NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM REPORT **44**

TRAFFIC ATTRACTION OF RURAL OUTDOOR RECREATIONAL AREAS

HIGHWAY RESEARCH BOARD
NATIONAL RESEARCH COUNCIL
NATIONAL ACADEMY OF SCIENCES—NATIONAL ACADEMY OF ENGINEERING

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TRAFFIC ATTRACTION OF RURAL OUTDOOR RECREATIONAL AREAS

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SUBJECT CLASSIFICATION:
- TRANSPORTATION ADMINISTRATION
- TRAFFIC CONTROL AND OPERATIONS
- TRAFFIC MEASUREMENTS

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NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM

Systematic, well-designed research provides the most effective approach to the solution of many problems facing highway administrators and engineers. Often, highway problems are of local interest and can best be studied by highway departments individually or in cooperation with their state universities and others. However, the accelerating growth of highway transportation develops increasingly complex problems of wide interest to highway authorities. These problems are best studied through a coordinated program of cooperative research.

In recognition of these needs, the highway administrators of the American Association of State Highway Officials initiated in 1962 an objective national highway research program employing modern scientific techniques. This program is supported on a continuing basis by funds from participating member states of the Association and it receives the full cooperation and support of the Bureau of Public Roads, United States Department of Transportation.

The Highway Research Board of the National Academy of Sciences-National Research Council was requested by the Association to administer the research program because of the Board's recognized objectivity and understanding of modern research practices. The Board is uniquely suited for this purpose as: it maintains an extensive committee structure from which authorities on any highway transportation subject may be drawn; it possesses avenues of communications and cooperation with federal, state, and local governmental agencies, universities, and industry; its relationship to its parent organization, the National Academy of Sciences, a private, nonprofit institution, is an insurance of objectivity; it maintains a full-time research correlation staff of specialists in highway transportation matters to bring the findings of research directly to those who are in a position to use them.

The program is developed on the basis of research needs identified by chief administrators of the highway departments and by committees of AASHO. Each year, specific areas of research needs to be included in the program are proposed to the Academy and the Board by the American Association of State Highway Officials. Research projects to fulfill these needs are defined by the Board, and qualified research agencies are selected from those that have submitted proposals. Administration and surveillance of research contracts are responsibilities of the Academy and its Highway Research Board.

The needs for highway research are many, and the National Cooperative Highway Research Program can make significant contributions to the solution of highway transportation problems of mutual concern to many responsible groups. The program, however, is intended to complement rather than to substitute for or duplicate other highway research programs.

This report is one of a series of reports issued from a continuing research program conducted under a three-way agreement entered into in June 1962 by and among the National Academy of Sciences-National Research Council, the American Association of State Highway Officials, and the U. S. Bureau of Public Roads. Individual fiscal agreements are executed annually by the Academy-Research Council, the Bureau of Public Roads, and participating state highway departments, members of the American Association of State Highway Officials.

This report was prepared by the contracting research agency. It has been reviewed by the appropriate Advisory Panel for clarity, documentation, and fulfillment of the contract. It has been accepted by the Highway Research Board and published in the interest of an effectual dissemination of findings and their application in the formulation of policies, procedures, and practices in the subject problem area.

The opinions and conclusions expressed or implied in these reports are those of the research agencies that performed the research. They are not necessarily those of the Highway Research Board, the National Academy of Sciences, the Bureau of Public Roads, the American Association of State Highway Officials, nor of the individual states participating in the Program.

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FOREWORD

By Staff

Highway Research Board

This report will be of particular interest to highway planners and traffic engineers concerned with the traffic patterns for rural outdoor recreational areas. The research pertains to the determination of traffic generation and trip distribution for recreational areas such as those created in many places by artificial lakes. The results of this study should enable rational planning of highway access and parking facilities.

New recreational areas often attract large volumes of traffic, which may require new or improved highway facilities. To evaluate the existing system or to plan and design highway improvements to serve a new or expanded rural recreational area, forecasts must be made for the anticipated traffic. The problem is basically to estimate the amount of traffic which a proposed new or expanded old recreational area will attract, and then assign this traffic to the highway system. Such forecasting and traffic assignments would determine the highway and parking needs required for any proposed new recreational development.

The researchers at the Research Institute of the Illinois Institute of Technology have used data collected from 18 Indiana State parks to make their analyses. A non-linear regression model was developed to estimate visitor volume as a function of the recreational characteristics offered by the State parks. The results from this analysis compare favorably with the results from a similar study conducted for reservoir recreational areas in Kansas.

To distribute the trips attracted by the Indiana State parks to the surrounding area, three gravity models were compared. The model producing the best results involved the development of an "activity index" that represents the relative frequency for outdoor recreational activity of the average county resident. This activity index is based on socioeconomic factors for each area.

The variation in traffic volumes is presented by month of year, day of week, and time of day. The ratio of the peak weekend visit volume to the average weekend volume was analyzed for the Indiana State parks as part of the traffic generation study.

The application of a prediction model is discussed in this report. It is believed that this research has developed the prediction technique to a point where it is ready to be applied and tested.

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ACKNOWLEDGMENTS

The project reported herein was begun under the direction of Miss Janis Pettyjohn (now Mrs. Janis Church), Research Engineer, who developed most of the basic background and initial planning for the study, and later acted as advisor on gravity model computations. The author, Andrew Ungar, as Senior Scientist, IIT Research Institute,* became principal investigator for the project in September 1964. Other Institute personnel associated with the project included Ronald C. Trilling, Associate Engineer.

The facilities used were those of the IIT Research Institute, which also had general administrative supervision of the project.

* Currently with Matson Research Corp., San Francisco, Calif.

TRAFFIC ATTRACTION OF RURAL OUTDOOR RECREATIONAL AREAS

SUMMARY

This report describes the research done with respect to the identification of the factors that determine visitor attraction of rural outdoor recreational areas. The factors that were examined included the characteristics and locations of the recreational areas, and demographic and socioeconomic variables. The motivation for the program is the need to develop quantitative analytical tools to aid in the design of access highways and parking areas for planned new facilities.

The research has fallen into five interrelated areas, as follows:

1. Investigation of applicability of trip distribution models. This has consisted principally of the comparison of three gravity models with one another, all using the same travel time factors but different measures of the recreational trip generating potential of demographic units, in this case counties. The measures were:

(a) Number of housing units.

(b) Number of households owning at least one auto.

(c) Measure (b) multiplied by a factor, called a normalized weighted activity index, that indicates the relative frequency of outdoor recreational activities of the average county resident.

These models were tested on a set of origin-destination data, counting visits to four Indiana State parks. All three models reproduced the observed trip distribution acceptably well. Measures of the variability of estimated county trip-ends with respect to observed trip-ends were also satisfactory. The three models showed a progressive trend to improvement, with the third being the best by a slight margin.

2. Application of a weighted activity index to measuring recreational activity. This is the index mentioned in item 1(c). The concept and estimate of the activity index as applied to individuals was introduced by Mueller and Gurin. The estimate utilizes the socioeconomic profile of an individual, involving his membership in some nine socioeconomic categories. The adaptation consisted of computing a weighted index, using the socioeconomic make-up of single and married adult males in a county. This is based on the assumption that almost all automobile trips to a park are headed by an adult male. Judged by its effect on the gravity model, the index is promising, but needs further development and tests.

3. Estimates of the attraction potential of a recreational area. Data on the characteristics of 18 Indiana State parks and weekend trips to those parks were used to estimate volume of visits as a function of park features. Separate estimates were made for average weekends and for the peak weekend. These results were compared with similar estimates made by Smith and Landman for visits to Federal reservoir recreational areas in Kansas.

The principal determinants of visits in Indiana were found to be measures of the capacity of the parks, and the size of the body of water available for water-oriented activities. In Kansas, similar measures were observed, but in addition, population distribution exhibited an influence. The difference in the two States was attributed to a saturation of use of the Indiana parks and to differences in the distribution of populations with respect to the recreational areas.

4. A number of surveys were summarized to determine the variation of recreational demand versus time. It was found that:

(a) More than one-half of recreational-vacation trips are taken in June, July and August. Between two-thirds and three-fourths of such trips occur from June through October.

(b) Judged from data on 18 Indiana State parks, about two-thirds of weekly trips to such parks occur on Friday, Saturday and Sunday.

(c) A subset of the previous data, for which hour-by-hour arrivals from 4 PM Friday to 9 PM Sunday were available, showed little variation among parks. Daily peaks were observed between 7 and 8 PM on Friday and around 1 PM on Sunday. There was a relatively constant rate of arrivals between 11 AM and 3 PM on Saturday. About two-thirds of weekend arrivals were on Sunday. An average of 12.6 percent of weekend arrivals was observed around the Sunday peak hour.

5. Outline of a prediction model. A prediction model suitable for application to the planning of new recreational areas was described. It utilizes the three foregoing elements; i.e., a trip distribution model, the weighted activity index, and the estimate of attraction potential. It was concluded that a prerequisite to the application of the model is a comprehensive regional survey of existing recreational facilities and their use patterns.

Further research on a prediction model and on the estimates of facility attractiveness is proposed.

CHAPTER ONE

INTRODUCTION AND RESEARCH APPROACH

BACKGROUND

Faced with an increasing demand for recreational facilities, Federal, State, and local agencies that administer outdoor recreational programs have recognized the need for improving their planning tools. Not only has there been rapidly increasing attendance at outdoor recreational areas, but there also have been marked shifts in the popularity of the facilities at these areas. Adequate long- and short-range planning of expansion and improvement of recreational areas requires the ability to forecast demands that will be made on the areas. In view of this requirement, extensive surveys and studies have been conducted to determine demand characteristics. Results of these studies and continuing reports of Federal and State agencies provide a wealth of information on recreational activities of the people in the United States.

Federal and State agencies that administer parks and forests are not alone in their concern with the problem of increasing demand for recreational facilities. The vast majority of the people who visit these areas use private automobiles. An increasing demand on the recreational areas is accompanied by an increasing demand on the highway system. Because new or improved highway facilities may be required, the ability to forecast this demand is very important to highway planners.

The growing demand for outdoor recreational facilities is in part attributable to growth in population, growth in per capita disposable income, increasing mobility of the population, and longer paid vacations, among other factors. However, though these indexes may indicate why demand is increasing, they do not begin to show the extent to which it has increased. For example, over the period 1951-1959, both population and per capita disposable income increased by only 15 percent, as compared to a 143 percent increase in visits to selected recreational areas, and an 86 percent increase in visits to national parks (*1*). This could indicate that there are other factors besides those associated with population growth and increasing affluence and leisure that have contributed to the expanded popularity of rural recreational facilities—as, perhaps, a need to compensate for the growing complexity and mechanization of our society; perhaps, also, greater awareness among people of the existence and value of rural parks and reservoirs. Alternatively, or in addition, a relatively small increase in such things as per capita income and mobility may exert a catalytic influence and result in a disproportionate increase in travel for recreational purposes.

However one explains the observed growth of participation in rural outdoor recreation, it is clear that projections of all the indicators that might have some influence on continued growth assure an accelerating increase in the demand for facilities for outdoor activities. With 1960 as the basis for comparison, population is expected to increase by about one-third by 1976, and to double by the year 2000 (*2*). Other variables, such as per capita disposable income and paid vacations, are predicted to increase at about the same rate. Although such projections must always be used with caution, there is room for considerable error without affecting the overall conclusion that a need exists to plan for the future by substantial increases in facilities providing opportunities for outdoor recreation.

SCOPE AND PURPOSE

This research program has been concerned with developing methods for determining the volume of traffic attracted by rural outdoor recreational areas, in terms of observable characteristics of the areas and of the user populations. Its ultimate purpose is the formulation of a prediction model for the volume of traffic to be expected at planned new facilities, to permit rational planning of access highways and parking areas. Attention has been focused primarily on State parks and reservoir areas, to which visitors are attracted principally from within a State and neighboring States.

The investigation has concentrated on the development of a trip distribution model, a model to reflect the influence of socioeconomic factors, a park attractiveness model, and a new-facility prediction model.

RESEARCH APPROACH

The research plan for the project was as follows:

1. *Review of Related Studies.* Although there are several reports of surveys and statistics relating to recreational travel as noted in the literature review, there is a relative scarcity of studies aimed at the development of prediction models as aids to the planning of new facilities. A report by Schulman (*3*), relating to visits to Indiana State parks, was found to be very useful. Reports on studies in Kansas by Smith and Landman (*4*), in Connecticut by Voorhees (*5*) and others, and a nationwide travel market study by Crampon (*6*), were also found to contain useful information.

2. *Investigation of Trip Distribution Models.* A promising trip distribution model, the "logarithmic distance" model, has been developed. The *F*-factor model has also been examined with good results, and several measures of the trip generation potential of counties were compared.

3. *Application of a Socioeconomic Activity Index.* An activity index is described which estimates the relative intensity of participation by an individual in outdoor recreational activities as a function of his socioeconomic characteristics. This index was adapted to be used with the socioeconomic profile of a county to estimate its activity potential, and the ability of the index to reflect socioeconomic differences between counties was demonstrated.

Indexes were computed for 46 counties in and around Indiana from which significant numbers of State park visitors were observed to originate, and these indexes were used as weighting factors in the gravity model computations.

4. *Use of Nonlinear Regression for Estimating Attractiveness.* Visitor counts at 18 Indiana State parks were used, in conjunction with detailed information on park characteristics, to develop a quadratic regression equation that estimates visitor volume as a function of those characteristics.

5. *Time Distribution of Travel.* A number of surveys were reviewed to determine the temporal variation of recreational travel.

6. *Prediction Model.* The models developed through the activities listed in items 1, 2, and 3 were combined and a prediction model was proposed, together with the requirements for a data base to make the results of a prediction meaningful.

This report summarizes the results of the foregoing research tasks, presents an analysis of the results and conclusions, and identifies problems for further research.

CHAPTER TWO

RESULTS, ANALYSIS, EVALUATION

REVIEW OF LITERATURE

Reports in a broad range from varied sources were reviewed. Besides the usual purposes of developing general background and ascertaining the status of recent pertinent research, an important aim of the review was to find useful sets of data for analysis, inasmuch as the resources and scope of this program did not provide for independent field surveys. A number of highly useful reports were found, relative to analytical techniques and survey data. These are referenced and discussed in appropriate later sections of this chapter.

Other references provide useful general background. These fall into several categories, as follows:

1. Descriptive statistics relating to the characteristics of users of local facilities, usually Statewide; general descriptions of the facilities; projections of future demand; and the economic value to the community of the tourist industry. These included reports from Arkansas (*8*), California (*9, 10*), Florida (*11*), Missouri (*12*), Oregon (*13*), West Virginia (*14, 15, 16*), Wisconsin (*17, 18, 19, 20, 21*), and the U.S. Bureau of Sport Fisheries and Wildlife (*22*). These statistics, though interesting as indicators of much of recreational research and unquestionably of considerable value to local planners, nevertheless present many problems to the statistical analyst. These problems have been discussed in detail by Clawson (*23*), who points out that there is an unexploited but potentially rich mine of data relating to outdoor recreation, if one can circumnavigate the gaps and inconsistencies in the data. Some of the problems are incomplete series of data, covering a limited period of time; data covering activities and groups of people in broader categories than those of concern to this study, with no means of separating out the subgroup of interest; and data presented as percentages where absolute numbers would be more useful. Nevertheless, it was possible to sift out many useful data.

