.27	27.14	25.23
7	Q	22.33	24.73	29.37	34.81	41.31	49.03
	B	36.85	35.34	32.88	29.42	28.39	26.40
8	Q	24.34	26.96	32.01	37.94	45.03	53.44
	B	38.35	36.89	34.22	30.49	29.55	27.48
9	Q	26.35	29.19	34.66	41.08	48.75	57.85
	B	39.75	38.12	35.47	31.48	30.63	28.48
10	Q	28.36	31.41	37.30	44.21	52.47	62.26
	B	41.05	39.37	36.63	32.40	31.63	29.41
11	Q	30.38	33.64	39.94	47.34	56.18	66.68
	B	42.26	40.53	37.71	33.26	32.57	30.28

TABLE XXI

QUANTITY AND DISCOUNTED BENEFIT OF SEGMENTED DEMAND FOR McINTOSH COUNTY BY DECISION TIME UNIT

Segment	Quantity (Q) Benefit (B)	Decision Time Units 1975	1975-1980	1980-1985	1985-1990	1990-1995	1995-2000
		(1)	(2)	(3)	(4)	(5)	(6)
1	Q (VDAY)	11.37	12.60	14.96	17.73	21.04	24.97
	B ($)	26.33	25.25	23.49	21.82	20.29	18.86
2	Q	14.72	16.30	19.36	22.95	27.23	32.32
	B	31.03	29.77	27.69	25.72	23.92	22.24
3	Q	18.07	20.01	23.76	28.16	33.42	39.67
	B	34.84	33.42	31.09	28.87	26.85	24.97
4	Q	21.41	23.72	28.16	33.38	39.62	47.01
	B	38.05	36.50	33.96	31.53	29.32	27.27
5	Q	24.76	27.43	32.57	38.60	45.81	54.36
	B	40.83	39.16	36.43	33.84	31.46	29.26
6	Q	28.11	31.13	36.97	43.82	51.20	61.71
	B	43.28	41.52	38.62	35.87	33.12	31.01
7	Q	31.46	34.84	41.37	49.03	58.19	69.06
	B	45.48	43.62	40.58	37.69	35.05	32.59
8	Q	34.80	38.55	45.77	54.25	64.38	76.40
	B	47.48	45.53	42.36	39.34	36.58	34.02
9	Q	38.15	42.25	50.17	59.47	70.75	83.75
	B	49.30	47.28	43.99	43.08	38.03	35.32
10	Q	41.50	45.96	54.57	64.69	76.77	91.10
	B	50.98	48.90	45.49	44.47	39.29	36.53
11	Q	44.85	49.67	58.98	69.90	82.96	98.45
	B	52.55	50.40	46.89	45.77	40.49	37.65

TABLE XXII

QUANTITY AND DISCOUNTED BENEFIT OF SEGMENTED DEMAND FOR MAYES COUNTY BY DECISION TIME UNIT

Segment	Quantity (Q) Benefit (B)	Decision Time Units 1975	1975-1980	1980-1985	1985-1990	1990-1995	1995-2000
		(1)	(2)	(3)	(4)	(5)	(6)
1	Q (VDAY)	22.79	25.85	31.94	39.41	48.65	60.11
	B ($)	52.75	51.81	50.16	48.50	46.91	55.20
2	Q	23.02	26.12	32.27	39.82	49.16	60.74
	B	53.12	52.18	50.52	48.84	47.25	45.73
3	Q	23.26	26.38	32.60	40.23	49.67	61.36
	B	53.50	52.54	50.87	49.19	47.58	46.05
4	Q	23.50	26.65	32.94	40.64	50.18	61.99
	B	53.87	52.90	51.22	49.52	47.90	46.37
5	Q	23.74	26.92	33.27	41.05	50.68	62.62
	B	54.23	53.26	51.57	49.86	48.23	46.69
6	Q	23.98	27.19	33.60	41.47	51.19	63.24
	B	54.60	53.62	51.90	50.19	48.55	47.00
7	Q	24.22	27.46	33.93	41.88	51.70	63.67
	B	54.96	53.97	52.25	50.52	48.87	47.30
8	Q	24.45	27.73	34.27	42.29	52.20	64.50
	B	55.31	54.32	52.59	50.85	49.18	47.61
9	Q	24.69	28.00	34.60	42.70	52.71	65.12
	B	55.66	54.66	52.92	51.17	49.50	47.91
10	Q	24.93	28.27	34.93	43.11	53.22	65.75
	B	56.01	55.01	53.25	51.49	49.81	48.21
11	Q	25.17	28.54	35.27	43.52	53.73	66.38
	B	56.36	55.35	53.58	51.81	50.11	48.51

