MEASURING NATIONAL PARK ATTRACTIVENESS

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The national parks of the United States are not competitors in a popularity contest. It cannot be said correctly that a park which is visited by twice as many people per year as another is twice as valuable as the other. It must be assumed, however, that park values do somehow influence park use. This study is an attempt to uncover the connection between park values and park popularity without assuming that a park's volume of visitation is a direct and adequate measure of its value.

Thirty-one areas with varied characteristics have been designated by the United States as national parks. They are administered under policies intended to preserve them unimpaired for the use and enjoyment of this and future generations of people. Millions of people use the various parks, and in using them create problems in their preservation. The volume of park visitation differs from year to year and from park to park, but it is not unpredictable.

The number of people visiting a given park in a given year depends partly, of course, on the characteristics of the park. But it also depends on where the park is located and where the people live. Comparable parks in different locations could have different rates of use. One's likelihood of visiting a given park tends to vary inversely with the distance between that park and one's home. A higher proportion of the people residing nearby visit a park in a given time period, and lesser proportions of those living farther away from it visit it during that time. In an attempt to make these generalizations more precise and to understand <u>why</u> they apply to park visitation, several alternative mathematical formulae have been fitted to visitation data from National Park Service files.

The formula which seems to work best says that for a given park the visitation rates for the several states tend to be inversely proportional to the 3/2 power of the distance (i.e., proportional to the reciprocal of the square root of the cubed distance between the center of the state and the park).[1] In equation form, we would write

$$R_{ij} = ak_j / \sqrt{D^3_{ij}} \qquad \text{(equation 1)}$$

where R_{ij} is the rate of visitation from state i at park j, D_{ij} is the distance from the center of state i to park j, and ak is a "constant" that varies. That is, k varies from park to park, but for a given park it is constant from state to state, and a is simply a constant of proportionality. To collect all variable terms on the left, then, we could write this as

$$\frac{R_{ij} \sqrt{D^3_{ij}}}{k_j} = a \qquad \text{(equation 2)}$$

Though at first it may seem to have nothing to do with the nature of national parks or with the reasons for national park travel, one thing that makes this formula interesting is that it has the same form as Kepler's third law of planetary motion, which in turn follows from Newton's law of gravity. In effect, Kepler found three and a half centuries ago that the angular velocities of the various planets around the sun varied inversely with the 3/2 power of their distances from the sun. Newton showed that this is what would have to be if it was the sun's gravity which kept the planets in orbit by precisely offsetting their centrifugal force. It is tempting to suggest by analogy that the reason a similar pattern of state visitation rates at a given national park has arisen is because it is the attraction of the park for the people of those states that offsets the distractions of other human activities and makes the rates what they are. For the analogy to be reasonable we need only assume that the force of attraction wanes with distance just as gravity does.

Kepler's principle applies to satellites in orbit around a planet, just as it does to planets in orbit around the sun, except that the value of k would depend on the mass of the central body. By analogy, if we fit equation 1 to park visitation and distance data and solve for each park's k, we could regard the figure we obtain as a function of the attractiveness ("mass") of a given national park. The different k's for different parks would be proportional to their different degrees of attractiveness. By relatively simple computations it is possible to solve for these k's from a table of visitation rates and a table of state-to-park distances. Using these k's, then, in equation 2, it turns out that for the largest available table of comparable data for a single year (rates of visitation at 12 parks in 1940) 91.8 per cent of the variance among the rates for 24 western states can be accounted for.

Another formula that has been tried out is known as the "theory of intervening opportunities," originated by the sociologist Samuel Stouffer.[2] Stouffer assumed that it is not distance as such which diminishes the attractiveness of a destination. Instead, alternative destinations closer at hand deter travel to the more remote place, and the more remote it is, the more such alternatives nearer by there will be and hence the greater the deterrent to the longer journey. As Stouffer put it, the number of people who will travel a given distance will depend on the ratio of opportunities at that distance to intervening opportunities.

In the case of national park travel, this could be expressed in the following formula:

$$\frac{R_{ij}\ I_{ij}}{O_j} = c \qquad \text{(equation 3)}$$

where R_{ij} again is the visitation rate from state i at park j, I_{ij} is the number of opportunities at lesser distances than park j is from state i, O_j is the number of opportunities at park j, and c is a constant. If each of the national parks were equal, so that each could be considered a unit "opportunity," this formula would simplify to

$$R_{ij} I_{ij} = c \qquad \text{(equation 4)}$$

where I_{ij} would denote simply the number of nearer parks. But when this simplified version of the formula was tried out on the table of 1940 visitation rates it only accounted for 57.2 per cent of the variance. The more elaborate formula (equation 3) requires a complicated computational procedure to solve iteratively for an "opportunity coefficient" for each park, but these can only be calculated for those parks for which state by state visitation rates happen to be available. For the 12 parks from which 1940 visitation data were preserved, the Stouffer opportunity coefficients were highly correlated with the k's obtained from equation 1. But since equation 3 still accounted for only 73.9 per cent of the variance in western states' visitation rates, the Stouffer formula clearly does not work as well as the one borrowed from Kepler. Moreover, from questionnaires returned by a sample of visitors to one national park, it is evident that intervening parks often serve as "stepping stones," facilitating rather than inhibiting travel to a more remote park.

