STABILITY OF RECREATIONAL DEMAND MODEL

D. C. Robinson and W. L. Grecco, Joint Highway Research Project, Purdue University

The principal objective of this study was to determine the stability of previously developed recreational demand models. Models were of the form $Y = A\, e^{-BX}$ and utilized easily obtainable and predictable variables. The study illustrated how the model can be used to predict future attendance and traffic volumes. Three parks were used in the study, and data were collected in interviews with 25 percent of arriving trips at the park entrances. Almost 12,000 interviews were conducted during the period from 1967 through 1969. The new reservoir model was developed by nonlinear regression analysis utilizing distance, population, and influence of other similar facilities. Two equations constituted the prediction model: one for when there is no other similar facility closer to a county than the reservoir under study, and one for when there is another such facility closer to the county than the reservoir under study. A comparison showed that, while parameter B remained fairly constant over time, there was an increase in parameter A.

•IN 1936, a national policy on flood control was established by the Congress of the United States. This policy provided that the federal government would cooperate with states and their political subdivisions on flood control projects; that flood problems would be tackled jointly by the U.S. Department of the Army and the U.S. Department of Agriculture; that project benefits must exceed project costs; and that projects recommended would not be constructed unless specifically authorized by law. Since 1936, more than 40 reservoirs have been constructed in the Ohio River Basin alone; 30 more are in the planning or construction stage.

Flood control, irrigation, and hydroelectric power were the 3 purposes originally considered in the benefit-cost analysis for justification of the construction of dams and their resulting reservoirs. There is, however, an added dividend of flood control dams that only in recent years has been recognized and included in the economic analysis. This dividend is the recreational lakes that are created by such dams.

Recreation is now recognized as an important business in this country. A substantial portion of the gross national product is derived from recreational pursuits in all areas of the nation.

The development of the future highway network must take into account the traffic-generating abilities of a recreational park or reservoir. A recreational facility is of little value unless it has adequate access. Recreational highways exhibit such unique traffic patterns that it is not enough simply to use techniques that have been found valid for the analysis of traffic flows on urban streets and nonrecreational rural highways. The multipurpose reservoirs are natural recreational attractions and consequently recreational traffic generators. It is essential for the full utilization of the recreational potential of a reservoir that transportation planning coincide with reservoir development plans. Little factual information is available at present that can be used by planners to estimate the recreational demand.

SCOPE

The area of water available for recreational purposes within the state of Indiana is in the process of being substantially increased under flood control programs of the U.S. Army Corps of Engineers. Six multipurpose reservoirs have been completed to date; 8 more are authorized and many more are planned (Fig. 1). The 6 completed reservoirs

have added a total of more than 20,000 acres of water at summer levels. The Indiana State Department of Natural Resources is responsible for the development and operation of recreational facilities at such reservoirs.

Not until 1967 (1) was any information made available to the Indiana Department of Natural Resources for the planning of recreational facilities at reservoirs (1). The result of this initial research, in which Cagles Mill and Mansfield reservoirs were studied, was a model (referred to as the "previous model") for the prediction of recreational trips to new reservoir areas in Indiana. The model utilized road distances, county population, and influence of other similar facilities as the parameters affecting attendance. The technique developed and reported in the literature illustrates how the model can be used to predict future attendance and traffic volumes to recreational areas at multipurpose reservoirs (2). During the initial work, insufficient data were collected at Monroe Reservoir (which was then in the process of being developed) to be incorporated in the prediction model.

The rapid growth of recreational travel that is expected in the next decade requires that all demand models be under continual surveillance. The scope of this work was to check the stability of the previous model.

The recreation facilities at each of the reservoirs are similar in type; however, the amount of facilities varies among the 3 reservoirs. For example, Cagles Mill and Mansfield each have 1 beach several hundred feet in length; Monroe has 3 beaches (one of which is operated by the U. S. Forest Service). Boat-launching ramps are provided at various locations around each reservoir: 5 at Mansfield, 2 at Cagles Mill, and 9 at Monroe. Within the main recreational areas at each reservoir are located the campgrounds, beaches, concession stands, boat rentals, picnic areas, hiking trails, and bathhouses. In general, each park is well kept by personnel who know and take pride in their work.

