

Simplified Procedure for Estimating Recreational Travel to Multi-Purpose Reservoirs

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This research reports the results of a study concerned with the development of a model that can be used to predict recreational trips to new reservoirs in Indiana. The model utilizes only road distance, county population, and the influence of other similar facilities as the parameters affecting attendance. A technique was developed illustrating how the model can be used to predict future attendance and traffic volumes.

Three parks were used in the study. Data were collected by conducting interviews of 25 percent of arriving trips at the park entrances. Over 13,000 interviews were conducted over a 2-yr period. Yearly distributions of trips by trip purpose and frequency were investigated.

The prediction model was developed by using nonlinear regression analysis to determine the parameters of distance, population and the influence of other parks. Two equations were developed, one for the condition where there is no other park closer to a county than the park under consideration and the other where there is another park closer. Together, the two equations constitute the prediction model.

•THE control and use of water resources is of major importance to the economic life of the United States. Flood control, irrigation, and hydroelectric power were originally the three purposes considered in the cost analysis for justification of the construction of dams and their reservoirs. However, not until recent years have the recreational benefits been generally included in the economic analysis or even recognized as an economic factor.

Recreation is now a big business in this country. A substantial portion of the Gross National Product is devoted to recreational pursuits in all areas of the nation.

Traffic patterns have changed because of the proportionate increase in personal expenditures for recreational purposes. Many rural highway sections serving recreational facilities now carry their peak travel loads on weekends.

The development of the future highway network must take into account the traffic generating abilities of a recreational park on a reservoir. A recreational facility is of little value without access. On some routes, peak volumes result from trips made for recreational purposes. On many routes, weekend traffic volumes exceed the weekday volumes and the increase is due mainly to recreational travel (1).

Future highway planning must take into consideration the traffic generating capabilities of this type of recreational facility. There is no point in having a well-developed park that is difficult to reach: the public will not go to such a park in numbers great enough to utilize the investment made in developing the park.

Water is a recreational magnet and will attract large numbers of people for recreational purposes. The multi-purpose dams and their reservoirs are natural recreational attractions and traffic generators. The recreational potential of a reservoir cannot be fully utilized unless transportation planning coincides with reservoir development plans so that an adequate transportation system is available as the recreational demand grows. The agencies responsible for planning must have some means of determining demand prior to construction so that the best use can be made of the available resources of land and money. At the present time, little factual information is available that can be used by planners to estimate the recreational demand. Many reservoir sites are located in areas with poor existing transportation facilities. Usually existing roads were designed for rural traffic of low volumes, and as such, these roads cannot begin to accommodate the traffic generated by a reservoir and its recreational facilities.

PURPOSE AND SCOPE

The flood control projects that have been and are being developed in Indiana produce many reservoirs which are suitable for recreational purposes (Fig. 1). The Indiana Department of Natural Resources is responsible for the development and operation of recreational facilities at such reservoirs. Very little information is available for plan-



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Figure 1. Reservoirs in Indiana.

ning recreational facilities. No one can accurately say how many sites are needed to satisfy the demand for recreation in a given area. No one knows what effect a reservoir park has on attendance at another park in the same general area.

The Department early in 1965 asked the Joint Highway Research Project at Purdue University to conduct a research program that would develop information that could be used for planning recreational developments at future reservoir sites. Three reservoirs were suggested, two had been in operation for several years and the third was in the process of being opened for public use although few facilities were available. The two developed parks are Lieber State Park on Cagles Mill Reservoir and Raccoon State Recreation Area on Mansfield Reservoir. The third park is located on Monroe Reservoir.

Funding for the project was provided by the U. S. Bureau of Public Roads of the U. S. Department of Transportation and the Indiana State Highway Commission through the Joint Highway Research Project. The purpose of the research was to develop a method that could be used to predict recreational attendance at planned reservoirs based on the characteristics of the recreational facilities, population, the distance from population centers to the planned reservoir, and the influence of other reservoirs in the vicinity. The determination of the growth patterns of attendance at new facilities as compared to established reservoirs is a secondary objective.

The park facilities at the reservoirs are similar in type. Boat launching ramps at various locations around the reservoirs are provided; 5 at Raccoon, 2 at Cagles Mill, and 9 at Monroe. Each boat ramp is provided with paved roads, parking area, and, usually, picnic grounds. These ramps may or may not be located in the main park.

Raccoon and Cagles Mill each have one beach several hundred feet long. Swimming is permitted only at the beaches with adequate lifeguard personnel and control equipment as well as diving boards and bath houses. Monroe is to have two beaches operated by the State and one operated by the U. S. Forest Service. These will be similar to the ones at Raccoon and Cagles Mill.

The camp grounds, beaches, concession stands, boat rentals, picnic areas, and bath houses are located within the main park at Raccoon and Cagles Mill. There are hiking trails available. In general, each park is well kept by personnel who know and take pride in their work. The recreational facilities available at each park are similar and it is difficult to visualize what additional types of facilities would be useful at this type of park.

The need for outdoor recreational areas can only increase. The Midwest as a region has 29 percent of the population of the 48 contiguous states, but only 12 percent of the recreational acreage (2). The use of flood control reservoirs for recreational purposes can provide a substantial portion of the needed public recreational areas and every effort should be made to utilize such areas in the most efficient manner for the benefit of the public.

Proper utilization of these facilities will require an adequate highway system. The purpose of this research was to provide a simplified method for estimating future traffic volumes for new facilities of this type.

DATA COLLECTION

In order to acquire sufficient data for the study, collection was made over a period extending from June 1965 until October 1966 at all three parks. Figure 1 shows the location of the three reservoirs. Data collection was begun early in the planning stage of the project in order to take full advantage of the summer season of 1965.

The primary source of data was a 25 percent interview of vehicular trips arriving at the parks. The 25 percent sample was considered adequate for analytical purposes and did not create a disruption in traffic flow. Each interview took approximately 20 seconds.

