APPENDIX C

ECONOMICS

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EVALUATION OF RECREATION NEEDS AND DEMANDS

Recreational Trends

Studies conducted by a variety of public and private groups have found that national demands for most recreational facilities are expected to increase into the next century. Increases in leisure time, physical fitness concerns, and environmental awareness are factors which will contribute to the rise in demands place on recreational facilities. Ongoing population shifts toward the southern and western regions of the United States will create additional use pressures on existing recreation facilities in these regions. Moreover, residents of the study area report increasing use of new types of water recreation equipment, such as airboats and jet-skis, which have the potential for more significant impact on the available resources.

Data Sources

Both the projected recreation visitation to the study area, and the economic evaluation of that visitation, were analyzed with travel cost method (TCM) models. Because of time and resource constraints, only existing and readily available information was used. To this end, the recreation analysis developed in 1993 by the Fort Worth District for Red River Waterway, Shreveport, Louisiana to Daingerfield, Texas was utilized. The "Evaluation of Recreation Needs, Demands, and Benefits and Costs" was updated and revised using current population projections. The information utilized for the analysis was from several sources:

- Population projections for the area were obtained from the Bureau of Economic Analysis, Department of Commerce "County Projections to 2040."

- The definition of the primary recreation study area was not altered from the original study. The study area was defined by the Vicksburg District office.

- Field surveys and interviews with study area residents and business proprietors were used to determine current recreation use patterns and identify perceived recreation needs and issues.

- The 1990 Texas Outdoor Recreation Plan provided net facilities needs for Regions 5 and 6 (roughly corresponding to the recreation study area), and facilities load factors, for certain specialized activities. In addition, the Texas Parks and Wildlife Department, the agency that prepared the Texas Outdoor Recreation Plan, provided raw survey data collected in 1987 for the preparation of the Plan, comprising the number of respondents and activity-days by major recreation activity and county of origin, and participation rate by planning region, for Lake O' The Pines and Caddo Lake.

- U.S. Census data (population, median age, and per capita income) were compiled for each of the counties identified in the Texas Parks and Wildlife Department raw survey data as a source of recreation visitation for any of the two sites.

- A Texas highway map was consulted to estimate the highway distance from each of the visitor source counties to each of the sites.

- Summary data from recreation visitor surveys conducted at Lake O' The Pines in 1986 and 1987 were used to derive average party size by major recreation activity category,

and the percentage of total annual visitation occurring on the peak day of the year, also by major activity category.

- Desirable peak-use load factors for various kinds of recreation facilities were obtained from *Guidelines for Understanding and Determining Optimum Recreation Carrying Capacity*, U.S. Department of Interior, Bureau of Outdoor Recreation, January 1977.

Study Area

The study area for this analysis, as previously identified in earlier analyses by Vicksburg District, comprises one county in Arkansas, two parishes in Louisiana, and sixteen counties in Texas, representing a zone of approximately 90 miles around the basin. About **90** percent of the total estimated existing recreation visitation to the study area originates within these counties. The counties and parishes, and their approximate one-way road distance from their principal population centers to the reaches of the watershed, are shown in Table 1.

Table 1.
County Population Centers and
Approximate Distance to Study Area

			approx. 1-way travel distance (miles) to:			
county	**state**	**principal population center**	**Lake O' The Pines**	**Big Cypress Bayou**	**Caddo Lake**	**Twelve Mile Bayou**
Miller	AR	Texarkana	70	56	60	64
Bossier	LA	Bossier City	74	62	47	23
Caddo	LA	Shreveport	68	54	39	15
Bowie	TX	Texarkana	64	56	60	64
Camp	TX	Pittsburg	30	54	64	124
Cass	TX	Atlanta	39	31	35	39
Franklin	TX	Mount Vernon	66	74	84	144
Gregg	TX	Longview	35	39	43	105
Harrison	TX	Marshall	30	16	20	47
Hopkins	TX	Sulphur Springs	87	95	105	165
Marion	TX	Jefferson	25	6	16	41
Morris	TX	Daingerfield	30	38	48	108
Panola	TX	Carthage	61	51	55	117
Red River	TX	Clarksville	71	99	109	169
Rusk	TX	Henderson	65	57	61	123
Smith	TX	Tyler	71	75	79	141
Titus	TX	Mount Pleasant	50	58	68	128
Upshur	TX	Gilmer	30	49	59	119
Wood	TX	Quitman	57	80	90	150

Related Recreational Developments

Related recreational developments are those within the study area that provide recreational opportunities that may influence future recreation use through the watershed. Caddo Lake State Park, managed by the Texas Parks and Wildlife Department, is among the most significant recreational development in the study area. Lake O' The Pines, managed by

the U.S. Army Corps of Engineers, also offers well-developed recreational opportunities. Use patterns associated with these developments can be used as an indicator of future utilization in the study area.

Current Use

Current use patterns of the study area were identified through direct observation and personal communications with representatives of the States of Texas and Louisiana, Marion County Chamber of Commerce, local business owners, and interested citizens.

Twelve Mile Bayou runs from Shreveport to Caddo Lake and constitutes the lowest portion of the study area. Water recreation is virtually nonexistent on Twelve Mile Bayou. There are no formal boat ramps on the bayou. Site surveys revealed evidence of bank fishing at overpasses, as well as bank fishing below the spillway at Caddo Lake. The lack of water recreation on Twelve Mile Bayou can be attributed to extremely limited access to the bayou, as well as an abundance of recreational facilities in the region.

Caddo Lake, which straddles the Texas-Louisiana border, attracts visitors from greater distances that most recreational lakes. This is largely due to the lake's unique beauty and the wide variety of recreational opportunities available. Water recreation on the open, eastern portion of the lake, (the Louisiana side) is most consistent with conventional lake recreation. This portion of the lake is used primarily for fishing, swimming, boating, and picnicking. Boating on the western end of the lake is limited to narrow boat lanes due to the presence of scattered trees and tree stumps, shallow waters, and oil rigs on the lake. These factors limit the extent of water recreation for safety reasons.

On the Louisiana side of the lake, there are approximately 13 boat ramps, with a total of 21 boat lanes in service. There are approximately 46 picnic sites and 23 campsites (10 R.V., 8 tent and 5 cabins) serving the Louisiana side of the lake. In addition, Earl Williamson Park in Oil City maintains a public swimming beach on Caddo.

The western portion (the Texas side) of Caddo Lake is a swamp-like area, with boat lanes and lily ponds dividing dense stands of cypress trees draped with Spanish moss. This area is used primarily for fishing, hunting, camping, nature study, and canoeing. Pleasure boating and water skiing also take place on this part of the lake, but are limited to cleared areas. Once again, safety is a factor which limits visitor freedom on the lake. However, there are a number of guide services available to facilitate visitor access to all that Caddo Lake offers.

The Texas side of Caddo Lake is served by approximately 5 boat ramps with a total of 7 lanes. In addition, there are approximately 84 picnic tables, 79 of which are located at Caddo Lake State Park. There are more than 93 campsites (65 located at the State Park). The campsites include 16 R.V. sites, 57 tent sites, and 24 cabins. Caddo Lake State Park, at the westernmost end of the lake, is the largest recreational facility on the lake.

The next section of the study area is Big Cypress Bayou which extends from Ferrell's Bridge Dam at Lake O' The Pines east through Jefferson, Texas to Caddo Lake. The bayou can be accessed from a public boat ramp in Jefferson. The primary recreational activities for this portion of the study area are canoeing, boating, and fishing, with limited water skiing.

Activities on Big Cypress Bayou are centered around Jefferson, with the exception of bank fishing below the dam at Lake O' The Pines. There are a number of businesses in Jefferson offering water recreation services. Several businesses offer boat tours and guide service. At least two businesses offer canoe rentals. The recreation needs, demands and benefits analysis of Big Cypress Bayou and Jefferson, Texas is provided in a separation section

of this report. Additional recreation surveys and analysis were developed for that portion of the study area because greater detail was necessary to evaluate the Port of Jefferson as a recreation area.

Lake O' The Pines is a Corps lake with numerous facilities and businesses supporting recreation. All types of water recreation can be experienced at the lake including fishing, swimming, camping, picnicking, boating, and water skiing. There are approximately 63 boat ramps providing access to the lake, 198 picnic sites (7 of which are group facilities), and 461 campsites (2 of which are group facilities).

In general, business owners in the study area who were interviewed indicate that, despite seasonal fluctuations in activity, business is very busy and seems to be in a period of growth. There was an overwhelming consensus among those interviewed that visitors are primarily from the Dallas-Fort Worth area, with additional visitors from Houston, Shreveport, Longview, and Tyler. However, this conclusion is not supported by the limited visitor survey data available (see below). One possible explanation is that recreation-related businesses (guides, tours, campgrounds, etc.) are patronized primarily by visitors from distant locations, with the (more numerous) locally-originating visitors simply recreating "on their own". The available data is insufficient to resolve this question.

Population Centers

The largest city in the study area is Shreveport, Louisiana, with a 1990 population of 198,525. Smaller, but closer to the study area, are the neighboring cities of Longview, Texas and Marshall, Texas, with 1990 populations of 104,948 and 57,483 respectively. The city of Texarkana, in Texas and Arkansas, has a total population roughly equal to that of Marshall, but with a much smaller influence on the study area because of its greater distance, and recreational competition from nearby Wright Patman Lake. Similarly, Tyler, Texas, with a 1990 population of 75,450, is limited in its influence by distance.

Present and Projected Population

As shown in Table 2 below, the 1990 population of the counties in the study area was just over 1,032,000. Caddo Parish, Louisiana, accounted for about one-fourth of the total, with Smith and Gregg Counties, Texas, accounting for another one-fourth. The study area population (inclusive of the economic and demographic effects of the proposed study) is projected to increase to 1,112,000 by 2050, an overall average annual growth rate of 0.12 per year.

