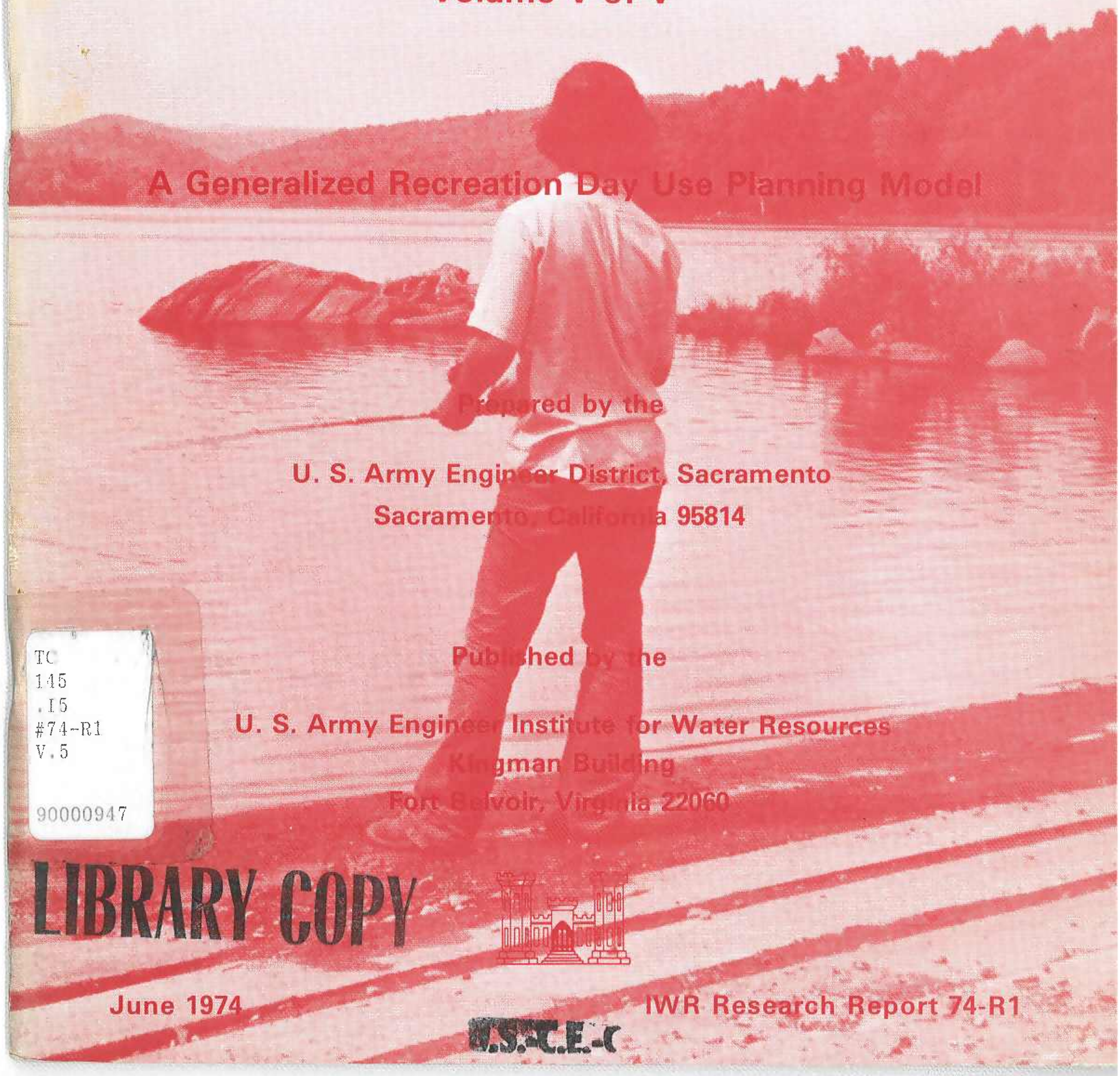
PLAN FORMULATION AND EVALUATION STUDIES — RECREATION

Volume V of V



A Generalized Recreation Day Use Planning Model

Prepared by the

U. S. Army Engineer District, Sacramento
Sacramento, California 95814

Published by the

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A Report Submitted to the
Department of the Army
Office of the Chief of Engineers

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PREFACE

In 1962, the Chief of Engineers initiated Corps-wide sampling of the existing recreation use on Corps of Engineers civil works reservoir projects. The data collected were incorporated into existing planning processes, provided the basis for improved administration of operating projects, and provided the foundation for specialized studies. An evaluation of the data collected indicated that improvements could be made to make the data more useful. Consequently, in 1965 the Director of Civil Works authorized studies to be undertaken to:

a. Evaluate the recreation use data collection procedure and recommend methods for improving the statistical accuracy of such data and applying standardized data collection on a Corps-wide basis.

b. Develop methodology for recreation use prediction. Preliminary methodology to be developed as soon as possible and a long-range research program initiated to improve and refine the methodology.

c. Develop methodology for determination of the number and type of recreation facilities needed to serve a given number of recreation days of use (facility load criteria).

d. Develop methodology for determination of recreation benefits.

The studies have been performed, formerly under the general functional direction of Mr. Harold L. Blakey, Office, Chief of Engineers, and presently under the general functional direction of Mr. Grant Ash, Office, Chief of Engineers.

The actual work has been assigned and performed in the Sacramento District, formerly under the direct supervision of Mr. Dale Crane and presently under the direct supervision of Mr. Fred Kindel. This report is the sixth of a series indicating significant results obtained from these studies. The previous reports were Contract Report No. 1, entitled "Analysis of Recreational Use of Selected Reservoirs in California;" Technical Report No. 1, entitled "Evaluation of Recreation Use Survey Procedures;" Technical Report No. 2, entitled "Estimating Initial Reservoir Recreation Use;" Technical Report No. 3, entitled "A preliminary Analysis of Day Use Recreation and Benefit Estimation Models for Selected Reservoirs;" and Technical Report No. 4, entitled "Estimating Recreational Facility Requirements."

This report presents results of a portion of the studies authorized by the Director of Civil Works and describes a methodology for estimating day use recreation and its associated benefits. The information presented is refined and more detailed than the earlier version described in Technical Report No. 3. Staff research efforts were performed by Mr. Richard E. Brown and Mr. William J. Hansen, under the research project leadership of Mr. Fred Kindel. Dr. Jack L. Knetsch, former Director of the Natural Resources Policy Center, the George Washington University, and Dr. Leonard Merewitz, School of Business Administration, University of California, Berkeley, provided expert consultant services and invaluable assistance during the study. Special appreciation is extended to the office and field personnel in the Fort Worth, Little Rock, Sacramento and Tulsa Districts who collected the data which provide the basis for this report.

PLAN FORMULATION AND EVALUATION STUDIES - RECREATION
TECHNICAL REPORT NO. 5
A GENERALIZED RECREATION DAY USE
PLANNING MODEL

TABLE OF CONTENTS

TABLE OF CONTENTS (Cont'd)

LIST OF TABLES AND FIGURES

SUMMARY

This report presents refined procedural guidelines for estimating reservoir recreation use and benefits for planning of water resources developments. The general planning model described and tested herein consists of the development of regional estimators for predicting recreation use at proposed reservoir projects and the operation on these estimators to derive the individual project demand schedules for estimating recreation benefits. The methodology presented is theoretically and empirically more precise than estimating procedures currently employed and is consistent with other existing and proposed authoritative standards for evaluating water resource developments.