2. General descriptions of the problems of managing outdoor recreational areas to improve user satisfaction (*24*), the attitudes and motivations of users (*25*), and statistics on user participation and satisfaction (*1, 26, 27*).

3. Techniques for conducting surveys and measuring and estimating the use of facilities (*28, 29, 30, 31, 32*). An alternative to the approach used here of attempting to develop a general model that can be applied to predicting traffic attraction to a large number of facilities of the same class has been discussed by Devaney (*31*). This is to conduct a survey and make projections for the particular facility that is under consideration. For example, he describes an elaborate study conducted in the planning phase of the construction of a bridge causeway to St. George Island, Fla. A large number of traffic generators, such as swimming, sightseeing, residential, and business, were considered. Annual traffic growth curves were prepared for each generator, and estimates were made of seasonal variations for each. This was done for each year over a 15-year projection period. When investments of the magnitude that was undoubtedly contemplated here are planned, a survey of this kind would seem to be essential.

As a general comment, Clawson's (*23*) estimate of the richness of the literature and statistics on outdoor recreation was confirmed. This was accompanied by an impression of vigorous interest and enthusiasm by workers in the field.

TRIP DISTRIBUTION MODELS

Three trip distribution models were compared initially using the four-park Indiana (*3*) survey data. These were all gravity models in the sense that the trips between a park and a county were directly proportional to a measure of recreational attraction between them, and inversely proportional to a function of the distance between them. The models were as follows:

1. The power-of-the distance form of the gravity model, in which a single exponent of the distance is estimated over the entire range of observed trips.

2. An adaptation of the *F*-factor model. Upon review, this was concluded to be an inadequate representation of the *F*-factor model in its usual form.

3. An *ad hoc* model, named the "logarithmic distance" model. It is of the form

$$T_{ij} = (T_i A_j)/[a\text{-}b \log(c\text{-}D_{ij})] \tag{1}$$

in which

a, b, and c = Estimated constants;
T_{ij} = Estimated number of trips between park i and county j;
T_i = Observed average number of trips per weekend to park i;
A_j = The measure of trip attraction associated with county j; and
D_{ij} = The highway distance between park i and county j.

This model was found to give a good fit for trips up to 73 miles from a park, representing about 65 percent of the observed trips. Over this range it was shown to give better results than the power-of-the-distance form.

It was decided in the second year to explore the potential of the *F*-factor model again. Computational problems had aborted the previous attempt, but this time no difficulties were encountered, and the first results looked promising. Several versions were run, using different measures of the recreational trip potential of the counties.

These were as follows:

1. The number of housing units in each county, as determined from Census data (*7*). This is the same measure as used in the prior work.

2. A new measure, housing units times percent owning autos, was computed using data on the percentage of households in each county with one or more automobiles.*

3. A socioeconomic model was applied. Briefly, an "activity index" was computed, and applied as a weighting factor to the auto ownership data. The activity index is supposed to represent the influence of the socioeconomic makeup of a county on the level of participation of its residents in outdoor recreational activities. The details of the model are described in a later section on "Socioeconomic Factors—Activity Index."

Because of the considerable time and effort involved in assembling the data for the computation of the activity index, this was done for only those counties that originated ten or more trips to a park, because at most a 10 percent change was anticipated. Even so this left 46 counties for which the data were collected. The individual activity indexes were divided by the average of the 46 to normalize them, and the auto ownership in each county was multiplied by its normalized index. The auto ownership data for the counties for which no index was computed were multiplied by the normalized average (i.e., one). The normalized activity indexes are given in Table 1. They range from a high of 1.10 for Hendricks County in central Indiana, to a low of 0.88 for Cook County (Chicago and suburbs), Ill. Figure 1 is a county map of Indiana showing the locations of the parks.

TABLE 1

NORMALIZED ACTIVITY INDEXES FOR 46 SELECTED COUNTIES

STATE	COUNTY CODE	COUNTY NAME	NORMALIZED ACTIVITY INDEX
Ind.	2	Allen	0.98
	3	Bartholomew	1.08
	6	Boone	1.04
	7	Brown	1.01
	9	Cass	1.02
	11	Clay	0.97
	12	Clinton	1.02
	16	Decatur	0.99
	18	Delaware	0.97
	20	Elkhart	1.02
	23	Fountain	1.01
	25	Fulton	1.01
	29	Hamilton	1.08
	30	Hancock	1.07
	32	Hendricks	1.10
	33	Henry	1.03
	34	Howard	0.98
	36	Jackson	1.02
	41	Johnson	1.09
	45	Lake	0.93
	46	LaPorte	0.98
	47	Lawrence	1.01
	48	Madison	1.01
	49	Marion	0.93
	50	Marshall	1.03
	53	Monroe	1.02
	54	Montgomery	1.03
	55	Morgan	1.06
	61	Parke	0.98
	66	Pulaski	1.00
	67	Putnam	1.02
	71	St. Joseph	0.96
	73	Shelby	1.04
	79	Tippecanoe	1.07
	83	Vermillion	0.96
	84	Vigo	0.90
Ill.	94	Champaign	1.03
	97	Cook	0.88
	100	Douglas	1.03
	102	Edgar	0.94
	117	Macon	0.94
	130	Vermillion	0.98
Ohio	168	Butler	0.98
	180	Hamilton	0.91
	198	Montgomery	0.96
Ky.	234	Jefferson	0.91

A comparison of all three forms of the *F*-factor model was made over the 73-mile range with the logarithm-of-the-distance model. The data (Table 2) show a single observation that overshadows all the others. This is connected with the trips between Marion County (Indianapolis) and Brown County Park, 49 miles away. The average number of weekend trips was: observed, 412; estimated by logarithm-of-distance model, 371; estimated by *F*-factor model for housing, 302; estimated by *F*-factor model for autos, 294; estimated by *F*-factor model for activity, 274. This single observation represents from one-half to two-thirds of the sums of squares of the differences between observed and estimated trips, and severely biases the comparison. Therefore, the standard errors of the differences were computed without this one observation.

Before those results are presented, some of the noteworthy observations are discussed. Examination of Table 2 shows the following gross effects:

1. With respect to all three *F*-factor models, something more than one-half the estimates were better than or as good as the estimates of the logarithmic distance model. This fact, together with the comparison of the standard errors, indicates that the *F*-factor models are at least as good as the logarithmic distance model. The failure of the logarithmic distance model above the 73-mile range, taken with the widely established use of the *F*-factor models, is further argument for the abandonment of the former model.

2. Auto ownership versus housing showed better or equal results in 37 out of 48 cases for the former.

3. Activity versus housing showed better or equal results in 32 out of 48 cases for the former.

4. Activity versus auto ownership showed better or equal results in 36 out of 48 cases for the former.

The net result is a trend of improvement from the housing measure, to auto ownership, to activity index.

* Data on housing units and auto ownership were found in Ref. (*5*).

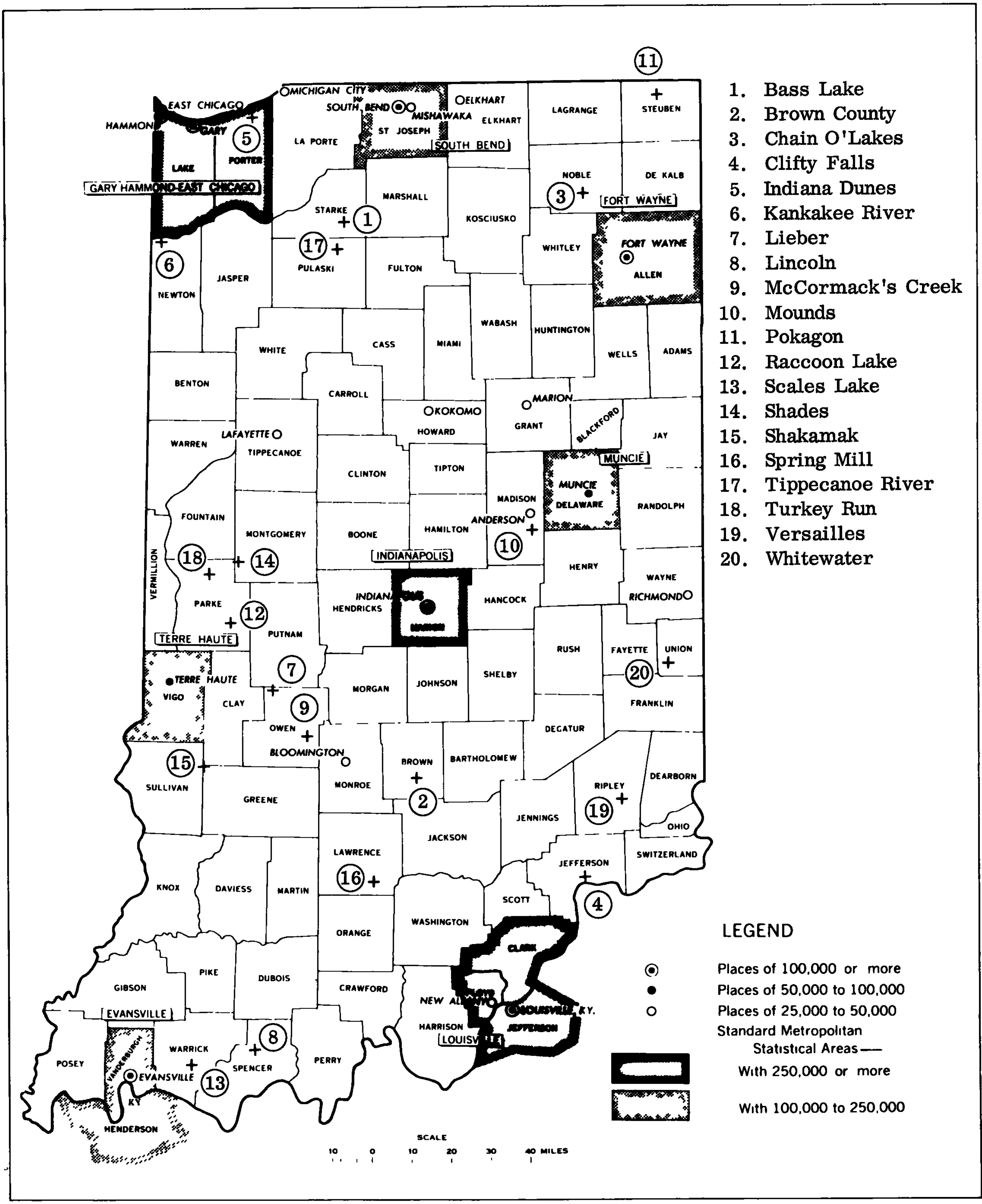

Figure 1. Locations of Indiana State parks.

TABLE 2

COMPARISON OF TRIP DISTRIBUTION MODELS OVER 73-MILE RANGE

	NUMBER OF TRIPS								
DIST. (MI)	OBS.	LOG-OF-DISTANCE MODEL	DIFF.	*F* (HOUSING)	DIFF.	*F* (AUTO)	DIFF.	*F* (ACTIVITY)	DIFF.
10	109	155	−46	95	14	97	12	98	11
11	8	30	−22	20	−12	21	−13	21	−13
13	41	34	7	36	5	37	4	39	2
16	330	272	58	293	37	299	31	314	16
23	17	16	1	36	−19	35	−18	34	−17
24	68	61	7	86	−18	86	−18	89	−21
25	37	46	−9	57	−20	62	−25	67	−30
27	14	7	7	8	6	9	5	9	5
28	91	58	33	65	26	70	21	76	15
29	18	6	12	9	9	9	9	9	9
30	15	12	3	14	1	14	1	14	1
31	93	97	−4	112	−19	109	−16	108	−15
33	60	84	−24	94	−34	91	−31	83	−23
34	47	66	−19	69	−22	68	−21	69	−22
35	14	7	7	9	5	9	5	9	5
36	33	36	−3	38	−5	37	−4	38	−5
37	6	12	−6	12	−6	13	−7	13	−7
38	17	15	2	16	1	17	0	16	1
39	8	4	4	5	3	5	3	5	3
40	46	65	−19	64	−18	63	−17	65	−19
42	20	18	2	21	−1	20	0	20	0
43	18	11	7	11	7	13	5	15	3
44	24	26	−2	23	1	23	1	24	0
45	32	19	13	23	9	25	7	26	6
46	24	13	11	12	12	13	11	14	10
47	3	3	0	3	0	3	0	3	0
48	10	13	−3	12	−2	13	−3	14	−4
49	412	371	41	302	110	294	118	274	138
51	98	86	12	72	26	74	24	77	21
53	26	34	−8	29	−3	30	−4	30	−4
54	19	12	7	9	10	10	9	10	9
55	3	8	−5	6	−3	6	−3	6	−3
57	89	84	5	80	9	77	12	73	16
58	4	9	−5	7	−3	7	−3	6	−2
59	19	18	1	15	4	15	4	14	6
61	26	33	−7	28	−2	27	−1	30	−4
62	5	8	−3	6	−1	5	0	6	−1
63	9	20	−11	15	−6	16	−7	14	−5
64	98	93	5	69	29	70	28	66	32
65	33	21	12	17	16	17	16	17	16
66	7	4	3	4	3	3	4	3	4
67	6	5	1	4	2	4	2	5	1
68	161	185	−24	140	21	135	26	130	31
69	4	2	2	2	2	1	3	1	3
70	28	17	11	12	16	12	16	12	16
71	8	10	−2	7	1	7	1	8	0
72	31	21	10	14	17	17	14	18	13
73	11	10	1	6	5	8	3	8	3

This conclusion is borne out by the standard errors, which decreased progressively in the three cases from 14.1 to 13.4 to 13.1. The standard error for the logarithmic distance model was 15.3.

The largest errors, except for Marion County, which as was noted was badly underestimated, were of two kinds. First, there was a tendency to overestimate trips from counties adjacent to the park's home county. Second, trips from two counties containing large universities (Tippecanoe, Ind., and Champaign, Ill.) and an industrial county (Lake, Ind.) were underestimated.

The overall conclusions regarding these comparisons are as follows:

1. In general, the *F*-factor models gave somewhat better results than the logarithmic distance model.

2. Although the activity index model was the best, it was not sufficiently better than the auto ownership model

to justify an unequivocal recommendation of its adoption. Comparing only the three *F*-factor models, at 17 distances it induced consistent trends to improvement but these were generally not large changes. At another 14 distances, it left the predictions essentially unchanged.