Table 2.
Projected Population
for Study Area Counties

county	state	1990	1995	2000	2005	2010	2020	2040	2050
Miller	AR	38,467	39,200	39,700	40,100	40,700	42,400	43,500	43,500
Bossier	LA	86,088	86,100	86,400	86,600	87,000	87,900	90,600	90,600
Caddo	LA	248,253	250,800	252,500	253,600	255,200	260,100	258,000	258,000
Bowie	TX	81,665	83,700	85,100	86,200	87,200	89,300	89,600	89,600
Camp	TX	9,904	10,100	10,200	10,200	10,300	10,400	10,300	10,300
Cass	TX	29,982	30,000	30,000	29,900	29,900	30,200	29,800	29,800
Franklin	TX	7,802	8,000	8,200	8,300	8,400	8,700	8,700	8,700
Gregg	TX	104,948	107,600	109,300	110,600	111,800	114,400	115,000	115,000
Harrison	TX	57,483	58,400	59,100	59,500	60,000	61,200	61,100	61,100
Hopkins	TX	28,833	29,600	30,200	30,700	31,100	32,000	32,100	32,100
Marion	TX	9,984	10,100	10,100	10,100	10,200	10,300	10,200	10,200
Morris	TX	13,200	13,300	13,300	13,400	13,400	13,600	13,600	13,600
Panola	TX	22,035	22,300	22,500	22,600	22,800	23,200	23,000	23,000
Red River	TX	14,317	14,300	14,200	14,100	14,100	14,100	13,900	13,900
Rusk	TX	43,375	43,500	43,200	42,900	42,800	43,000	42,400	42,400
Smith	TX	151,309	157,900	162,900	167,100	170,800	177,000	179,600	179,600
Titus	TX	24,009	24,500	24,800	25,100	25,300	25,800	25,700	25,700
Upshur	TX	31,370	31,900	32,400	32,700	33,100	33,800	33,900	33,900
Wood	TX	29,380	29,800	30,100	30,300	30,600	31,100	31,100	31,100
Total Study Area		1,032,404	1,051,100	1,064,200	1,074,000	1,084,700	1,108,500	1,112,100	1,112,100

per Capita Participation and Total Visitor-days

Both the projected recreation visitation to the study area, and the economic value of that visitation, were analyzed with travel cost method (TCM) models. Because of time and resource constraints, only existing and readily available information was used. However, the only existing, available data sufficiently detailed for present analytical purposes were for visitors originating within the state of Texas, and recreation locations within the state of Texas (Lake O' The Pines and Caddo Lake). No data was available for the Twelve Mile Bayou portion of the study area. The published data in the State Comprehensive Outdoor Recreation Plans (SCORPs) for Louisiana and Arkansas, unlike the Texas Outdoor Recreation Plan, are so highly aggregated as to be of limited use for an analysis like this, and the respective state agencies, unlike the Texas Parks and Wildlife Department, were unable to provide more specific information. It was therefore necessary to apply the visitation and economic value relationships modeled from Texas data to visitors originating in the Louisiana and Arkansas counties in the study area. Visitation originating from outside the Texas counties included TPWD raw survey data, or from the remainder of the United States, was generally ignored.

These simplifications are not unreasonable for this level of study effort, and are judged not to seriously affect the findings of this analysis. However, any additional recreation studies for this study should include more specific and detailed data collection, including recreation visitor surveys at all relevant sites.

The Texas Parks and Wildlife Department (TPWD), the agency that prepared the Texas Outdoor Recreation Plan (TORP), provided the Fort Worth district office with raw survey data collected in 1987 for the 1990 TORP, comprising, for Lake O' The Pines and Caddo Lake, (1)

the number of respondents and total activity-days for the surveyed year by county of origin and major recreation activity, and (2) the "participation rate" - meaning the proportion of the population visiting *one or more times* in the survey year - by TPWD multi-county region. Neither set of data directly showed the number of visitor-days per capita as a function of distance traveled, which is the basis for a travel cost model, so an indirect approach was necessary: estimating per capita visitor-days by county as the product of separately estimated relationships between the number of annual *visits per visitor* for each county and travel distance, and between the proportion of the population of each county visiting one or more times in the survey year (that is, *visitors per capita*) and travel distance. (For each reach, statistical regressions were performed relating visitation by county of origin to county per capita income and median age, as well as travel distance. The former two variables were found not to be statistically significant, however, and visitation was found to be adequately explained by distance alone.)

Visits per Visitor

The data on the number of respondents and total activity-days for the surveyed year by county of origin and major recreation activity were used to estimate the number of visits per visitor per year, by county of origin. Since visitors often engage in more than one activity per visit, to avoid double-counting (and in accordance with TPWD's own methodology) it was assumed that the activity showing the maximum number of activity-days, divided by the number of respondents, reflected the number of visits per visitor for each county. For visitors from at least 75 miles away, it was further assumed that they would be camping, and the maximum number of activity-days was therefore divided by the number of activity-days of camping per respondent (to account for multiple activity-days occurring during the multi-day camping visit). The data did not permit the latter adjustment to be made county-by-county, and there was not evident statistical relationship between travel distance and the number of activity-days of camping per respondent, so the average number of activity-days of camping per respondent over all counties was used for each reach. The resulting inferred numbers of visits per visitor were regressed against one-way travel distance, and for each reach the best statistical fit was found to be of the form

$$Y = a + bX^{-n}$$

where Y is the number of visits per visitor, X is the one-way travel distance, a and b are regression parameters, and n was determined by trial and error to maximize R^2 for the statistical relationship (subject to the additional constraint that the closest county not have an unreasonably high number of visits per visitor). Tables 3 and 4 display the TPWD raw data for visits per visitor and the regression parameters that yielded the best statistical fit, for Lake O' The Pines and Caddo Lake. Figures 1 and 2 graphically display the observed data points and the fitted curve for each reach.

Visitors Per Capita

A weighted-average travel distance from each TPWD region to each reach was calculated by summing the product of the distance from each county for which visitation was reported by its population, and dividing by the sum of the county populations in that region. The surveyed values of visitors per capita were regressed against one-way travel distance, and for each reach the best statistical fit was again found to be of the form

$$Y = a + bX^{-n}$$

where Y is the proportion of population visiting, X is the one-way travel distance, a and b are regression parameters, and n was determined by trial and error to maximize R^2 for the statistical relationship (subject to the additional constraint that the closest county not have more than 100 percent of its population visiting). Tables 5 and 6 display the TPWD raw data

for proportion of population visiting at least once and the regression parameters that yielded the best statistical fit, for Lake O' The Pines and Caddo Lake. Figures 3 and 4 graphically display the observed data points and the fitted curve for each reach.

Visitor-Days

For each county reporting visitation in the TPWD data, the two modeled estimates (visitor-days per visitor, and visitors per capita) based on its travel distance were multiplied together to produce a total participation rate. This in turn was multiplied by county population to produce total visitor-days from each county. Tables 7 and 8 show this calculation for each reach, with counties listed in increasing order of travel distance. The study area accounts for about 95 percent of the recreation visitor-days for Lake O' The Pines, compared to about 86 percent of the visitor-days for Caddo Lake. This implies that Caddo Lake is a stronger attractor to more distant visitors than Lake O' The Pines, arguably because Caddo Lake is much more distinctive (if not unique) in terms of physical, aesthetic, and recreational attributes.

Table 3.
Estimation of Visits per Visitor,
Lake O' the Pines

county	TPWD region	approx. 1-way travel distance (miles)	number of respondents	RAW DATA: respondents and activity-days for Lake O' The Pines camping	picnicking	hiking	nature study	swimming	fishing	boating	implied annual visits per visitor	predicted[1]
Marion	6	25	12	23	53	0	0	340	222	250	28.333	18.408
Camp	6	30	1	0	6	0	0	9	0	0	9.000	12.892
Harrison	6	30	19	14	101	0	0	175	38	111	9.211	12.892
Morris	5	30	4	3	0	0	0	9	47	0	11.750	12.892
Upshur	6	30	14	37	6	0	0	85	148	16	10.571	12.892
Gregg	6	35	31	72	61	20	66	231	154	106	7.462	9.567
Cass	5	39	11	75	6	0	0	7	110	23	10.000	7.774
Titus	5	50	0	0	0	0	0	0	0	0	0.000	4.870
Wood	6	57	1	0	0	0	0	0	4	0	4.000	3.829
Panola	6	61	1	0	5	0	0	0	0	2	5.000	3.389
Bowie	5	64	1	0	3	0	0	3	0	2	3.000	3.111
Rusk	6	65	2	0	0	0	0	2	0	1	1.000	3.027
Franklin	5	66	0	0	0	0	0	0	0	0	0.000	2.947
Red River	5	71	1	3	0	0	0	0	0	0	3.000	2.696
Smith	5	71	0	0	0	0	0	0	0	0	0.000	2.696
Hopkins	5	87	0	0	0	0	0	0	0	0	0.000	1.847
Hunt	4	98	2	8	0	0	0	0	5	1	1.699	1.532
Nacogdoches	14	106	1	2	0	0	0	0	0	0	0.849	1.361
Henderson	6	107	0	0	0	0	0	0	0	0	0.000	1.342
San Augustine	14	107	0	0	0	0	0	0	0	0	0.000	1.342
Fannin	22	115	2	5	2	0	0	0	0	0	1.082	1.210
Anderson	8	119	1	0	0	0	0	0	2	2	0.849	1.153
Angelina	14	122	1	0	0	0	0	1	0	1	0.425	1.115
Grayson	22	143	1	12	0	0	0	12	12	12	5.096	0.909
Houston	14	155	0	0	0	0	0	0	0	0	0.000	0.826
Collin	4	156	1	3	0	0	0	3	0	0	1.274	0.820
Dallas	4	160	3	8	0	0	0	9	6	7	1.274	0.798
Tarrant	4	190	1	0	0	0	0	0	0	1	0.425	0.669
Brazos	13	212	2	3	3	0	0	3	0	23	4.884	0.608
Jefferson	15	229	1	0	2	0	2	0	0	0	0.849	0.572
Hood	4	231	0	0	0	0	0	0	0	0	0.000	0.568
Harris	16	241	0	0	0	0	0	0	0	0	0.000	0.551
Grimes	13	248	0	0	0	0	0	0	0	0	0.000	0.540
Archer	3	281	2	10	0	0	0	0	1	1	2.123	0.500
Washington	13	282	0	0	0	0	0	0	0	0	0.000	0.499
Brazoria	16	291	0	0	0	0	0	0	0	0	0.000	0.490
Travis	12	291	0	0	0	0	0	0	0	0	0.000	0.490
Burnet	12	297	0	0	0	0	0	0	0	0	0.000	0.485
Lavaca	17	353	1	0	0	0	0	1	0	0	0.426	0.447
Gray	1	455	1	10	0	0	0	0	10	0	4.257	0.411
Lubbock	2	482	1	2	0	0	0	0	0	0	0.849	0.406
Midland	9	487	1	1	0	0	0	0	4	4	1.699	0.404
Ector	9	505	0	0	0	0	0	0	0	0	0.000	0.401
Potter	1	517	1	0	0	0	0	0	5	1	2.123	0.399
Randall	1	517	1	1	0	0	0	0	8	0	3.397	0.399
Crane	9	539	1	0	0	0	0	1	0	0	0.425	0.396
Moore	1	566	1	0	3	0	0	3	3	0	1.274	0.392
TOTALS			124	292	251	20	68	894	779	564		
% of total activity-days			10.18%	8.76%	0.70%	2.37%	31.17%	27.16%	19.67%			