The number on Indiana passenger car licenses includes the number of the county of residence of the listed owner. This was recorded and used as the county of origin for the trip. The driver was asked the purpose of the visit; the number of adults and children were determined. Children were considered to be persons under 12 years of age since no charge is made for admittance of persons under 12. Note was made of any

equipment carried such as a boat, house trailer, or camping trailer. Time of day, date, park and place of entry (main gate or isolated boat ramp) were recorded.

The interviews were conducted at the gatehouses at Raccoon and Cagles Mill. No gatehouses were in operation at Monroe during this period. The advantage of conducting interviews at the gatehouses was that the vehicles were already stopped in order to pay fees, and no further disruption of traffic was necessary. Also, it was possible to determine which vehicles had already paid and thus duplication of interviews was prevented. Vehicles on park business were not charged admission and were not included in the sample. It was therefore possible to exclude all those vehicles which were not entering the park for the first time. Unfortunately, this was not possible at the boat ramps at Raccoon or Monroe; however, the volumes at the boat ramps were low enough so that it was possible to ask if the trip had entered the park previously, without causing an undue delay to traffic. At Cagles Mill there is an attended gatehouse at the only isolated boat ramp.

The majority of the interviews were conducted over the weekend periods, from Friday afternoon to Sunday afternoon, during the summer months. Weekends were selected randomly. During 1965, the parks were visited every two weeks beginning early in June and continuing through August. Raccoon was visited one weekend and Cagles Mill and Monroe the next weekend throughout the summer. Periodic visits were made during the fall and winter and also during the spring of 1966, in order to determine the yearly distribution of trips. During the 1966 summer season, visits were made to each park every third weekend. Weekday visits were made in June and August only.

The general procedure for weekends was to begin at 2 p. m. on Friday and interview until 9 or 10 p. m. On Saturdays, interviewing would begin at 9 a. m. and continue until 8 p. m. On Sundays, interviewing would begin at 9 a. m. and continue until 5 p. m. The hours were selected on the basis of observations made at Raccoon Park. After about 9 p. m. on Fridays, few arrivals were noted, and few arrived before 9 a. m. on any day of the week. The parks were open 24 hours a day during the summer, but interviews were conducted only during the stated hours. The park records on attendance showed that on weekends the arrivals during the interview period usually accounted for about 90 percent of the total visitors on Saturdays and Sundays and about 75 percent on Fridays. Weekday interviews were conducted in essentially the same manner as were the weekend interviews.

PREPARATION OF DATA

The data were summarized by means of the IBM 7094 computer utilizing FORTRAN IV. The large number of data items precluded any attempt at hand calculation. Over the 2-yr period, 13,340 samples were collected.

Since the visitors were asked to state the purpose of their visit, many multiple purposes were stated. Most trips to a reservoir are probably made for more than one purpose; however, in this study only the stated purposes were recorded since these were considered to be the purposes which inspired the trip. No effort was made to determine if, in fact, the stated purposes were actually accomplished. The fact of interest was what attracted the visitor to the park, not what he actually did once he had arrived at the park. The trip purposes considered were boating, camping, fishing, picnicking, swimming, hiking, looking, and others.

Some trip purposes were not compatible with multiple listing. Looking and other categories were not listed with multiple purposes. For instance, a trip purpose given as "boating and looking around" was classified only as "boating." A camping trip which also lists picnicking as a purpose does not logically make sense, as an overnight camping trip without meals is hardly feasible. Some of these trips (camping and picnicking) may have appeared on the summation sheets but they were summed with the camping trips for analytical purposes. A trip for which boating and swimming were given as the reasons for making the trip could not justifiably be counted as boating rather than swimming or vice versa as no reason existed for making an arbitrary judgment as to what category in which to place the trip. A multi-purpose trip of swimming and boating could not be listed as both a swimming and a boating trip. The solution to this problem was to list each trip as a separate entry.

TABLE 1
SAMPLING DAYS AND EXPANSION FACTORS

Park	1965		1966	
	Sampling Days	Expansion Factor	Sampling Days	Expansion Factor
Raccoon	107	0.287	128	0.342
Cagles Mill	79	0.210	75	0.200
Monroe	75	0.200	80	0.212

A summation program was used to determine the trips to each park for each year from each county in Indiana and Illinois as well as from other states. The trips from each county could be determined also by type, that is boating trips from each county to each park could be determined. The number of people, or adults and children, could be determined in the same manner as were the number of trips.

When county trip totals were determined, it became apparent that over 80 percent of all trips came from within 125 miles of a park. For the purpose of this analysis, no counties beyond 125 miles of the closest park were considered. The observed trips per county beyond this range were so few as to be insignificant.

In order to standardize the trip rate from any particular county, a unit of measure was selected as trips per 1000 population. There is a large variation among county populations. Marion County contains 785,000 people, while Union County contains 6000. Obviously, the total number of trips from the two counties will vary even if the distances to a park are the same. The use of a trip rate will tend to normalize the disparity of population differences.

The trips from each county were converted into trips per 1000 population. Observed trips were divided by a factor, called the expression factor which is the percentage of all trips to a park that were sampled in a year. The total trips were obtained from the