PART I: INTRODUCTION

Purpose and Scope

1. This report offers refined procedural guidelines for an analytical evaluation of reservoir recreation use and benefits consistent with the requirements of the Federal Water Projects Recreation Act of 1965 (Public Law 89-72) and with the Water Resources Council's (WRC) "Proposed Principles and Standards for Planning Water and Related Land Resources" [21][1/]. A general model is described for use in project planning. Two empirical demonstrations are given, complete with sensitivity analyses of the evaluations, and an outline is presented of the general steps involved in replicating the procedure.

General

2. The economic value of recreation as a water resource project output is measured by the willingness to pay for the amount of recreation consumed. The current procedure for approximating the willingness to pay is to estimate recreation benefit as the product of a "unit day value" multiplied by the total number of recreation days estimated to occur at a site. The procedure is in accordance with existing standards which were designed as a temporary solution.

> Pending the development of improved pricing and benefit evaluation techniques, desirable uniformity in the treatment of recreation in the planning of projects and programs and in cost allocation will be accomplished through the application of unit values that reflect the concensus judgement of qualified technicians. The unit values per recreation day set forth herein are intended to measure the amount

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1/ Numbers in brackets refer to references cited, pages 36-37.

> that the users should be willing to pay, if such payments were required, to avail themselves of the project recreation resources. [20]

Recommended bounds for the unit values are given, and "informed judgement" determines the applicable point value in each individual situation.

3. In the WRC standards currently being proposed, this method is again allowed, "while recreation evaluation methodology is being further developed" [21].

> While the method is in a sense correct in attempting to associate the value of recreation benefits with a figure that purports to be what consumers of the commodity would be willing to pay for the opportunity to participate, in fact it yields very poor approximations to the aggregate value of the willingness to pay, and is consequently a poor and inept measure of benefits. [7]

In addition, during the past decade, research studies have already developed improved recreation evaluation methodology. However, little success has been achieved in assimilating the results of this research into the planning and evaluating procedures of the Federal agencies concerned with water resource planning. Two reasons for this have been suggested. "First, research results on particular areas of interest are often confusing and contradictory. Second, although improved methodology has been developed, data sources have often not been identified to the extent that these methods can be implemented empirically in planning circumstances"[16].

4. With respect to estimating the national economic development benefits of recreation for water resources projects, these difficulties have been overcome. A theoretical model--the travel-cost approach--has been developed which has received general acceptance in the economics of outdoor recreation field and which can be assimilated into the planning process. In

discussing the travel-cost approach and other methodologies for estimating recreation benefits Cicchetti, _et al_, concluded:

> In summary, the travel-cost approach is a significant theoretical effort aimed at meaningful policy recommendations to estimate both demand quantities and dollar benefits generated by outdoor recreation. As the methodology stands, it represents both a theoretically valid and an empirically feasible method. [2]

5. In a previous report [13], the Corps of Engineers provided a preliminary demonstration of the empirical feasibility of the travel-cost approach to reservoir recreation planning. It was shown that estimating equations capable of predicting recreation use at a proposed reservoir can be devised, and that these same equations can be used to derive a project recreation demand schedule which yields the national economic development benefits attributable to the project.

6. The study was distinguishable from similar efforts by the precision enabled with the quantity of recreation data available. The previous analysis was based upon recreation attendance data collected from 52 reservoir projects from seven US Army Engineer Districts during the years 1966-69 [15, 16]. Initially, data from 19 reservoirs from two of the seven districts were used to develop regional day use estimators with which the travel-cost approach could be employed to estimate recreation benefits.

7. It was apparent from the initial analysis that even though the same variables significantly affected recreation attendance in different geographic regions, the magnitude of the effects varied between regions. In addition it was clear that too small a region (e.g., a single reservoir) prevented the introduction of necessary variables. Accordingly, it was

hypothesized that the nation could be divided into a workable number of geographic regions (such as those described in [16]) for which sufficiently accurate use estimators could be developed. Further work has validated this hypothesis using data collected from 31 reservoirs in the Southwestern Division of the Corps of Engineers, which participated in the data collection program.

PART II: THE GENERALIZED MODEL

Background

8. Leisure time, personal income and mobility are usually considered the most important factors for estimating total demand for outdoor recreation. Other significant factors include such socio-economic measures as age, race, occupation and education. These factors do influence aggregate recreational use and will effect recreational patterns changing over time.

> It is recognized that use patterns can change. A shortening of the work week would change cyclic use patterns; a change in management and development policy would change activity use patterns. However, the timing, direction and magnitude of these changes are essentially inestimable. [14]

Accordingly, the traditional, general factors which influence aggregate recreational behavior are not included in the quantitative model. They must be accommodated by judicious use of the model.

9. Outdoor recreation differs from most consumer goods in two fundamental respects. The market price is usually nominal or zero, and travel costs which are analogous to distribution costs for most goods are paid separately from the market price for recreation and are large relative to that price. Thus, it is not surprising that the most important factors in explaining recreational use at a particular project are those that describe the distribution of people about the project, namely the distances between the recreation site and origins of potential users and the populations of these areas of origin.

10. Two other factors should be included in the project planning estimates of recreational use and benefits. The first is some measure (quantitative

or qualitative) of the attributes of the recreation area which make the project more or less attractive to the potential visitors. A large project, other things being equal, would be expected to attract more visitors than a relatively smaller one. The other factor is a measure of the substitutes (alternative--often referred to as competitive--water oriented recreation areas) available to the visitors. In general, as the number of water resource projects in a region increases, the total attendance for these projects increases, but the substitution effect on existing reservoirs by the addition of new ones is a tendency toward reduced attendance, or at least a reduction in rate of increase for the individual reservoirs. The increase in total attendance may be explained partly by the fact that there is an average reduction of the price (travel costs) for some visitors. The reduction in attendance or rate of increase of attendance at existing reservoirs may occur because the new reservoirs are lower priced (closer) to some visitors who would otherwise have used the existing reservoirs.[2/]

11. The only way to econometrically measure the effects of the projects' attributes on the consumption of their services is to study a system of reservoirs rather than each reservoir separately. Accordingly, regional use estimators are used rather than the "most similar project" approach described in [15].

2/ The increase is a movement down a regional demand schedule; the decrease is a shift inward of the existing reservoirs demand schedules.

Variables

12. The dependent variable, V_{ij}, is the amount of day use recreation occurring during a year at reservoir *j*, which originates from a geographic area *i*.[3/] The measurement is in recreation days. The independent variables in the generalized model are:

- P_i, the population of area *i*.
- D_{ij}, the travel distance between area *i* and reservoir *j*. The measurement is the one-way road mileage between the largest city in area *i* and the closest public access site at reservoir *j*.
- A_j, a measure of the attributes of reservoir *j*. The measurement is water surface acres at average recreation pool. [4/]
- And S_{ij}, an index of the substitutes for reservoir *j* available to the consumers in area *i*.