[1] $Y = 0.3688 + 11282 * X^{2.0}$
$R^2 = 0.76$

Figure 1.
Observed and Predicted
Visits per Visitor per Year,
Lake O' The Pines

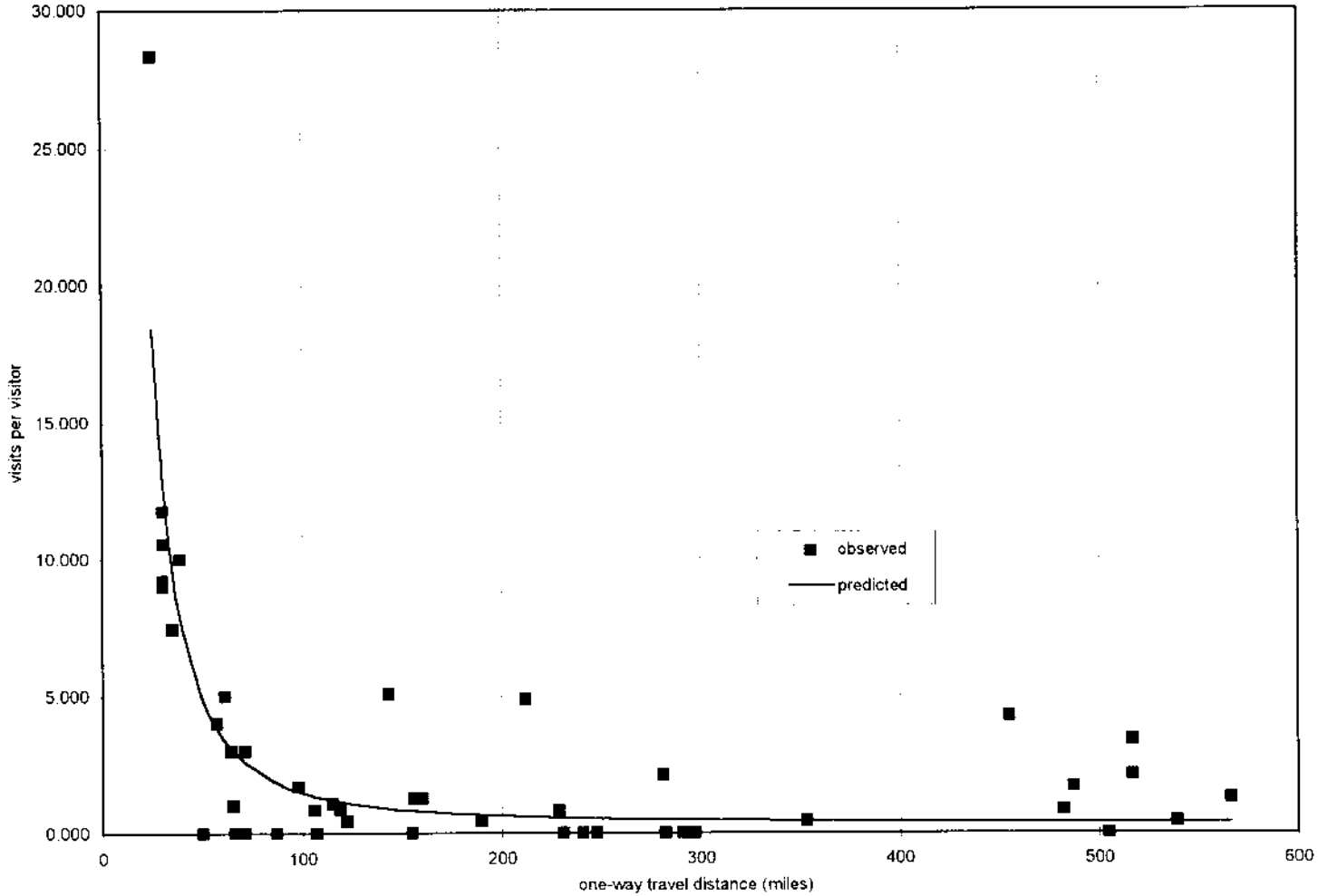

Table 4.
Estimation of Visits per Visitor,
Caddo Lake

county	TPWD region	approx. 1-way travel distance (miles)	number of respondents	RAW DATA: respondents and activity-days for Lake O' The Pines: camping	picnicking	hiking	nature study	swimming	fishing	boating	implied annual visits per visitor	predicted*
Marion	6	16	5	5	3	0	0	2	45	9	9.000	8.849
Harrison	6	20	12	4	8	1	0	26	29	50	4.167	7.387
Cass	5	35	9	12	2	0	0	32	89	19	9.889	4.786
Gregg	6	43	8	2	8	2	2	0	106	15	13.250	4.113
Morris	5	48	1	0	0	0	0	0	6	6	6.000	3.802
Panola	6	55	1	0	2	0	0	0	0	0	2.000	3.457
Upshur	6	59	2	0	0	0	0	2	0	1	1.000	3.295
Bowie	5	60	1	1	0	1	1	0	0	1	1.000	3.258
Rusk	6	61	1	0	0	0	0	0	1	1	1.000	3.222
Camp	6	64	1	1	0	0	0	0	0	0	1.000	3.120
Titus	5	68	1	0	0	3	3	0	0	0	3.000	2.998
Smith	6	79	1	7	0	0	0	0	0	0	3.343	2.722
Franklin	5	84	0	0	0	0	0	0	0	0	0.000	2.619
Wood	6	90	0	0	0	0	0	0	0	0	0.000	2.510
San Augustine	14	101	1	6	0	0	0	0	6	6	2.866	2.343
Nacogdoches	14	104	0	0	0	0	0	0	0	0	0.000	2.303
Hopkins	5	105	0	0	0	0	0	0	0	0	0.000	2.290
Red River	5	109	0	0	0	0	0	0	0	0	0.000	2.241
Henderson	6	115	1	3	0	0	0	0	0	0	1.433	2.174
Angelina	14	123	1	5	0	0	0	0	0	5	2.388	2.094
Anderson	6	125	0	0	0	0	0	0	0	0	0.000	2.076
Hunt	4	136	0	0	0	0	0	0	0	0	0.000	1.983
Fannin	22	153	0	0	0	0	0	0	0	0	0.000	1.866
Houston	14	156	1	3	0	0	0	0	0	0	1.433	1.847
Dallas	4	168	4	55	0	0	3	23	3	14	6.667	1.780
Collin	4	169	0	0	0	0	0	0	0	0	0.000	1.776
Grayson	22	181	0	0	0	0	0	0	0	1	0.000	1.718
Tarrant	4	198	1	3	0	3	0	0	0	0	1.433	1.647
Jefferson	15	222	1	10	7	0	0	0	0	0	4.776	1.566
Brazos	13	230	1	0	0	0	0	25	25	20	11.940	1.542
Hood	4	239	1	2	0	0	0	0	0	0	0.955	1.517
Grimes	13	239	1	10	0	8	0	0	0	1	4.776	1.517
Harris	16	247	1	0	0	0	0	0	4	0	1.910	1.497
Washington	13	273	1	0	0	0	1	0	0	0	0.478	1.438
Travis	12	299	2	4	0	0	0	0	0	0	0.955	1.388
Burnet	12	305	1	0	0	0	0	0	4	0	1.910	1.378
Brazoria	16	309	1	0	4	0	0	0	20	0	9.552	1.372
Archer	3	313	0	0	0	0	0	0	0	0	0.000	1.365
Lavaca	17	359	0	0	0	0	0	0	0	0	0.000	1.301
Lubbock	2	490	0	0	0	0	0	0	0	0	0.000	1.182
Midland	9	495	1	1	0	0	0	1	0	1	0.478	1.178
Gray	1	498	0	0	0	0	0	0	0	0	0.000	1.176
Ector	8	515	1	0	0	0	0	0	2	0	0.955	1.165
Potter	1	525	0	0	0	0	0	0	0	0	0.000	1.159
Randall	1	525	0	0	0	0	0	0	0	0	0.000	1.159
Crane	9	547	0	0	0	0	0	0	0	0	0.000	1.147
Moore	1	574	0	0	0	0	0	0	0	0	0.000	1.132
TOTALS			64	134	34	18	10	111	340	160		
% of total activity-days					16.81%	4.27%	2.26%	1.25%	13.93%	42.66%	18.82%	