Proper utilization of these facilities requires an adequate highway system, ranging from local access roads to state highways. The main objective of this research was to provide a simplified method for estimating future traffic volumes for new facilities of this type.

PROCEDURE

Data collection for this continuing study was carried out between June 1967 and August 1969 at each of the 3 parks. The primary source of data was a 25 percent interview survey of vehicular trips arriving at the parks. The 25 percent sample was chosen because it was considered adequate for analytical purposes and it did not create delays to arriving visitors. During the 3-year period, interviews were performed at the following locations within each park:

Park	Location
Mansfield	Main gate; dam and Hollandsburg boat ramps
Cagles Mill	Main gate; Cunot dock boat ramp
Monroe	Paynetown, Fairfax, and Hardin Ridge gatehouses; Cutright, Dam, and Moores Creek boat ramps

In the interviews, the driver was asked from which county the trip had originated and the purpose of the trip, the interviewer recorded the license number (the prefix of which, on Indiana passenger cars, is a code number relating to the county in which the car was licensed); the number of adults and children (persons under 12 years of age); equipment carried such as a boat, house trailer, or camping trailer; and time of day, date, park, and location (main gate or boat ramp). The number of adults and children was of greater importance prior to 1967 because the fee charged was dependent on the number of adults in each car. However, in 1967 the state introduced a fixed rate for each vehicle; and in 1968, an optional season pass was available.

All the interviews in 1967, 1968, and 1969 were conducted during weekends from Friday afternoon to Sunday afternoon during the months of June, July, and August. Weekends were assigned at random. In 1967, each park was visited on 3 weekends.

In 1968, Mansfield and Cagles Mill were each visited on 3 weekends, and Monroe was visited on 4 weekends. In 1969, each park was visited on 4 weekends.

The general procedure adopted in 1965 and 1966 was maintained during 1967, 1968, and 1969. Interviewing took place on Fridays from 2 p.m until 9 p.m., Saturdays from 9 a.m. until 8 p.m., and Sundays from 9 a.m. until 5 p.m. These hours were selected on the basis of a pilot study made at Mansfield in 1965. After about 9 p.m. on Fridays and before 9 a. m. on any day of the week, few arrivals were noted. The parks were open 24 hours a day throughout 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 for about 75 percent on Fridays.

During the 3-year period (1967 through 1969), 11,800 samples were collected by the interviewers and, of this number, 11,400 were usable. The data obtained from the interviews were coded for the summation program that was used primarily to determine the number of annual trips to each park from each county in Indiana and Illinois and from other states.

It was not an unusual occurrence for a visitor to report multiple purposes when asked the reason for visiting a particular reservoir. It is probable that most trips to a reservoir are made with more than one purpose in mind. However, in this study, only the purposes reported were recorded because these were considered to be the purposes that inspired the trip. Also, no effect was made to determine whether, in fact, the stated purposes were actually accomplished. The trip purposes considered were boating, camping, fishing, picnicking, hiking, swimming, looking, and other.

It was apparent, once county trip totals were determined, that more than 90 percent of all trips originated from within 125 miles of a reservoir. Thus, for the purpose of this analysis, no counties beyond 125 miles of each reservoir were considered. The observed trips per county beyond this range were so sparse as to be insignificant. To standardize the trip rate from any particular county required a unit of measure. The previous model used trips per 1,000 population; this was adhered to in this phase. The official attendance (vehicles) for each year at Mansfield and Cagles Mill was obtained from attendance records maintained by the Department of Natural Resources; Monroe attendance figures were obtained from the park superintendent at Monroe Reservoir and the U. S. Forest Service.

The official total attendance figure for each reservoir was divided by the appropriate total attendance expansion factor, which is the ratio of samples interviewed at boat ramps to samples interviewed at main entrances (Table 1). In the case of Monroe, the expansion factors were applied only to the official attendance figures of the State Recreaction Area; the attendance at Hardin Ridge (U. S. Forest Service) Recreation Area was included later. The estimated total attendance (vehicles) at each reservoir for each year is given in Table 1.