Another sociologist, Joseph Cavanaugh, once tried out a different "gravitational" equation on various batches of travel data, including some data from some national parks.[3] He used George K. Zipf's P_1P_2/D formula for intercity migration, which says that the amount of interaction between any pair of human aggregates will tend to be proportional to the product of their populations divided by the distance between them. This is considered by some sociologists to be "gravitational" insofar as P for population is analogous to M for mass. But as we shall see, this is a bad analogy. If P_1 is taken to represent the "population" of a national park, and P_2 the population of a given state, Zipf's formula could be rewritten as

$$V_2/P_2 = b\ P_1/D \qquad \text{(equation 5)}$$

where V_2 is the number of visitors to the park from that state, and b is some constant of proportionality. Or, generalizing,

$$R_{ij} = b\ P_j/D_{ij} \qquad \text{(equation 6)}$$

which, for comparison with equations 2 and 4, is equivalent to

$$\frac{R_{ij}\ D_{ij}}{P_j} = b \qquad \text{(equation 7)}$$

The obvious "bug" in this formula is the concept of "park population." National parks don't have populations in the sense that cities do. Taking annual totals of visits at each of the parks as indexes of the average population present at any given time in each park, however, and applying equation 7 to the 1940 table of visitation rates, we were able to account for 68.7 per cent of the variance. Thus, Zipf's formula is slightly inferior to the Stouffer formula and clearly inferior to the one based on the Kepler-Newton gravitational model.

But even if the Zipf formula had been more effective, it wouldn't have made as much sense conceptually. Purporting to be gravitational, it implies that the "mass" exerting an attracting force consists of a human population present at the destination of travel. This is hardly true of a national park. Many of us go to national parks _in spite of_ the other people there. Though there may be some exceptions, certainly it is not _generally_ the case that the people already there are what constitutes a national park's attractiveness.

In an attempt to measure national park attractiveness and ascertain what it comprises, questionnaires were sent to two categories of people having far better than average familiarity with the parks. One sample consisted of ninety persons affiliated with the National Park Service (the Superintendent, Chief Ranger, and

Chief Park Naturalist, at each of the thirty park units). The other sample consisted of leaders named on the letterheads or on officer rosters of various voluntary associations concerned with national parks, wilderness, wildlife preservation, etc.

The questionnaires were one-page rating forms, listing the thirty-one national parks in alphabetical order, with a series of numbers printed after each park name. The recipient was asked to check which parks he'd ever been to, and to circle a number from 1 to 9 after each such park in order to indicate his judgment of its relative attractiveness. Then he was asked to state on the back of the form, if he wished, his own standards of park attractiveness. With the aid of two follow-up mailings (a reminder postcard, and a duplicate questionnaire) responses were obtained from all but seven of the 90 National Park Service personnel. At least one person at each park returned a questionnaire. The rate of returns was also gratifying, though less spectacular, from the voluntary association leaders sample.

Not all of the questionnaires that were returned were actually filled out as requested, however. Some members of both samples indicated which parks they'd been to but insisted it was impossible to give comparative ratings of their relative attractiveness.[4] Some of these partial refusals did go on to indicate what park attractiveness consisted of for them. Their comments are worth quoting. One wrote, "I have been in 30 of the 31 listed parks. I would not attempt to single out by comparison any one being most attractive. Each has its individuality as to attractiveness. . . . If I were to single out any one, of course I would be charged as being biased, for it would be [the park where I work]." Another respondent said, "To rate one more attractive than the other is like asking a person which is more valuable, your eyesight or your hearing. Collectively the national parks help to form a composite representation of the 'crown jewels' of our nation. Each in its own way contributes to the whole."

Another expressed the enormity of the rating task by saying, "I find it most difficult to comply with your request. It's a little like asking a mother which one of her children she likes best."