* $Y = 0.812 + 97.45913 * X^{0.6}$

$R^2 = 0.20$

Figure 2.
Observed and Predicted
Visits per Visitor per Year,
Caddo Lake

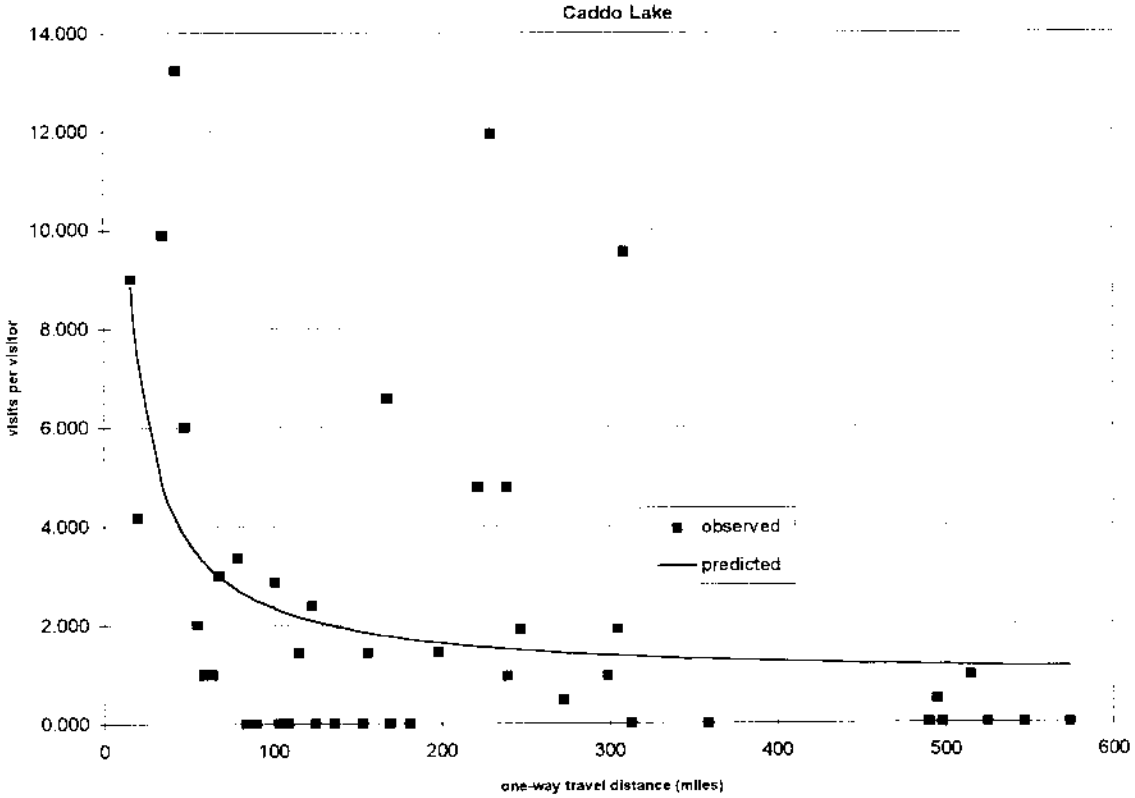

Table 5.
Estimation of Visitors per Capita,
Lake O' The Pines

TPWD region	1990 population	approx. 1-way travel distance (miles)	visitors per capita: observed	predicted*
		25		0.5658
		40		0.2210
5	199,808	60	0.040964	0.0982
6	566,355	63	0.160853	0.0891
14	154,011	120	0.004386	0.0246
22	119,825	137	0.006061	0.0188
4	3,140,204	171	0.007439	0.0121
13	166,844	227	0.005277	0.0069
15	239,397	229	0.003690	0.0067
16	3,009,906	244	0.000000	0.0059
3	7,973	281	0.005115	0.0045
12	599,084	291	0.000000	0.0042
17	18,690	353	0.002475	0.0028
2	222,636	482	0.002045	0.0015
9	230,197	497	0.005450	0.0014
1	229,379	514	0.007477	0.0013

* $Y = 353.6134 * X^{-2.0}$
$R^2 = 0.62$

Table 6.
Estimation of Visitors per Capita,
Caddo Lake

TPWD region	1990 population	approx 1-way travel distance (miles)	visitors per capita: observed	predicted*
		25		0.2607
		40		0.1119
5	199,808	67	0.028916	0.0442
6	566,355	70	0.062016	0.0408
14	154,011	120	0.006579	0.0155
22	119,825	175	0.000000	0.0079
4	3,140,204	179	0.006376	0.0075
13	166,844	238	0.007916	0.0045
15	239,397	222	0.003690	0.0051
16	3,009,906	251	0.003026	0.0041
3	7,973	313	0.000000	0.0028
12	599,084	299	0.005435	0.0030
17	18,690	359	0.000000	0.0022
2	222,636	490	0.000000	0.0012
9	230,197	506	0.005450	0.0012
1	229,379	526	0.000000	0.0011