The observed trips from a county were divided by the appropriate county trip expansion factor, which is the proportion of the estimated total park trips that were sampled in a year. County trip expansion factors are given in Table 1.

The Indiana county population estimates for 1967, 1968, and 1969 were linear interpolations of projections developed by the Indiana University, Graduate School of Business (3). The Illinois county population estimates were linear projections of 1960 census data and U. S. Bureau of Census estimates for 1966 (4). The distance figures were developed from the center of each county to the center of each reservoir. Road miles of the primary highway system were measured.

It became apparent, when Illinois and Indiana county trip rates were compared for equivalent distances from a reservoir, that Illinois county trip rates were significantly lower. It was necessary that a state-line penalty equal to 30 miles be added to all Illinois counties. This has the effect of including in the analysis only those Illinois counties within 95 miles of a reservoir.

ANALYSIS

Model Development

For each reservoir, a plot of the county trip rates (calculated from 1967, 1968, and 1969 data) versus distance from the reservoir indicated an exponential relation. This

supported Matthias' choice of an exponential model to describe the 1965 and 1966 data. It should be added that this result was not entirely unexpected because previous research (5) showed an exponential relation between trip length and distance.

The form of the function used by Matthias and subsequently in this research is

$$Y = A\, e^{-BX}$$

where

Y = annual trips/1,000 population from a county to a reservoir;
A = Y intercept of nonlinear regression curve;
B = rate of change of nonlinear regression curve; and
X = distance from a county to a reservoir, in tens of miles.

There are 2 approaches by which parameters A and B in the equation may be estimated. First, it is possible to use the method of least squares after the function is transformed into

$$\ln Y = \ln A - BX$$

Second, a nonlinear regression analysis that estimates the parameters in an iterative manner may be applied. The first approach assumes that the errors in the transformed function are additive, which necessitates that the errors in the original be multiplicative (an assumption that has no physical basis). The second approach assumes that additive errors are in the original function and, because errors of an additive nature are more probable, this method was adopted. (An added benefit from the use of the second approach was only apparent later; this was when certain distant counties were found to have 0 trip rates. A logarithmic transformation would not have been able to deal with this situation.)

The nonlinear regression analysis utilized was NONLIN, a revised version of SHARE 3094 (6); this was described in some detail by Matthias (1). Basically the program finds the estimates of parameters A and B in the function $Y = A\, e^{-BX} + \epsilon$ by minimizing

$$\sum \epsilon^2 = \sum (Y - \hat{Y})^2$$

where ϵ is the residual error, and $\hat{Y}$ is the estimate of Y. It is an iterative technique that requires an initial estimate of the parameters A and B.

The previous model was made up of 2 regression equations. One equation was to be used for counties that are closest to the specified reservoir, and the other for counties that are closer to one or more other reservoirs than to the specified reservoir. The decision was made to arrange the data into 9 subgroups. Six subgroups were for a combination of Cagles Mill and Mansfield (3 years by closest and intervening categories); and 3 subgroups were for Monroe (3 years by 1 group containing all counties). There are 2 reasons for isolating Monroe data: (a) It is apparent from the total attendance figures that Monroe is still in its initial growth period (in contrast to Cagles Mill and Mansfield, which are older reservoirs), and (b) Monroe is a much larger reservoir than either of the other two (10,750 acres compared to Cagles Mill's 1,400 and Mansfield's 2,100), and is, in a sense, unique because it will remain the largest single body of water in the state for many years. The second reason is essentially the reason for the closest and intervening county groups being combined for Monroe. It is felt that Monroe is such a large trip attractor that intervening opportunities are not really applicable. Most of the reservoirs planned by the state are more nearly the size of Cagles Mill and Mansfield; therefore, for predictive purposes, a model based on data from these 2 reservoirs should be more reliable than one that either includes Monroe data or is based on Monroe data alone.