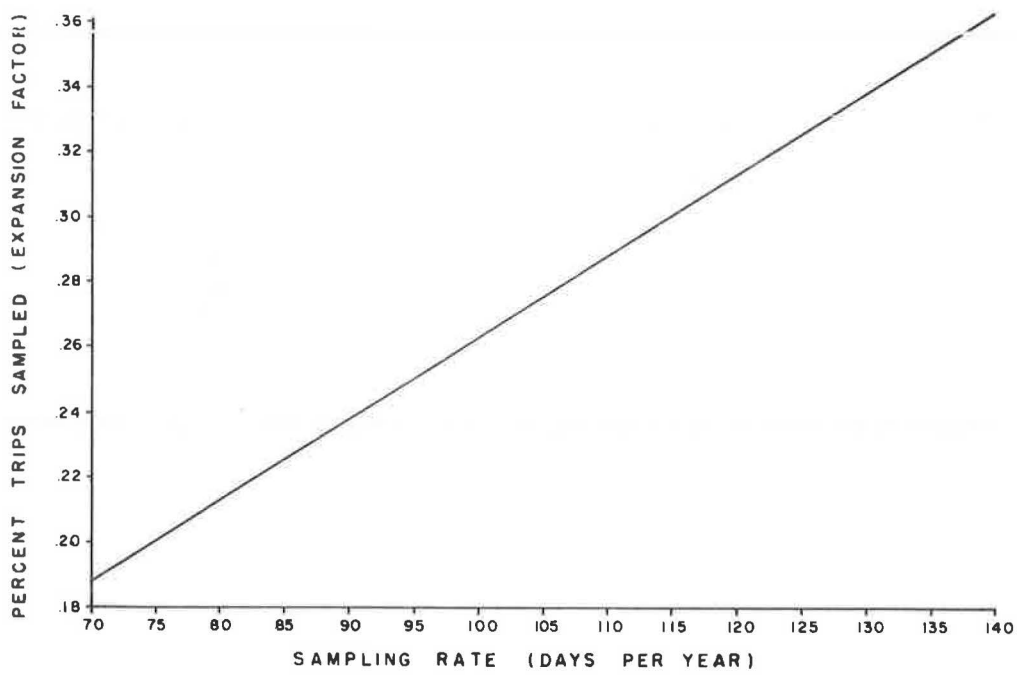


Figure 2. Expansion factors.

Department of Natural Resources' weekly tally sheets which were available for 1965 and 1966. A sampling day is a day of weekday sampling. If a weekend day, Friday, Saturday, or Sunday, was used, a multiplier of five was used as weekend days produce about five times as many trips as a weekday day. Therefore, one weekend produces 3×5 , or 15 sampling days. The total sampling days for each park and each year are given in Table 1.

The observed trips from a county were multiplied by four to reflect the 25 percent sample. The resulting value was then divided by the expansion factor from Figure 2, determined from the number of sampling days in order to obtain the total annual trips from that county to a park. By dividing the total trips, or boating, swimming, camping, or picnicking trips by the county population in thousands, the trip rate for any desired trip purposes can be obtained.

The county population data projections for 1965 and 1966 were linear projections of the 1950 and 1960 census data (3). The trip rates for each county for both years, to all three parks were computed for total, boating, camping, picnicking, and swimming trips.

The distance figures were developed from the center of each county to the center of each park. Road miles were measured using the primary highway system.

ANALYSIS

Development of Prediction Model

A normal plot of the trip rates versus distance of the various counties from a reservoir produced a curved line. A plot of the same data on a semilogarithmic graph produced a straight line, indicating that an exponential type of function should describe the trip rates in terms of distance. This result was expected since the relationship between trip frequency and distance has been shown to be exponential (4). The relationship is based on the premise that a trip desires to be as short as possible; a person making a trip for any purpose will usually go no further than is necessary to satisfy the purpose for which the trip is being made.

For determining the trip rate, the function used was:

$$Y = A e^{-Bx} \quad (1)$$

where

Y = trips per 1000 population from a county to a reservoir,

A = Y intercept of nonlinear regression curve,

e = base of natural logarithms,

B = rate of change of nonlinear regression curve, and

x = distance in tens of miles from a county to a reservoir.

Two regression curves were developed; one is to be used for counties that are closest to the specified park and the other for trips to a park from a county that is not the closest. Trips were observed from a particular county to more than one park. If the assumption that a trip desires to be as short as possible is correct, then the characteristics or the parameters of Eq. 1 should be different for each case. Case one is the condition where there is no park closer to a county than the park under consideration. Case two is the condition where one or more parks are closer to the county than the park under consideration.

In accordance with these conditions, the counties were separated into two groups for each park. All counties that were closer to the park considered than to any other park were placed into one group. The other group contained all counties that were closer to a park other than the one under consideration.

Monroe was not considered for the purposes of estimating the parameters because the park was not fully operational during this period. No beaches were open for swimming, only extremely limited camping and picnicking facilities were available, and fishing was not permitted. Only boating could be considered to be in normal operation at Monroe. The road network serving the area was inadequate. The roads were narrow, winding, and mostly unpaved.

In 1966, Raccoon Park did not permit swimming because the reservoir pool level was too low. For this reason, the 1966 data for Raccoon were not included in this portion of the analysis.

Eq. 1 is nonlinear in that the function is not linear for the parameters; it is not of the linear form

$$Y = B_0 + B_1 Z_1 + \dots + B_n Z_n + \epsilon \quad (2)$$

The estimation of the parameters by the method of least squares can be made by using a logarithmic transformation into the form

$$\ln Y = \ln A - Bx \quad (3)$$

This approach assumes the errors in the original function are multiplied and are therefore additive in the transformed model. The logarithmic transformation may not give good estimates of the parameters because the transformed model is not the same function as the original (5).

A nonlinear regression analysis was used to obtain the parameters A and B. The method selected was a minor variant of SHARE 3094 (6). This program finds the estimates of the parameters A and B in the function $Y = Ae^{-Bx} + \epsilon$ by minimizing

$$\Sigma \epsilon^2 = \Sigma (Y - \hat{Y})^2 \quad (4)$$

where ϵ is the residual error and \hat{Y} is the estimate of Y. In order to solve $\Sigma \epsilon^2 = \Sigma (Y - \hat{Y})^2$, the partial differential equations of $Y = Ae^{-Bx}$ with respect to the parameters must be used since

$$\frac{\partial (\Sigma \epsilon^2)}{\partial \hat{A}} = -2 \Sigma (Y - \hat{Y}) \frac{\partial \hat{Y}}{\partial \hat{A}} = 0 \quad (5)$$

and

$$\frac{\partial (\Sigma \epsilon^2)}{\partial \hat{B}} = -2 \Sigma (Y - \hat{Y}) \frac{\partial \hat{Y}}{\partial \hat{B}} = 0 \quad (6)$$

are the normal equations which must be solved simultaneously for \hat{A} and \hat{B} , the estimates of A and B.