For a thorough test of the effectiveness of the activity measure it would be advisable to compute the activity index for a few more counties—at least those from which a substantial number of trips were predicted but few were observed. It is believed, however, that a much more important factor is the absence of data relating to competing destinations. County-of-origin data were available for only 5 of the 20 State parks, and following Schulman's lead (*3*) the data relating to Mounds State Park were not used. If a study were planned now, and assuming that the resources were available, it would be recommended that a complete survey of outdoor recreational travel patterns be conducted, somewhat on the pattern of the 1 percent sample survey in the Connecticut study (*5*). At the least, it would be advisable to have O-D data for all the State parks and the principal competing areas such as reservoirs, large county and municipal parks, and important private resort areas.

An example of a difference between prediction and observation that might be corrected by including competition is the 27 percent overestimate of trips from Monroe County to Brown County State Park. Bloomington, the principal population center of Monroe County is almost midway between Brown County State Park and McCormick's Creek State Park, which was not included in the O-D survey.

ESTIMATION OF TRAVEL TIME FACTORS

A first estimate of travel time factors was made using the percentage of total observed trips in 10-mile increments from the parks. This proved to be inadequate. The original factors were then adjusted by using the procedure recommended by the Bureau of Public Roads (*33, 34*), where at each 1-mile interval

$$F_{\text{adjusted}} = F_{\text{current}}\left(\frac{\text{Percent observed trips}}{\text{Percent current prediction}}\right) \quad (2)$$

Because of the great fluctuation in numbers of households in successive 1-mile intervals, it was impossible to fit a smooth travel time curve by eye. Instead, a relatively good fit was obtained by using a 10-mile floating average proceeding in 1-mile steps. The travel time factors from this iteration (Table 3) were used in the computations for the three *F*-factor models.

The possibility of making an additional adjustment was examined, but it was decided that no substantial improvement would result without resorting to an involved procedure like a weighted least-squares fit, and this could not be justified at the time.

As a further illustration of the great mile-by-mile fluctuation of numbers of trips, the observed number of trips is plotted against distance in Figure 2. The plot extends over only the 0- to 73-mile range, which is sufficient to illustrate the variability, and also the fit of the *F*-factor (activity index) model plotted in the same figure.

TABLE 3

TRAVEL TIME (*F*-) FACTORS USED IN GRAVITY MODELS

DIST. (MI)	*F*-FACTOR	DIST. (MI)	*F*-FACTOR	DIST. (MI)	*F*-FACTOR
1-10	1250	52	135	93	41
12	1150	53	130	94	40
13	1100	54	125	95	39
14	1050	55	121	96-7	38
15	1025	56	116	98	37
16	1000	57	112	99	36
17	960	58	108	100-1	35
18	930	59	104	102	34
19	880	60	101	103-4	33
20	840	61	97	105	32
21	800	62	94	106-7	31
22	760	63	91	108-9	30
23	720	64	88	110-1	29
24	660	65	86	112	28
25	607	66	83	113-5	27
26	560	67	80	116-7	26
27	518	68	78	118-9	25
28	481	69	76	120-1	24
29	448	70	73	122-4	23
30	417	71	71	125-7	22
31	390	72	69	128-30	21
32	366	73	67	131-3	20
33	343	74	66	134-7	19
34	323	75	64	138-40	18
35	304	76	62	141-4	17
36	287	77	60	145-9	16
37	272	78	59	150.4	15
38	257	79	57	155-9	14
39	244	80	56	160-5	13
40	231	81	54	166-72	12
41	220	82	53	173-80	11
42	209	83	52	181-90	10
43	199	84	51	191-4	9
44	190	85	49	195-200	8
45	182	86	48	201-6	7
46	174	87	47	207-15	6
47	166	88	46	216-26	5
48	159	89	45	227-41	4
49	153	90	44	242-64	3
50	146	91	43	265-300	2
51	141	92	42	300-590[a]	1

[a] 500 miles was used as a dummy distance for out-of-state counties that originated no trips to a given park. *F*(500) was set at 0.

The individual county-to-park trips, observed and estimated (using the activity measure), are compared in Tables 4, 5, 6, and 7.

The corresponding standard errors of the differences between observations and estimates, and the percent RMS errors, are given in Table 8. Table 9 gives the identifying county code numbers.

SOCIOECONOMIC FACTORS—ACTIVITY INDEX

The results of using an activity index based on a socioeconomic profile of a county as a weighting factor in the gravity model were discussed in the foregoing section. Some form of this approach has been or is being used in other studies (*4, 5, 6*).

TABLE 4

COMPARISON OF OBSERVED[a] AND ESTIMATED TRIPS, BROWN COUNTY STATE PARK

	0			1			2			3			4			5			6			7			8			9		
COUNTY[b]	OBS.	EST.	DIFF.	OBS.	EST.	DIFF.	OBS.	EST.	DIFF.	OBS.	EST.	DIFF.	OBS.	EST.	DIFF.	OBS.	EST.	DIFF.	OBS.	EST.	DIFF.	OBS.	EST.	DIFF.	OBS.	EST.	DIFF.	OBS.	EST.	DIFF.
00	—	—	—	2	0	2	10	10	0	202	151	51	2	1	1	2	1	1	9	6	3	45	34	11	1	2	−1	3	2	1
10	7	8	−1	4	7	−3	2	4	−2	1	2	−1	3	5	−2	6	4	2	14	11	3	1	1	0	12	10	2	2	3	−1
20	4	3	1	4	4	0	8	7	1	1	1	0	2	3	−1	1	1	0	3	3	0	7	7	0	5	20	−15	15	11	4
30	11	7	4	2	3	−1	16	18	−2	12	6	6	9	7	2	2	3	−1	27	28	−1	2	1	1	3	1	2	5	6	−1
40	6	13	−7	86	68	18	6	6	0	2	3	−1	1	0	1	20	11	9	4	3	1	11	24	−13	20	20	0	412	274	138
50	2	2	0	2	2	0	3	3	0	128	163	−35	4	5	−1	37	67	−30	1	0	1	2	2	0	3	0	3	2	4	−2
60	3	13	−10	1	2	−1	2	2	0	1	1	0	2	2	0	2	1	1	1	1	0	3	7	−4	2	2	0	3	6	−3
70	5	5	0	7	6	1	2	4	−2	27	20	7	1	1	0	1	1	0	1	1	0	1	5	−4	1	1	0	12	8	−4
80	2	3	−1	1	1	0	5	9	−4	1	2	−1	11	18	−9	2	3	−1	1	0	1	2	2	0	3	6	−3	6	6	0
90	1	1	0	3	2	1	2	1	1	1	0	1	1	5	−4	1	2	−1	1	3	−2	19	43	−24	1	3	−2	1	1	0
100	1	1	0	3	2	1	2	3	−1	2	1	1	1	0	1	1	0	1	1	1	0	1	1	0	1	1	0	2	1	1
110	1	3	−2	1	1	0	1	3	−2	1	1	0	1	0	1	1	0	1	2	3	−1	2	3	−1	1	3	−2	1	2	−1
120	1	0	1	1	0	1	1	1	0	1	0	1	1	1	0	1	2	−1	1	1	0	1	0	1	1	2	−1	1	2	−1
130	2	7	−5	1	1	0	1	0	1	1	1	0	1	1	0	1	2	−1	1	1	0	1	0	1	—	—	—	—	—	—
160	—	—	—	—	—	—	—	—	—	2	2	0	—	—	—	1	1	0	1	1	0	—	—	—	11	17	−6	3	4	−1
170	3	4	−1	1	2	−1	2	3	−1	1	4	−3	2	3	−1	1	1	0	4	11	−7	1	1	0	1	3	−2	1	0	1
180	42	58	−16	1	1	0	—	—	—	1	1	0	—	—	—	1	0	1	1	1	0	1	0	1	—	—	—	—	—	—
190	1	1	0	1	1	0	2	3	−1	1	1	0	2	1	1	1	0	1	1	1	0	2	3	−1	22	24	−2	—	—	—
200	—	—	—	1	1	0	—	—	—	1	0	1	—	—	—	2	2	0	1	1	0	—	—	—	1	0	1	1	1	0
210	1	2	−1	1	0	1	1	0	1	1	1	0	1	1	0	1	0	1	3	4	−1	—	—	—	1	0	1	3	1	2
220	—	—	—	1	1	0	1	1	0	3	7	−4	1	3	−2	1	0	1	2	6	−4	1	1	0	1	1	0	1	3	−2
230	1	0	1	—	—	—	1	1	0	1	1	0	30	61	−31	1	0	1	3	9	−6	—	—	—	1	0	1	1	1	0
240	—	—	—	1	2	−1	1	0	1	1	2	−1	1	0	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
250	—	—	—	1	3	−2	—	—	—	—	—	—	—	—	—	1	0	1	—	—	—	—	—	—	1	0	1	1	1	0
260	1	2	−1	—	—	—	1	1	0	1	0	1	—	—	—	—	—	—	1	0	1	—	—	—	1	2	−1	—	—	—
270	—	—	—	1	1	0	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2	7	−5	—	—	—	—	—	—
280	1	0	1	1	0	1	2	8	−6	1	1	0	1	0	1	—	—	—	—	—	—	—	—	—	—	—	—	1	2	−1
290	—	—	—	1	0	1	0	1	−1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

[a] Total observed trips = 1,617. [b] Left column denotes groups of counties by tens. Individual counties within each decimal group are denoted by the numbers heading the remaining columns.

TABLE 5

COMPARISON OF OBSERVED[a] AND ESTIMATED TRIPS, SHADES STATE PARK

	0			1			2			3			4			5			6			7			8			9		
COUNTY[b]	OBS.	EST.	DIFF.	OBS.	EST.	DIFF.	OBS.	EST.	DIFF.	OBS.	EST.	DIFF.	OBS.	EST.	DIFF.	OBS.	EST.	DIFF.	OBS.	EST.	DIFF.	OBS.	EST.	DIFF.	OBS.	EST.	DIFF.	OBS.	EST.	DIFF.
00	—	—	—	1	0	1	6	3	3	1	2	−1	2	1	1	1	1	0	14	9	5	1	0	1	3	3	0	1	2	−1
10	1	1	0	3	3	0	6	6	0	—	—	—	1	0	1	1	0	1	1	1	0	1	0	1	3	2	1	—	—	—
20	2	1	1	0	1	−1	—	—	—	18	9	9	1	0	1	1	1	0	1	0	1	1	3	−2	1	1	0	8	5	3
30	2	1	1	1	0	1	13	10	3	2	1	1	5	4	1	1	1	0	1	0	1	1	1	0	1	1	0	1	0	1
40	—	—	—	3	3	0	1	1	0	1	1	0	1	1	0	6	9	−3	2	2	0	1	1	0	9	7	2	80	69	11
50	1	1	0	1	0	1	1	2	−1	3	2	1	41	39	2	2	2	0	2	1	1	—	—	—	—	—	—	—	—	—
60	1	1	0	5	8	−3	1	0	1	—	—	—	2	2	0	—	—	—	1	0	1	5	5	0	—	—	—	1	1	0
70	1	0	1	4	4	0	—	—	—	2	1	1	1	1	0	1	0	1	—	—	—	1	2	−1	1	0	1	30	21	9
80	1	1	0	1	0	1	1	2	−1	8	5	3	10	12	−2	1	2	−1	2	0	2	1	0	1	—	—	—	1	1	0
90	1	1	0	2	2	0	1	0	1	1	0	1	9	9	0	1	1	0	1	2	−1	7	52	−45	1	1	0	1	0	1
100	1	1	0	2	4	−2	2	2	0	1	1	0	—	—	—	—	—	—	2	2	0	—	—	—	—	—	—	1	2	−1
110	1	2	−1	1	2	−1	—	—	—	—	—	—	—	—	—	—	—	—	1	2	−1	1	2	−1	—	—	—	—	—	—
120	—	—	—	—	—	—	—	—	—	—	—	—	1	1	0	—	—	—	1	0	1	1	1	0	1	2	−1	1	1	0
130	20	20	0	—	—	—	—	—	—	—	—	—	—	—	—	1	3	−2	1	0	1	—	—	—	1	1	0	1	0	1
140	1	0	1	1	1	0	1	0	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
160	—	—	—	—	—	—	—	—	—	1	1	0	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
170	—	—	—	—	—	—	—	—	—	1	2	−1	—	—	—	—	—	—	1	2	−1	—	—	—	1	1	0	—	—	—
180	1	8	−7	—	—	—	1	0	1	—	—	—	1	0	1	—	—	—	—	—	—	—	—	—	—	—	—	1	1	0
190	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	6	−5	—	—	—
200	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	0	1
220	—	—	—	—	—	—	—	—	—	1	1	0	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
230	—	—	—	—	—	—	—	—	—	—	—	—	1	5	−4	—	—	—	—	—	—	—	—	—	1	0	1	—	—	—
250	—	—	—	—	—	—	—	—	—	—	—	—	1	1	0	—	—	—	—	—	—	—	—	—	—	—	—	1	0	1
260	—	—	—	—	—	—	1	1	0	—	—	—	1	0	1	1	0	1	1	1	0	—	—	—	—	—	—	—	—	—
270	—	—	—	1	0	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	2	−1	—	—	—	—	—	—
280	—	—	—	—	—	—	1	5	−4	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	0	1	—	—	—
290	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	1	0	—	—	—	—	—	—	—	—	—