Monroe Model—The idea underlying the following analysis is that, if it can be shown that the parameter B_i (for i = 1 to 3) does not vary significantly among the 3 years, it might be possible to derive a prediction equation (with a pooled estimate of parameter B) by extrapolating the parameter A to the design year.

The first step in the analysis was to test for homogeneity of variances of the trip-rate data during the 3-year period. This assumes that the regression equations were reasonable predictors to the data (which they were). Under these conditions, testing from homogeneity of variances in the data is approximately equivalent to testing for homogeneity of the error estimates of the regression equations. Homogeneity of the error estimates of the regression equations is necessary in order to test the significance of B_i.

Two tests were applied to the data: (a) Bartlett's test (7), in which a chi-square statistic is computed (assuming that there are normal populations), and (b) Foster-Burr's test (8), in which a Q-statistic is computed that is a monotone function of the coefficient of variation of the sample variances. The fact that the populations are not normal reduces the inferences possible from Bartlett's test; however, less research has been directed toward non-normal populations than to normal populations, so the test was applied bearing the limitations in mind.

Both Bartlett's test and Foster-Burr's test produced highly significant statistics for the raw data, Y, and transformed data, ln(Y + constant), and this led to the rejection of the hypothesis of equal population variances (the constant was added to enable the logarithmic transformation to be made). On the basis of this result, it was decided to delete from the data those counties having trip rates of less than 1.0. It was hoped that homogeneous variances would result from this action. This reduced the sample sizes from 64 for each year to 52, 46, 51 for 1967, 1968, 1969 respectively. The nonlinear regression program was rerun with the smaller data sets, and the parameters produced are given in Table 2. Most of the parameters have been only slightly reduced by excluding trip rates less than 1.0.

Bartlett's test and Foster-Burr's test were applied to these data; the chi-square statistic from Bartlett's test was 0.393, and the Q-statistic from Foster-Burr's test was 0.335, both of which are insignificant at an α-level of 0.01. In this case the hypothesis of homogeneity of variances cannot be rejected.

It was then possible to test the hypothesis that the parameters B_i are equal. The procedure, explaned by Ostle (9), is to first test the hypothesis that all the observations can be described by 1 regression equation. If the F-statistic computed is significant (leading to the rejection of the hypothesis), the hypothesis of equal parameters B_i can be tested by another F-test. F-values of 8.63 and 0.496 respectively were obtained from the 2 tests; thus, the hypothesis that all the observations can be described by 1 regression equation is rejected at an α-level of 0.25.

The pooled estimate of parameter B for inclusion in the equation for each year was established when the nonlinear regression program was run for 1967, 1968, and 1969 data combined. The value of B was calculated to be 0.558. As a last step, the nonlinear regression program was rerun for each year, a regression line with parameter B = 0.558 was forced through the data, and parameter A was obtained in the equation

$$Y - A\,e^{-0.558X}$$

The 3 equations that resulted were as follows:

$$Y = 217\,e^{-0.558X} \text{ for } 1967$$

$$Y = 355\,e^{-0.558X} \text{ for } 1968$$

$$Y = 634\,e^{-0.558X} \text{ for } 1969$$

Figure 2 shows how parameter A varies from 1967 to 1969. The sharp increase that has occurred is a combination of the growth of Monroe in terms of facilities, reputation, and popularity and an increase in recreational trip-making in general. The former is by far the largest component of the growth.

From the explanation given above, an extrapolation of the present trend of parameter A (line A) is likely to overestimate the design-year parameter A. What is more likely to happen is a leveling off as indicated by lines B, C, and D. Unless there is knowledge of other factors, however, there is no basis for choosing any one line over the others. It was, therefore, decided to use the value of parameter A as obtained from the 1969 data and to acknowledge that it is a conservative estimator of the total annual trips to Monroe in some future year.

Figure 1. Major reservoirs in Indiana.