The required partial differential equations were

$$\frac{\partial \hat{Y}}{\partial \hat{A}} = e^{-\hat{B}x} \quad (7)$$

and

$$\frac{\partial \hat{Y}}{\partial \hat{B}} = x \hat{A} e^{-\hat{B}x} \quad (8)$$

These two equations were substituted into Eqs. 5 and 6. The equations may be solved by finding the values of A and B which will minimize Eq. 4. This is the method used by the SHARE 3094 program. It is an iterative technique which requires an initial estimate of the true parameters.

The initial parameters were developed by estimating parameters for a linear transformation of the data for the total trips to Raccoon for 1965 and to Cagles Mill for 1965 and 1966. The results were such that a value of 250 was selected as the initial estimate for A and a value of 0.466 was selected for B. A similar procedure was used for intervening parks with the resulting estimates of 120 for A and 0.466 for B. The values used proved satisfactory as initial estimates.

Using the data for total trips, a linear transformation of the form $\ln Y = \ln A - Bx$ was made for the purpose of testing if the various regression lines produced could be considered parallel (7). A standard F test using analysis of variance techniques which compared the variance between the individual slopes and the variance about the individual lines using the mean squares s_1^2 and s_2^2 , respectively, showed the following variance ratio:

$$\frac{s_2^2}{s_1^2} (2, 82) = \frac{0.776}{0.368} = 2.108 < 2.35$$

for an α level of 0.10. The hypothesis is that the lines are parallel and since s_2^2/s_1^2 , distributed as $F(2, 82)$ where 2 and 82 are the degrees of freedom for s_2^2 and s_1^2 , is less than 2.35 it cannot be said that the lines are not parallel. The α level was chosen to be relatively high in order to reduce the chance of making a type II error, or to accept the hypothesis when in fact it is false. It was thought to be more advantageous to accept a higher probability of making a type I error or to reject the hypothesis as false when it actually is true (7). If the lines produced by the transformed equation can be accepted as being parallel under the above conditions, it should be safe to conclude that the actual nonlinear regression lines are also parallel; that is the slopes of the lines can be considered equal. This approach was used because there is no satisfactory way to perform an analysis of variance for the nonlinear case.

The number of iterations required to estimate the parameters was usually less than 10 and in no case was a computer force off used because the number of programmed iterations had been exceeded. The initial parameters are then used to calculate an estimate of A and B. The new estimate is then used to get a better estimate. This process continues until a satisfactory answer is reached.

An iterative technique for estimating parameters of a nonlinear system may or may not work satisfactorily depending on the form of the iterative technique used. The SHARE program used for this research employs the method known as Marquardt's compromise (8). This method is a compromise between the linearization (or Taylor series) and the steepest descent methods (6). Its chief advantage is that it seems to be applicable to a greater range of problems than the two other methods. Taylor series may not converge as it is a linear form. Marquardt's compromise method almost always converges and does not slow down as does the steepest descent method which often converges very slowly and often requires changes in scale. For nonlinear problems, no particular method of iteration can be considered best because for a particular problem, modification of any method may result in quicker convergence. A satisfactory answer is one which satisfies the criteria imposed.

Several criteria for stopping are available. When the slope of $\Sigma (Y - \hat{Y})^2$ is near zero; that is, when the partial derivatives approach zero, the criteria are satisfied. In the SHARE program the value of the slope is considered to be near zero when the actual value is less than 0.0001. There are two additional ways in which the SHARE program may be satisfied, when the changes in A and B become too small for an iteration or when any predetermined number of iterations have been made. In this case the standard convergence criteria supplied with the program were used. The Epsilon Test was used to determine convergence (6). This test is passed whenever

$$\frac{|\delta_j|}{\tau + |b_j|} < \epsilon, \text{ for all } j \quad (9)$$

where

- b_j = value of the j th parameter,
- τ = constant used in convergence test (10^{-3}),
- ϵ = convergence criteria (5×10^{-5}), and
- δ_j = increment to b_j .

The program produces 10 sets of parameters, A and B, for use in Eq. 1. The equations developed are to be used to predict trip rates for the total trips, boating, swimming, picnicking, and camping trips for both cases. The 1965 data for Raccoon and Cagles Mill were used as well as the 1966 data for Cagles Mill. The values were averaged for each category and the average values of A and B were used to produce straight line plots on a semilogarithmic graph for estimating purposes (Figs. 3 and 4).

Using estimating lines for trips to the closest park and intervening park, one is able to produce over 95 percent of the total trips to Raccoon for 1965 and to Cagles Mill for 1965 and 1966. This estimate (95 percent) is considered to be entirely adequate for future planning purposes.

Standard statistical tests such as simultaneous significance tests for multiple contrasts in the analysis of variance were run on the trips to the parks for the various trip purposes (9). The trips were converted to percentages in order to account for the difference in total observed trips which resulted from the differences in the number of observation days as well as the differences in the annual attendance at each park. Of interest in these tests was whether or not there were any significant differences for the various trips due either to parks or to years.

