Some Characteristics of Weekend Travel to Indiana State Parks

Lawrence L. Schulman
Graduate Assistant
and William L. Grecco
Research Engineer
Joint Highway Research Project
Purdue University

This study was concerned with the determination of a single exponent gravity model for the prediction of weekend recreational trips. However, before any work could be done with a model of this type the expression had to be clearly and precisely defined for the specific type of trip. It was, therefore, the ultimate purpose of the study to define for a recreational trip the areas of origin and destination and the variables to represent the parameters of the model, then to determine the required constants. The model having been determined, a statistical analysis was made on the comparison of observed and calculated trips to check the ability of the model to predict weekend recreational travel.

The gravity model used in this work returns to the basic statement of the Newtonian gravitational concept and may be written:

\[ T_{ij} = K \frac{T_i \cdot T_j}{(D_{ij})^x} \]

where:

- \( T_{ij} \) = the number of automobile trips from residential area \( j \) to recreational area \( i \)
- \( T_i \) = the total number of automobile trips attracted to recreational area \( i \)
- \( T_j \) = a measure of the relative ability of residential area \( j \) to generate automobile recreational trips
- \( D_{ij} \) = the road distance between residential area \( j \) and recreational area \( i \)
- \( x \) = an exponent which is determined for the type of recreational trip of concern
- \( K \) = a computational constant

Use of the model in this form shows that the model tends to either over- or under-estimate the total number of trips attracted to the park.
and must be corrected by multiplication of the number of trips attracted from each county by a correction factor

\[ C.F. = \frac{n}{\sum_{j=1}^{n} T_{ij}} \]

where:

- \( n \) is the total number of trips attracted to recreational area \( i \) from all of the individual residential areas \( j \)
- \( n \) is the number of residential areas \( j \)

However, the need for using this correction factor can be eliminated and the computations simplified if the model is redefined. The resulting form is:

\[ T_{ij} = \frac{R_j}{(D_{ij})^x} \]

where

- \( R_j \) is some measure of the ability of county \( j \) to generate recreational trips

By definition, a trip of any specified length must represent a spatial movement between two areas—one serving as the origin and the other as the destination of the trip. Therefore, the initial decision in this study was to choose an area of origin and an area of destination for the recreational trip. There are many different types of recreational trips made every week, each with varying destinations; in general, however, the recreational trip will begin at the home. For ease of data collection, the origin of the recreational trips was defined as the county.

Since there had been little previous work done in this area, the choice of destination for the recreational trip was unrestricted. The choice of state parks was based on the availability and ease of data collection and the importance of this type of recreational trip in the immediate and long-range future. It is also felt that the model defined for this type of trip will be applicable to trips terminating at a recreational area constructed in conjunction with water resource projects. This area provides one of the greatest potentials for recreational development. At present there are 20 state parks in the Indiana system which are located as shown in Figure 1.

In this study a field survey was made on five of the 20 parks. These were Brown County, Mounds, Shades, Tippecanoe River and Turkey
Run. The information required was the total number of trips from each county represented at the park. It was, therefore, necessary to determine the origin of each trip being made to the park during the study period. Since only the "county" of origin was desired, it was decided that a license plate study would be best, and because the Indiana license plates are prefixed by the county number, the data collection was made with little disturbance to the flow of traffic. Observations were made at each
gatehouse while the admission fees were being collected. The trips were recorded by county of origin and also by hour of arrival.

The data were collected for five consecutive weekends starting Friday, July 12, 1963, and ending Sunday, August 11, 1963. This time of the year was chosen since it was assumed that, in general, peak weekend recreation travel would occur during the summer months. The observations were not continuous, but were made between the hours of 4-9 p.m. on Fridays, 8 a.m.-8 p.m. on Saturdays and 8 a.m.-6 p.m. on Sundays. These hours were assumed to include most of the weekend travel.

The individual trips from county to park were tallied by weekend. These figures represented the total number of recreational trips for each county to each of the five parks for each of the five weekends observed, or variable $T_{ij}$.