13. The most common method [5, 10, 13] of introducing a measurement of substitutes has been by using an index generated by a gravity variable of the general form:

$$s_i = \sum_{k=1}^{n} \frac{a_k}{d_{ik}} \qquad (1)$$ [5/]

where *i* denotes the area of origin, *k* denotes one of the *n* substitute sites available to the users in *i*, a_k is a measure of substitute *k*'s attributes (usually a measure of size), and d_{ik} is the distance (air or road) between area *i* and substitute *k*.

3/ The county set area of origin, initially developed in Technical Report No. 3 [13], defines the geographic area. A more complete description of this areal unit is contained in the following section describing the empirical applications.

4/ A slight variation in this variable for projects with uniquely large attendances will be discussed in the following section.

5/ Numbers in parentheses denote equations.

14. The disadvantage of the index (1) is that the effect of the substitutes is evaluated only by a measure of their attributes and their location in relation to the area of origin. No consideration is given to the attributes or location of the project being evaluated in relation to the existing water resource system. In the diagram below, assume that <u>i</u> represents an area of origin, <u>k</u> is an existing reservoir, and j_1 and j_2 are proposed projects of similar size.

The substitution effect of <u>k</u> on visitation from area <u>i</u> to j_1 and j_2 is assumed to be equal if (1) is used. However, because of their relative distances from <u>i</u>, it appears that <u>k</u> would have a much greater effect on visitation from <u>i</u> to j_2 than on visitation to j_1. Therefore, the attributes of the project being evaluated and its location in the existing water resource system are both important when evaluating the substitution effect of alternative sites on visitation from a specific area of origin.

15. The assumption that the most significant effect of substitutes can be attributed to those projects considered by the users as more "attractive" than the reservoir in question allows a refinement to (1) which partially overcomes the oversimplification discussed above. For the generalized model the effect of substitutes is measured by:

$$S_{ij} = \left(1 + \sum_{k=1}^{n} \frac{\ln a_k}{d_{ik}}\right)^2 \quad \text{for all} \quad \frac{\ln a_k}{d_{ik}} > \frac{\ln a_j}{d_{ij}} \tag{2}$$

where the subscripts _i_, _j_, and _k_ are the same as described for (1), _a_ is measured by the water surface acres at gross pool and _d_ is again the road mileage from the largest city in area _i_ to the nearest access at reservoirs _j_ or _k_.

16. The major difference between (2) and (1) is the restricted summation. Only those substitutes which are more attractive than the project in question contribute to the index. The ratio of the natural logarithm of gross pool size to the distance between the project and the area of origin is used to measure the relative level of attractiveness. This in itself is an oversimplification of all of the factors which influence the visitor's choice as to which project to visit, but it is an improvement over (1). The use of the natural logarithm of the size measure is not unique to this study and implies that the effect of pool size on the attractiveness of available substitutes increases but at a decreasing rate with an increase in pool size.

17. There are two minor differences between (1) and (2). The addition of 1 to the restricted summation prevents S_{ij} from equalling zero. The need for this will be apparent when the functional form of the estimator is described. The other difference is the squaring of the initial index which implies that the total effect of all substitutes increases at an increasing rate. Hence, this index measures the substitution effect of the existing reservoirs as a system.

Functional Form

18. Deriving an accurate mathematical description of the interrelationships between the factors which affect recreation use is as important as selecting the proper variables to measure these factors. It is usually assumed that a multiplicative relationship exists between visitation and population or distance. Most previous studies [5, 9, 10, 22] have used either a logarithmic or double logarithmic formulation to describe this relationship. However, as discussed in Technical Report No. 3 [13], the logarithmic formulation is biased and contains a misspecification of the error term. Other studies [3, 11, 12, 15] have assumed the elasticity of population is one (i.e., a doubling of population results in an exact doubling of visitation) and have used per capita attendance (V_{ij}/P_i) as the dependent variable. The per capita model, however, does not correctly describe the effect of distance, also contains a misspecification of the error term, and requires a questionable assumption as to the elasticity of population. Accordingly, the estimator initially described in Technical Report No. 3 [13], is employed.

19. The general form of the estimator is:

$$V_{ij} = B_0 + (P_i/D_{ij})(B_1 + B_2A_j + B_3/S_{ij}) + E_{ij} \tag{3}$$

where the B's are the regression coefficients to be estimated, and E_{ij} is the error term. This estimator fits well statistically, and it is plausible.

20. The coefficients are estimated using multiple linear regression techniques with the regressors defined by the products of P_i/D_{ij} and the

terms within the other parentheses. Since S is negatively correlated with use, it enters the denominator of a regressor; hence the need for the restriction that S_{ij} must not equal zero. The signs of B_0 and B_1 can be either positive or negative.

21. Equation (3) is called a regional estimator because it is constructed from data within a geographic region. It is a simple model of the relationship between recreational day use and the independent variables which measureably influence day use recreation. It should be used to derive initial estimates of use at a proposed project.

Estimating Recreation Benefits

22. As long as the outdoor recreation being measured is resource oriented and the expense of traveling to the recreation site is a major portion of the total costs incurred by the visitor for his outing, the travel-cost approach is a valid methodology for estimating its national economic development benefits. The theoretical background of this approach has been adequately described elsewhere [1, 3, 5, 7, 8, 9, 11, 13] and is not reiterated here. A synopsis of the underlying assumptions of this approach is presented in Technical Report No. 3 [13], including a discussion and an application of the adjustment for the time bias described by Cesario and Knetsch [1].

23. For the benefit estimates presented in Technical Report No. 3 [13], it was assumed that the consumers do make a trade off between time costs (T) and money costs (C) and that the trade off can be described by the composite variable (CT). The form of the function was deduced from the reasonable assumption that there is a diminishing marginal or incremental

effect on frequency rates for increases in time or money outlays as the size of the time or money expenditure increases [1]. The effect on the visit rate of adding ten cents to money costs is likely to be greater for trips costing fifty cents than for trips costing several dollars. This assumption requires that the trade-off function be convex to the origin; a requirement met by the functional form (CT).

24. The assumption of diminishing marginal effects of increases in time and money costs has a significant effect on the benefit computations for the individual reservoirs. Some idea as to the magnitude of this effect can be ascertained by comparing benefits derived under this assumption to benefits derived under the assumption of constant marginal effects on visitation from increases in time or money costs. Constant marginal effects imply a linear trade-off function which, although not as precise, theoretically, as the convex function, is an improvement over ignoring the time constraint. However, it does require that time costs be approximated by some constant rate per hour derived from such measures as a minimum wage rate or the income foregone while traveling to and from the project [8].

25. By using the convex and linear trade-off functions "upper" and "lower" bound estimates of the benefits accruing to an individual project can be estimated. The benefits from the linear function, although higher than benefits derived when the time constraint is ignored, will be lower than benefits derived using the convex trade off. This is to be expected since the assumption of constant marginal effects from increases in travel costs results in a more rapid decline in the expected frequency of visitation than the convex function for similar increases in money costs.