COMPARISON OF OBSERVED[a] AND ESTIMATED TRIPS, TIPPECANOE RIVER STATE PARK

	0			1			2			3			4			5			6			7			8			9		
COUNTY[b]	OBS.	EST.	DIFF.	OBS.	EST.	DIFF.	OBS.	EST.	DIFF.	OBS.	EST.	DIFF.	OBS.	EST.	DIFF.	OBS.	EST.	DIFF.	OBS.	EST.	DIFF.	OBS.	EST.	DIFF.	OBS.	EST.	DIFF.	OBS.	EST.	DIFF.
00	—	—	—	1	0	1	13	7	−6	2	1	1	1	0	1	1	1	0	2	1	1	—	—	—	3	3	0	15	14	1
10	1	0	1	—	—	—	4	3	1	—	—	—	—	—	—	—	—	—	—	—	—	2	1	1	3	2	1	—	—	—
20	26	6	20	1	1	0	—	—	—	1	0	1	—	—	—	14	9	5	—	—	—	4	5	−1	2	0	2	2	1	1
30	1	1	0	1	0	1	2	1	1	1	1	0	19	7	12	2	1	1	—	—	—	2	3	−1	1	1	0	—	—	—
40	1	0	1	1	1	0	—	—	—	9	6	3	1	1	0	53	28	25	22	21	1	1	1	0	5	3	2	18	15	3
50	18	11	7	—	—	—	5	6	−1	1	1	0	1	1	0	1	0	1	2	1	1	5	1	4	1	0	1	1	0	1
60	—	—	—	—	—	—	—	—	—	1	0	1	8	10	−2	—	—	—	15	13	2	1	0	1	—	—	—	0	1	−1
70	—	—	—	14	24	−10	—	—	—	1	0	1	—	—	—	8	21	−13	—	—	—	—	—	—	1	0	1	5	7	−2
80	1	1	0	—	—	—	1	0	1	—	—	—	1	2	−1	2	2	0	—	—	—	—	—	—	—	—	—	1	1	0
90	—	—	—	4	7	−3	4	1	3	—	—	—	1	2	−1	—	—	—	—	—	—	35	91	−56	—	—	—	—	—	—
100	1	0	1	2	5	−3	1	0	1	0	1	−1	—	—	—	—	—	—	1	1	0	—	—	—	—	—	—	1	3	−2
110	2	3	−1	1	3	−2	—	—	—	—	—	—	—	—	—	1	1	0	1	1	0	1	1	0	—	—	—	—	—	—
120	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	0	1	1	0	1	—	—	—	1	0	1
130	1	3	−2	—	—	—	—	—	—	3	0	3	—	—	—	0	4	−4	—	—	—	—	—	—	—	—	—	—	—	—
140	—	—	—	—	—	—	—	—	—	1	1	0	1	1	0	1	1	0	1	0	1	—	—	—	—	—	—	—	—	—
160	—	—	—	—	—	—	—	—	—	1	1	0	1	0	1	—	—	—	—	—	—	—	—	—	1	1	0	1	1	0
180	1	3	−2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
190	—	—	—	1	0	1	1	3	−2	—	—	—	—	—	—	1	0	1	—	—	—	—	—	—	1	3	−2	—	—	—
200	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	1	0	1	0	1	—	—	—
210	1	0	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	1	0	1	0	1	1	0	1	—	—	—
230	—	—	—	—	—	—	—	—	—	—	—	—	1	2	−1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
240	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	0	1	—	—	—	1	1	0	—	—	—
250	—	—	—	1	9	−8	—	—	—	—	—	—	1	2	−1	—	—	—	1	1	0	—	—	—	—	—	—	1	1	0
260	—	—	—	1	3	−2	1	4	−3	—	—	—	—	—	—	1	1	0	—	—	—	—	—	—	—	—	—	—	—	—
270	1	1	0	—	—	—	—	—	—	—	—	—	—	—	—	1	2	−1	—	—	—	1	6	−5	1	0	1	—	—	—
280	—	—	—	—	—	—	1	0	1	—	—	—	—	—	—	—	—	—	1	1	0	—	—	—	—	—	—	1	5	−4
290	—	—	—	1	2	−1	—	—	—	—	—	—	—	—	—	1	0	1	1	1	0	—	—	—	—	—	—	—	—	—

[a] Total observed trips = 435. [b] Left column denotes groups of counties by tens. Individual counties within each decimal group are denoted by the numbers heading the remaining columns.

TABLE 7

COMPARISON OF OBSERVED[a] AND ESTIMATED TRIPS, TURKEY RUN STATE PARK

	0			1			2			3			4			5			6			7			8			9		
COUNTY[b]	OBS.	EST.	DIFF.	OBS.	EST.	DIFF.	OBS.	EST.	DIFF.	OBS.	EST.	DIFF.	OBS.	EST.	DIFF.	OBS.	EST.	DIFF.	OBS.	EST.	DIFF.	OBS.	EST.	DIFF.	OBS.	EST.	DIFF.	OBS.	EST.	DIFF.
00	—	—	—	3	0	3	8	7	1	3	4	−1	9	4	5	2	0	2	24	14	10	1	1	0	6	3	3	5	5	0
10	1	2	−1	13	21	−8	16	8	8	—	—	—	2	2	0	1	1	0	1	1	0	1	1	0	9	7	2	1	1	0
20	4	4	0	1	1	0	1	1	0	27	33	−6	—	—	—	3	2	1	4	2	2	9	5	4	4	3	1	16	8	8
30	4	4	0	1	0	1	22	16	4	7	4	3	15	7	−8	5	1	4	1	2	−1	3	2	1	3	1	2	1	1	0
40	1	1	0	7	5	2	6	4	2	4	3	1	1	1	0	51	24	27	8	4	4	2	3	−1	26	13	13	145	118	27
50	5	2	3	1	0	1	3	3	0	4	8	−4	41	56	−15	9	7	2	5	2	3	2	1	1	1	0	1	1	1	0
60	3	3	0	49	51	−2	1	1	0	1	1	0	6	3	3	1	0	1	2	2	0	11	17	−6	2	1	1	2	1	1
70	1	1	0	12	8	4	1	0	1	3	3	0	1	1	0	2	1	1	1	0	1	5	6	−1	1	1	0	53	31	22
80	4	2	2	1	0	1	8	7	1	17	34	−17	60	83	−23	2	2	0	5	8	−3	1	1	0	1	1	0	3	4	−1
90	2	0	2	6	4	2	1	1	0	—	—	—	36	27	9	4	8	−4	7	9	−2	74	118	−44	2	3	−1	1	1	0
100	17	5	12	8	8	0	17	16	1	3	3	0	—	—	—	—	—	—	4	5	−1	—	—	—	1	0	1	3	5	−2
110	5	6	−1	7	5	2	3	2	1	2	2	0	1	2	−1	1	1	0	7	6	1	11	10	1	1	6	−5	1	1	0
120	1	1	0	—	—	—	1	1	0	1	1	0	5	1	4	2	7	−5	2	2	0	1	1	0	4	6	−2	2	4	−2
130	70	89	−19	1	1	0	—	—	—	—	—	—	—	—	—	5	8	−3	1	2	−1	—	—	—	1	0	1	1	2	−1
140	2	2	0	1	1	0	1	2	−1	—	—	—	1	3	−2	—	—	—	2	5	−3	1	1	0	1	0	1	3	2	1
150	1	1	0	1	1	0	1	2	−1	1	1	0	1	2	−1	1	0	1	1	1	0	1	0	1	1	3	−2	1	0	1
160	1	1	0	1	0	1	1	1	0	1	1	0	—	—	—	—	—	—	—	—	—	1	1	0	1	5	−4	—	—	—
170	—	—	—	—	—	—	—	—	—	—	—	—	1	2	−1	—	—	—	2	4	−2	—	—	—	1	2	−1	—	—	—
180	2	17	−15	1	1	0	—	—	—	—	—	—	—	—	—	—	—	—	1	0	1	—	—	—	1	0	1	1	0	1
190	1	1	0	1	1	0	1	2	−1	—	—	—	1	0	1	1	0	1	—	—	—	1	2	−1	2	13	−11	1	0	1
200	1	1	0	—	—	—	1	0	1	—	—	—	1	0	1	1	1	0	—	—	—	—	—	—	1	1	0	1	0	1
210	1	2	−1	1	0	1	—	—	—	—	—	—	—	—	—	—	—	—	1	2	−1	—	—	—	—	—	—	—	—	—
220	1	0	1	1	0	1	1	0	1	1	2	−1	—	—	—	—	—	—	1	1	0	—	—	—	—	—	—	—	—	—
230	—	—	—	1	1	0	—	—	—	—	—	—	2	13	−11	1	0	1	1	3	−2	1	1	0	—	—	—	—	—	—
240	1	0	1	—	—	—	—	—	—	—	—	—	—	—	—	1	0	1	—	—	—	1	0	1	—	—	—	1	1	0
250	1	0	1	2	5	−3	1	0	1	1	1	0	1	1	0	—	—	—	—	—	—	1	1	0	—	—	—	1	1	0
260	1	0	1	1	2	1	1	3	−2	—	—	—	—	—	—	1	1	0	—	—	—	1	0	1	1	2	−1	1	0	1
270	1	1	0	—	—	—	1	0	1	1	1	0	1	0	1	—	—	—	1	0	1	1	6	−5	—	—	—	1	1	0
280	—	—	—	—	—	—	3	14	−11	1	0	1	—	—	—	1	0	1	1	0	1	1	1	0	1	1	0	2	7	−5
290	1	0	1	1	1	0	—	—	—	1	0	1	1	1	0	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

[a] Total observed trips = 1,250. [b] Left column denotes groups of counties by tens. Individual counties within each decimal group are denoted by the numbers heading the remaining columns.

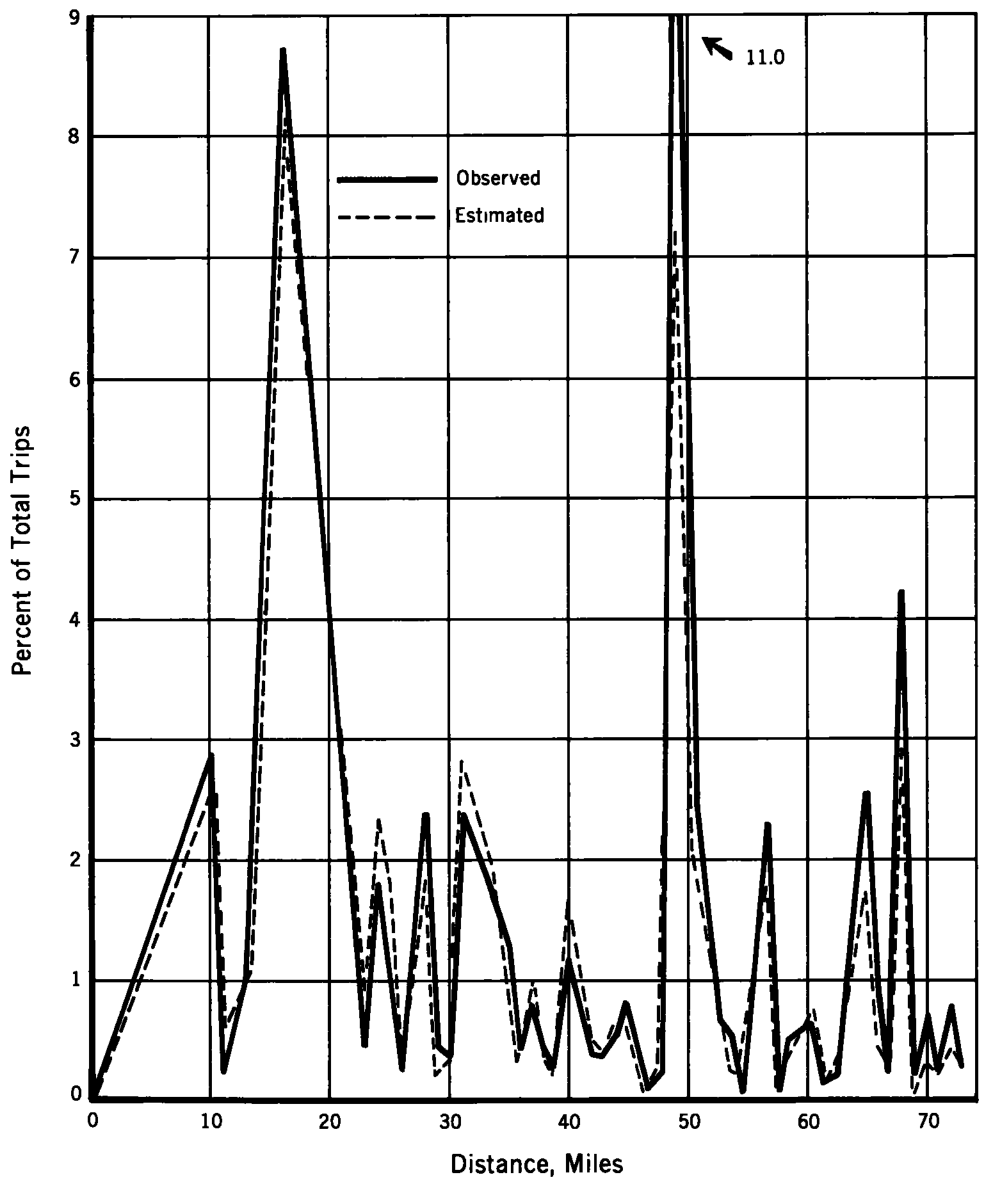

Figure 2. Distribution of trips to Indiana State parks.

In a recent study, Crampon (*6*) investigated data relating to the number of out-of-State visitors to 45 States and the District of Columbia. He fitted power-of-the-distance gravity models for each of the 46 cases, using population of the originating State as a measure of attraction. He noted a considerable variation in the value of the exponent of distance relative to the destinations, ranging from -0.293 for New York State to -3.836 for Alaska. In subsequent analysis he was able to reduce the variability of the results substantially by applying a succession of multiplicative factors to his original estimates. That is, he computed a so-called modified mean, R_j, referring to the jth State-of-origin, as follows:

$$R_j = [\Sigma_i (V_{ij}/W_{ij})]/N \qquad (3)$$

in which V_{ij} is the observed number of visitors from the jth State to the ith destination, and W_{ij} is the estimated number. The summation is over all destinations, excluding the two highest and two lowest ratios, and the remaining number is N. The reduction in variability was among the R_j over all origins. The stabilizing factors were in the expression

$$W_{ij} = (a_1 + b_1 I_j)(a_2 + b_2 M_j)(a_3 + b_3 A_j)G_{ij} \qquad (4)$$

in which G_{ij} is the original gravity model estimate of trips from origin j to destination i, and the three factors in parentheses are simple linear regressions representing, respectively, median income, mobility, and age of the population of the originating State. The measure of mobility is the percentage of Census respondents who changed county of residence from 1955 to 1960, and the measure

TABLE 8

MEASURES OF VARIATION OF DIFFERENCES BETWEEN OBSERVATIONS AND GRAVITY MODEL ESTIMATES

STATE PARK	STANDARD ERROR [a]	PERCENT RMS ERROR [b]
Brown County	11.1	152
Shades	4.4	133
Tippecanoe River	6.5	176
Turkey Run	5.7	102

[a] Dividend is one less than the number of observations, to obtain unbiased estimate.

[b] Percent RMS error $= 100 \times \frac{\text{Standard error}}{\text{Avg. No. of Trips per County}}$

of age is the percentage of the population over 65 years old.

The approach taken in this study is somewhat different from Crampon's. It uses a multiple classification analysis technique described by Mueller and Gurin (*35*), and is based on data from interviews with 2,750 adults regarding the frequency of their participation in 11 outdoor recreational activities. These ranged from "automobile riding for sightseeing and relaxation," in which 71 percent of the subjects participated; to "outdoor swimming or going to a beach," in which 45 percent participated; to "skiing and other winter sports," with 6 percent participation. Data were also collected, in the categories listed in Table 10, on the socioeconomic characteristics of the respondents. These data were collected in a series of tables, and some useful multivariate analyses were performed. One table, for example, shows the relationship between income and frequency of engaging in specific activities. For each of 5 income groups and each of the 11 activities, the percentage of each of the 55 categories is shown according to whether the respondents engaged in an activity often, one to four times in the past year, or not at all.