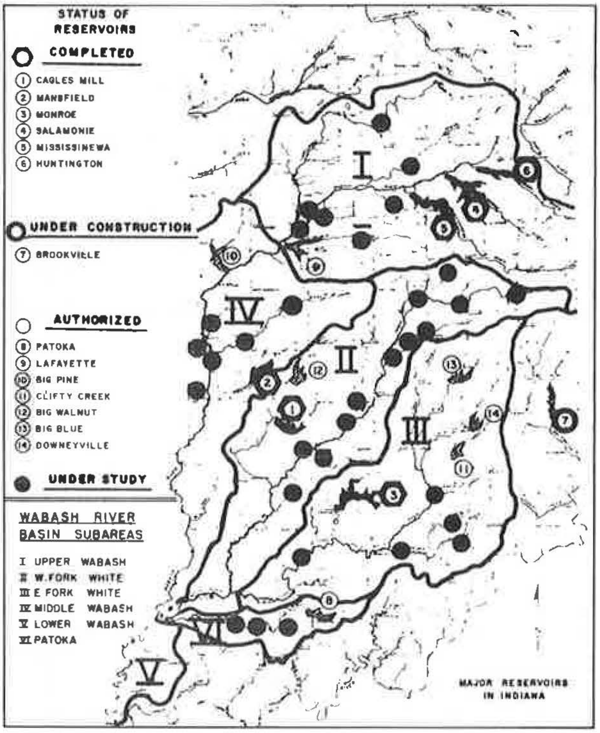


Figure 2. Changes in parameter A in Monroe model from 1967 to 1975.

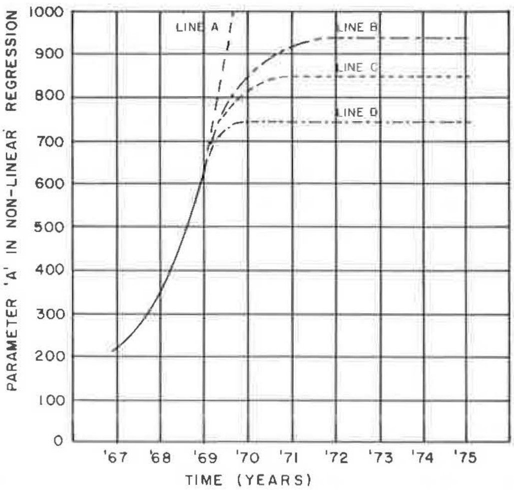


Table 1. Attendance and trip expansion factors.

Facility	Year	Total Attendance Expansion Factor	Estimated Total Attendance	County Trip Expansion Factors
Cagles Mill	1967	0.814	42,713	0.015
	1968	0.781	50,570	0.012
	1969	0.760	43,149	0.022
Mansfield	1967	0.739	60,486	0.018
	1968	0.808	63,592	0.014
	1969	0.855	41,477	0.030
Monroe	1967	0.915	39,269	0.051
	1968	0.897	77,758	0.012
	1969	0.870	108,646	0.013

Table 2. Nonlinear regression parameters.

Trip Rates <1.0	Year	Monroe		Closest		Intervening	
		A	B	A	B	A	B
Included	1967	228	0.606	517	0.571	387	0.715
	1968	342	0.530	554	0.736	105	0.354
	1969	656	0.588	363	0.523	202	0.548
Excluded	1967	222	0.576	516	0.570	243	0.453
	1968	340	0.525	520	0.638	107	0.305
	1969	648	0.575	362	0.521	127	0.511

The choice of a 1969 equation as the prediction equation was not based on the fact that no significant differences were found between the B_1 parameters. The equation adopted as the Monroe model,

$$Y = 634\ e^{-0.558X}$$

however, does include a contribution from the data of each year (the pooled estimate of B), and so the previous analysis has not been ignored. The Monroe model is shown in Figure 3.

New Reservoirs Model—The new reservoirs model is to consist of 2 equations (one from each of the closest and intervening groups of equations) that are considered to be the best for prediction purposes.

Exactly the same procedure that was employed in the development of the Monroe model was employed to develop the equations for the new reservoirs model. The parameters of the 3 equations for the initial run of the nonlinear regression program are given in Table 2. Once again, the variances of each year's data were not homogeneous until counties with trip rates of less than 1.0 were excluded from the analysis. The program was rerun, and the parameters of the 3 new equations obtained are also given in Table 2. The results from Bartlett's test and Foster-Burr's test for those data were such that the hypothesis of equal variances could not be rejected.