These tests showed that there existed no significant difference between Raccoon and Cagles Mill for the purpose of boating, picnicking, and swimming. From this, it is inferred that the attraction of each park is the same and the only difference in trips ar-

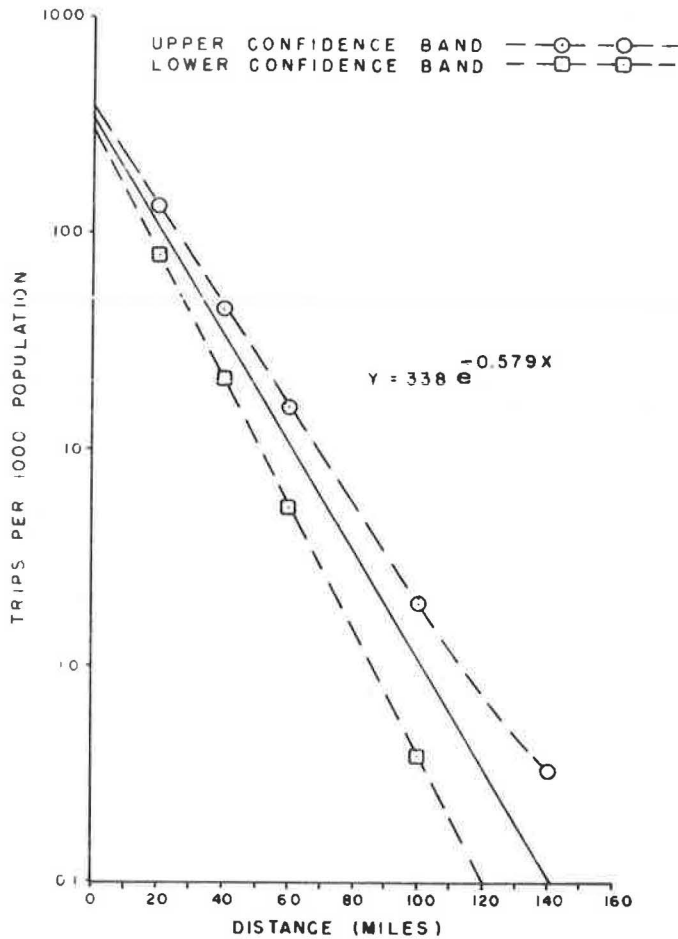


Figure 3. Total trips to closest park.

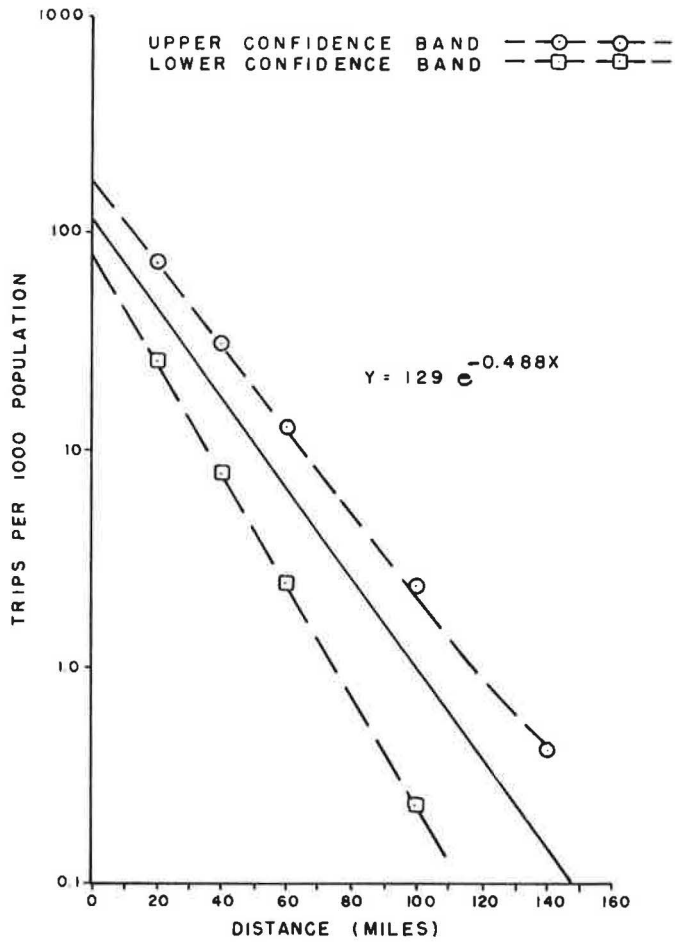


Figure 4. Total trips with intervening park.

iving at each park can be attributed to the population distribution around each park. More of the population is closer to Raccoon than to Cagles Mill. The fact that the estimating line for total trips to the closest park has a higher X intercept (338.4 vs 129.3) than the line for total trips to a park with an intervening park, validates the assumption that a recreational trip desires to be as short as possible.

For the two primary curves (Figs. 3 and 4), confidence intervals were computed by determining the lines for the average values of the upper and the lower confidence bands as determined by the standard convergence criteria. The lines appear to diverge as X

TABLE 2
SINGLE PURPOSE TRIPS IN PERCENT
OF TOTAL ANNUAL TRIPS

Activity	Raccoon 1965	Cagles Mill 1965	Cagles Mill 1966
Boating	11.1	9.6	18.2
Camping	3.2	4.8	5.1
Picnicking	6.5	5.7	6.5
Swimming	12.3	12.4	15.2

TABLE 3
MULTI-PURPOSE TRIPS IN PERCENT
OF TOTAL ANNUAL TRIPS

Activity	Raccoon 1965	Cagles Mill 1965	Cagles Mill 1966
Boating	36.9	37.6	47.1
Camping	18.4	25.7	13.4
Picnicking	32.3	36.4	21.6
Swimming	38.1	55.6	31.9

TABLE 4
TRIP PURPOSE IN PERCENT OF TOTAL
ANNUAL TRIPS, AVERAGED FOR
ALL PARKS

Activity	Percent
Boating	40.0
Camping	19.9
Picnicking	30.0
Swimming	42.0

TABLE 5
AVERAGE TRIP PURPOSE IN PERCENT FOR
JUNE, JULY, AND AUGUST

Activity	Raccoon 1965	Cagles Mill 1965	Cagles Mill 1966
Boating	36.0	36.0	33.0
Camping	18.6	21.0	16.0
Picnicking	32.0	33.3	25.5
Swimming	42.0	55.1	45.5

a park are made before June (Fig. 8). By the end of August, more than 90 percent of the total annual trips have been made. The arrival rate for the months other than June, July, and August will be much less than those plotted. These figures may be used as the average arrival rates and daily distributions for the parks involved.