An "activity index" was computed for each respondent. He received a score of 1 for each activity in which he engaged four times or less in the previous year, and a score of 2 if he participated a greater number of times. Additional scores of 2 or 4 were added if responses to general questions indicated particularly high frequencies of activity. Thus an individual's index could range between 0 and 26. The mean activity index of adult males in the survey was 6.74. A multiple classification analysis was performed on the data. This technique permits the effect of membership in each socioeconomic class to be estimated in such a way that the effects are additive. The estimates were made so as to minimize the error variance with respect to the observed activity indexes. The estimated components of activity are reproduced from Mueller and Gurin (*35*) in Table 10. The activity index of an individual may be estimated by adding up the components corresponding to his membership in each of the listed categories. Thus, a white male (0.24), earning between $7,500 and $9,999 a year (0.45), who is a salesman (− 0.92), who completed high school (0.91), lives in a suburb (− 0.12) in the Northeastern U.S. (− 1.03), gets a two-week paid vacation (0.27), is 35 to 44 years old (0.49), and is married but has no children (0.75), is estimated to have an activity index of 0.77 + 6.74 (the grand mean) = 7.51. That is, he engages in outdoor activities a little more frequently than the average adult male.

It was decided to adapt these results to the travel study by computing a weighted average activity index for each of a selected number of counties, based on the socioeconomic profile of the county. The profile used was based on the characteristics of male heads of families and single male adults, on the assumption that almost all auto visits to parks are headed by members of that population.

A weighted component of the activity index may be computed for each socioeconomic factor in the following way. Let the index h refer to a factor, say education, and the index k refer to a subclassification of the factor, say "completed high school." Further, let a_{hk} be the component of the activity index in the (h, k) subclass. If P_h is the total male population of a county that can be classified according to the hth factor, and p_{hk} is the male population in the (h, k) subclass, we may compute a weighted component, A_h, of the activity index, corresponding to the hth factor, by

$$A_h = \Sigma_k \frac{a_{hk}\, p_{hk}}{P_h} \qquad (5)$$

Thus, the following data on "education of head of family" were used for Brown County, Indiana:

Subclass	*Population*	*Component of activity index*
Grade school, none	943	− 0.75
Some high school	374	− 0.05
Completed high school	326	0.91
Some college; has college degree	202	0.36
Total	1845	

The corresponding value of A_h is then $(943 \times -0.75 + 374 \times -0.05 + 326 \times 0.91 + 202 \times 0.36)/1845 = -0.198$ *.

To obtain the estimate of the activity index of a county, the weighted components corresponding to all the factors in Table 10 are added to the grand mean. An illustration for two Indiana counties, Marion and Brown, is also presented in Table 10.

Data for the estimation of the weighted components of the activity index were obtained from the 1960 Census of population (*36*). The categories and subclasses reported in the Census and those used by Mueller and Gurin (*35*)

* This is a slight simplification. The data quoted here refer to the male population 25 years and over, whereas the components were estimated by Mueller and Gurin on the basis of a male population 18 and over. When an adjustment is made for this discrepancy, $A_h = -0.163$. The method of making the adjustment is described in the Appendix.

did not coincide at several points. However, it is believed that a reasonable adjustment was made in every instance. The details of the computations and the adjustments are described in the Appendix.

TABLE 9
LIST OF COUNTY CODES

Indiana

1. Adams
2. Allen
3. Bartholomew
4. Benton
5. Blackford
6. Boone
7. Brown
8. Carroll
9. Cass
10. Clark
11. Clay
12. Clinton
13. Crawford
14. Daviess
15. Dearborn
16. Decatur
17. DeKalb
18. Delaware
19. Dubois
20. Elkhart
21. Fayette
22. Floyd
23. Fountain
24. Franklin
25. Fulton
26. Gibson
27. Grant
28. Greene
29. Hamilton
30. Hancock
31. Harrison
32. Hendricks
33. Henry
34. Howard
35. Huntington
36. Jackson
37. Jasper
38. Jay
39. Jefferson
40. Jennings
41. Johnson
42. Knox
43. Kosciusko
44. LaGrange
45. Lake
46. LaPorte
47. Lawrence
48. Madison
49. Marion
50. Marshall
51. Martin
52. Miami
53. Monroe
54. Montgomery
55. Morgan
56. Newton
57. Noble
58. Ohio
59. Orange
60. Owen
61. Parke
62. Perry
63. Pike
64. Porter
65. Posey
66. Pulaski
67. Putnam
68. Randolph
69. Ripley
70. Rush
71. St. Joseph
72. Scott
73. Shelby
74. Spencer
75. Starke
76. Steuben
77. Sullivan
78. Switzerland
79. Tippecanoe
80. Tipton
81. Union
82. Vanderburgh
83. Vermillion
84. Vigo
85. Wabash
86. Warren
87. Warrick
88. Washington
89. Wayne
90. Wells
91. White
92. Whitley

Illinois

93. Cass
94. Champaign
95. Clark
96. Coles
97. Cook
98. Crawford
99. DeKalb
100. Douglas
101. DuPage
102. Edgar
103. Ford
104. Grundy
105. Henderson
106. Iroquois
107. Jackson
108. Jasper
109. Kane
110. Kankakee
111. Lake
112. Lawrence
113. Livingston
114. Logan
115. McHenry
116. McLean
117. Macon
118. Madison
119. Marion
120. Marshall
121. Monroe
122. Montgomery
123. Morgan
124. Moultrie
125. Pedria
126. Piatt
127. Rock Island
128. Sangamon
129. Tazewell
130. Vermillion
131. Wabash
132. Warren
133. Washington
134. White
135. Will
136. Winebago
137. Woodford
138. Boone
139. DeWitt
140. Effingham
141. Macoupin
142. Shelby
143. Adams
144. LaSalle
145. Ogle
146. St. Clair
147. Bond
148. Carroll
149. Christian
150. Clay
151. Clinton
152. Cumberland
153. Fayette
154. Fulton
155. Gallatin
156. Greene
157. Hancock
158. Jefferson
159. Lee
160. Mason
161. Pulaski
162. Richland

Ohio

163. Allen
164. Athens
165. Auglaize
166. Belmont
167. Brown
168. Butler
169. Clark
170. Clermont
171. Clinton
172. Colombiana
173. Cuyahoga
174. Darke
175. Defiance
176. Franklin
177. Fulton
178. Greene
179. Guernsey
180. Hamilton
181. Hancock
182. Harrison
183. Highland
184. Holmes
185. Huron
186. Jackson
187. Jefferson
188. Knox
189. Licking
190. Logan
191. Lorain
192. Lucas
193. Mahoning
194. Marion
195. Medina
196. Mercer
197. Miami
198. Montgomery
199. Morgan
200. Muskingum
201. Paulding
202. Pickaway
203. Pike
204. Portage
205. Preble
206. Richland
207. Ross
208. Seneca
209. Stark
210. Summit
211. Trumbull
212. Tuscarawas
213. Union
214. Van Wert
215. Vinton
216. Warren
217. Wayne
218. Williams
219. Wood

Kentucky

220. Anderson
221. Baren
222. Boone
223. Campbell
224. Daviess
225. Estill
226. Fayette
227. Franklin
228. Greenup
229. Hardin
230. Harrison
231. Henderson
232. Henry
233. Hopkins
234. Jefferson
235. Jessamine
236. Kenton
237. McCracken
238. Marshall
239. Meade
240. Monroe
241. Oldham
242. Pendleton
243. Shelby
244. Taylor
245. Union
246. Webster

Michigan

247. Alcona
248. Allegan
249. Bay
250. Benzie
251. Berrien
252. Branch
253. Calhoun
254. Cass
255. Emmet
256. Genesee
257. Grand Traverse
258. Hillsdale
259. Ingham
260. Jackson
261. Kalamazoo
262. Kent
263. Lake
264. Lenawee
265. Macomb
266. Muskegon
267. Newaygo
268. Oakland
269. Osceola
270. Ottawa
271. Saginaw
272. St. Clair
273. St. Joseph
274. Tuscola
275. Van Buren
276. Washtenaw
277. Wayne

Missouri

278. Butler
279. Franklin
280. Jefferson
281. Maries
282. St. Louis

Wisconsin

283. Brown
284. Calumet
285. Chippewa
286. Dane
287. Jefferson
288. Kenosha
289. Milwaukee
290. Polk
291. Racine
292. Richland
293. Rusk
294. Sheboygan
295. Washington
296. Waukesha

TABLE 10

COMPARISON OF ACTIVITY INDEXES FOR TWO INDIANA COUNTIES

FACTOR	COMPONENT OF ACTIVITY INDEX	WEIGHTED COMPONENT OF ACTIVITY INDEX	
		MARION COUNTY	BROWN COUNTY
Income:		0.154	−0.052
Under $3,000	−0.88		
$3,000-4,999	0.02		
$5,000-7,499	0.41		
$7,500-9,999	0.45		
$10,000 and over	0.26		
Education of head:		0.040	−0.163
Grade school; none	−0.75		
Some high school	−0.05		
Completed high school	0.91		
Some college; has college degree	0.36		
Occupation of head:		0.128	0.039
Professional	0.11		
Manager; officials	0.54		
Sales personnel; clerical	−0.92		
Craftsmen	0.41		
Laborers	0.06		
Service workers	−1.36		
Farm operators	−0.27		
Retired and others not in labor force	−0.20		
Paid vacation:		—[a]	—[a]
None	−0.34		
1 week	−1.03		
2 weeks	0.27		
3 weeks	0.72		
4 weeks or over	1.09		
Place of residence:		−0.422	0.610
Central cities	−0.74		
Suburban areas	−0.12		
Adjacent areas	0.38		
Outlying areas	0.61		
Region:		0.180	0.180
West	0.54		
North Central	0.18		
Northeast	−1.03		
South	0.34		
Age of head:		0.268	0.076
18-24	1.93		
25-34	0.99		
35-44	0.49		
45-54	−0.11		
55-64	−0.84		
65 and over	−2.04		
Life cycle:		0.108	0.070
Single adult under 45	1.01		
Married, under 45, no children	0.75		
Married with children 4½ years or less	−0.04		
Married with children between 4½ and 18	0.47		
Married, over 45, no children	−0.61		
Single adult over 45	−0.39		
Race of respondent:		−0.069	0.238
White	0.24		
Nonwhite	−2.06		
Grand mean	6.74	*6.740*	*6.740*
County activity index, sum of components		7.13	7.74
Normalized index [b]		0.93	1.01

[a] Occupation and vacation were combined, as described in the Appendix. [b] County index/Avg. index (= 7.66).

CHARACTERISTICS OF RECREATIONAL AREAS—REGRESSION ANALYSIS

It was decided early in this program that if the influence of the characteristics of recreational areas on visitor attraction were to be studied, the most promising method was some form of multiple regression analysis. The approach of the analysis was to fit an equation that represented the number of observed trips to a recreational area as a function of a number of variables that described a collection of such areas in terms of their known characteristics. The purpose was twofold:

1. To try to gain some insight into what makes for "attractiveness" in a recreational area.
2. To develop a prediction equation that could be generalized and extended to other areas.

The starting point of our analysis was Schulman's work (*3*), previously referred to. For his model Schulman considered the 48 variables given in Table 11. Because observations of visits were available for only 20 parks, only (at most) a general mean and 19 other parameters could be estimated. Schulman selected the 19 variables that were pairwise most highly correlated with the observed visits (the first 19 in Table 11). His equation (corrected)* in ten variables is Eq. 6 in Table 12.

The motivation in undertaking an independent analysis of the same data was the hope that a nonlinear regression model would result in a better fit than the linear model, and that a nonlinear model might give some insight into the way in which the variables affected attendance.

Fortunately, Schulman's original data for all variables were obtainable from Prof. W. L. Grecco at Purdue University. On examining these, it was evident that some variables were redundant and could be eliminated. For example, variables 15 and 44, "waterfront located on premises" and "swimming allowed" exactly duplicate each other; that is, one occurs precisely where the other does.† In the same way, because they either duplicated or complemented other variables, Nos. 10, 11, 17, 20, 28, 32, 41, 46, and 48 were eliminated.

On further consideration, it appeared highly doubtful that individual dichotomous variables such as "availability of laundry tubs" and "archery course" could have, by themselves, a significant effect on attendance. It was decided to group most of those that had not already been eliminated for redundancy into one of two classes that were called "amenities" and "activities," respectively. In the first group were placed eight variables (Nos. 5, 6, 13, 18, 21, 25, 26, and 37) that generally contribute to comfort and convenience (for example, showers and hot water). Under activities are included such things as water skiing and fishing. This group contains eleven items (Nos. 12, 14, 24, 31, 33, 35, 38, 40, 42, 47, and a single tally if there are either wildlife exhibits (34) or a museum (43) or both). Swimming (44) was retained as a separate variable. The total number of items in each group was tallied for each park and treated as a new variable in the subsequent analysis.

It had been intended to precede the regression analysis with a factor analysis, as a means of reducing the total number of variables to a manageable number, and to group related variables. This proved to be unnecessary, inasmuch as the objectives had been attained by the *ad hoc* analysis just described. Before proceeding to the non-

TABLE 11

VARIABLES CONSIDERED FOR THE REGRESSION ANALYSIS

VARIABLE NUMBER	DESCRIPTION
1	Number of picnic tables
2	Number of campsites
3	Area of lakes
4	Acres of park intensively developed
5	Availability of flush toilets
6	Bathhouse on premises
7	Number of cabin rooms
8	Area of picnic shelters
9	Total capacity of guest-living facilities
10	Lectures given
11	Beach available
12	Fishing permitted
13	Availability of showers
14	Naturalist service available
15	Waterfront located on premises
16	Number of foot trails marked
17	Location on river
18	Availability of electricity
19	Population within 60 miles
20	Availability of pit toilets
21	Availability of laundry tubs
22	Number of rooms in inn
23	Dining room capacity
24	Recreation field on premises
25	Availability of firewood
26	Concessions provided
27	Total acreage of park
28	Drinking water provided
29	Number of private baths
30	Miles of park drives
31	Bridle trails provided
32	Saddle barn on premises
33	Water skiing allowed
34	Wildlife exhibits
35	Playground equipment available
36	Population within 10 miles
37	Availability of hot water
38	Tennis and other games
39	Population within 30 miles
40	Boat launching sites available
41	Pool on premises
42	Archery course
43	Museum on premises
44	Swimming allowed
45	Capacity of group camps
46	Hiking conducted
47	Bicycles rented
48	Boats rented

* Schulman (*3*) defines the dependent variable as the number of trips to a park per weekend Actually, this should be corrected to tens of trips. The coefficients of variables *B* and *F* have also been corrected. Correspondingly, the standard error of estimate is ten times the value reported; i.e., 309 instead of 30 9.

† Because of this, it is difficult to understand why one should be listed as having the 15th highest correlation with number of visits and the other should be 44th.