The hypothesis of equal B_1 parameters for each year for closest and intervening was tested next, and in both cases it was found that the hypothesis could not be rejected. The data for each year were combined within closest and intervening, and the nonlinear regression program was rerun to find a pooled estimate of parameter B for each group. The pooled estimates of B were 0.573 and 0.407 for closest and intervening respectively. The result of forcing these B values through the data for each year is the following equations for closest:

$$Y = 520\ e^{-0.573X} \text{ for 1967}$$

$$Y = 465\ e^{-0.573X} \text{ for 1968}$$

$$Y = 398\ e^{-0.573X} \text{ for 1969}$$

and for intervening:

$$Y = 212\ e^{-0.407X} \text{ for 1967}$$

$$Y = 151\ e^{-0.407X} \text{ for 1968}$$

$$Y = 136\ e^{-0.407X} \text{ for 1969}$$

It is immediately apparent that parameter A is decreasing in both cases (while in the case of Monroe, parameter A was increasing yearly). To understand why this is the case requires that the location of Mansfield and Cagles Mill with respect to Monroe be considered. All 3 reservoirs are within 60 miles of each other; because of this, it would be naive to think that the attendance at Mansfield and Cagles Mill should remain unaffected during the growth period of Monroe. It is considered likely that this downward trend in parameter A is no more than a transient response to the appearance of Monroe and that it will not continue for more than a few years. For this reason and for the reason that the future recreational reservoirs (for which the new reservoirs model is intended) will not be close to such a large facility as Monroe, it was decided to use the equations that were developed from 1967 data for closest and intervening.

The actual equations adopted to constitute the new reservoirs model are

$$Y = 520\ e^{-0.573X} \text{ for closest}$$

$$Y = 212\ e^{-0.407X} \text{ for intervening}$$

Both equations, which are shown in Figures 4 and 5 respectively, use the pooled estimate of parameter B.

Trip-Making Characteristics

Total Annual Trips—It is not enough for the planner to know how many trips (as predicted by the new reservoirs model) will be made to a particular reservoir in any year. The additional information that he requires is the distribution of those trips during the year, the week, and the day so that he can provide for adequate park facilities, seasonal hiring of park staff, and easy and adequate access. Because the planner is interested in the maximum volumes, it is in terms of these that the following analysis is performed.

Approximately 95 percent of all trips to a reservoir are made between the beginning of April and the end of September. This is based on the earlier study, for no out-of-season interviews were performed during this phase. The maximum volume week was determined for each reservoir for each year from official attendance figures, and the average ratio of maximum volume week to total annual trips was calculated to be approximately 10 percent.

In the earlier work, it was found that, on the average, 25 percent of all weekly trips arrived at the reservoir during the period from Monday through Friday morning, assuming that weather conditions were similar. This means that, on the maximum volume weekend, 75 percent of the 10 percent of the total annual trips to the reservoir can be expected, which amounts to 7.5 percent.

Approximately 50 percent of all weekend trips arrived on Sunday. It is, therefore, concluded that on the maximum volume weekend the reservoir attendance will amount to 7.5 percent of the total annual trips and that the highest daily volume (3.75 percent of the total annual trips) will occur on Sunday.

Trip Distribution—A further breakdown may be made on the basis of hourly arrivals that were recorded for each reservoir in the initial phase. It can be seen that, on the average, 62 percent of all Sunday arrivals come in the 4-hour period between 11 a.m. and 3 p.m. This information can be used to calculate the capacity required on reservoir access roads.

Besides the vehicular trips that can be expected on the maximum volume weekend, it is of importance to know how many people are associated with those trips. During this study, it was found that the average number of persons per trip was 3.75 and the average number of children per trip was 1.02.

Figure 6 shows that 90 percent of the sample trips originated within the 125-mile radius adopted for this analysis. This median distance traveled is 52 miles, and the associated travel time is 62 minutes.