The maximum number trips observed in one day was a Sunday when 1348 trips were sampled at Raccoon State Recreation Area.

Figure 9 shows the trips rates by purpose. The values were determined in the same manner as were the values for total trips. The plots show the relative attractiveness of each activity.

Of interest is the relationship of the curves to each other in terms of distance. For distances of less than 30 miles, swimming is the largest trip producer; beyond 45 miles,

increases, but actually the confidence interval decreases as X increases. The largest value of the confidence band occurs when X is zero. This is apparently because fewer observations are available for the smaller values of X than are available for the larger values of X. In other words, fewer counties are closer to the parks than are further from the parks, using 50 miles as a division point.

Trips by Purpose

In order to determine what percentage of the total trips each trip purpose produces, two tables were developed. Table 2 gives the percentage of total trips contributed by each single purpose; no multi-purpose trips are included. Table 3 is considered to be more useful in explaining the trip purposes because it gives the multi-purpose trips as well as the single purpose trips for each purpose.

One conclusion is that swimming is the most preferred activity; followed in order by boating, picnicking, and camping (Tables 4 and 5).

Arrival distributions were plotted to determine the arrival patterns both for total trips and for each trip purpose. Considerable variations exist among the days of the weekend (Figs. 5, 6, and 7). The only major difference between parks was noted in the magnitude of trips per hour. This effect however, has already been explained as being due to the population distribution around the parks.

The values for the arrival distributions were obtained by averaging the summer weekend observations for June, July, and August. Less than 30 percent of the total annual trips to

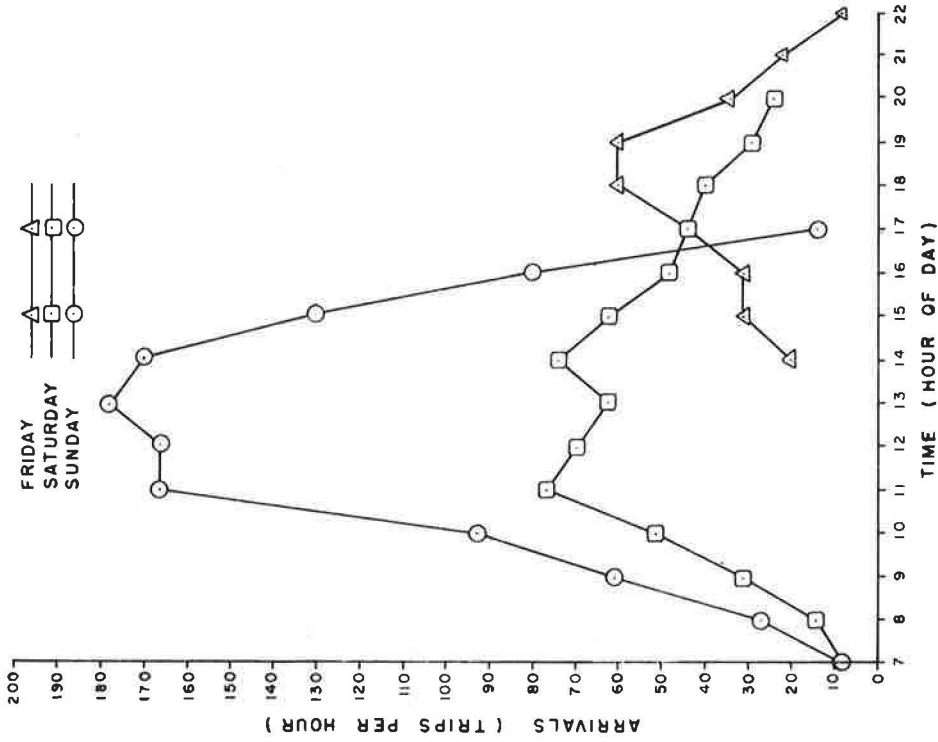


Figure 5. Total trip arrivals, Raccoon, 1965.

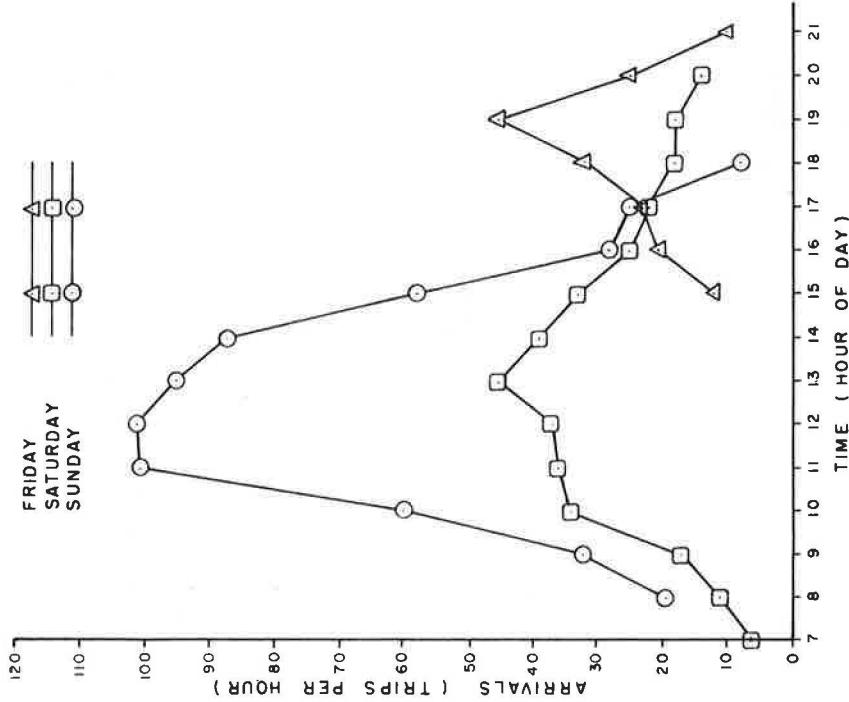


Figure 6. Total trip arrivals, Cagles Mill, 1965.