TABLE XXIII

QUANTITY AND DISCOUNTED BENEFIT OF SEGMENTED DEMAND FOR MUSKOGEE COUNTY BY DECISION TIME UNIT

Segment	Quantity (Q) Benefit (B)	Decision Time Units 1975	1975-1980	1980-1985	1985-1990	1990-1995	1995-2000
		(1)	(2)	(3)	(4)	(5)	(6)
1	Q (VDAY)	45.56	50.46	59.92	71.02	84.29	100.03
	B ($)	105.46	101.16	94.11	87.40	81.27	75.57
2	Q	81.33	90.09	106.97	126.78	150.47	178.56
	B	148.39	142.32	132.41	122.97	114.34	106.32
3	Q	117.11	129.71	154.01	182.55	216.64	257.09
	B	176.46	169.24	157.45	146.23	135.97	126.43
4	Q	152.89	169.33	201.06	238.31	282.82	335.63
	B	197.52	189.45	176.25	163.69	152.20	141.53
5	Q	188.66	208.95	248.10	294.07	348.99	414.16
	B	214.47	205.70	191.37	177.73	165.26	153.67
6	Q	224.44	248.57	295.15	349.83	415.17	492.69
	B	228.69	219.34	204.06	189.51	176.22	163.85
7	Q	260.22	288.19	342.19	405.59	481.34	571.22
	B	240.96	231.11	215.01	199.68	185.68	172.65
8	Q	296.00	327.81	389.24	461.35	547.52	649.76
	B	251.77	241.48	224.66	208.64	194.01	180.39
9	Q	331.77	367.43	436.28	517.11	613.70	728.29
	B	261.45	250.76	233.29	216.66	201.46	187.32
10	Q	367.55	407.05	483.33	572.88	679.87	806.82
	B	270.46	259.16	241.11	223.92	208.22	193.60
11	Q	403.33	446.67	530.37	628.64	746.05	885.36
	B	278.47	266.84	248.25	230.56	214.12	199.34

TABLE XXIV

QUANTITY AND DISCOUNTED BENEFIT OF SEGMENTED DEMAND FOR OKMULGEE COUNTY BY DECISION TIME UNIT

Segment	Quantity (Q) Benefit (B)	Decision Time Units 1975	1975-1980	1980-1985	1985-1990	1990-1995	1995-2000
		(1)	(2)	(3)	(4)	(5)	(6)
1	Q (VDAY)	22.91	25.34	29.99	35.47	41.97	49.70
	B ($)	53.03	50.79	47.11	43.65	40.47	37.54
2	Q	23.67	26.18	30.99	36.65	43.37	51.32
	B	54.22	51.93	48.17	44.63	41.38	38.37
3	Q	24.43	27.02	31.99	37.84	44.77	52.97
	B	55.38	53.04	49.20	45.59	42.26	39.19
4	Q	25.20	27.87	32.99	39.02	46.17	54.63
	B	56.51	54.11	50.20	46.52	43.12	39.99
5	Q	25.96	28.71	33.99	40.20	47.57	56.28
	B	57.60	55.16	51.17	47.42	43.96	40.76
6	Q	26.73	29.56	34.99	41.38	48.97	57.94
	B	58.67	56.18	52.12	48.29	44.77	41.52
7	Q	27.49	30.40	35.99	42.56	50.36	59.60
	B	59.71	57.18	53.04	49.15	45.56	42.26
8	Q	28.25	31.24	36.99	43.75	51.76	61.25
	B	60.72	58.15	53.94	49.98	46.36	42.97
9	Q	29.02	32.09	37.99	44.93	53.16	62.91
	B	61.71	59.09	54.81	50.79	47.09	43.67
10	Q	29.78	32.93	38.99	46.11	54.56	64.56
	B	62.67	60.02	55.67	51.59	47.83	44.35
11	Q	30.55	33.78	39.99	47.29	55.96	66.26
	B	63.62	60.92	56.51	52.36	48.55	45.04