RESULTS

The primary objective of this phase was to evaluate the growth trends of recreational usage of multipurpose reservoirs with reference to the model developed earlier. The choice of an exponential model, $Y = A e^{-BX}$, to relate trip rates and distances in the earlier phase was substantiated by the data collected during this study. Three equations of the same form were developed. Of these, 2 equations (developed from data collected at Mansfield and Cagles Mill reservoirs) constituted the new reservoirs model. The third equation (the Monroe model) is to be used to predict annual trips to Monroe reservoir only.

The 2 equations developed in the initial phase for the closest and intervening categories were $Y = 338 e^{-0.479x}$ and $Y = 129 e^{-0.488}$ respectively. Comparing the equations from both phases shows that, although an increase in the value of parameter A (by factors of 1.54 and 1.64 for the closest and intervening categories respectively) has occurred over time, there has been little change in the value of parameter B (almost none in the case of the closest counties). This is an important result, for it implies that a growth in the trip rates (which was being investigated in this phase) is best measured by changes in the value of parameter A. Furthermore, if continued study indicates even higher trip rates, only the parameter A in each of the 2 equations need be adjusted. It is not known by how much or in what manner parameter A of the 2 equations is likely to change during a period of 1 or 2 decades. The data collected in this recreational study rendered any prediction of the future behavior of parameter A unwise; only the fact that A did increase over time was observed.

Figure 3. Annual trips to Monroe.

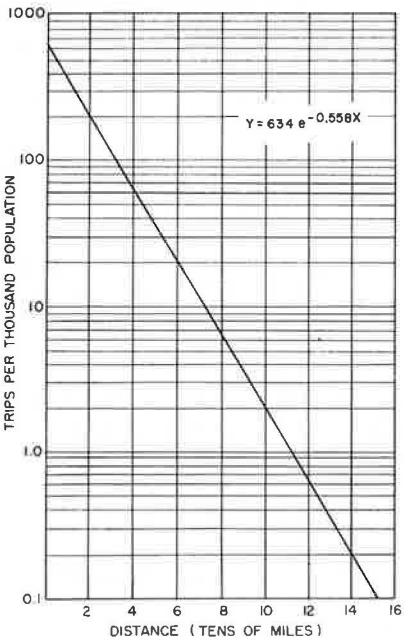


Figure 4. Annual trips to closest park.

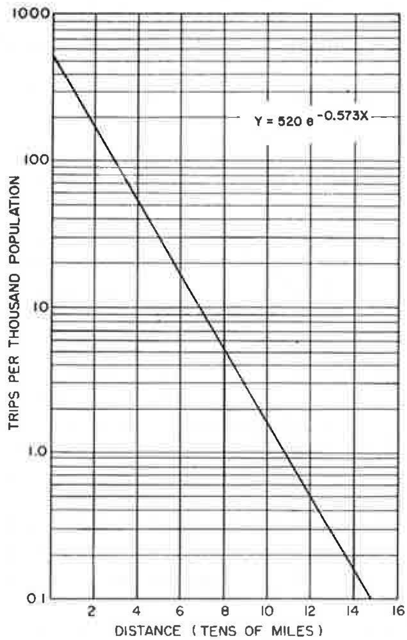


Figure 5. Annual trips to intervening park.

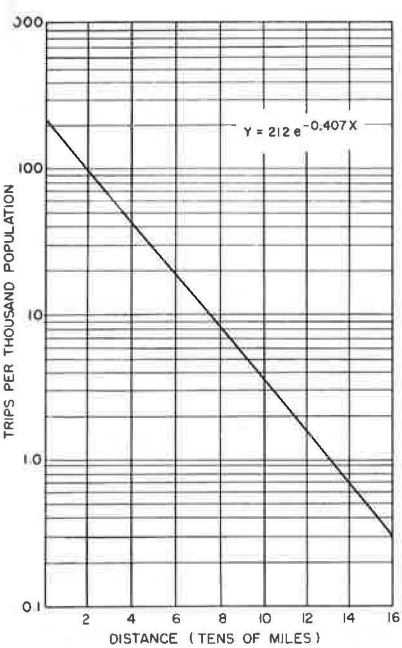
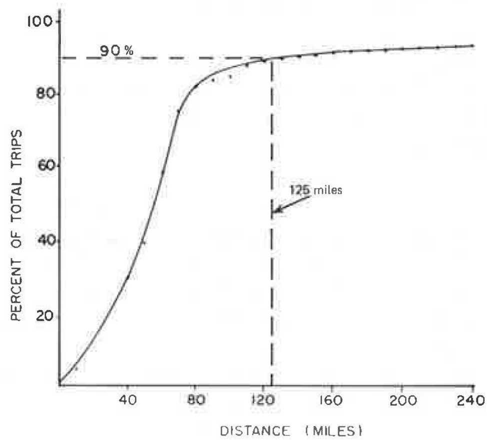