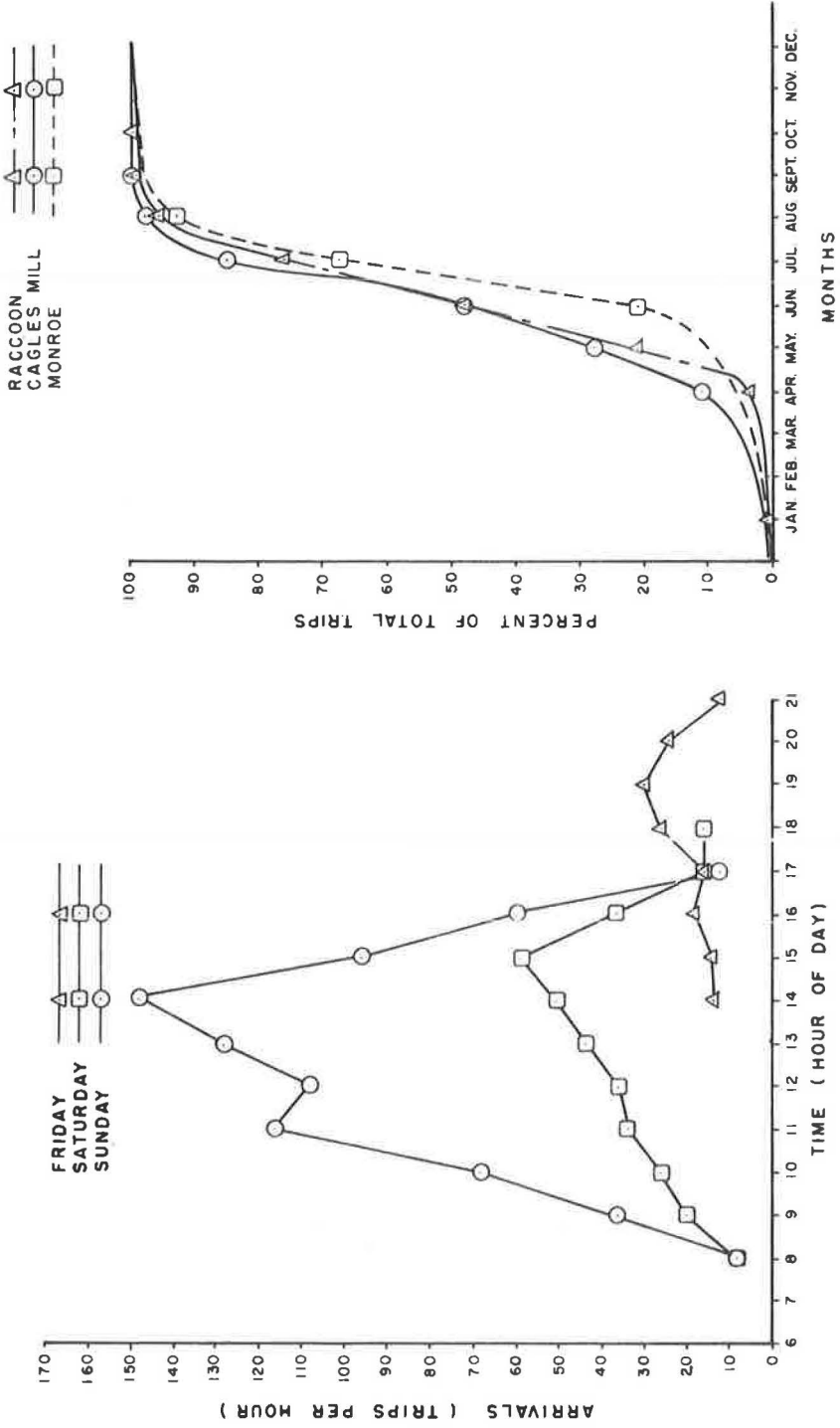


Figure 7. Total trip arrivals, Cagles Mill, 1966.

Figure 8. Cumulative trips.

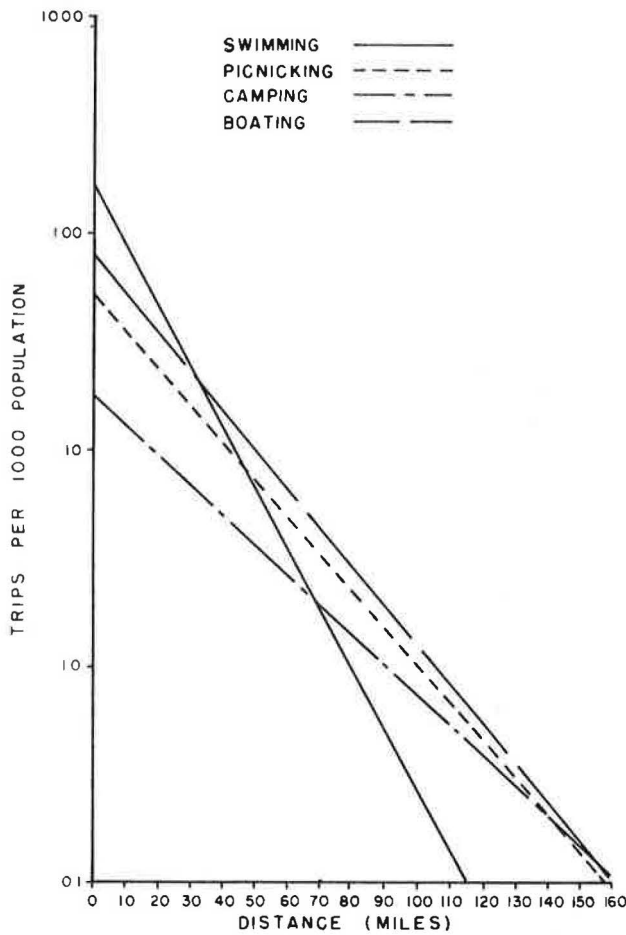


Figure 9. Trip rates by purpose for closest park, 1965.