TABLE XXV

QUANTITY AND DISCOUNTED BENEFIT OF SEGMENTED DEMAND FOR ROGERS COUNTY BY DECISION TIME UNIT

Segment	Quantity (Q) Benefit (B)	Decision Time Units					
		1975	1975-1980	1980-1985	1985-1990	1990-1995	1995-2000
		(1)	(2)	(3)	(4)	(5)	(6)
1	Q (VDAY)	28.72	31.86	37.93	45.10	53.65	63.86
	B ($)	66.49	63.87	59.57	55.50	51.73	48.25
2	Q	34.64	38.43	45.74	54.39	64.70	77.01
	B	75.09	72.14	67.28	62.68	58.43	54.49
3	Q	40.56	44.99	53.55	63.67	75.75	90.17
	B	82.44	79.20	73.86	68.81	64.14	59.82
4	Q	46.48	51.55	61.36	72.96	86.80	103.32
	B	88.86	85.36	79.61	74.17	69.14	64.48
5	Q	52.39	58.12	69.18	82.25	97.85	116.47
	B	94.58	90.85	84.73	78.94	73.58	68.58
6	Q	58.31	64.68	76.99	91.54	108.90	129.63
	B	99.73	95.80	89.34	83.23	77.59	72.36
7	Q	64.23	71.24	84.80	100.83	119.95	142.78
	B	104.42	100.30	93.54	87.15	81.24	75.76
8	Q	70.15	77.81	92.61	110.12	131.00	155.91
	B	108.72	104.44	97.72	90.75	84.59	78.89
9	Q	76.07	84.37	100.43	119.41	142.05	169.09
	B	112.71	108.27	101.29	94.07	87.69	81.78
10	Q	81.99	90.93	108.24	128.70	153.10	182.24
	B	116.43	111.83	104.62	97.17	90.58	84.47
11	Q	87.91	97.50	116.05	137.99	164.15	195.39
	B	119.90	115.17	107.73	100.07	93.28	86.99

TABLE XXVI

QUANTITY AND DISCOUNTED BENEFIT OF SEGMENTED DEMAND FOR SEQUOYAH COUNTY BY DECISION TIME UNIT

Segment	Quantity (Q) Benefit (B)	Decision Time Units 1975	1975–1980	1980–1985	1985–1990	1990–1995	1995–2000
		(1)	(2)	(3)	(4)	(5)	(6)
1	Q (VDAY)	15.37	17.08	20.40	24.31	29.00	34.60
	B ($)	35.58	34.24	32.04	29.91	27.96	26.14
2	Q	18.38	20.43	24.39	29.06	34.67	41.37
	B	39.98	38.08	36.00	33.61	31.41	29.60
3	Q	21.39	23.77	28.39	33.82	40.35	48.15
	B	43.76	41.38	39.40	36.78	34.38	32.58
4	Q	24.40	27.11	32.38	38.58	46.02	54.92
	B	47.08	44.28	42.39	39.57	36.99	35.19
5	Q	27.41	30.45	36.37	43.34	51.70	61.69
	B	50.04	46.87	45.05	42.06	39.31	37.53
6	Q	30.42	33.80	40.36	48.09	57.37	68.46
	B	52.71	49.02	47.46	44.31	41.41	39.63
7	Q	33.43	37.14	44.36	52.85	63.05	75.23
	B	55.16	51.34	49.66	46.36	43.34	41.56
8	Q	36.44	40.48	48.35	57.61	68.72	82.00
	B	57.41	53.30	51.69	48.25	45.10	43.33
9	Q	39.45	43.83	52.34	62.36	74.40	88.78
	B	59.50	55.12	53.56	50.01	46.74	44.98
10	Q	42.46	47.17	56.33	67.12	80.07	95.55
	B	61.44	56.82	55.32	51.64	48.27	46.51
11	Q	45.47	50.51	60.33	71.88	85.75	102.32
	B	63.26	58.41	56.96	53.17	49.70	47.94