Figure 6. Cumulative distribution of trips.



The single equation that constitutes the Monroe model is $Y = 634\ e^{-0.558x}$. There is no way of comparing this equation with those of the new reservoirs model because in its development all counties within 125 miles of Monroe were used in the same category. No Monroe data were used in the initial phase, so there is no way to make a comparison between the 2 phases of the study. This equation is a conservative estimator for the total annual trips to Monroe because Monroe can still be considered to be in its initial growth period.

It is concluded that the new reservoirs model, which is based on easily understood and readily obtainable variables (distance, population, and influence of similar facilities), is able to predict future attendance at new reservoirs with reasonable accuracy. In contrast to other previously developed models, which require many socioeconomic and park characteristics variables (often difficult to measure and evaluate and extremely difficult to project), the new reservoirs model is probably as accurate and much simpler to use. The new reservoirs model is adequate for advanced-planning purposes and can be used to predict reservoir attendance and traffic volume estimates.

The objectives of this study were to check the previously developed models for stability over time and to present a simplified procedure that could be easily implemented by the highway department. One can conclude that models of this type must be under constant surveillance, for the demand function is obviously changing. The simplified prediction procedure can be summarized in the following manner:

1. Determine the location of the reservoir;
2. Locate other similar recreational facilities;
3. Determine the road distance (miles) to the reservoir from counties within 125 miles;
4. Obtain county population predictions for the design year;
5. Determine which of the counties are closer to the reservoir under study than to any other similar facility;
6. Determine the trip rates for each county closest to the reservoir (Fig. 4);
7. Determine the trip rates for the remaining counties (Fig. 5);
8. Calculate for each county the total annual trips by multiplying the trip rate by the population prediction; and
9. Sum the total annual trips for all counties, and divide by 0.9 to account for trips originating farther than 125 miles away and to obtain the estimated total trips for the design year.

REFERENCES

1. Matthias, J. S. Recreational Impact of Multi-Purpose Reservoirs. Joint Highway Research Project, Purdue Univ., Aug. 1967.
2. Matthias, J. S., and Grecco, W. L. Simplified Procedure for Estimating Recreational Travel to Multi-Purpose Reservoirs. Highway Research Record 250, 1968, pp. 54-69.
3. Indiana Population Projections: 1965-1986. Graduate School of Business, Indiana Univ., Res. Rept. 3, Sept. 1966.
4. U. S. Bureau of the Census. Estimates of the Population of Counties and Metropolitan Areas, July 1, 1966: A Summary Report. U. S. Govt. Printing Office, Washington, D. C., Current Population Repts., Series P-25, No. 427, 1969.
5. Data Projections. Chicago Area Transportation Study, Final Rept., Vol. 2, July 1960.
6. Marquardt, D. W. Least Squares Estimation of Non-Linear Parameters, A Computer Program in FORTRAN IV Language. IBM, Share Library Distribution 3094, March 1964.
7. Bartlett, M. S. Some Examples of Statistical Methods of Research in Agriculture and Applied Biology. Jour. the Royal Statistical Soc. (suppl.), Vol. 4, No. 137, 1937.
8. Foster, L. A. Testing for Equality of Variances. Purdue Univ., PhD thesis, 1964.
9. Ostle, B. The Problem of Several Samples of Groups. In Statistics in Research, Iowa State Univ. Press, 1963, Section 8.26.