26. An additional reason for estimating lower-bound benefits comes from the fact that the outdoor recreation experience consists of more than just what occurs at the recreation site. Clawson and Knetsch [4] describe the "whole recreation experience" as consisting of five phases: planning or anticipation, travel to the site, on-site experience, return travel and recollection. To the extent that the travel phases are perceived as recreation, the travel costs are too high a proxy for the price paid for the reservoir recreation. Some of the travel probably would be undertaken for recreation without the reservoir.

27. There is also imprecision in the visitors' perception of the price paid. When deriving the demand schedule it is assumed that a dollar price for recreation is the same whether it represents a gate fee or a transportation cost. If this assumption is invalid, it is hypothesized that the effect of a gate fee on reducing visitation would be more pronounced than the effect of an increase in travel costs. However, it is very unlikely that the effect on the benefit computations of imprecision in the visitors' perception of price paid in variable travel costs is as significant as assuming constant marginal effects from increasing travel costs. The linear trade-off function will, therefore, still provide an adequate lower bound of the project's recreation benefits. As continuing research provides additional insight as to visitors' perception of price and trade off between time and money costs, the distance between the upper and lower benefit bound will be reduced and more precise estimates of the recreation benefits will be possible.

PART III: EMPIRICAL APPLICATIONS

Sites and Data Descriptions

28. As mentioned earlier, two empirical applications of the general theoretical model are presented in this report. One application is essentially the same as that from which the Sacramento regional estimator presented in Technical Report No. 3 [13] was derived. Data from seven reservoirs located in the foothills surrounding the Central Valley of California were used in this application. The other is a general application of the model using 31 reservoirs from the Southwestern Division, including the 12 reservoirs from which the Fort Worth regional estimator was derived in [13]. A list of the reservoirs included in these applications is presented in Table 1 and their geographical locations in Figures 1 and 2.

29. Except for the changes discussed below, variable measurements for the estimators are compiled as originally described in Technical Report No. 3 [13]. For this study the populations of the areas of origin are measured using 1970 census data [18] rather than projections from the 1960 census [17]. This is, in fact, the only difference between the Sacramento regional estimator presented in this report and the one presented in [13]. The distances between areas of origin and substitute water recreational opportunities are measured by the one-way road mileage; air mileage was used in the Fort Worth regional estimator.

TABLE 1

STUDY RESERVOIRS

Sacramento District

1. Black Butte Lake
2. Harry L. Englebright Lake
3. New Hogan Lake
4. Pine Flat Lake
5. Terminus Dam and Lake Kaweah
6. Success Lake
7. Isabella Lake

Southwestern Division

Fort Worth District:

1. Belton Lake
2. Benbrook Lake
3. Town Bluff Dam and B.A. Steinhagen Lake
4. Grapevine Lake
5. Hords Creek Lake
6. Lavon Lake
7. Lewisville Lake
8. Navarro Mills Lake
9. Proctor Lake
10. San Angelo Lake
11. Whitney Lake
12. Canyon Lake

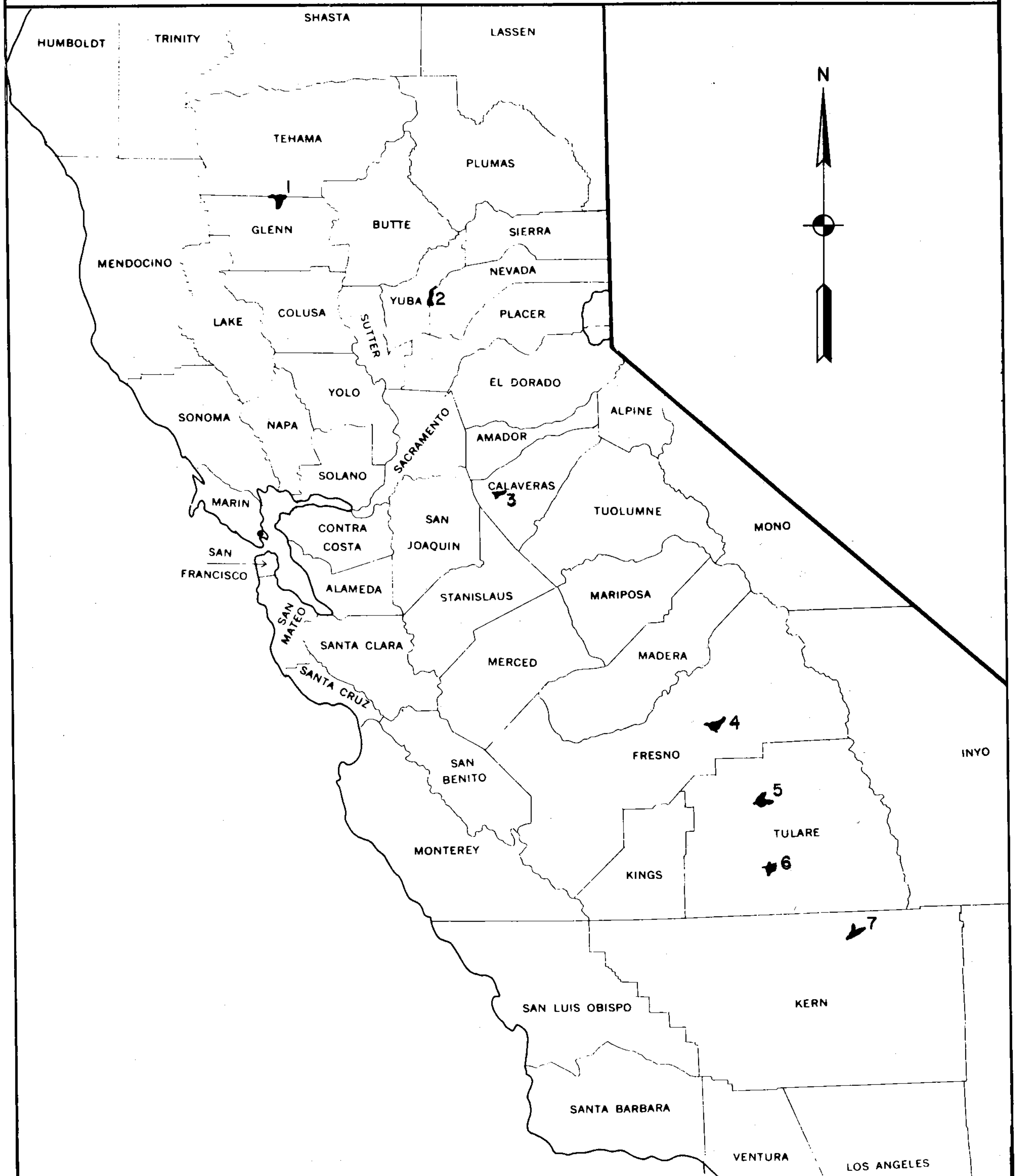
Little Rock District:

13. Beaver Lake
14. Bull Shoals Lake
15. Greers Ferry Lake
16. Norfork Lake
17. Table Rock Lake

Tulsa District:

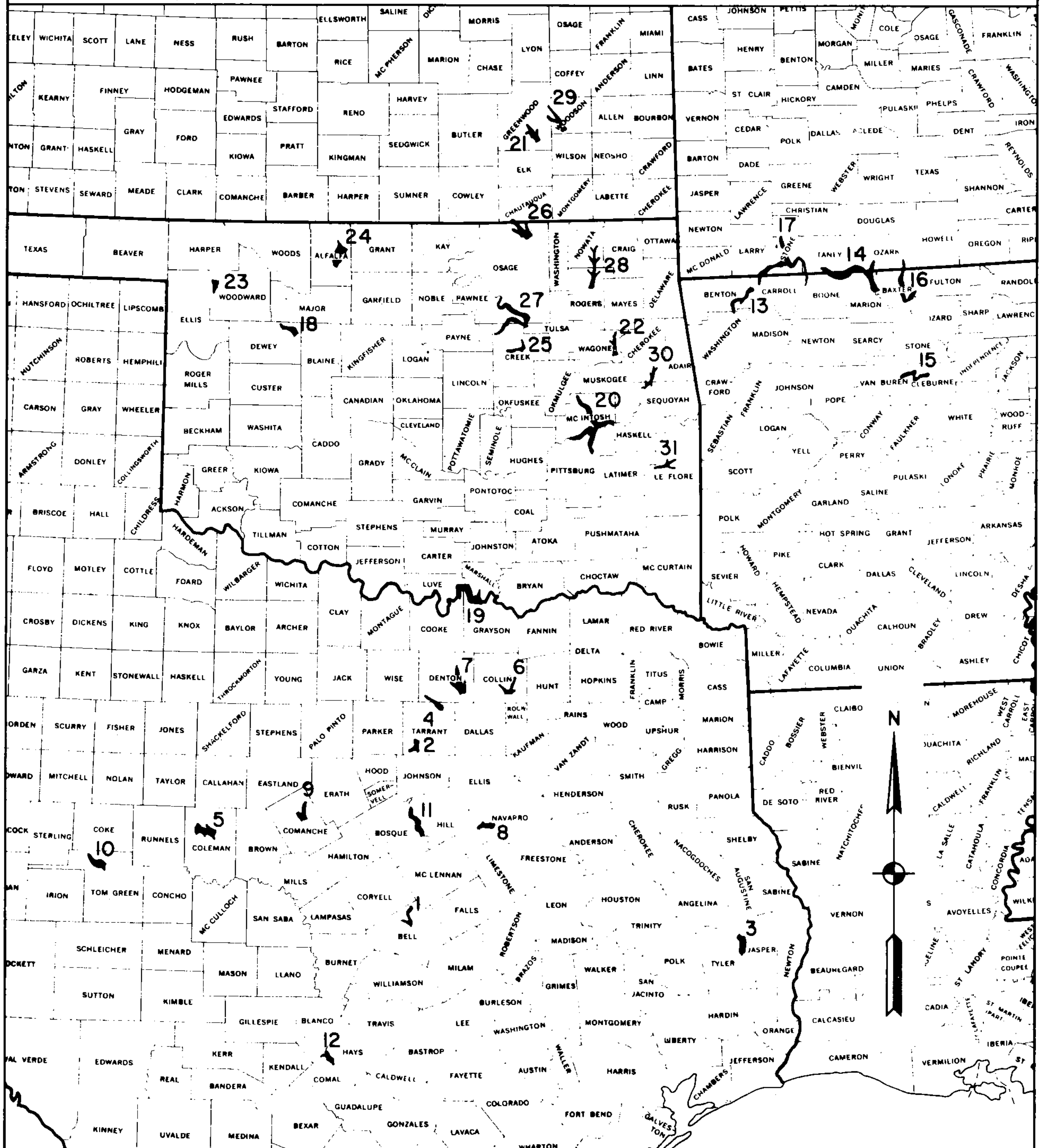
18. Canton Lake
19. Denison Dam and Lake Texoma
20. Eufaula Lake
21. Fall River Lake
22. Fort Gibson Lake
23. Fort Supply Lake
24. Great Salt Plains Lake
25. Heyburn Reservoir
26. Hulah Lake
27. Keystone Lake
28. Oologah Lake
29. Toronto Lake
30. Tenkiller Ferry Lake
31. Wister Lake

Figure 1



RESERVOIR LOCATIONS
SACRAMENTO DISTRICT

Figure 2



RESERVOIR LOCATIONS
SOUTHWESTERN DIVISION

30. For the Southwestern Division reservoirs, only those counties within a radius of 200 road miles of the project are considered as potential areas of origin. The initial criterion of 250 road miles was used in Technical Report No. 3 [13] to insure that for each project at least 90 percent of its surveyed day use originated from the counties included in its market area. However, an analysis of the 31 projects included in the Southwestern Division study indicated that a mileage criterion of 200 miles included more than 95 percent of the surveyed day use from all but two of the projects (Norfork Lake--88 percent and Table Rock Lake--88 percent). The 200-mile limitation is used for the Southwestern Division study since it contains a sufficient percentage of the day use surveyed and greatly reduces the data compilations required. The 200-mile limitation also contains more than 95 percent of the surveyed day use for all but two of the Sacramento District projects (Pine Flat Lake--84 percent and Lake Kaweah--89 percent), but, because of the smaller number of reservoirs involved, the 250-mile criterion is retained for this application.

31. For the Southwestern Division application the county set areal units are described by the following criteria. Each county with measured road mile distance of 50 miles or less from a project defines a county set. Counties which are 51 to 125 miles from a reservoir are clustered in groups of 4-5 contiguous counties to define a county set, and counties from 126-200 miles are clustered in groups of 7-9 contiguous counties. An example of the deployment of county sets about Canton Lake is presented in Figure 3. The above criteria delimit 706 reservoir-county set observations for the