TABLE XXVII

QUANTITY AND DISCOUNTED BENEFIT OF SEGMENTED DEMAND FOR TULSA COUNTY BY DECISION TIME UNIT

Segment	Quantity (Q) Benefit (B)	Decision Time Units 1975	1975-1980	1980-1985	1985-1990	1990-1995	1995-2000
		(1)	(2)	(3)	(4)	(5)	(6)
1	Q (VDAY)	212.00	235.22	279.98	332.90	396.03	471.40
	B ($)	490.79	471.51	439.75	409.68	381.73	356.14
2	Q	271.08	300.75	357.99	425.65	506.37	602.74
	B	574.33	551.79	514.58	479.37	446.87	416.77
3	Q	330.16	366.29	436.00	518.41	616.71	734.08
	B	642.59	877.10	575.73	536.33	499.95	466.29
4	Q	389.24	431.83	514.01	611.16	727.05	865.42
	B	700.43	932.66	627.54	584.61	545.71	508.25
5	Q	448.32	497.36	592.02	703.91	837.39	996.76
	B	750.72	980.97	672.59	626.57	584.05	544.73
6	Q	507.40	562.90	670.02	796.66	947.73	1128.10
	B	795.23	1023.74	712.49	663.74	618.71	577.05
7	Q	566.47	628.43	748.03	889.41	1058.07	1259.44
	B	835.24	1062.17	748.34	697.13	649.83	606.07
8	Q	625.55	693.97	826.04	982.16	1168.10	1390.78
	B	871.61	1097.08	780.90	727.47	678.12	632.45
9	Q	684.63	759.51	904.05	1074.91	1278.75	1522.12
	B	904.91	1129.11	810.75	755.29	704.04	656.62
10	Q	743.71	825.05	982.05	1167.66	1389.09	1653.46
	B	935.70	1158.68	838.33	779.54	728.00	678.96
11	Q	802.79	890.58	1060.06	1260.42	1499.43	1784.80
	B	964.32	1186.17	863.99	803.44	749.47	699.73

TABLE XXVIII

QUANTITY AND DISCOUNTED BENEFIT OF SEGMENTED DEMAND FOR WAGONER COUNTY BY DECISION TIME UNIT

Segment	Quantity (Q) Benefit (B)	Decision Time Units 1975	1975-1980	1980-1985	1985-1990	1990-1995	1995-2000
		(1)	(2)	(3)	(4)	(5)	(6)
1	Q (VDAY)	19.30	21.76	26.61	32.48	39.68	48.50
	B ($)	44.69	43.63	41.79	39.97	38.26	36.64
2	Q	23.83	26.86	32.84	40.09	48.98	59.86
	B	51.19	49.98	47.87	45.78	43.11	41.98
3	Q	28.35	31.96	39.07	47.70	58.28	71.23
	B	56.65	55.31	52.29	50.66	47.18	46.45
4	Q	32.88	37.06	45.31	55.31	67.58	82.60
	B	61.36	59.51	57.38	54.88	50.70	50.31
5	Q	37.40	42.16	51.54	62.92	76.88	93.96
	B	65.51	63.96	61.26	58.59	53.79	53.71
6	Q	41.93	47.26	57.78	70.53	86.18	105.33
	B	69.23	67.58	64.73	61.91	56.56	56.76
7	Q	46.45	52.37	64.01	78.14	95.48	116.69
	B	72.59	70.86	67.87	64.91	59.06	59.51
8	Q	50.98	57.47	70.25	85.75	104.78	128.06
	B	75.66	73.86	70.75	67.66	61.36	62.03
9	Q	55.50	62.57	76.48	93.36	114.08	139.42
	B	78.49	76.63	73.39	70.19	63.47	64.35
10	Q	60.03	67.67	82.72	100.97	123.38	150.79
	B	81.12	79.19	75.85	72.55	65.43	66.38
11	Q	64.55	72.77	88.95	108.58	132.68	162.15
	B	83.58	81.59	78.14	74.74	67.26	68.39

VITA

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