* $Y = 85.57616 * X^{-1.8}$
$R^2 = 0.77$

Figure 3.
Observed and Predicted
Visitors per Capita per Year,
Lake O' The Pines

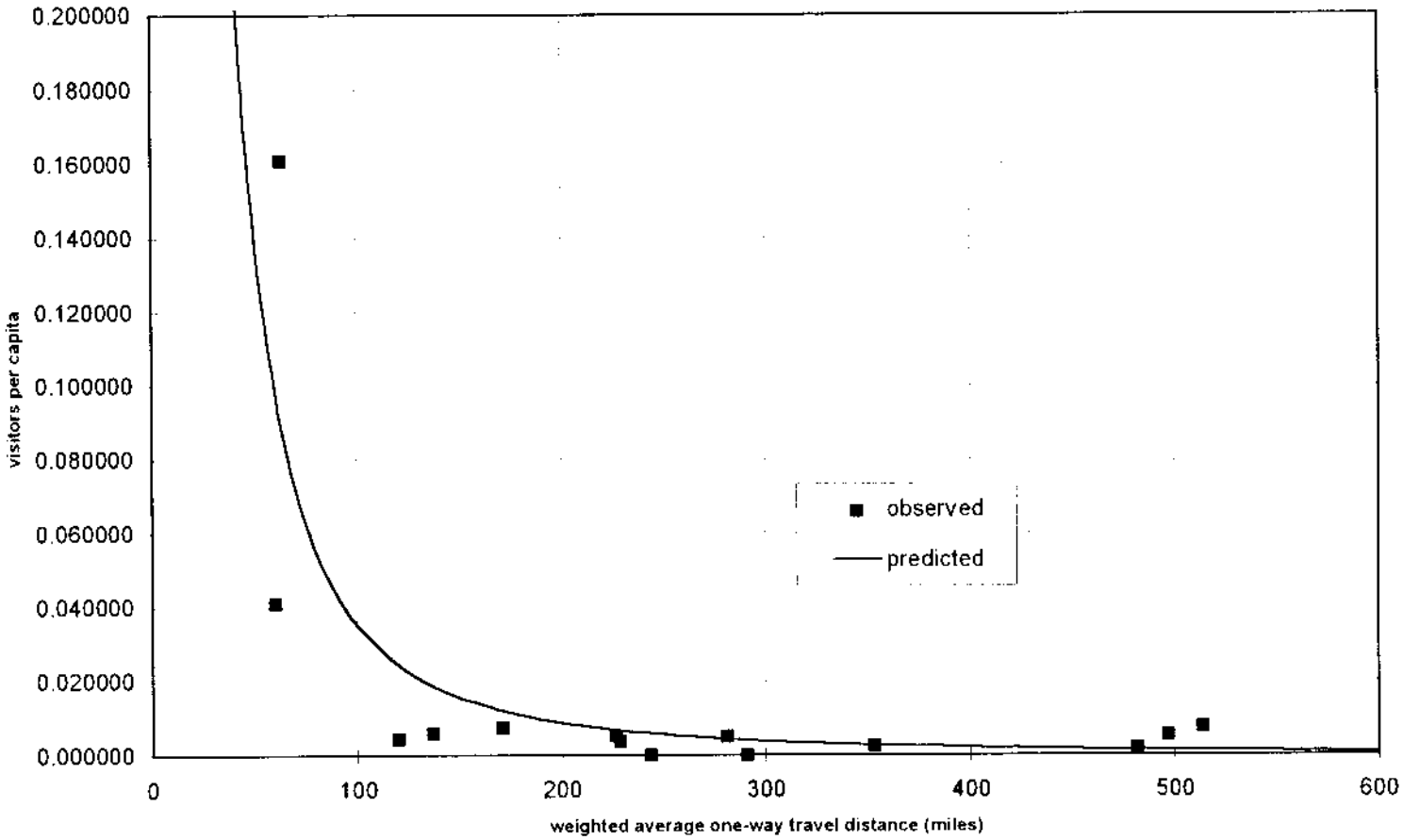

Figure 4.
Observed and Predicted
Visitors per Capita per Year,
Caddo Lake

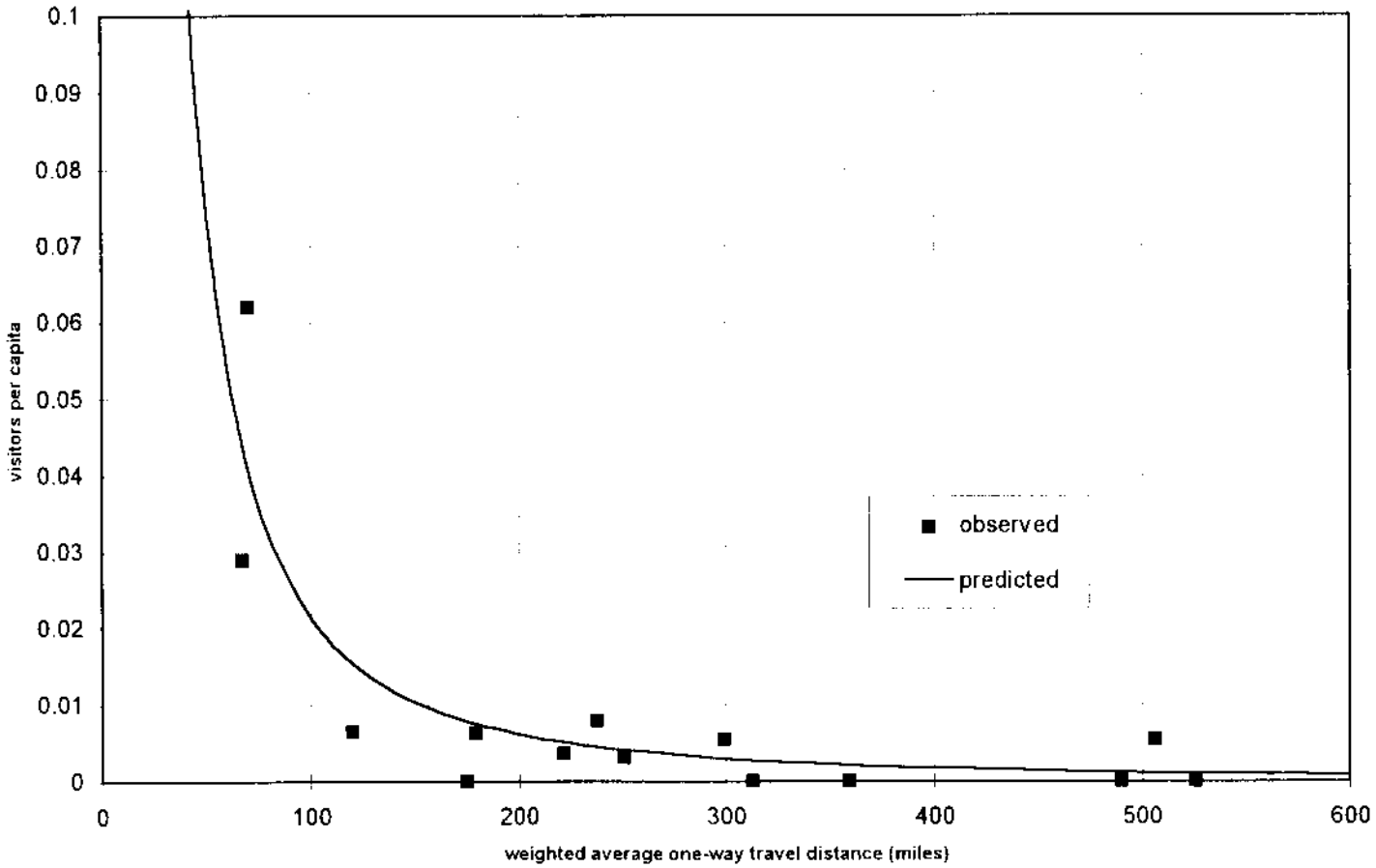

Table 7.
Total Participation Rate and Visitor-Days,
Lake O' The Pines

county		principal population center	1990 population	approx. 1-way travel distance (miles)	visits per visitor per year	visit per capita per year	total participation rate	total visitor-days	cumulative visitation: number	cumulative visitation: percent
Marion	TX	Jefferson	9,984	25	18.4080	0.5658	10.4149	103,982	103,982	8.27%
Camp	TX	Pittsburg	9,904	30	12.8924	0.3929	5.0655	50,168	154,151	12.26%
Harrison	TX	Marshall	57,483	30	12.8924	0.3929	5.0655	291,178	445,328	35.43%
Morris	TX	Daingerfield	13,200	30	12.8924	0.3929	5.0655	66,864	512,192	40.75%
Upshur	TX	Gilmer	31,370	30	12.8924	0.3929	5.0655	158,903	671,096	53.39%
Gregg	TX	Longview	104,948	35	9.5666	0.2887	2.7615	289,817	960,913	76.45%
Cass	TX	Atlanta	29,982	39	7.7743	0.2325	1.8074	54,190	1,015,103	80.76%
Titus	TX	Mount Pleasant	24,009	50	4.8696	0.1414	0.6888	16,537	1,031,640	82.07%
Wood	TX	Quitman	29,380	57	3.8293	0.1088	0.4168	12,245	1,043,885	83.05%
Panola	TX	Carthage	22,035	61	3.3888	0.0950	0.3220	7,096	1,050,981	83.61%
Bowie	TX	Texarkana	81,665	64	3.1112	0.0863	0.2686	21,935	1,072,916	85.36%
Rusk	TX	Henderson	43,375	65	3.0271	0.0837	0.2534	10,989	1,083,905	86.23%
Franklin	TX	Mount Vernon	7,802	66	2.9468	0.0812	0.2392	1,866	1,085,771	86.38%
Caddo	LA	Shreveport	269,688	68	2.7967	0.0765	0.2139	57,679	1,143,450	90.97%
Miller	AR	Texarkana	39,913	70	2.6592	0.0722	0.1919	7,660	1,151,109	91.58%
Red River	TX	Clarksville	14,317	71	2.5948	0.0701	0.1820	2,606	1,153,715	91.79%
Smith	TX	Tyler	151,309	71	2.5948	0.0701	0.1820	27,542	1,181,257	93.98%
Bossier	LA	Bossier City	91,106	74	2.4171	0.0646	0.1561	14,220	1,195,477	95.11%
Hopkins	TX	Sulphur Springs	28,833	87	1.8474	0.0467	0.0863	2,488	1,197,965	95.31%
Hunt	TX	Greenville	64,343	98	1.5315	0.0368	0.0564	3,628	1,201,594	95.60%
Nacogdoches	TX	Nacogdoches	54,753	106	1.3609	0.0315	0.0428	2,345	1,203,939	95.78%
Henderson	TX	Athens	58,543	107	1.3422	0.0309	0.0415	2,427	1,206,366	95.98%
San Augustine	TX	San Augustine	7,999	107	1.3422	0.0309	0.0415	332	1,206,697	96.00%
Fannin	TX	Bonham	24,804	115	1.2099	0.0267	0.0324	802	1,207,500	96.07%
Anderson	TX	Palestine	48,024	119	1.1535	0.0250	0.0288	1,383	1,208,883	96.18%
Angelina	TX	Lufkin	69,884	122	1.1148	0.0238	0.0265	1,851	1,210,734	96.32%
Grayson	TX	Sherman	95,021	143	0.9085	0.0173	0.0157	1,493	1,212,227	96.44%
Houston	TX	Crockett	21,375	155	0.8264	0.0147	0.0122	260	1,212,487	96.46%
Collin	TX	Mckinney	264,036	156	0.8204	0.0145	0.0119	3,147	1,215,634	96.71%
Dallas	TX	Dallas	1,852,810	160	0.7975	0.0138	0.0110	20,410	1,236,045	98.34%
Tarrant	TX	Fort Worth	1,170,103	190	0.6693	0.0098	0.0066	7,671	1,243,716	98.95%
Brazos	TX	Bryan	121,862	212	0.6078	0.0079	0.0048	583	1,244,299	98.99%
Jefferson	TX	Beaumont	239,397	229	0.5719	0.0067	0.0039	923	1,245,222	99.07%
Hood	TX	Granbury	28,981	231	0.5682	0.0066	0.0038	109	1,245,331	99.08%
Harris	TX	Houston	2,818,199	241	0.5510	0.0061	0.0034	9,455	1,254,786	99.83%
Grimes	TX	Anderson	18,828	248	0.5402	0.0057	0.0031	58	1,254,845	99.83%
Archer	TX	Archer City	7,973	281	0.4997	0.0045	0.0022	18	1,254,862	99.83%
Washington	TX	Brenham	26,154	282	0.4987	0.0044	0.0022	58	1,254,920	99.84%
Brazoria	TX	Brazosport	191,707	291	0.4900	0.0042	0.0020	392	1,255,313	99.87%
Travis	TX	Austin	576,407	291	0.4900	0.0042	0.0020	1,179	1,256,492	99.96%
Burnet	TX	Burnet	22,677	297	0.4847	0.0040	0.0019	44	1,256,536	99.97%
Lavaca	TX	Hallettsville	18,690	353	0.4473	0.0028	0.0013	24	1,256,560	99.97%
Gray	TX	Pampa	23,967	455	0.4113	0.0017	0.0007	17	1,256,577	99.97%
Lubbock	TX	Lubbock	222,636	482	0.4054	0.0015	0.0006	137	1,256,714	99.98%
Midland	TX	Midland	106,611	487	0.4044	0.0015	0.0006	64	1,256,778	99.99%
Ector	TX	Odessa	118,934	505	0.4010	0.0014	0.0006	66	1,256,845	99.99%
Potter	TX	Amarillo	97,874	517	0.3990	0.0013	0.0005	52	1,256,896	100.00%
Randall	TX	Amarillo	89,673	517	0.3990	0.0013	0.0005	47	1,256,944	100.00%
Crane	TX	Crane	4,652	539	0.3956	0.0012	0.0005	2	1,256,946	100.00%
Moore	TX	Dumas	17,865	566	0.3920	0.0011	0.0004	8	1,256,954	100.00%

Table 8.
Total Participation Rate and Visitor-Days,
Caddo Lake

county		principal population center	1990 population	approx. 1-way travel distance (miles)	visits per visitor per year	visits per capita per year	total participation rate	total visitor-days	cumulative visitation: number	cumulative visitation: percent
Marion	TX	Jefferson	9,984	16	8.849	0.5820	5.1505	51,423	51,423	8.63%
Harrison	TX	Marshall	57,483	20	7.387	0.3895	2.8772	165,389	216,811	36.39%
Cass	TX	Atlanta	29,982	35	4.785	0.1422	0.6807	20,408	237,220	39.82%
Caddo	LA	Shreveport	269,688	39	4.417	0.1171	0.5170	139,442	376,661	63.22%
Gregg	TX	Longview	104,948	43	4.113	0.0982	0.4039	42,392	419,054	70.34%
Bossier	LA	Bossier City	91,106	47	3.859	0.0837	0.3229	29,420	448,474	75.28%
Morris	TX	Daingerfield	13,200	48	3.802	0.0806	0.3063	4,043	452,517	75.96%
Panola	TX	Carthage	22,035	55	3.457	0.0631	0.2180	4,804	457,321	76.76%
Upshur	TX	Gilmer	31,370	59	3.295	0.0556	0.1831	5,744	463,065	77.73%
Bowie	TX	Texarkana	81,665	60	3.258	0.0539	0.1757	14,345	477,410	80.14%
Miller	AR	Texarkana	39,913	60	3.258	0.0539	0.1757	7,011	484,421	81.31%
Rusk	TX	Henderson	43,375	61	3.222	0.0523	0.1686	7,314	491,734	82.54%
Camp	TX	Pittsburg	9,904	64	3.120	0.0480	0.1498	1,483	493,218	82.79%
Titus	TX	Mount Pleasant	24,009	68	2.998	0.0430	0.1290	3,097	496,315	83.31%
Smith	TX	Tyler	151,309	79	2.722	0.0329	0.0894	13,531	509,846	85.58%
Franklin	TX	Mount Vernon	7,802	84	2.619	0.0294	0.0771	601	510,447	85.68%
Wood	TX	Quitman	29,380	90	2.510	0.0260	0.0652	1,916	512,363	86.00%
San Augustine	TX	San Augustine	7,999	101	2.343	0.0211	0.0495	396	512,759	86.07%
Nacogdoches	TX	Nacogdoches	54,753	104	2.303	0.0200	0.0461	2,526	515,285	86.49%
Hopkins	TX	Sulphur Springs	28,833	105	2.290	0.0197	0.0451	1,300	516,585	86.71%
Red River	TX	Clarksville	14,317	109	2.241	0.0184	0.0413	591	517,176	86.81%
Henderson	TX	Athens	58,543	115	2.174	0.0167	0.0363	2,127	519,303	87.17%
Angelina	TX	Lufkin	69,884	123	2.094	0.0148	0.0310	2,167	521,470	87.53%
Anderson	TX	Palestine	48,024	125	2.076	0.0144	0.0299	1,434	522,904	87.77%
Hunt	TX	Greenville	64,343	136	1.983	0.0124	0.0245	1,577	524,481	88.04%
Fannin	TX	Bonham	24,804	153	1.865	0.0100	0.0187	463	524,944	88.11%
Houston	TX	Crockett	21,375	156	1.847	0.0097	0.0178	381	525,325	88.18%
Dallas	TX	Dallas	1,852,810	168	1.780	0.0084	0.0150	27,870	553,195	92.86%
Collin	TX	Mckinney	264,036	169	1.775	0.0084	0.0148	3,918	557,113	93.51%
Grayson	TX	Sherman	95,021	181	1.718	0.0074	0.0127	1,206	558,319	93.72%
Tarrant	TX	Fort Worth	1,170,103	198	1.647	0.0063	0.0104	12,116	570,434	95.75%
Jefferson	TX	Beaumont	239,397	222	1.566	0.0051	0.0080	1,917	572,352	96.07%
Brazos	TX	Bryan	121,862	230	1.542	0.0048	0.0074	902	573,254	96.22%
Hood	TX	Granbury	28,981	239	1.517	0.0045	0.0068	197	573,451	96.26%
Grimes	TX	Anderson	18,828	239	1.517	0.0045	0.0068	128	573,578	96.28%
Harris	TX	Houston	2,818,199	247	1.497	0.0042	0.0063	17,806	591,384	99.27%
Washington	TX	Brenham	26,154	273	1.438	0.0035	0.0051	133	591,517	99.29%
Travis	TX	Austin	576,407	299	1.388	0.0030	0.0042	2,395	593,912	99.69%
Burnet	TX	Burnet	22,677	305	1.378	0.0029	0.0040	90	594,002	99.71%
Brazoria	TX	Brazosport	191,707	309	1.372	0.0028	0.0039	742	594,744	99.83%
Archer	TX	Archer City	7,973	313	1.365	0.0028	0.0038	30	594,774	99.84%
Lavaca	TX	Hallettsville	18,690	359	1.301	0.0022	0.0028	52	594,827	99.84%
Lubbock	TX	Lubbock	222,636	490	1.182	0.0012	0.0015	324	595,150	99.90%
Midland	TX	Midland	106,611	495	1.178	0.0012	0.0014	152	595,302	99.92%
Gray	TX	Pampa	23,967	498	1.176	0.0012	0.0014	34	595,336	99.93%
Ector	TX	Odessa	118,934	515	1.165	0.0011	0.0013	156	595,491	99.96%
Potter	TX	Amarillo	97,874	525	1.159	0.0011	0.0013	123	595,615	99.98%
Randall	TX	Amarillo	89,673	525	1.159	0.0011	0.0013	113	595,728	100.00%
Crane	TX	Crane	4,652	547	1.147	0.0010	0.0012	5	595,733	100.00%
Moore	TX	Dumas	17,865	574	1.132	0.0009	0.0010	19	595,752	100.00%