TABLE 12

REGRESSION EQUATIONS FOR ATTRACTIVENESS OF PARKS

EQ. NO.	EQUATION [a]	MULT. CORR. FACTOR	STD. ERROR (TRIPS)
(6)	$Y = -903.6 + 6.1T - 5.8C + 3.6L + 2.2D - 646.3B - 2.6G + 726.5F - 430.0R + 217.7E + 0.01P$	0.926	309
(7)	$Y = 188.5 + 2.51T + 4.34L + 1.11S - 25.26H - 48.19A$	0.965	235
(8)	$Y = -432.8 + 4.14T + 10.81L + 80.67H - 0.0032T^2 + 0.0130L^2 - 12.07A^2 - 0.0367TL + 0.00736TS + 0.0236LS - 0.219HS$	0.988	178
(9)	$Y = 316 + 2.8T + 6.6L + 1.1S - 58.4H + 1.1D - 45.4A$	0.982	234

[a] Y = Estimated average trips per weekend
T = Number of picnic tables
C = Number of campsites
B = Availability of bathhouse
F = Availability of fishing
R = Location on a river
E = Availability of electricity
L = Area of the lake (tens of acres)
D = Acres of park extensively developed
G = Capacity of total living facilities
P = Population within 60 miles of park (in thousands)
S = Area of picnic shelters (tens of square feet)
H = Number of hiking trails
A = Amenities

linear regression, a linear multivariate regression equation was estimated,* using all of the surviving variables. These were Nos. 1, 2, 3, 4, 8, 9, 16, 19, 23, 44, 45, and amenities and activities. Eq. 7 (Table 12) presents the fit with the smallest standard error, in five variables. From this, it was decided to try a nonlinear fit, estimating coefficients for pure quadratic terms in all five variables, and all cross-product terms in the four most important variables. No cross-product terms with amenities were estimated, because prior analysis showed the effect of this variable to be marginal. The results, an 11-term equation, appear as Eq. 8 (Table 12). It is evident that this is a much better fit of the data than a linear equation provides.

* All the analyses done at IITRI were with an IBM 7094 computer, using the BMDO2R stepwise regression routine of the Biomedical Computer Programs of the University of California, Los Angeles.

Table 13 presents the observed and estimated values for the 18 parks in the analysis. (Two parks, Chain O'Lakes and Kankakee River, were not included in the analysis as they did not appear to be in full operation in 1964 and had small numbers of visitors.) A graphical comparison is shown in Figure 3. It should be noted that "visitors" means number of autos. No information on vehicle occupancy was available.

The single best predictor of the number of visitors is the number of picnic tables. In some ways, this is a disappointing result, though not without value. It is much easier to believe that the numbers of picnic tables are an effect of the visitor demand on a park rather than a cause. Otherwise, the planners of a new facility could ensure

TABLE 13

WEEKEND VISITORS TO INDIANA STATE PARKS

STATE PARK	AVG. NO. OF WEEKEND VISITORS: OBSERVED	PREDICTED	DIFF.	PEAK WEEK-END	RATIO, PEAK / AVG.
1. Bass Lake	498	773	+275	1069	2.1
2. Brown County	1721	1790	+69	2087	1.2
3. Clifty Falls	821	757	−64	1111	1.4
4. Indiana Dunes	3255	3276	+21	4338	1.3
5. Lieber	1367	1387	+20	1931	1.4
6. Lincoln	704	757	+53	914	1.3
7. McCormick's Creek	860	942	+82	1066	1.2
8. Mounds	322	352	+30	603	1.9
9. Pokagon	1749	1654	−95	2383	1.4
10. Raccoon Lake	1667	1496	−171	2373	1.4
11. Scales Lake	193	103	−90	298	1.5
12. Shades	380	418	+38	467	1.2
13. Shakamak	912	721	−191	1207	1.3
14. Spring Mill	1446	1575	+129	1749	1.2
15. Tippecanoe River	348	393	+45	413	1.2
16. Turkey Run	1228	1099	−129	1531	1.2
17. Versailles	1239	1279	+40	1709	1.4
18. Whitewater	1635	1560	−75	2463	1.5

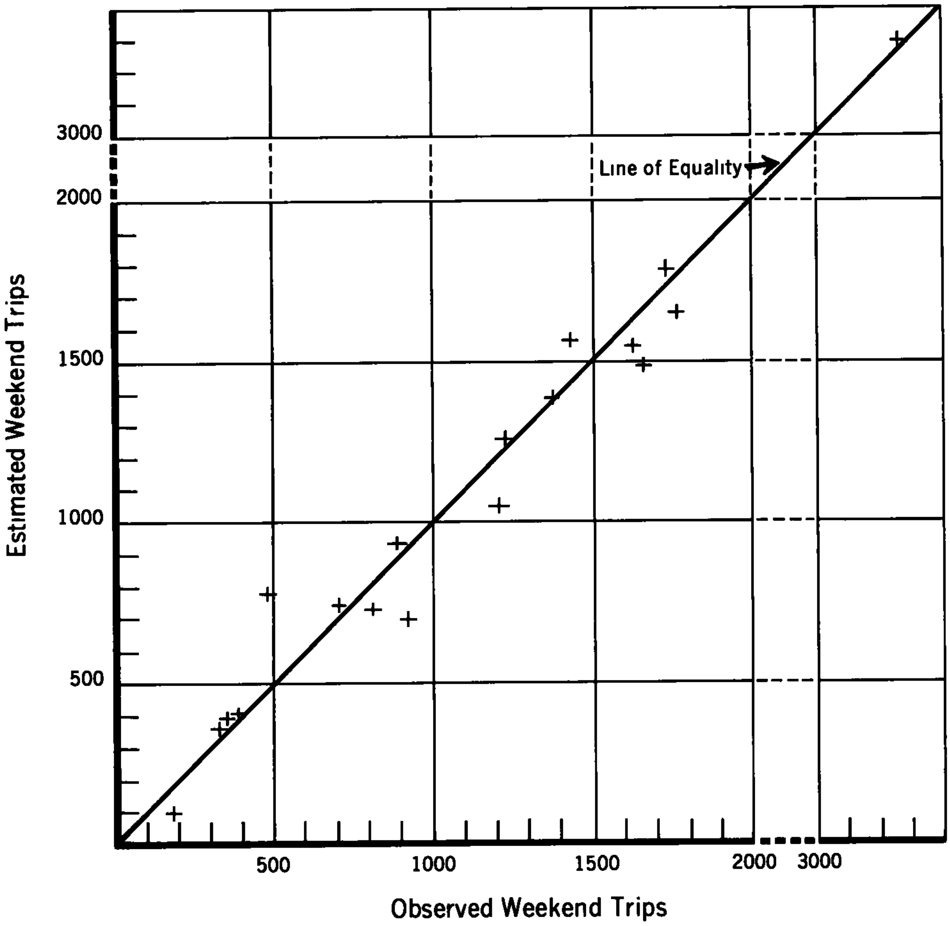

Figure 3. Observed vs estimated average number of weekend trips to 18 Indiana State parks.

the attraction of large numbers of visitors simply by providing a large number of picnic tables.

The average number of visitors (cars) per table per weekend over all parks is 3.7. The largest single deviation from the average occurred at Raccoon Lake, where there were 9.5 weekend visitors per table (the ratios at the other parks were between 1.9 and 5.1, and 13 of the 18 were between 2.2 and 3.9). A plausible explanation for this is that this recreational area has the second largest lake of all the parks in Indiana. Inasmuch as the size of lake (where there is one) runs picnic tables a close second as a predictor of visitors, this is a reasonable result. It is also more believable that this variable will represent an attractor of visitors, as many studies have attested to the importance of swimming as an outdoor recreational activity in summer.

The next variable, the number of hiking trails, is somewhat more difficult to explain, although this doubt may represent a personal bias on the part of the author. Apart from the importance of hiking as an attractive park activity, it may be noted that the number of trails is correlated to some extent with the number of picnic tables and the size of the park, and thus may be an indirect measure of these other variables. The effect of amenities appears only in the quadratic term, and as a negative factor, and must therefore be regarded as a spurious effect. Similarly, no significance can be attached to the cross-product terms, except as fortuitous correction terms contributing to an improved fit.

It was surprising to the author that three variables that might be expected from *a priori* considerations to have important positive effects on attractiveness did not appear as such. One of these is amenities, which already has been discussed. The second is activities. One would think that the greater the variety of activities one can engage in, the greater would be the attractiveness of a park. However, this effect did not appear. The third variable is population around the park (within 60 miles). Again, one would expect that the more people available to visit, the greater would be the number of visitors, but this too was not reflected in the equations.

Thus, of all the factors in the equations the only one that is credible as a causative predictor is the size of lake, and others that were expected to be predictors do not appear. One is led to the conclusion that the Indiana parks are operating at or near capacity. This would explain the insensitivity of the results to the size of the area population, and to other measures of attractiveness.

Some interesting light is thrown on this question by looking at the figures for the peak weekend at each park; that is, the weekend among the 13 of the survey when the greatest number of visitors was observed. As is noted later, the date of this weekend varied from park to park over the entire summer. The ratio of the peak to the average weekend visits is shown in Table 13. Except for two high values (1.9 and 2.1), the ratios are all between 1.2 and 1.5.

A simple linear regression was computed for the peak weekend trips. This is shown as Eq. 9 in Table 12. It is interesting to note that the significant variables are the same as in Eq. 7, for the average weekend, except that one variable, the number of acres of the park that are extensively developed, has been added. It is reasonable to regard this variable as a measure of the capacity of the park with regard to one-day visitors. This observation would seem to support the hypothesis that the Indiana parks attract visitors mainly in proportion to their capacity.

On an average summer weekend in 1963, something over 20,000 visits to all 20 State parks were observed. At a rough estimate, these visitors were drawn from an area with 2 million auto-owning households. Inasmuch as about two-thirds of the visits were on Sunday, this comes out to the order of 2 visits per 300 households.

In Kansas, observations made in 1963-4 at eleven Federal reservoir recreational areas showed about 20,000 trips on an average Sunday (*4*). Estimating some 600,000 auto-owning households in the feeder area, this results in 10 visits per 300 households, or 5 times the rate in Indiana.

One can only guess at the reasons for this difference. It could be explained on the basis that Kansans have many fewer places at which they can pursue water-oriented outdoor activities than do Indianans, and that the recreational capacities of the reservoirs near the larger population concentrations are greater than those of most Indiana parks. Indeed, five of the eleven reservoirs had an average of more than 1,900 trips, whereas only one of the Indiana parks had more than that number.

The Kansas study reports a regression equation for estimating reservoir trip ends in an approach similar to that reported here. It is, in effect, a quadratic equation in five variables, including the number of grills provided, the area of the conservation pool, a factor representing the type of surface on the access road, and the populations in a 50-mile radius around the reservoir and in a 50- to 100-mile ring, respectively. The heaviest population concentration occurred in the 50- to 100-mile rings, and this factor was the more significant of the two population variables.

Two of the five variables in the Kansas study—the number of grills and the area of the conservation pool—are comparable to the number of picnic tables and the area of the lake in the current study equation. It is interesting to note that population appears as an important factor in the Kansas equation but not in the present one. A sensitivity to population concentration in Kansas might indicate that the reservoirs are not used to capacity for recreation, in contrast to the situation in Indiana.

One additional comparison of the Indiana and Kansas data is of interest. In Indiana, the O-D survey showed that 50 percent of the trips originated within 50 miles of the parks, 80 percent within 105 miles, and 90 percent within 148 miles. The comparable figures for Kansas are under 40 miles, 80 miles, and 110 miles, respectively.

The differences, such as they are, would seem to be a function of the differences in the distribution of population concentrations in the two areas. The heavily populated areas in Kansas are sparser and farther apart than in Indiana, but in general relatively close to one or more reservoirs in the survey.

TIME DISTRIBUTION OF TRAVEL

A number of useful studies were found containing information relating to the time distribution of outdoor recreational travel. Undoubtedly other similar studies exist, but enough information was obtained to present the outlines of the variation in traffic volume by month of the year, day of the week, and time of day. The purposes of the several studies varied, consequently the bases of the data are not completely consistent. However, whenever possible, adjustments have been made to permit comparisons.

Time Distribution by Month

Four sets of data relating to month-by-month variation in travel are plotted in Figure 4. The purposes of travel varied, ranging from "overnight vacation-recreation trips" (*19*), to "(non-local) travel and tourism" (*14*), to travel for "outdoor sports, vacation, and viewing scenery" (*15*), to "vacationing in State park and State forest tourist cabins" (*16*). The data are discussed in turn, as follows:

1. Overnight vacation-recreation trips of Wisconsin residents (*19*). The trips include those taken out of State as well as in-State. The original data were divided into four classes, according to the size of the home community of the respondent. Those data have been weighted by class size and combined into a single set in Figure 4. More than one-half of the trips were taken in June, July, and August.

2. The only other complete set of data concerns cabin vacationists in West Virginia State parks and forests (*16*). These data, covering all twelve months, are somewhat biased, because not all parks and forests make their cabins available all year around. Thus, the data for the colder months probably underestimate the proportion of total visits made to the West Virginia facilities, and consequently overestimate the proportion in the warmer months. For example, 78 percent of the cabin visits occur from June to October, compared to 67 percent of vacation-recreation trips during those months in the Wisconsin data.

3. A third set of statistics concerns non-local travel and tourism in West Virginia (*14*). The data cover only the months June through October. Purposes of travel included other reasons besides outdoor recreation (for example, business and social and family visits). Many travelers gave more than one reason for their trip. Vacationing

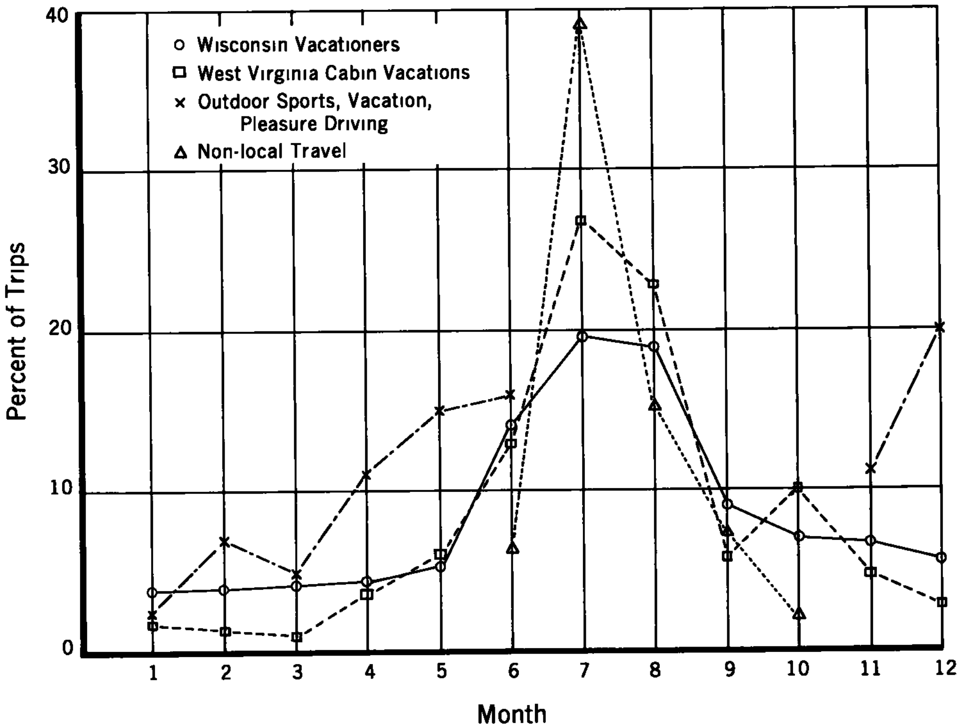

Figure 4. Monthly variation in vacation travel.

was mentioned by almost one-half, one-fifth were viewing scenery (pleasure driving), and a little more than 5 percent were engaged in outdoor sports.