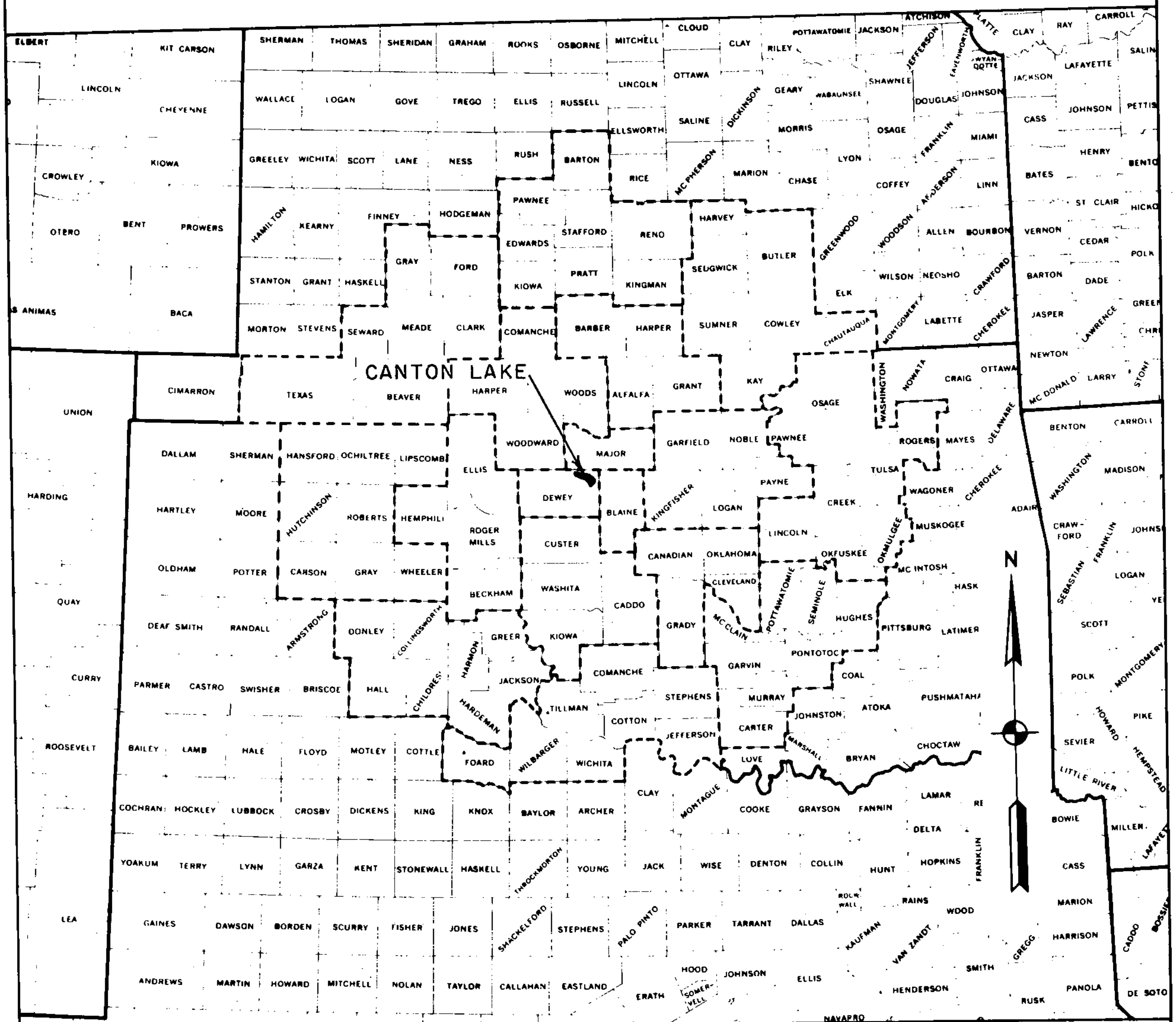
Southwestern Division study. The Sacramento District application consists of the 168 reservoir-county set observations initially described in Technical Report No. 3 [13].

Uniquely Large Reservoirs

32. The 31 reservoirs in the Southwestern Division application exhibit a wide variation in average annual attendance for both total use (173,000-8,736,000) and day use exclusive of users staying in area (109,000-4,737,000). Because of the nature of the linear regression technique employed, the effectiveness of the estimator over the majority of reservoirs is greatly reduced by the relative contribution of a few reservoirs with uniquely large attendance. Thus, better overall results can be expected for the Southwestern regional model by developing two estimators, one for the uniquely large reservoirs and one for all remaining projects.

33. Technical Report No. 1 [16], in discussing possible alternatives for a nationwide Corps' recreation survey, suggests a criterion of over 2-1/2 million total recreation days annually to delimit the uniquely large reservoirs. Using this criterion five of the Southwestern Division reservoirs (Grapevine Lake, Lavon Lake, Whitney Lake, Table Rock Lake and Lake Texoma) are categorized as uniquely large as measured by their average annual attendance for 1966-69. Thus, two estimators are developed for the Southwestern Division; one from the 126 reservoir-county set observations from the five reservoirs categorized as uniquely large, and one from the 680 observations from the 26 remaining reservoirs.

Figure 3



----Set Boundary

DEPLOYMENT OF COUNTY SETS

ABOUT CANTON LAKE

34. The general theoretical model (3) is used to develop both Southwestern regional estimators, but with a slight variation in the measure of project attributes for the uniquely large reservoirs. For most Corps' reservoirs land is not a limiting factor, and the water surface area is the most significant variable for measuring reservoir characteristics. However, when the attendance becomes extremely large, the availability of land as well as the availability of water surface area becomes a significant factor in measuring the behavior of the visitors. Therefore, for the uniquely large reservoirs a project's attributes (A_j') are measured by its total project area rather than just its water surface area.

Recreation Day Use Estimator - Sacramento Region

35. The Sacramento regional estimator is:

$$V_{ij} = -4,577 + (P_i/D_{ij})\ \underset{(0.26)}{(-2.52} + \underset{(0.00006)}{0.00131\ A_j} + \underset{(0.84)}{27.13/S_{ij})} \qquad (4)$$

where the variables and subscripts are as defined in paragraph 12. The numbers beneath the estimator are the standard errors of the coefficients. All coefficients are significant at 0.5 percent. The coefficient of determination, R^2, is 0.92, indicating 92 percent of the total variation among the observations of recreational day use for the Sacramento region is explained by the estimator.

36. The coefficient of determination measures the proportion of the total variation of all observations explained by the regional estimators. However, it is not the pertinent statistic when measuring the variation over a set of observations associated with an individual reservoir. A comparison

of the survey estimates of use for each reservoir with their use estimates as derived from the Sacramento regional estimator is presented in Table 2. Overall, 94 percent of the variation of the day use attendance among the study reservoirs is explained by the estimator.

Recreation Day Use Estimators - Southwestern Region

37. For the uniquely large reservoirs, the Southwestern regional estimator is:

$$V_{ij} = -854 + (P_i/D_{ij})\ (0.00025\ A'_j + 110.68/S_{ij}) \qquad (5)$$

$$\qquad\qquad\qquad (0.00004) \qquad (12.89)$$

with $R^2 = 0.60$ For the remaining reservoirs, it is:

$$V_{ij} = -2{,}632 + (P_i/D_{ij})\ (10.26 + 0.00012\ A_j + 25.33/S_{ij}) \qquad (6)$$

$$\qquad\qquad\qquad (1.10)\ (0.00005) \qquad (2.62)$$

with $R^2 = 0.58$

The regression coefficient B_1 was insignificant for the uniquely large reservoirs at significance level .20. (If the test were repeated a number of times we would call the coefficient nonzero more than 20 percent of the time when it actually was zero.) Therefore, its regressor was deleted from the analysis. For both estimators all remaining coefficients are significant at .05. The R^2 values indicate that for both groups of reservoirs almost 60 percent of the variation in their observations are explained by their respective estimator. Table 3 presents a comparison of the survey estimates of use at the Southwestern Division reservoirs with their use estimates derived from the regional estimators. The estimators explain 80 percent of the variation in use among the 31 reservoirs.