Tables 9 and 10 display projected population and visitor-days for each reach. (Since the total participation rate for each county is assumed to be constant over time, recreation visitation is simply proportional to population.) The two reaches generated an estimated 2.0 million recreation visitor-days in 1990, with Lake O' The Pines accounting for over two-thirds of the total. This total would increase to about 2.1 million visitor-days by 2050.

As shown, adjustments to total visitor-days were made for Lake O' The Pines and Caddo Lake, to account for visitation originating outside the nominal study area. In the case of Lake O' The Pines, total 1987 visitation at the project was known from survey data collected at that time to be 1.4 million, and the difference between that total and the estimate for the study area was assumed to represent visitation originating from distant areas in Texas and the remainder of the United States. The proportional difference between the total 1987 visitation and estimated 1987 visitation for the study area was assumed to remain constant over time. In the case of Caddo Lake, the adjustment represented the difference between estimated visitor-days for the study area, and visitor-days for all counties reporting visitation in the TPWD data, based on 1990 populations. Again, the proportional difference was assumed to remain constant over time.

Consolidation of Reaches

The statistical relationships resulting from the above analyses were substantially different for each of the reaches, reflecting the physical and qualitative differences in their recreation experiences, despite their relatively close proximity to each other. (In the absence of any specific data, Twelve Mile Bayou was considered to be represented by the Caddo Lake demand model.)

Table 9.
Projected Population and Visitor-days,
Lake O' The Pines

county	state	principal population center	approx. 1-way travel distance (miles)	total visitation rate	projected population: 1987	1990	2000	2010	2020	2040	2050	projected visitor-days: 1987	1990	2000	2010	2020	2040	2050
Miller	AR	Texarkana	70	0.1919	39,200	39,913	39,700	40,700	42,400	43,600	43,600	7,500	7,700	7,600	7,800	8,100	8,300	8,300
Bossier	LA	Bossier City	74	0.1561	90,660	91,106	86,600	87,900	90,600	91,000	91,000	14,100	14,200	13,500	13,700	14,100	14,200	14,200
Caddo	LA	Shreveport	68	0.2139	269,860	269,688	252,500	255,200	260,100	268,000	268,000	57,700	57,700	54,000	54,600	55,600	55,200	55,200
Bowie	TX	Texarkana	64	0.2686	79,137	81,865	86,100	87,200	89,300	89,600	89,600	21,300	21,900	22,900	23,400	24,000	24,100	24,100
Camp	TX	Pittsburg	30	5.0655	10,115	9,904	10,200	10,300	10,400	10,300	10,300	51,200	50,200	51,700	52,200	52,700	52,200	52,200
Cass	TX	Atlanta	39	1.8074	30,294	29,982	30,000	29,900	30,200	29,800	29,800	54,800	54,200	54,200	54,000	54,600	53,900	53,900
Franklin	TX	Mount Vernon	66	0.2392	7,648	7,802	8,200	8,400	8,700	8,700	8,700	1,800	1,900	2,000	2,000	2,100	2,100	2,100
Gregg	TX	Longview	36	2.7615	110,344	104,948	109,300	111,800	114,400	115,000	115,000	304,700	289,800	301,800	308,700	315,900	317,600	317,600
Harrison	TX	Marshall	30	5.0655	57,356	57,483	59,100	60,000	61,200	61,100	61,100	290,600	291,200	299,400	303,900	310,000	309,500	309,500
Hopkins	TX	Sulphur Springs	87	0.0863	28,588	28,833	30,200	31,100	32,000	32,100	32,100	2,500	2,500	2,600	2,700	2,800	2,800	2,800
Marion	TX	Jefferson	25	10.4149	9,293	9,984	10,100	10,200	10,300	10,200	10,200	96,800	104,000	105,200	106,200	107,300	106,200	106,200
Morris	TX	Daingerfield	30	5.0655	13,609	13,200	13,300	13,400	13,600	13,600	13,600	68,900	66,900	67,400	67,900	68,900	68,900	68,900
Panola	TX	Carthage	61	0.3220	21,799	22,035	22,600	22,800	23,200	23,000	23,000	7,000	7,100	7,200	7,300	7,500	7,400	7,400
Red River	TX	Clarksville	71	0.1820	15,489	14,317	14,200	14,100	14,100	14,100	13,900	2,800	2,600	2,600	2,600	2,600	2,600	2,500
Rusk	TX	Henderson	66	0.2634	43,347	43,375	43,200	42,800	43,000	42,400	42,400	11,000	11,000	10,900	10,800	10,900	10,700	10,700
Smith	TX	Tyler	71	0.1820	160,484	161,309	162,900	170,800	177,000	179,600	179,600	27,400	27,500	29,700	31,100	32,200	32,700	32,700
Titus	TX	Mount Pleasant	60	0.6888	23,129	24,009	24,800	25,300	25,800	25,700	25,700	15,900	16,500	17,100	17,400	17,800	17,700	17,700
Upshur	TX	Gilmer	30	5.0655	30,526	31,370	32,400	33,100	33,800	33,900	33,900	154,600	158,900	164,100	167,700	171,200	171,700	171,700
Wood	TX	Quitman	57	0.4168	28,279	29,380	30,100	30,600	31,100	31,100	31,100	11,800	12,200	12,500	12,800	13,000	13,000	13,000
Subtotal, Study Area					1,059,016	1,060,303	1,064,400	1,085,600	1,111,200	1,112,700	1,112,500	1,202,300	1,198,000	1,226,400	1,246,800	1,271,300	1,270,800	1,270,700
Other Areas												206,900	206,200	211,000	214,800	218,800	218,700	218,700
Total												1,409,200	1,404,200	1,437,400	1,461,400	1,490,100	1,489,500	1,489,400