Because the original data were in terms of percent per month over the surveyed 5-month period, an adjustment has been made to make this set comparable to the 12-month sets. Based on the latter sets, it was estimated that roughly 70 percent of the year's non-local travel occurs from June through October. Thus, the corresponding points in Figure 4 have been multiplied by 0.7.

4. The fourth set of data covers only an 8-month period, from November through the following June. It is similar in scope to the previous set, but was taken in a relatively small area of West Virginia (*15*). These data have also been adjusted for plotting in Figure 4, but are not comparable to the other data, except to show month-by-month trends. The adjustments were made as follows: The percentages of travelers each month indicating outdoor sports, vacation, or pleasure driving as the principal reason for travel were added for each month. These numbers were multiplied by the percent by month of annual travel, available from the same report. The resulting percentages are quite small, ranging from 0.2 to 2.0. Because these values are so small, they have been scaled up by a factor of 10 in the plot.

The one notable thing about these data is that, over the period surveyed, the greatest number of recreation-vacation trips occurred during December. This is explained in part by the fact that more than one-fourth of the trips surveyed in December were for the purpose of engaging in outdoor sports, compared to 3 percent each in February and April. It is surprising, however, that only 1 percent of January travelers were engaging in winter sports. The report does not explain the contrast between December and January except indirectly, by stating that the samples in the winter months were so small that the data are of questionable reliability. Beyond this, one may conjecture that the area surveyed has some facilities for winter sports and that conditions for these sports were much better in December than in January.

The general conclusions from the four sets of data are simple. It will surprise no one to learn that July is the most popular month for recreational travel, followed closely by August and less closely by June and September, in that order. Of the overnight vacation-recreation trips originating in Wisconsin, 52 percent occur during the months of June through August. Remembering the bias of cabin vacation statistics with respect to outdoor recreational trips in general, 63 percent of the cabin trips were made during the same three months.

Time Distribution by Day of Week

Two groups of data were available for day-to-day variation in traffic volume, as follows:

1. The first group were in two West Virginia surveys (*14, 15*). These data (Table 14), it will be recalled, refer in general to non-local travel, only part of which was for outdoor recreation.

In the first case, heaviest traffic was on Saturday, with

TABLE 14

DAY-OF-WEEK VARIATION IN WEST VIRGINIA NON-LOCAL TRAFFIC

DAY OF WEEK	PERCENT OF TOTAL REF. *14*	REF. *15*
Sunday	13.4	17.0
Monday	16.5	13.7
Tuesday	13.1	12.5
Wednesday	10.4	15.0
Thursday	13.1	13.6
Friday	13.1	14.0
Saturday	20.4	14.3

twice the load of the most lightly traveled day, Wednesday. In the second set, the heaviest traffic was observed on Sunday, with Wednesday almost as heavy. The second set presents the averages of data taken at nine separate survey points, which showed considerable variation among them. There is insufficient collateral information to allow any attempt at explaining these variations.

One could say, on the basis of these data, that on the average tourist and related traffic is fairly constant throughout the week, with a small peak on the weekend. However, too many large local variations are smoothed out in the averages to be able to draw useful conclusions for roads in the vicinity of specific recreational areas.

2. There is a much more useful set of data in the Indiana park survey (*3*), in which attendance for 18 Indiana State parks cover 13 weeks over the 3-month June-to-August period. The data presented do not give a day-to-day breakdown, but show the total number of visitors during the week (for each park), and the number and percentage of visitors on the weekend. The weekend is counted from Friday morning through Sunday evening.

In the analysis, the data corresponding to the Memorial Day and July 4th holidays are separated out. Because both holidays occurred on Thursday in the year of the survey, there was a significant decrease in the percentage of visits on the following weekend. The percentages on those weekends were about halved, compared to preceding and succeeding weekends. In terms of numbers, all but one of the parks received substantially fewer visitors on the weekend following July 4th than on the preceding weekend. At one-half the parks, there were also fewer visitors on the weekend immediately after July 4th than on the weekend succeeding that one, although the differences were not as great. It is not known whether the weather had anything to do with this. By contrast, the totals for the week including the holiday showed the greatest number of visitors for the entire season at almost every park.

TABLE 15

WEEKENDS RANKED BY VOLUME OF VISITS

WEEK ENDING	AVERAGE RANK	RANK OF AVERAGE RANK
June 2	9.2	9.5
June 9	5.8	6
June 16	9.0	8
June 23	4.9	4.5
June 30	3.7	1
July 7	9.5	11.5
July 14	9.2	9.5
July 21	3.8	2
July 28	6.2	7
Aug. 4	4.3	3
Aug. 11	4.9	4.5
Aug. 18	9.5	11.5
Aug. 25	10.9	13

Minus the two indicated weekends, the average percentage of weekend visits was 66.4, with a standard deviation of 0.7. Scales Lake State Park, near the southwest corner of the State, had the fewest visitors, averaging about 200 per weekend; Indiana Dunes State Park, on Lake Michigan, had the greatest number, averaging more than 3,000 per weekend. One-half the parks averaged more than 1,000 per weekend.

To get an idea of weekend-to-weekend variation, the weekends within each park were ranked from 1 to 13, with the heaviest attendance given rank 1. The ranks, averaged over all parks, are listed by weekend in Table 15. These averages have been ranked in turn. In the case of ties, pairs of ranks were averaged.

The ranks among parks vary considerably, but examining average ranks, the weekends ending June 9, 23, and 30; July 21 and 28; and August 4 and 11 had the heaviest traffic. Extreme individual variations are shown in Table 16. Peaks occurred at 11 parks in June, 5 in July, and 2 in August. Minima were 11 in August, 4 in July, and 3 in June. These numbers and those in Table 15 may seem to contradict the previous statement that the heaviest recreational traffic occurs in July and August, but in fact these is no contradiction; if monthly attendance rather than weekend figures are compared, July and August are still the most heavily attended months. However, the contrast between weekend figures and monthly totals is itself of interest.

Examining the ratios of maximum to minimum number of visitors, one-half were between 1.7 and 2.0.

Hour-by-Hour Time Distribution

Schulman (*3*) gives extensive data on arrivals at the five parks surveyed (Mounds State Park, besides the four previously mentioned) from 4 PM on Friday to 9 PM on Sunday. There are no important differences among the parks in this respect. The principal results are given in Table 17 and Figure 5, showing the hourly distribution of arrivals, combined for the five parks. Arrivals on Friday, Saturday, and Sunday were 6.9, 24.5, and 68.6 percent, respectively. Daily peaks occurred between 6 and 8 PM on Friday and around 1 PM on Sunday. There is a relatively constant rate of arrivals between 11 AM and 3 PM on Saturday.

TABLE 16
EXTREME VARIATIONS IN WEEKEND VISITS TO INDIANA PARKS

PARK	HEAVIEST WEEKEND NO. OF VISITORS	HEAVIEST WEEKEND WEEK ENDING	LIGHTEST WEEKEND NO. OF VISITORS	LIGHTEST WEEKEND WEEK ENDING	RATIO OF GREATEST TO SMALLEST NO. OF VISITORS
Bass Lake	1069	6-30	120	8-18	8.9
Brown County	2087	6-23	1417	7-14	1.5
Clifty Falls	1111	8-18	605	6-9	1.8
Indiana Dunes	4338	6-30	2310	8-25	1.9
Lieber	1931	6-9	755	8-25	2.6
Lincoln	914	6-30	456	8-25	2.0
McCormick's Creek	1066	6-23	567	7-7	1.9
Mounds	603	7-21	193	7-7	3.1
Pokagon	2383	6-30	1300	8-18	1.8
Raccoon Lake	2373	6-30	965	8-25	2.5
Scales Lake	298	6-9	100	8-18	3.0
Shades	467	7-21	281	8-25	1.7
Shakamak	1207	6-9	667	8-18	1.8
Spring Mill	1749	7-7	1036	6-2	1.7
Tippecanoe River	413	7-14	270	6-9	1.5
Turkey Run	1531	7-28	860	7-7	1.8
Versailles	1709	8-4	701	8-25	2.4
Whitewater	2463	6-9	666	8-25	3.7

Using average figures, it is estimated that the maximum traffic load of about 12.6 percent of arrivals will occur during a 1-hr period around 1 PM on Sunday. This reduces to the following numbers of arrivals for four of the parks:

Park	*Peak-Hr Traffic Load* *Estimated*	*Peak-Hr Traffic Load* *Observed*
Brown County	204	197
Shades	55	44
Tippecanoe River	55	45
Turkey Run	158	177

No information was available on duration of stay, which would permit an estimate of loads on parking facilities.

A PREDICTION MODEL

The following discussion is intended to apply to the establishment of new facilities, either through the expansion of existing parks or the creation of new ones.

First, consideration is given to an area like Indiana, where the State parks appear to be operating at or near capacity and a need probably exists for more rural outdoor recreational areas. The first step in planning for a sizable addition should be a Statewide survey of recreational attitudes, needs, and practices, similar to that conducted in Connecticut (*5*). At the same time, origin-destination counts should be made at all of the State parks and, so far as possible, competing areas of comparable character. For the reasons discussed under the section on "Trip Distribution Models," distribution and prediction models can have only limited value unless they include all significant competing areas.

An analysis of the distribution of distances traveled to recreational areas, county by county, should be instructive. Counties, or groups of counties, whose residents were traveling the farthest would indicate areas with a deficiency of recreational opportunities that could be met by the establishment of local parks.

At this point, the trip distribution model should be recomputed, preferably using the activity weighting on auto ownership as a measure of county-based trip generation

TABLE 17
HOURLY DISTRIBUTION BY PERCENT OF TOTAL WEEKEND TRIPS TO ALL STATE PARKS

TIME OF DAY	PERCENTAGE OF TOTAL TRIPS FRIDAY	SATURDAY	SUNDAY
8-9		1.13	0.74
9-10		1.47	2.98
10-11		2.87	7.22
11-12		2.85	10.86
12-1		2.53	12.57
1-2		2.79	11.11
2-3		2.85	9.98
3-4		2.03	6.41
4-5	1.15	1.78	4.30
5-6	1.38	1.49	2.22
6-7	1.57	1.36	0.09
7-8	1.59	0.82	0.05
8-9	1.17	0.49	0.02

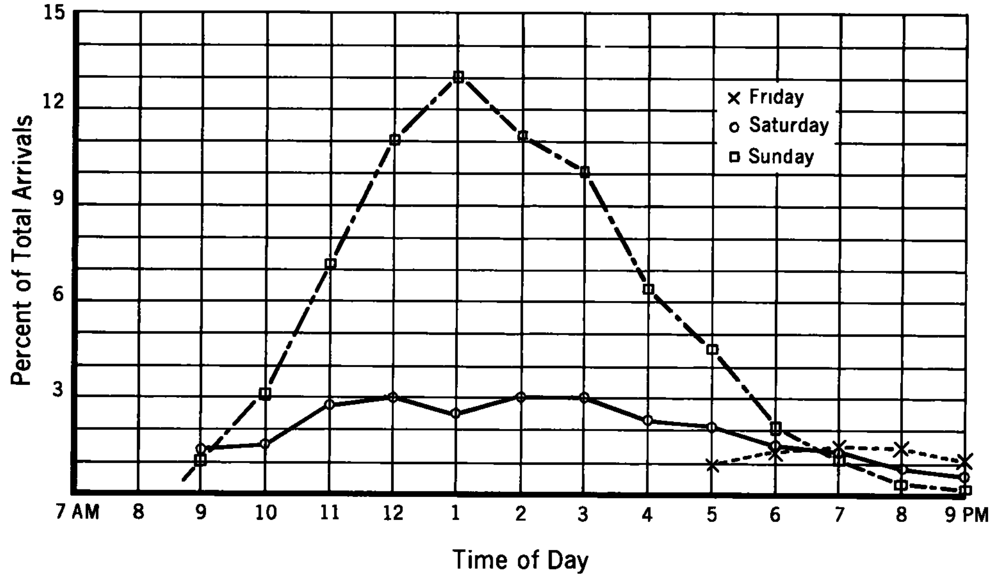

Figure 5. Distribution of arrivals to all Indiana State parks by time of day.

potential, or a similar measure. The main purpose of this computation would be to produce a new calibration utilizing the expanded data base.

The results of this computation might also be used to identify areas whose recreational opportunities needed to be expanded. For example, in the four-park survey 655 weekend trips were observed to originate from Marion County (Indianapolis), whereas only 476 were estimated. The nearest of the parks to Indianapolis is 49 miles away (Brown County). This could indicate, if the estimation model is otherwise correct, that there is a shortage of outdoor recreational facilities around Indianapolis.

Next, Eq. 8 (Table 12) could be used to estimate the number of visitors that a new facility might attract. The first requisite in design seems to be a sizeable body of water that can be used for swimming and other water activities. The number of picnic tables must be regarded as a measure of capacity. Interpretation of this measure in terms of the spacing of tables and the corresponding developed acreage required must be left to experts in park design and management. Plans for an appropriate number of hiking trails should also be included. Beyond this, although additional development in terms of amenities and activities does not enter the equation, one would think that a certain minimum level of such development would be necessary in terms of good design alone.

The point about the insensitivity of the prediction to surrounding population, although it is difficult to accept, is reiterated. In further support of this point, it is noted that four parks (Lincoln, Scales Lake, Shakamak, and Spring Mill) each had populations between 5.1 and 5.5 million within 60 miles, yet their average weekend visits were 704, 193, 912, and 1,446, respectively, a considerable range.

A final check on the prediction would require recomputation of the distribution model, using the Statewide-calibration travel time factors, to estimate the numbers of visitors to the new park from the counties, and to estimate its effect on its closest competitors.

A similar approach would be recommended for an area like Kansas, but a different estimating equation should be used, to reflect the previously noted sensitivity there to population factors.

Extensive Statewide or regional surveys of the kind that has been recommended are difficult to perform and expensive, but they appear to be a prerequisite to the rational planning of costly new recreational facilities. More light should be thrown on this question when the results and analysis of the Connecticut study (*5*) become available.

CHAPTER THREE

CONCLUSIONS

A number of conclusions and some working hypotheses can be drawn from the results of this research, as follows:

1. The calibrated *F*-factor form of the gravity model reproduces the distribution of trips over the observed 590-mile range acceptably well. County trip-ends, with the exception of a small number of large discrepancies, are also well reproduced.

2. Three measures of the recreational trip-generating potential of a county were used in the gravity model. They were:

(a) Number of housing units in the county.
(b) Number of households owning at least one auto.
(c) Auto ownership multiplied by an activity index, representing the relative average frequency of participation of the county's population in outdoor activities.