TABLE 2

AVERAGE ANNUAL DAY USE ESTIMATES

Sacramento Region

Reservoir	Sacramento Regional Estimator: Survey Estimate	Sacramento Regional Estimator: Regional Estimator
	(values represent thousands of recreation days)	
Black Butte	161	164
Englebright	109	67
New Hogan	243	272
Pine Flat	493	612
Lake Kaweah	289	236
Success	481	430
Isabella	845	839

TABLE 3

AVERAGE ANNUAL DAY USE ESTIMATES

Southwestern Region

Reservoir	Southwestern Regional Estimator: Survey Estimate	Southwestern Regional Estimator: Regional Estimator
	(Values represent thousands of recreation days)	
Belton	1,465	748
Benbrook	1,886	2,092
B. A. Steinhagen	565	1,160
Grapevine*	2,234	2,607
Hords Creek	109	261
Lavon*	2,496	2,497
Lewisville	1,932	2,407
Navarro Mills	341	984
Proctor	305	518
San Angelo	392	797
Whitney*	1,903	1,376
Canyon	789	1,298
Beaver	1,161	1,115
Bull Shoals	1,514	571
Greers Ferry	1,056	803
Norfork	1,077	622
Table Rock*	1,944	1,830
Canton	909	368
Lake Texoma*	4,737	5,004
Eufaula	1,476	1,578
Fall River	318	531
Fort Gibson	1,937	891
Fort Supply	269	279
Great Salt Plains	540	439
Heyburn	316	712
Hulah	289	508
Keystone	1,674	1,693
Oologah	1,024	1,033
Toronto	255	644
Tenkiller Ferry	948	587
Wister	495	405

*Uniquely large estimator used

A Discussion of the Estimators

38. For all three estimators the regression coefficients B_2 and B_3 are positive, as expected. Thus, other things being equal, an increase in the measure of project size will result in an increase in the expected visitation while an increase in the index of substitution will yield a decrease in the expected visitation. It can also be shown that throughout the relevent range an increase in population (distance) will be accompanied by an increase (decrease) in the expected visitation, all of which make the estimators theoretically plausible as well as statistically significant. In addition, for all three estimators, the regression constant, B_0, is negative which implies that the per capita rate increases with an increase in population.

Estimating Benefits

39. Demand curves for the individual projects are constructed from the regional estimators by using the variable or out-of-pocket travel costs as the proxy for price paid. For a general description of the methodology employed and an example of its application using the convex trade-off function, see Technical Report No. 3 [13]. For the convex trade off, the proxy for price is derived solely from the variable travel costs of 4.68 cents per mile [13, 19]. These costs are doubled to account for round trip mileage and then divided by the load factor, the average number of people arriving in each vehicle [15], to determine the proxy for price. For the Sacramento region, the load factor is 3.21 and the proxy for price paid is 2.92 cents per mile, while for the Southwestern Region the values are 2.98 and 3.14, respectively.

40. For the linear trade-off function an evaluation of the time costs must also be made. For this study the value of time per hour is assumed to be equal to a minimum wage rate of $1.65 per hour per vehicle and the average travel speed 50 miles per hour. The average time cost per person per mile is then $1.65 divided by the average travel speed and the average number of persons per vehicle or 1.03 cents for the Sacramento region and 1.11 cents for the Southwestern. These values are then doubled to account for round trip mileage and added to the variable travel costs per person per mile as determined above. For the linear trade-off function the representative proxies are 4.98 cents and 5.36 cents for the Sacramento and Southwestern regions.

41. Benefits for the study reservoirs have been computed using both the linear and convex trade-off functions and are presented in Tables 4 and 5. It is apparent from these data that the total benefits accruing to a reservoir are not only a function of the number of people expected to visit the project at zero price, but also the additional willingness to pay for the opportunity to recreate at each lake. There are many factors uniquely influencing the user's willingness to pay for the recreational opportunities of a particular reservoir; some of the most important are his proximity to the site, its attributes and the availability of substitute recreation areas to him. All of these factors affect the slope of the individual project's demand curve and in turn the area beneath the curve which is used to evaluate the project's national economic development benefits.

42. The unit value approach would be appropriate for measuring recreation benefits if, for each reservoir, the average benefit per visitor (the area beneath the project demand curve divided by the expected visitors at market price) could be approximated without first constructing the project's demand schedule. However, it is very unlikely that an accurate estimate of this value can be made without some initial understanding of the demand curve unique to that project. The average benefits per visitor presented in Tables 4 and 5 are the appropriate unit values for evaluating the study reservoirs and illustrate the wide variations which exist for projects within the same geographic area. These values are, in general, beyond the range of values ($0.50 - $1.50) permitted since 1964 for general recreation under the guidelines of Supplement No. 1 [20].

TABLE 4

AVERAGE ANNUAL BENEFITS

Sacramento Region

Project	Regression Estimate (thousands)	Convex Trade Off: Total (thousands)	Convex Trade Off: Average per visitor	Linear Trade Off: Total (thousands)	Linear Trade Off: Average per visitor
		($)	($)	($)	($)
Black Butte	164	450	2.75	260	1.60
Englebright	67	44	.65	28	.40
New Hogan	272	1,016	3.75	759	2.80
Pine Flat	612	2,226	3.65	1,451	2.35
Lake Kaweah	236	756	3.20	472	2.00
Success	430	1,153	2.70	656	1.50
Isabella	839	3,082	3.70	2,358	2.80

TABLE 5

AVERAGE ANNUAL BENEFITS

Southwestern Region

Project	Regression Estimate (thousands)	Convex Trade Off Total (thousands)	Convex Trade Off Average per visitor	Linear Trade Off Total (thousands)	Linear Trade Off Average per visitor
		($)	($)	($)	($)
Belton	748	2,985	4.00	2,686	3.60
Benbrook	2,092	6,714	3.20	4,704	2.25
B.A. Steinhagen	1,160	5,179	4.45	4,977	4.30
Grapevine	2,607	10,578	4.05	8,615	3.30
Hords Creek	261	893	3.40	729	2.80
Lavon	2,497	10,189	4.10	8,450	3.40
Lewisville	2,407	9,208	3.85	7,140	2.95
Navarro Mills	984	4,152	4.20	3,924	4.00
Proctor	518	2,172	4.20	2,033	3.90
San Angelo	797	1,802	2.25	1,010	1.25
Whitney	1,376	6,015	4.35	5,741	4.15
Canyon	1,298	5,458	4.20	4,655	3.60
Beaver	1,115	3,340	3.00	2,427	2.15
Bull Shoals	571	2,101	3.70	1,803	3.15
Greers Ferry	803	2,630	3.30	2,199	2.75
Norfork	622	2,315	3.70	2,032	3.25
Table Rock	1,830	7,774	4.25	6,971	3.80
Canton	368	1,478	4.00	1,369	3.70
Lake Texoma	5,004	21,023	4.20	19,150	3.85
Eufaula	1,578	5,872	3.70	5,055	3.20
Fall River	531	2,095	3.95	1,962	3.70
Fort Gibson	891	3,082	3.45	2,427	2.75
Fort Supply	279	1,014	3.65	890	3.20
Great Salt Plains	439	1,822	4.15	1,677	3.80
Heyburn	712	2,773	3.90	2,301	3.25
Hulah	508	2,079	4.10	1,912	3.75
Keystone	1,693	5,771	3.40	4,350	2.55
Oologah	1,033	3,814	3.70	3,127	3.05
Toronto	644	2,578	4.00	2,418	3.75
Tenkiller Ferry	587	2,257	3.85	1,904	3.25
Wister	405	1,475	3.65	1,241	3.05

43. In the Sacramento region the average benefits per visitor range from $0.65 to $3.75 for the convex trade off (estimates of the upper bounds) and from $0.40 to $2.80 for the linear trade off (estimates of the lower bounds). The lowest average benefits accrue at Englebright Lake, a small reservoir situated in Northern California, far from populous areas and near substantial alternative water recreation opportunities. The highest average benefits accrue at the larger reservoirs, Isabella, Pine Flat and New Hogan, serving the state's major metropolitan areas and, especially with Isabella, situated where fewer significant alternatives exist. 6/ The Southwestern Division reservoirs exhibit similar results and further illustrate the appropriateness of the travel-cost approach to benefit estimation.