The summation of all the $T_{ij}$'s for a specific weekend and specific park results in the total trips to that park for a weekend or variable $T_i$. This approximation is reasonable since most of the trips will arrive during the selected time periods.

The next quantity to be determined was some estimate of the number of recreational trips which could be generated by a county. To date no satisfactory research had been done in this area, but some study had been done in the area of the social-recreational trips. It was decided to use the number of dwelling units in the county as a measure of recreational travel, for it has been shown that on the average there is approximately one social-recreational trip per dwelling unit per day.

The last quantity to be determined was $D_{ij}$, which is the road-distance between the county and the park. It has been a recent practice to replace distance with travel time; however, in this study replacement was not deemed necessary. In most cases where this transformation has been made the trips were internal or interzonal within an urban area; however, most recreational trips, especially those to a state park, are external trips. In contrast to an internal trip, the study of external trips concerns travel on rural roads which for the most part will allow a "free flowing" movement. Therefore, the nature of the rural trip is such that, on the average, the total travel time for all trips of a given length will be the same, so the use of total travel time would provide no additional accuracy in the study.

Since the county was defined as the origin, it was assumed that the center of population for this area would be the county seat. Observations show that generally the county seat actually is located in the geographic center of the county. The road distances were established by
a series of links connecting each county seat. The total distance between each county $j$ and the park $i$ was the summation of those links which resulted in the shortest trip. Figure 2 shows the series distance links
determined for Indiana. Similar grids were developed for Michigan, Wisconsin, Illinois, Missouri, Tennessee, Kentucky and Ohio.

The model constants were computed from the collected data. In order to compute these values a Fortran IV program was written for the IBM 7090. In essence, the program simulated the following mathematical procedures. The basic gravity model as previously stated can be rewritten in the form

\[ K \cdot D_{ij} = \frac{T_i}{T_{ij}} = C_{ij} \]

where \( d_{ij} \) is an observable variable, \( C_{ij} \) is a calculated variable and \( K \) and \( x \) are unknown constants to be determined. For every observation of \( D_{ij} \) there is a corresponding value for \( C_{ij} \). When the log of both sides of the equation is taken, the resultant form is

\[ \log C_{ij} = \log K + x \log D_{ij} \]

which is similar to the general equation for a straight line \( y = A + BZ \), where \( y \) is equal to \( \log C_{ij} \), \( Z \) is equal to \( \log D_{ij} \), the y-intercept is equal to \( \log K \), and the slope of the line is equal to \( x \). Theoretically then, a plot of the values of \( \log C_{ij} \) and \( \log D_{ij} \) should approximate a straight line with the aforementioned characteristics and the slope and y-intercept of the theoretical line can be determined by performing a simple linear regression analysis. Returning to the gravity model, the value \( x \) is numerically equal to the slope of the plotted log values and \( K \) is equal to the antilog of the y-intercept of the plotted log values.

Based on the previous definitions and calculation procedures, the model can be stated in its final computational form as:

\[ T_{ij} = \frac{T_i}{\sum_{j=1}^{n} \frac{R_j}{D_{ij}}} 1.64 \]

The model, having been defined, is used in the following manner. Assume we have the system shown in Figure 3. We have a proposed recreational area A and wish to determine the number of recreational trips which the proposed area will attract from residential areas 1, 2 and 3. We know Area 1 which is 100 miles away can generate a total of 2,000 recreational trips, Area 2 which is 150 miles away can generate 4,000 trips, Area 3 which is 50 miles away can generate 4,000 trips. We also know that the proposed area has the ability of attracting a total of 1,000 trips from the surrounding areas. By proper usage of the gravity model we can determine that 122 trips will originate from
Area 1, 128 trips will originate from Area 2 and 750 trips will originate from Area 3.