Of the three, the last appeared to give the best results, but only by a narrow margin over auto ownership.

3. The activity index was developed from a multiple classification analysis technique using data on the socioeconomic profile of a county. On general principles, this appears to be a better estimating method than linear regression, as most factors (for example, years of schooling) do not have a linear effect on frequency of participation in outdoor activities. Although there were indications that the activity index does reflect observed differences of recreational activity among counties, its effect was not sufficiently great to justify an unequivocal recommendation. It needs to be tested on a wider data base that includes all significant competing recreational areas, and will probably have to be modified on the basis of that test. However, there is too much evidence, from too many sources, indicating the influence of socioeconomic factors on recreational patterns, to consider the abandonment of this approach.

4. Regression equations estimating average number of weekend visits and peak weekend visits, respectively, to 18 Indiana State parks showed good results. The regressions were on a relatively small number of park characteristics. The principal indicators of attractiveness were measures of general capacity (picnic tables and the size of the intensively developed area of the park), and the capacity of the park for water-oriented activities (the size of the lake, where there was one). Surprisingly, the estimate did not reflect the degree of development of the park, in terms of amenities or activities. Also, no effect of differences in the size of the feeder populations was observed.

5. In the case of the average weekend estimate, a quadratic regression equation, with interaction terms, gave better results than a simple linear equation.

6. The interpretation of the results of the regression analysis was that the Indiana State parks were operating at or near capacity. A comparable analysis of visits to Federal reservoir recreational areas in Kansas showed the number of visits to be sensitive to measures of capacity, as in Indiana, but also to population size factors. This difference is attributed to differences in population distribution in the two States, and to differences in the numbers and types of outdoor recreational opportunities available to the two populations.

7. Because of what was judged to be an inadequate data base, no attempt was made to predict the attractiveness of a new recreational area in Indiana. However, using the elements of the gravity model, the socioeconomic model, and the park attractiveness regression model, a prediction model was described, and recommended for use with a comprehensive data base.

CHAPTER FOUR

SUGGESTED ADDITIONAL RESEARCH

Based on the findings of this study, two lines of useful additional research are suggested, as follows:

1. A model for the prediction of the traffic attraction of planned new facilities was outlined in Chapter Three. It is believed that this model would also be useful for identifying areas of a region that are particularly in need of new rural outdoor recreational facilities.

The requirements of a data base for applying this model were also outlined. The author is not aware of the existence of any comprehensive sets of data such as are thought to be required, except in Connecticut, where a thorough study and analysis of those data is under way (*5*). Unless comparable data can be found elsewhere, further research along these lines would have to rely on the planning and funding of a thorough survey in an appropriate area.

2. The regression analyses of the attractiveness of recreational facilities were based on more easily obtainable sets of data. For these it was sufficient to have data on the numbers of trips to the facilities, general demographic data, and data on the characteristics of the facilities.

It is believed that it would be useful to extend this analysis to a substantial number of additional areas, including not only State park and reservoir systems, but also vacation areas such as National parks and forests. Data for such analyses could be obtained with a relatively modest amount of effort and funding.

With the results of these analyses, it is hoped that it would be possible to generalize the hypotheses that were formulated regarding factors controlling visits to the Indiana and Kansas systems, and to characterize regions and types of recreational systems over a broader range of characteristics. Such a study would also contribute broader insights to the problems of planning new facilities.

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APPENDIX

CALCULATION OF WEIGHTED COMPONENTS

As was noted in Chapter Two under "Socioeconomic Factors—Activity Index," data from the *1960 Census of Population* (*36*) were used to compute the weighted components of the activity index. Because the subclassifications in the Census tabulations did not always coincide with the factor subclassifications given in Table 10, a number of adjustments had to be made in the computations. In general, where county breakdowns were missing in a few subclasses, weighted averages were computed from the Statewide data.

The formats and table numbers are identical from part to part of the Census reference. In the following sections, references to table numbers of all the sources are given, except that references to Table 10 are always to Table 10 in this report. A numerical example of the computation is given for each factor, based on data for Brown County, Indiana.

INCOME

The data are taken from Table 86.

Subclassifications coincided, except that there was no division in the Census data at $7,500. Adjacent divisions, to be combined into two subclasses, were $5,000-5,999, $6,000-6,999, $7,000-7,999, $8,000-8,999, and $9,000-9,999.

In a sampling of counties, it was noted that the number of families with incomes in the $7-8,000 range was about one-half the sum of incomes in the $6-7,000 and $8-9,000 ranges, and that there were always fewer families in the top range than in the low range. Based on this observation, a formula for a weighted split of the $7-8,000 range was developed. A few computations based on this procedure were compared with computations in which the numbers in the $7-8,000 range were simply split in half. No significant difference was observed, so the simpler procedure was adopted.

Example

Range	Number of Families	Component of Activity Index	Product, No. × Component
Under $3,000	506	− 0.88	− 445
$3,000-4,999	411	0.02	+ 8
$5,000-7,499	509	0.41	+ 209
$7,500-9,999	201	0.45	+ 90
$10,000 and over	173	0.26	+ 45
Total	1800		− 93

Weighted component = − 93/1800 = − 0.052

EDUCATION OF HEAD

Table 83 contains an adequate breakdown, by county, of the completed education of males over 25 years of age. No such breakdown is available for completed education of males 18-24. Inasmuch as the basis of the activity index component is completed education of males 18 and over, a weighted adjustment was made for the 18-24 class, based on Statewide data. Let

f = Statewide fraction of married male heads between 18 and 24 (data in Table 110).
$1 - f = k$ = fraction of male heads 25 and older.
t = number of male heads in county 25 and older.

Statewide data on the education of males in the 18-24 group, from Table 102, were used to compute a weighted component of activity, a_0, for this group.

The number, d, of males 25 and over with a grade school education or less is found by difference from

$$d = t - (s + h + c) \qquad \text{(A-1)}$$

in which

s = number with some high school;
h = number of high school graduates; and
c = number with at least some college.

The corresponding components of the activity index are a_d, a_s, a_h, and a_c. Then the county weighted component of the activity index is found from

$$k\left\{a_d\left[\frac{t-(s+h+c)}{t}\right] + s\,a_s/t + h\,a_h/t + c\,a_c/t\right\} + f\,a_0 \qquad \text{(A-2)}$$

This rearranges to the more convenient computational form

$$\frac{k(a_s - a_d)s + k(a_h - a_d)h + k(a_c - a_d)c}{t} + [k\,a_d + f\,a_0] \qquad \text{(A-3)}$$

Example

For Indiana, $f = 0.0573$, $k = 0.9427$, and $a_0 = 0.3363$.
For Brown County,

$t = 1{,}845 \qquad h = 326$
$s = 374 \qquad c = 202$

Then, using the values for a_d, a_s, a_h, and a_c from Table 10.

$$k(a_s - a_d) = 0.66$$
$$k(a_h - a_d) = 1.56$$
$$k(a_c - a_d) = 1.05$$

Also, $k\,a_d = -0.707$, $f\,a_0 = 0.019$, and their sum is -0.688.

Finally, the weighted component of activity is $(0.66 \times 374 + 1.56 \times 326 + 1.05 \times 202)/1845 - 0.688 = -0.163$. Different Statewide adjustments were made for the other States.

OCCUPATION OF HEAD AND PAID VACATION

No Census data were found on paid vacations. Consequently, the paid vacation weighted component was estimated from data relating to occupation of head, based on what are thought to be reasonable assumptions about paid vacations. Referring to Table 10, the following correspondence was made between the subclasses for the two factors:

Occupation of Head	Activity Component	Paid Vacation (weeks)	Activity Component	Combined Component
Professional	0.11	3	0.72	0.83
Manager; officials	0.54	3	0.72	1.26
Sales; clerical	− 0.92	2	0.27	− 0.65
Craftsmen	0.41	2	0.27	0.68
Laborers	0.06	1	− 1.03	− 0.97
Service workers	− 1.36	1	− 1.03	− 2.39
Farm operators	− 0.27	0	− 0.34	− 0.61
Retired, etc.	− 0.20	0	− 0.34	− 0.54

The following match was made between occupation subclasses in Table 10 and the Census occupation classifications. Except in the one item noted below, the data are from Table 84.

Activity Index Subclass	Census Subclass
Professional	Professional
Managers; officials	Managers, officials, and proprietors except farm
Sales personnel; clerical	Clerical and kindred workers; Sales workers
Craftsmen	Craftsmen, foremen and kindred workers. Operatives and kindred workers (including semi-skilled factory workers and drivers)
Laborers	Farm laborers and farm foremen; laborers, except farm and mine
Service	Private household workers; Service workers, except private household
Farm operators	Farm owners
Retired and others not in labor force	From Table 83, "Other 65 and older," under classification "Male 14 and over not in labor force."

The county total was computed from

Total = Males employed + Other 65 and older − Occupation not reported (A-4)

Example

Total = 1618 + 302 − 105 = 1815

Weighted component of activity = (0.83 × 80 + 1.26 × 62 − 0.65 × 110 + 0.68 × 878 − 0.97 × 206 − 2.39 × 72 − 0.61 × 105 − 0.54 × 302)/1815 = 0.039

PLACE OF RESIDENCE

Data for these computations were obtained from Ref. (*7*). Because there was no apparent way to identify "suburban areas" and "adjacent areas" separately, they were combined into a single subclass, and an average of the corresponding components, (− 0.12 + 0.38)/2 = 0.13, was used. The following data were available:

U = Percent urban population = Residents of places with 2,500 or more residents;
R = Percent rural = 100 − percent urban;
C = Central city residents = Residents of cities with 25,000 or more residents;
T = Total county population; and
S = Percent suburban-adjacent = $U - (C/T) \times 100$.

Example

Inasmuch as Brown County is entirely rural, Marion County is used as an example. For this county $U = 91.2$, $R = 8.8$, C(Indianapolis) = 476,258, $T = 697{,}567$, 100 $C/T = 68.3$, $S = 91.2 - 68.3 = 22.9$.

Weighted component of activity = − 0.74 × 0.683 + 0.13 × 0.229 + 0.61 × 0.088 = − 0.422.

REGION

Everyone in the sample was in the North Central region, for which the activity component is 0.18.

AGE OF HEAD

Returning to Ref. (*36*), Table 83 contains, by county, the "Age of Persons in the Labor Force." Age groups coincide, but there is a single grouping for men 45-64, whereas Table 10 requires a split, 45-54 and 55-64. From Table 27, referring to the State as a whole, it is noted that the ratio of persons 45-54 to persons 55-64 is about 5:4. Hence, a weighted average of components is used for the 45-64 county data; that is, [5(− 0.11) + 4(− 0.84)]/9 = − 0.43.

To the group "65 and over" in the labor force there is added an estimate of retired ambulatory persons 65 and over. This is obtained from the previously referenced "Male Not in Labor Force—Other 65 and Over." This latter group consists almost entirely of (a) ambulatory retired persons, and (b) Persons disabled or ill but not institutionalized. To allow for the second category, only one-half of the entire group is added to the 65 and over labor force numbers.

Example

In Brown County there are 109 persons 65 and over in the labor force and 302 65 and over not in the labor force. Total persons in the labor force are 1,611. The total sample is 1,611 + 302/2 = 1,762.

The weighted component of activity = (1.93 × 228 + 0.99 × 339 + 0.49 × 316 + (− 0.43) × 619 + (− 2.04) × 109 + 302/2)/1762 = 0.076.

LIFE CYCLE

This was the most difficult and most complicated of the adjustments.

1. From Tables 94 and 96:

   J = All males in State 18-44
   S = All males in State 45 and older

2. From Table 110:

   F = All husband-wife families in State
   H = Married males under 45
   $K = F - H$ = Married males 45 and older

3. For State:

   A = Single males, 18-44 = $J - H$
   B = Single males, 45 and older = $S - K$
   $R_A = A/(A + B)$ = Fraction of single adult males aged 18-44
   $R_B = 1 - R_A$ = Fraction of single adult males 45 and over.

Then a combined activity component for single adults in a county is taken to be

$$a_s = (1.01)R_A + (-0.39)R_B \qquad \text{(A-5)}$$

For Indiana, $R_A = 0.63$, $R_B = 0.37$, and $a_s = 1.01 \times 0.63 + (-0.39) \times 0.37 = 0.49$.

4. Because county data tabulate families with young children in terms of children 6 and younger, a Statewide adjustment must be made for the 4½-year division in Table 10.

From Table 96:

Let

C_1 = Number of children in State under 5 (as an approximation to 4½)
C_2 = Number of children age 6

Assume:

(1) Family with 6-year old child has only one such.
(2) One-half of these families also have children under 5.

Then

$$[(C_1 + C_2/2)/(C_1 + C_2)]Y_1 \approx Y_2 \qquad \text{(A-6)}$$

in which

Y_1 = Families in county with children 6 or younger
Y_2 = Families in county with children 4½ or less.

For Indiana, the coefficient in square brackets is 0.92.

5. From Table 27, by county:

   T = All males
   D = Males under 18

6. From Table 82, by county:

   M = Married couples (hence married males)
   C_3 = Couples with children 6 or less
   C_4 = Couples with children under 18
   C_5 = Husband under 45
   C_6 = Husband under 45 with children under 18.

7. From Table 83:

   I = Inmate of an institution (male), 14 and over.

   Assume one-half of these are under 18 (orphans, juvenile delinquents, hospitalized, etc.).

8. Total reference population, P, is

$$P = T - D - I/2 \qquad \text{(A-7)}$$

9. Referring to the components in Table 10, and coefficients for Indiana in items 3 and 4, the weighted component of the activity index for Indiana is

$$0.49 + \{-\ 0.61\ [(M\text{-}C_4) - (C_5\text{-}C_6)] + 0.75 \times C_5\text{-}C_6 - 0.04 \times 0.92\ C_3 + 0.47\ [(1\text{-}0.92)C_3 + (C_4\text{-}C_3)] - 0.49M\}/P \qquad \text{(A-8)}$$

10. In more convenient computational form,

$$0.49 + \{-\ 1.10\,M - 0.47\,C_3 + 1.08\,C_4 + 1.36\,C_5 - 1.36\,C_6\}/P \qquad \text{(A-9)}$$

Example

For Brown County, the weighted activity index component is

$$0.49 + \{-\ 1.10 \times 1633 - 0.47 \times 477 + 1.08 \times 854 + 1.36 \times 706 - 1.36 \times 568\}/(3502 - 1333 - [\text{no inmates}]/2) = 0.070.$$

RACE

From Table 27:

T = Total males 21 and over
N = Non-white males 21 and over

Then the weighted component is

$$[0.24\ (T - N) - (2.06)\ N]/T$$
$$= [0.24\ T - (0.24 + 2.06)\ N]/T \qquad \text{(A-10)}$$

Example

$$(0.24 \times 1989 - 2.30 \times 2)/1989 = 0.238.$$

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