Table 10.
Projected Population and Visitor-days,
Caddo Lake

county	state	principal population center	approx. 1-way travel distance (miles)	total visitation rate	projected population: 1990	2000	2010	2020	2040	2050	projected visitor-days: 1990	2000	2010	2020	2040	2050
Miller	AR	Texarkana	60	0.1767	39,913	39,913	39,913	39,913	39,913	39,913	7,000	7,000	7,000	7,000	7,000	7,000
Bossier	LA	Bossier City	47	0.3229	91,106	91,106	91,106	91,106	91,106	91,106	29,400	29,400	29,400	29,400	29,400	29,400
Caddo	LA	Shreveport	39	0.5170	269,688	269,688	269,688	269,688	269,688	269,688	139,400	139,400	139,400	139,400	139,400	139,400
Bowie	TX	Texarkana	60	0.1767	81,665	85,100	87,200	89,300	89,600	89,600	14,300	14,900	15,300	15,700	15,700	15,700
Camp	TX	Pittsburg	54	0.1498	9,904	10,200	10,300	10,400	10,300	10,300	1,500	1,500	1,500	1,600	1,500	1,500
Cass	TX	Atlanta	35	0.6807	29,982	30,000	29,900	30,200	29,800	29,800	20,400	20,400	20,400	20,600	20,300	20,300
Franklin	TX	Mount Vernon	84	0.0771	7,802	8,200	8,400	8,700	8,700	8,700	600	600	600	700	700	700
Gregg	TX	Longview	43	0.4039	104,948	109,300	111,800	114,400	116,000	116,000	42,400	44,200	46,200	46,200	46,600	46,600
Harrison	TX	Marshall	20	2.8772	57,483	59,100	60,000	61,200	61,100	61,100	165,400	170,000	172,600	176,100	175,800	175,800
Hopkins	TX	Sulphur Springs	105	0.0451	28,833	30,200	31,100	32,000	32,100	32,100	1,300	1,400	1,400	1,400	1,400	1,400
Marion	TX	Jefferson	16	5.1505	9,984	10,100	10,200	10,300	10,200	10,200	51,400	52,000	52,500	53,100	52,500	52,500
Morris	TX	Daingerfield	48	0.3063	13,200	13,300	13,400	13,600	13,600	13,600	4,000	4,100	4,100	4,200	4,200	4,200
Panola	TX	Carthage	55	0.2180	22,035	22,500	22,800	23,200	23,000	23,000	4,800	4,900	5,000	5,100	5,000	5,000
Red River	TX	Clarksville	109	0.0413	14,317	14,200	14,100	14,100	14,100	13,900	600	600	600	600	600	600
Rusk	TX	Henderson	61	0.1886	43,375	43,200	42,800	43,000	42,400	42,400	7,300	7,300	7,200	7,300	7,100	7,100
Smith	TX	Tyler	79	0.0894	151,309	162,900	170,800	177,000	179,600	179,600	13,500	14,600	15,300	15,800	16,100	16,100
Titus	TX	Mount Pleasant	88	0.1290	24,009	24,800	25,300	25,800	25,700	25,700	3,100	3,200	3,300	3,300	3,300	3,300
Upshur	TX	Gilmer	59	0.1831	31,370	32,400	33,100	33,800	33,900	33,900	5,700	5,900	6,100	6,200	6,200	6,200
Wood	TX	Quitman	90	0.0652	29,380	30,100	30,600	31,100	31,100	31,100	1,900	2,000	2,000	2,000	2,000	2,000
Subtotal, Study Area					1,060,303	1,086,307	1,102,507	1,118,807	1,120,907	1,120,70	514,000	523,400	528,900	535,700	534,700	534,700
Other Areas											78,200	90,100	91,000	92,200	92,000	92,000
Total											592,200	613,500	619,900	627,900	626,700	626,700

Gross Facility Needs

Peak Day Demand

The modeled total recreation visitor-days for each site was disaggregated into annual activity-days by major recreation activity category, based on the proportions shown in the TPWD raw sample data. See Tables 14 and 15 (discussed below). The resulting projections of annual activity days were converted to peak-day activity-days, using summary data from recreation visitor surveys conducted at Lake O' The Pines in 1986 and 1987 (displayed in Table 11), on the assumption that Lake O' The Pines would apply to other reaches of the study area.

Table 11.
Percent of Total Year Activity-Days
Occurring on Peak Day,
Lake O' The Pines (1986-87)

	avg. persons per party	peak day parties	total year parties	peak day % of total year
camping	2.43	764	52,951	1.44%
picnicking	3.14	882	45,947	1.92%
hiking	1.00	485	47,917	1.01%
nature study	1.00	723	41,590	1.74%
swimming	1.00	6,027	274,566	2.20%
shore fishing	1.00	1,208	107,360	1.13%
boat fishing	2.06	3,061	272,118	1.12%
boating	2.06	2,126	184,256	1.15%

Facility Standards

Facility standards are the units of facilities or resources required to support various recreational activities. For most kinds of facilities, peak-day activity-days were converted to gross facility requirements using peak-use load factors in *Guidelines for Understanding and Determining Optimum Recreation Carrying Capacity* (U.S. Bureau of Outdoor Recreation, January 1977). One of the goals of that study was to determine a range of optimum recreation resource capacities - "the amount of recreation use of a recreation resource which reflects the level of use most appropriate for both the protection of the resource and the satisfaction of the participant" - for a wide variety of outdoor recreation activities. This determination was based on research literature review, evaluation of existing recreation facility capacity standards, and interviews with recreation administrators, planners and participants. The report suggested a range of optimum instantaneous peak-use load capacity values for each recreation activity, specifying "low", "base", and "high" intensity utilization of the resource in question. The present analysis uses the "base" peak-use load factors given in that report. Additional load factor information was derived from *1990 TORP - Assessment and Policy Plan* (Texas Parks and Wildlife Department, 1990), and *Bayou DeSiard Recreation Demand Study* (U.S. Army Waterways Experiment Station, September 1984). The specific load factors used are displayed in Table 12.

Table 12.
Facility Requirements Criteria

activity number	for peak day parties: units	number	turnover rate	for peak day persons: units	
camping	campsites/acre	7	1.00	persons/acre	17.02
picnicking	tables/acre	13	1.80	persons/acre	73.48
hiking	parties/trail mile	12	4.60	persons/trail mile	55.20
nature study	parties/trail mile	12	4.60	persons/trail mile	55.20
swimming	swimmers/water acre	435.6	2.20	persons/water acre	958.32
shore fishing	fishermen/shoreline foot	0.033	1.70	persons/shoreline foot	0.057
boat fishing	boats/water acre	2	1.80	persons/water acre	7.41
boating	parties/lane	20	n/a	persons/lane	41.16
	boats/water acre	0.15	2.40	persons/water acre	0.741
horseback riding	parties/trail mile	5.5	2.11	persons/trail mile	11.61

The conversions shown from peak day parties to peak day persons are based on the number of persons per party for each activity, as shown in table 11, and the daily turnover rate for each activity, from the Bureau of Outdoor Recreation report discussed above and Lake O' The Pines survey data. For boating lanes, for which no daily turnover rate is shown, it is assumed that each lane has a capacity of five launches per hour, and that the peak hour represents 25 percent of peak day's traffic.

The general considerations for each recreation activity are summarized below.

Camping, Multi Use: These areas are intended to service recreational vehicles. In general, each site has a paved pullout, delineated impact area with table grill, fire ring, lantern holder, utility table, restrooms and showers. Pullouts vary in length and overflow parking areas are provided for campers bringing additional vehicles.

Camping, Tent: These areas are designed for tent campers and generally consist of walk-in campsites complete with picnic table, impact area, grill, and tent pad, and feature centralized restrooms with showers. Cars are parked in clustered parking lots.

Picnicking: Picnicking is defined as an outdoor activity where the primary purpose is the preparation and/or eating of meals. These areas are intended to serve as individual facility or small group areas. Each site consists of a defined impact area with table and grill.

Multi-Used Trails: These trails offer a natural hike/bike experience and usually provide access to primitive campsites, bank fishing, and scenic areas.

Shore Fishing: Shore fishing is described as fishing that occurs along a freshwater body, either on the shore or on structures associated with that resource.

Boat Fishing: The category boat fishing is defined as the act of fishing from a boat in a freshwater seating for a non-commercial purpose.

Boat Launch Lanes: These areas consist of boat ramps, parking, restrooms and courtesy docks. Boat ramps are generally constructed of concrete and are located so as to minimize hazards to boating operations. Courtesy docks are provided at all boat launching ramps whenever possible.

Horseback Riding: In most cases, equestrian trails are incompatible with other trail types and are designed so as not to conflict with them. The surface of equestrian trails consists of compacted materials, are resistant to normal use and erosion, usable when wet and not dusty when dry. If possible, existing natural material or grass is preferred. Erosion control and stabilization should be given high priority in the design and construction of these trails and vegetation growth should be encouraged as much as possible to stabilize all areas adjacent to the trail not receiving foot traffic. Rest areas are generally provided along the trails and located so as not to result in degradation of scenic resources or adjacent areas.

Facility Needs

For each recreation activity, projected annual activity-days were multiplied by the appropriate percent of total year activity-days occurring on the peak day (from Table 11), and divided by the appropriate facility standard (from Table 12) to obtain the number of units that would optimally support the activity. See Tables 14 and 15 (discussed below).

Resource Inventory and Analysis

Land uses along the study area vary. Near Shreveport, Louisiana, the water's edge is heavily wooded and mostly undeveloped. Soda Lake State Wildlife Management Area, a 12,000 acre parcel of land owned by Caddo Parish Levee Board and leased to the Louisiana Department of Wildlife and Fisheries, is located approximately fifteen miles north of Shreveport along Twelve Mile Bayou. Interstate 220, Highway 71, and State Roads 173 and 169 cross over Twelve Mile Bayou at various locations. The areas under several of the bridges are used as boat access points, evidence that boat ramps are needed. People also access the water by using docks and ramps located at their homes along the river banks. Small boat ramps are also found at Caddo Lake's dam. No major constraints to development exist along most of the segment from Shreveport to Caddo Lake, expect along Soda Lake State Wildlife Management Area.

The area near the spillway has been cleared of vegetation, but upstream from the dam the land and water's edge are heavily wood with bald cypress trees. Numerous land uses exist around the lake. Caddo Lake State Park provides people with opportunities to camp, fish, boat, and study nature. The state park has a two-lane boat ramp, providing a location where the public can launch their pleasure craft. There is a high incidence of individuals who fish from their boats and a small number of people who water ski. Residences and small commercial establishments exist along the lake's perimeter, thereby reducing the land available for the development of public use facilities.

Bald cypress trees extend beyond the lake's western boundary and upstream along the banks of Big Cypress Bayou. Between Caddo Lake and Jefferson, Big Cypress Bayou was channelized by the U.S. Army Corps of Engineers in the late 1800's to facilitate travel by steamboat. The river is wider in this portion and trees are not found growing in the water as at Caddo Lake or along the non-channelized portion of Big Cypress Bayou west of Jefferson. Houses and water access points are dispersed along the river's shores.

Between Jefferson and Lake O' The Pines, Big Cypress Bayou becomes narrower and has limited access. Cypress trees protrude through the water's surface and grow up alongside the river's tightly winding banks. Informal discussions with local citizens indicated that this portion of Big Cypress Bayou is used for canoeing, whereas motorboats use the wider portion of the river east of Jefferson. The channel is flanked by large parcels of agricultural land which primarily support cattle. These lands are prone to flooding and remain swampy for periods of time, but these conditions do not pose a constraint to development. As mentioned earlier, a detailed analysis of recreation along Big Cypress Bayou and Jefferson, Texas is provided in a separate section of this report.

Big Cypress Bayou terminates at Ferrell's Bridge Dam, located at the lower end of Lake O' The Pines, a reservoir owned and operated by the U.S. Army Corps of Engineers. Based on the master plan completed in May 1989, areas around the lake were either left undisturbed or developed into recreational amenities. Overall, the shores are tree-lined and provide natural scenic beauty.

Table 13 summarizes the existing recreation facilities available at each reach.