6/ It should be noted that the regression estimates at market (zero) price for Englebright was lower and for Pine Flat higher than the survey estimates. This need not mean that the average benefit estimates are too low or too high. It depends on the distribution of estimate errors over the distance measurements. If underestimation of nearby observations is the source of a lower total estimate then a too low estimate of average benefit will follow. However, this does not appear to be the case with Englebright. If overestimation of more distant observations is the source of a higher total estimate then a too high estimate of average benefit will follow. This appears to be the case with Pine Flat.

PART IV: REPLICATION

The Geographic Region

44. The empirical applications of the general model illustrate the versatility of the model when employed in regions of varying sizes and geographic areas. In selecting an optimal regional configuration, several factors must be considered; most important is the eventual assimilation of the methodology into project planning. Any test of applicability to the Corps must include a test of fit into existing Corps operations. It is imperative that the planners who use the model for predicting use and benefits at a proposed project have an understanding of the potentialities and limitations of the model. With this understanding the planners can then refine their regional estimator to account for factors unique to their region or adjust the use estimate of a particular project which has a unique characteristic not considered by the regional estimator.

45. Considerable insight can be gained by planners who use the models if they are involved in the process of developing them. Since the majority of the use and benefit estimation for project formulation is done at the District level, the logical regional configuration would coincide with District boundaries. Other factors, such as data collection costs or too few existing reservoirs within a District, should be considered before regional boundaries are selected. However, it appears that in general District boundaries would be the most functional. In any event, the general steps required to develop the estimators are the same, and the following paragraphs describe the general effort required to replicate empirical applications.

Areal Observation Unit

46. An observation unit is defined by an area of origin and a reservoir. In defining these units, the reservoirs are selected first and county sets are constructed about each reservoir. The elements of the county sets are counties or sub-county census divisions. The estimates of recreational use and the measurements of the independent variables are made for these elements. The elements are clustered to form county sets and the measurements are aggregated for the reservoir-county set measurements.

47. A region's criterion for delimiting sets is a function of the county configurations and the appropriate market area boundary of that region. In general, the market area for each reservoir will be divided into three zones, the first of which will extend 50 road miles from the reservoir. The other two zones will divide the remaining road mile radius in half. Thus, if the appropriate road mile radius of the market area is 250 miles, the first zone will extend 0-50 road miles from the region's projects, the second 51-150 and the third 151-250. Each of these zones will then be subdivided into county sets which approximate zone segments.

48. If the counties are of relatively uniform size then a specific number of contiguous counties will be grouped within each zone to form the county sets, such as in the Southwestern application. If the counties are of irregular sizes, then the counties will be grouped to form a specific number of sets within each zone, such as the Sacramento application. The exact number of sets formed within each zone is a function of several factors; however, as a general guide there should be approximately four sets delimited in the first zone and ten each in the second and third.

The Measurements

49. Recreation Use. A regional estimator is developed from observations of the recreation at existing reservoirs within the region. Recreation use estimates by elements of the county sets are required. These estimates can be derived from part of the data collected by a recreation survey at the selected reservoirs [16]. The data required are the city or county of user origin by type of user (to determine day use attendance by area of origin) and the number of persons per vehicle (to determine the regional load factor). The estimates of use by origin are used in the determination of the size of the market area. The delimiting road mileage radius is the distance required for the majority of the reservoirs to include the counties or sub-counties of 90 percent of the day users.

50. Independent Variables. For the general model, measures of county populations, road mileages, and project size are readily obtainable from census reports, road maps and project descriptions. A standardized computer program can be developed to compute the alternative indices. The additional input required for this program would be, for each county of origin, a list of all alternative water resource projects available to the users within 100 road miles of the county, their gross pool size, and their road mileage to the county.

The Use of the Estimators

51. Multiple linear regression computer programs are readily available. Each region should initially develop its use estimator from the factors described above. Subsequently, additional variables may be introduced if

additional investigation identifies other factors which have a significant effect on a region's use patterns and which improve the precision and maintain the credibility of the regional estimator. However, such variables should not be included in the regional estimator unless they can be quantitatively measured for proposed projects as well as existing ones.

52. Generally, for a proposed reservoir project an annual estimate of recreation use is made for each tenth year throughout the life of the project. Accordingly, measurements of the independent variables for the proposed project are compiled for each year of estimate. It should be noted that the resulting use estimates can be used regardless of the benefit estimation procedure employed. However, it should be emphasized that these use estimates are output of a simple model of the relationship between recreational day use and the independent variables which measureably affect that use. Non-quantified influences are not accommodated by the estimator. Informed judgment can be guided by the estimator or can adjust the estimates.

53. Operations on the estimator and the proposed project's variables to derive demand schedules are routine computer operations. In the empirical applications the proxies for price were derived from national average travel cost data. For project planning purposes the individual regions should develop their own proxies for price paid to account for regional differences in such factors as toll charges and state and local taxes. The differences in the regional proxies for price will not affect the benefit estimating technique.

PART V: CONCLUSIONS

54. Reservoir recreation within a closed geographic region can be effectively modeled. Regional estimators can predict recreation attendance and its distribution over areal origins. The value of the recreation as an economic good can be approximated from operations on the regional estimators by using the appropriate travel costs as proxy for the price paid and acknowledging the disutility of time and visitor perceptions of the price actually paid.

55. The procedural guidelines presented in this study are applicable for evaluating reservoir recreation and are consistent with existing and proposed authoritative standards. The technique can be replicated and assimilated into existing Corps' planning procedures. However, it should be prescribed only if the value of the greater theoretical and empirical precision of the planning estimates are worth greater planning effort.

56. The potential of the generalized planning model exceeds its current application. The general form enables easy accommodation of future findings regarding other variables influencing recreation. It can evaluate alternate spatial distributions of reservoirs within a region. Finally, it could be used to develop regional demand schedules for evaluating allocations of expenditures over regions.

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This report presents refined procedural guidelines for estimating reservoir recreation use and benefits for planning of water resources developments. The general planning model described and tested herein consists of the development of regional estimators for predicting recreation use at proposed reservoir projects and the operation on these estimators to derive the individual project demand schedules for estimating recreation benefits. The methodology presented is theoretically and empirically more precise than

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SECURITY CLASSIFICATION OF THIS PAGE *(When Data Entered)* estimating procedures currently employed and is consistent with other existing and proposed authoritative standards for evaluating water resource developments.