TABLE 6

AVERAGE NUMBER OF PERSONS PER TRIP

Park	1965	1966
Raccoon	3.72	3.40
Cagles Mill	3.84	3.63
Monroe	3.80	3.63

picnicking is the most attractive; and camping is the most attractive beyond 70 miles. The curves for boating, picnicking, and camping tend to converge with an increase in distance which indicates that as the distance increases the trip purpose has less effect on the trip rate. It may also indicate that more multi-purpose trips are made for longer distances than for shorter distances.

The curve for swimming reflects the fact that swimming, as a separate activity, can be satisfied closer to home than can most other activities. Also, the high rate for short distances reflects the desire of many people for a short duration trip for a swim. This can also be inferred from the arrival distributions which show the swimming arrivals to be later in the day.

Persons Per Trip

The average number of persons per trip is given in Table 6. The values were obtained by dividing the total number of people sampled who visited a park in a year by the

TABLE 7
PERCENT OF TOTAL ANNUAL TRIPS OCCURRING ON
MAXIMUM VOLUME WEEKEND

Year	Park	Total Annual Trips	Maximum Weekend Volume	Percent of Total
1965	Raccoon	57,146	2,778	4.8
1965	Cagles Mill	30,695	2,431	7.9
1966	Cagles Mill	41,322	3,329	8.1

tendance, the maximum number of trips for a weekend for Raccoon and Cagles Mill were found for 1965 and 1966. The Department of Natural Resources weekly tally sheets were used to obtain the exact number of trips for Cagles Mill in 1966. Sufficient data for 1965 were not available since only abbreviated tally sheets were made available. For this reason, the observed study values for the highest volume weekend were used. The results are given in Table 7. The average value is 6.9 percent.

The maximum number of trips occur on Sunday. For any weekend when weather conditions are similar, Sunday will have the maximum volume of arriving trips. For the maximum weekends in Table 7, the daily breakdown is listed in Table 8.

For planning purposes, the maximum volume that will be expected can be computed easily from the estimated total arrival trip volume. Since the Sunday trips of the maximum volume weekend account for, on the average, 53.5 percent of the total trips, 0.535 multiplied by 6.9 percent of the total annual trips will give an estimate of the maximum number of trips that can be expected in one day. Therefore, approximately 3.7 percent of the total annual trips can be expected as the maximum daily volume.

CONCLUSIONS

The objective of this research was to develop a method of predicting attendance for recreational purposes at new reservoirs. The method developed appears to be an effective tool for predicting future recreational attendance at reservoir parks. The model $Y = Ae^{-Bx}$ is able to produce accurate trip estimates to a reservoir if the trip rates are placed into two categories, trips to the closest park and trips with an intervening park.

The model for the case of total annual trips to the closest park is $Y = 338.4e^{-0.5791X}$. When there is an intervening park, the model becomes $Y = 129.3e^{-0.4875X}$. Distance measured in tens of miles and population measured in thousands are the two variables necessary to use the equations which will produce annual trip rates for a county.

The method is able to predict future attendance with reasonable accuracy based on distance, population, and the influence of similar parks. Previously developed models required many socioeconomic and park characteristics variables which are difficult to measure and evaluate and extremely difficult to project (10). The model developed is probably as accurate and is much simpler to use. The model is adequate for advanced planning purposes and can be used to predict reservoir attendance and traffic volume estimates.

TABLE 8
DAILY TRIPS ON MAXIMUM VOLUME WEEKEND

Year	Park	Sunday	Saturday	Friday	Percent of Weekend Trips Occurring as Sunday Trips
1965	Raccoon	1,419	865	494	51.0
1965	Cagles Mill	1,276	748	407	52.5
1966	Cagles Mill	1,938	766	625	57.2

total number of trips sampled in that same year. There is no significant difference among the values, the average value being 3.69 persons per trip.

Maximum Volume

Some knowledge of the maximum expected weekend volume could be of interest to planners. To determine the maximum weekend at-

Statistical evidence indicates that there is no significant difference between parks of similar type with regard to their ability to attract visitors. There is one attraction rate for trips to a reservoir that is closer to the point of trip origin than another reservoir and another attraction rate for trips when there is another reservoir closer to the point of trip origin than the reservoir being considered. The difference in attraction rates substantiates the assumption that a trip desires to be as short as possible. Generally, people will not go past a park to get to another that has similar facilities.

The county trip rate to a park is also directly related to the distance between the county and the park; the longer the distance, the smaller the trip rate per 1000 population for that county.

The attendance at any proposed site is dependent on the population, its distance from that park, and the location of other similar parks with regard to the location of the population. These parameters are easily understood and readily available to any planning agency. Distance can be determined from an official state highway map. Population data and projection techniques are common tools for the planner (11).

Growth of the trip rates is a possibility, but was not included in this report because a 2-yr time period is not sufficient for an accurate examination of the possible changes in trip rates. The continuing phase of this project should investigate possible growth of the trip rate.

The trip rate appears to be a handy tool. The high correlation index values (R^2) for total trips (0.84 to 0.97) indicates that the trip rate technique was effective in eliminating county population variations. The correlation index values also tend to validate the assumption that socioeconomic factors and park facility quantities can be considered uniform in that all parks tend to draw trips from what is essentially a uniform cross section of all types of social and economic population groups.

Additional work is contemplated which will test the stability over time of the proposed trip rates and will evaluate travel time as a factor in lieu of travel distance.

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