The previous sections have dealt with the determination of the constant terms in the gravity model. As pointed out, these constants were determined on the basis of field observation of the total number of trips to the park. This procedure was valid for determining the constants, but for prediction purposes this procedure would be impossible since the proposed area would not be in existence at this stage and no observations could be made. Therefore, it was necessary to (1) develop a method of prediction of the total trips that will be attracted to a proposed recreational area, and (2) determine that area over which the trips should be distributed.

For the first it was decided to evolve a multiple regression model based on the characteristics of the area proposed. This decision was based on the feeling that the total number of trips attracted to a recreational area will be some function of its size, facilities, activities and adjacent populations.

The model was based upon data from the 20 state parks, beaches and recreational areas in the Indiana State Park System. The variables, 48 variables, the analysis was performed by computer. The format used by the Indiana Department of Conservation, Division of State Parks. These variables were compared with the total weekend trips to each of the corresponding parks. The sampling period was a 13-week span.
beginning with the weekend of June 2, 1963, and ending with the weekend of August 25, 1963.

Because of the magnitude of a multiple regression analysis using 48 variables, the analysis was performed by computer. The format used required that the variables be read into the computer in order of their importance. A first-order correlation between the dependent variable and each of the independent variables was determined. On the basis of this correlation the variables were ordered and put into the computer. The analysis resulted in the following 10-term equation of prediction

$$y = 90.36 + 0.61 X_1 - 0.58 X_2 + 3.60 X_3 + 0.22 X_4 - 0.65 X_5 - 0.26 X_6 - 0.73 X_7 - 43.00 X_8 + 21.77 X_9 + 0.11 X_{10}$$

where:

- $y$ = total weekend trips to a park
- $X_1$ = number of picnic tables
- $X_2$ = number of campsites
- $X_3$ = area of the lake (in hundreds of acres)
- $X_4$ = acres of the park extensively developed
- $X_5$ = availability of a bath house on premises
- $X_6$ = capacity of total living facilities (in guest nights)
- $X_7$ = availability of fishing
- $X_8$ = location on a river
- $X_9$ = availability of electricity
- $X_{10}$ = population within 60 miles of park (in thousands)

The regression model had a coefficient of correlation ($r$) of .926, and a standard deviation of 30.9 trips.

Since the function of the gravity model is to distribute the predicted number of attracted recreational trips from the park to their counties of origin, the sphere of influence of the park, or the distance from which a recreational facility has the ability to attract trips, must be determined. Having this distance, the predicted recreational trips can be distributed among all the counties within the specified distance. For this purpose several curves were developed, based on the data collected at the five parks during the field study. For each park, all the counties represented were arranged numerically by increasing distance from the park and the cumulative percentage at each distance determined. Figure 4 shows the relation between the cumulative percentage of total trips and the distance within which these trips occurred.

Since we realized that a small percentage of arrivals at state parks
come from an impulse stop of a through driver, or a visitor on a social trip to a nearby friend or relative, it was deemed sufficient to account for only 90 percent of the total trips. The curve indicates that, on the average, 90 percent of the total trips will occur from within 148 miles of the park and this is the figure recommended for use.

In the way of further analysis of the characteristics of recreational travel, two studies were performed to determine the distribution of arrivals at state parks. The first study, based on all 20 areas, indicated that between 65-68 percent of the total recreational trips that are made during a week occur on the weekend. The second study, based on the five state parks sampled, was made to determine the peak hour of arrival on the weekend. The resulting curve is presented in Figure 5.

This study indicates that the peak hour of arrival on Friday evening is between 7-8 p.m., during which nearly 2 percent of the total weekend trips arrive, and that the peak hour of arrival on Sunday is between noon-1 p.m., during which nearly 10 percent of the total weekend trips arrive. On Saturday there does not seem to be one peak hour, but an almost constant arrival rate between the hours of 10 a.m. and 3 p.m. with a slight decrease at 1 o’clock. During this period 10 percent of the total weekend trips arrive. It is also interesting to note the pre-
Fig. 5. Percentage of total arrivals to all state parks distributed by time of day.

dominance of Sunday arrivals. Nearly 70 percent of the weekend arrivals occur on Sunday.