Table 13.
Existing Facilities

		Lake O' The Pines	Caddo Lake
camping	(campsites)	459	122
picnicking	(picnic areas)	191	130
hiking	(trail miles)	0	0
nature study	(trail miles)	1	0
swimming	(water acres)	14	0
shore fishing	(shoreline feet)	150,000	0
boating	(boat ramp lanes)	63	28
horseback riding	(trail miles)	0	0

Net Facility Needs

The gross facility requirements were compared to the inventoried facilities existing at each site to determine net facility requirements for each site. The net facilities requirements for multi-use trails and equestrian trails, however, had to be estimated differently. The demand for these kinds of facilities could not be adequately modeled by the existing survey data, because existing facilities of these kinds are limited or nonexistent in the study area. Net facility needs for TPWD Regions 5 and 6 (an area approximately equal to the recreation study area), as reported in the 1990 TORP, were therefore used instead.

Tables 14 and 15 summarize the projected activity-days, gross facility requirements, existing facilities, and net facility requirements for Lake O' The Pines and Caddo Lake.

Recreation Development Opportunities

Specific recreation development opportunities for the entire study area were not developed for this phase of study, however, as indicated by tables 14 and 15, adequate demand exists to support additional recreation development. It is considered that the available data and current analyses are not adequate to support projecting facilities planning far enough into the future to provide for replacement, upgrading, or expansion of facilities. Therefore, additional recreation demand surveys will be required in future phases of study in order to scale recreation facilities more accurately.

Table 14.
Projected Activity-Days, Gross Facility Requirements, Existing Facilities, and Net Facility Requirements, Lake O' The Pines

PROJECTED ACTIVITY-DAYS

	% dist.	1990	2000	2010	2020	2040	2050
camping	10.18%	143,000	146,300	148,800	151,700	151,700	151,600
picnicking	8.75%	122,900	125,800	127,900	130,400	130,400	130,300
hiking	0.70%	9,800	10,000	10,200	10,400	10,400	10,400
nature study	2.37%	33,300	34,100	34,600	35,300	35,300	35,300
swimming	31.17%	437,700	448,100	455,500	464,600	464,300	464,300
shore fishing	9.06%	127,100	130,100	132,300	134,900	134,900	134,800
boat fishing	18.11%	254,300	260,300	264,600	269,800	269,700	269,700
boating	19.67%	276,100	282,700	287,400	293,000	292,900	292,900
TOTAL		1,404,200	1,437,400	1,461,400	1,490,100	1,489,500	1,489,400

PEAK-DAY GROSS FACILITY REQUIREMENTS

	facility units	1990	2000	2010	2020	2040	2050
camping	(campsites)	849	869	884	901	901	900
picnicking	(picnic areas)	417	427	434	443	443	443
hiking	(trail miles)	2	2	2	2	2	2
nature study	(trail miles)	10	11	11	11	11	11
swimming	(water acres)	10	10	10	11	11	11
shore fishing	(shoreline feet)	26,090	26,682	26,116	26,629	26,629	26,610
boat fishing	(water acres)	386	395	402	410	409	409
boating	(boat ramp lanes)	77	79	81	82	82	82
boating	(water acres)	4,300	4,400	4,480	4,560	4,560	4,560

EXISTING FACILITIES

	facility units	
camping	(campsites)	469
picnicking	(picnic areas)	191
hiking	(trail miles)	0
nature study	(trail miles)	1
swimming	(water acres)	14
shore fishing	(shoreline feet)	150,000
boating	(boat ramp lanes)	63
boating*	(water acres)	15,600

* includes boat fishing

PEAK DAY NET FACILITY REQUIREMENTS

	facility units						
camping	(campsites)	390	410	425	442	442	441
picnicking	(picnic areas)	226	236	243	252	252	252
hiking	(trail miles)	2	2	2	2	2	2
nature study	(trail miles)	9	10	10	10	10	10
swimming	(water acres)	0	0	0	0	0	0
shore fishing	(shoreline feet)	0	0	0	0	0	0
boating	(boat ramp lanes)	14	79	81	82	82	82
boating*	(water acres)	0	0	0	0	0	0

* includes boat fishing

Table 15.
Projected Activity-Days, Gross Facility Requirements, Existing Facilities, and Net Facility Requirements, Caddo Lake

PROJECTED ACTIVITY-DAYS

	% dist.	1990	2000	2010	2020	2040	2060
camping	16.81%	99,600	103,100	104,200	105,600	105,400	105,400
picnicking	4.27%	25,300	26,200	26,400	26,800	26,700	26,700
hiking	2.26%	13,400	13,900	14,000	14,200	14,200	14,200
nature study	1.25%	7,400	7,700	7,800	7,900	7,900	7,900
swimming	13.93%	82,500	86,400	86,300	87,400	87,300	87,300
shore fishing	14.22%	84,200	87,200	88,100	89,300	89,100	89,100
boat fishing	28.44%	168,400	174,500	176,300	178,600	178,200	178,200
boating	18.82%	111,500	116,500	116,700	118,200	117,900	117,900
TOTAL		592,200	613,600	619,900	627,900	626,700	626,700

PEAK-DAY GROSS FACILITY REQUIREMENTS

	facility units	1990	2000	2010	2020	2040	2060
camping	(campsites)	591	612	619	627	626	626
picnicking	(picnic areas)	86	89	90	91	91	91
hiking	(trail miles)	2	3	3	3	3	3
nature study	(trail miles)	2	2	2	2	2	2
swimming	(water acres)	2	2	2	2	2	2
shore fishing	(shoreline feet)	16,621	17,213	17,391	17,628	17,588	17,588
boat fishing	(water acres)	256	265	268	271	271	271
boating	(boat ramp lanes)	31	32	33	33	33	33
boating	(water acres)	1,740	1,800	1,820	1,840	1,840	1,840

EXISTING FACILITIES

	facility units	
camping	(campsites)	122
picnicking	(picnic areas)	130
hiking	(trail miles)	0
nature study	(trail miles)	0
swimming	(water acres)	0
shore fishing	(shoreline feet)	0
boating	(boat ramp lanes)	28
boating*	(water acres)	25,400

* includes boat fishing

PEAK DAY NET FACILITY REQUIREMENTS

	facility units						
camping	(campsites)	469	490	497	506	504	504
picnicking	(picnic areas)	0	0	0	0	0	0
hiking	(trail miles)	2	3	3	3	3	3
nature study	(trail miles)	2	2	2	2	2	2
swimming	(water acres)	2	2	2	2	2	2
shore fishing	(shoreline feet)	16,621	17,213	17,391	17,628	17,588	17,588
boating	(boat ramp lanes)	3	4	5	5	5	5
boating*	(water acres)	0	0	0	0	0	0

* includes boat fishing

URBAN FLOOD DAMAGE INVESTIGATION

A reconnaissance-level investigation of urban flood damages for the city of Jefferson was conducted. The investigation was based upon information from the Federal Emergency Management Agency (FEMA) and from discussions with hydraulic and hydrologic engineers with the Fort Worth District, as well as historic flood information.

Due to the limited availability of hydraulic and topographic data, the economic damage investigation was conducted using two methods: regression analysis and simulation of economic and hydraulic conditions. These two methods were utilized in order to arrive at a range of answers, and therefore, develop a type of sensitivity analysis for estimation of flood damages.

Regression Analysis Method

The first method consisted of using the FEMA flood delineation for the 100-year event from the Flood Insurance Rate Map dated October 1982. In Spring 1995, an inventory was made of the flood plain lands to identify existing flood plain development. The inventory included enumeration, classification and value estimation of the numbers and types of structures within the 100-year limits.

Based on the FEMA delineation, it was determined that sixteen structures fall within the 100-year limits. Of these structures, five are residential (including three mobile homes), and the remaining eleven are commercial structures. The estimated average value of the improvements is $25,000.

A regression model developed by the Fort Worth District was used to determine a range of existing expected annual damages for Jefferson. This model was developed using the results of detailed studies conducted by the Fort Worth District and is utilized when little is known about the hydraulic conditions of a study area. The regression analysis provides estimates of low, most likely, and high EADs. The results of the regression analysis for Jefferson is as follows: low EAD = $13,000, most likely EAD = $21,100, and high EAD = $34,300.

As stated, the regression model is based on studies conducted by the Fort Worth District. Therefore, the damages are estimated on stage-damage relationships of other studies. It is known that the start-of-damages frequency for Jefferson is the 50-year event, while most other studies have a much more frequent start-of-damages. Therefore, it is felt that the low EAD is a more reliable indicator of urban flood damages in Jefferson.

Simulation Method

The second flood damage estimation method simulated hydraulic and economic conditions based on the known start-of-damages frequency of 50-years. The STDMA flood damage program was utilized. Hydraulic and structure files were created which essentially distributed a number of structures throughout the 50-year to SPF flood zones. A simulated hydraulic file was created which assumed parallel flood profiles at 1.0 foot increments. A total of 40 structures were assumed to be within the 50-year to SPF limits with an average value of $25,000.

The simulation method resulted in existing expected annual damages of $3,300. This method is more reliable as far as the stage-damage relationship specific to Jefferson, however, major assumptions were made about the flood profiles and distribution of structures within the flood plain.

Sensitivity Analysis

No alternatives were analyzed in detail, therefore, a sensitivity analysis was performed to determine a range of project first costs which could be supported based on the range of existing expected annual damages.

The assumption is made that a fifty-percent reduction in damages could be obtained with an alternative. This assumption is a reasonable approximation based on past Fort Worth District studies. The range of existing condition EADs using the above methodologies is $3,300 to $34,400. Therefore, the net benefits range from $1,700 to $17,300.

Other assumptions were made to determine a range of first costs supportable. These include a 50-year period of analysis, annual interest rate of 7.75%, 12-month construction period, and annual operation and maintenance expense of $500. Given the above assumptions, the range of project first cost supportable is $14,000 to $200,000.

The levee which protects the city of Jefferson has had is effectiveness reduced by road cuts through the levee. Therefore, a potential flood damage reduction measure is to fill-in the levee cuts which now reduce the designed level of protection. A preliminary cost estimate for filling in the levee cuts is $250,000.

There is a twenty percent difference between the preliminary cost estimate ($250,000) and the high-end first cost supportable ($200,000). Given the high degree of uncertainty associated with hydraulic conditions and the uncertainty associated with EAD, net benefits and first costs supportable, additional analysis is warranted.