One detailed comment merits quotation in full:

> I have been inside of all thirty-one of our National Parks with the sole exception of that in the Virgin Islands which I hope sooner or later to visit. Many of them I have visited repeatedly. It is utterly impossible to comply with your request to rate them comparatively in 'relative attractiveness' and in my opinion such a rating would have no useful significance whatever. As well compare a cyclone with an earthquake.
>
> Moreover, in my view, publication of the results of such a superficial rating as you propose might do great harm in misleading the uninformed public into thinking some parks of great scientific and cultural importance to be relatively unimportant -- which would be a sad distortion of the facts, and might furnish an excuse for neglecting needed appropriations for areas thus discriminated against.
>
> In my opinion research and effort would be much more usefully employed in emphasizing the value of the National Parks generally and the need for adding outstanding areas, such as the North Cascades, before they are commercially exploited and lost.

Some of the implications of this comment will be reviewed later, after the results of the rating operation have been presented.

A number of respondents suggested that meaningful comparisons could be made within subsets of parks of similar character -- e.g., comparing Carlsbad Caverns, Mammoth Cave, and Wind Cave, or comparing Mt. McKinley, Mt. Rainier, and Glacier. They felt, however, that it was meaningless to compare a park from one category with a park from another category that was different in kind. Several of these respondents, nevertheless, gave as a general criterion of park attractiveness the "naturalness" of the scene, or alluded in some way to wilderness. Allusions to this sort of criterion are not surprising in view of the sorts of people included in the samples, but what is significant is that they transcend the conviction that the various parks are incommensurable. Of similar significance is the fact that of 25 questionnaires returned with the comment that no meaningful comparisons could be made, numerical ratings were nevertheless indicated on 14 of them.

On another 90 questionnaires, numerical ratings were given, but no verbal indication of attractiveness criteria was offered. Another 51 respondents rated the parks and included among their stated criteria some more or less emphatic reference to preservation of the area in its primeval condition. Only two questionnaires listed quality of manmade facilities as a prime factor in evaluating park attractiveness, though two others suggested that the important criterion was the balance between natural features and manmade facilities. A variety of other criteria, usually including some reference to scenic aspects, wildlife, geological features, etc., were listed on 27 other questionnaires. Finally, two questionnaires gave ratings and then commented on the back not about the criterion of attractiveness but on the probable unrepeatability of the ratings.

A few of the statements of criteria deserve quotation. One respondent who stressed "preservation" maintained that "such indescribable beauty brings out the best in us." By implication, we visit national parks for what they do to us. What we do to them, on the other hand, diminishes them, as another respondent indicated by saying, "Parks are generally attractive to me in proportion as the natural scene is not obscured by developments for the mass accommodation of visitors." One of the voluntary association respondents, referring to a particular park she felt had been over-used, said she would never wish to see it again "or recommend to others seeking the ultimate in soul-satisfaction, because it is so infested with human beings, their parking lots and cafeterias, stage shows in the evenings" etc. Another woman wrote the following statement, quoted in full:

> In a five-month tour of the parks checked, I came to realize that all of them, <u>if</u> they had been left in their natural condition, would deserve a rating of nine. However, since the parks bear the scars of human intrusion, I have rated them as to:
>
> 1) naturalness of scene
> 2) wilderness areas as opposed to commercial developments
> 3) management -- commercial vs. natural
> 4) naturalism of features -- were they overdone, such as tame bears and fenced pools, in Yellowstone, or were they left in a natural condition for viewers to enjoy in their original state?

> 5) ratio of hiking, horseback riding, walking vs. auto sightseeing, motel-hopping, and fishing.
>
> In sum, my rating of a park depends on its natural condition: the more natural the park, the higher the rating.

Again, there is no pretense that this kind of statement is surprising when it comes from a person in the categories to which the questionnaire was sent. However, knowing that these were the kinds of criteria the respondents had in mind makes interpretable the scale values we calculated from their numerical ratings.

Only a few of the respondents had visited all or nearly all of the parks, though most had visited at least half a dozen or more. Only 14 were able to rate Virgin Islands National Park, whereas 154 rated Yellowstone. Other parks were rated by varying numbers of respondents ranging between these two extremes.

The numbers to be circled on the rating form were arbitrary, of course, and could not be taken at face value as cardinal quantities. A person giving a certain park a rating of 8, for example, was not necessarily calling it twice as attractive as another park he rated at 4, or 8/9 as attractive as one he rated at 9. Fortunately, however, there is a straightforward method for ascertaining from frequency distributions of ratings what the average subjective width of each numerical interval was for the various respondents. By the "method of successive intervals," these interval widths were inferred and then the median scale value of each park was calculated.[5] Two separate sets of scale values were obtained, one from each respondent sample. These are given in Table 1. To avoid misunderstanding, it should be borne in mind that the numbers in the table do not refer to the original series of integers from 1 to 9 that appeared on the questionnaires. Instead they take as their unit the average standard deviation of the frequency distributions.

In Figure 1, the scale values computed from the voluntary association leaders' ratings are plotted against the scale values calculated from the ratings

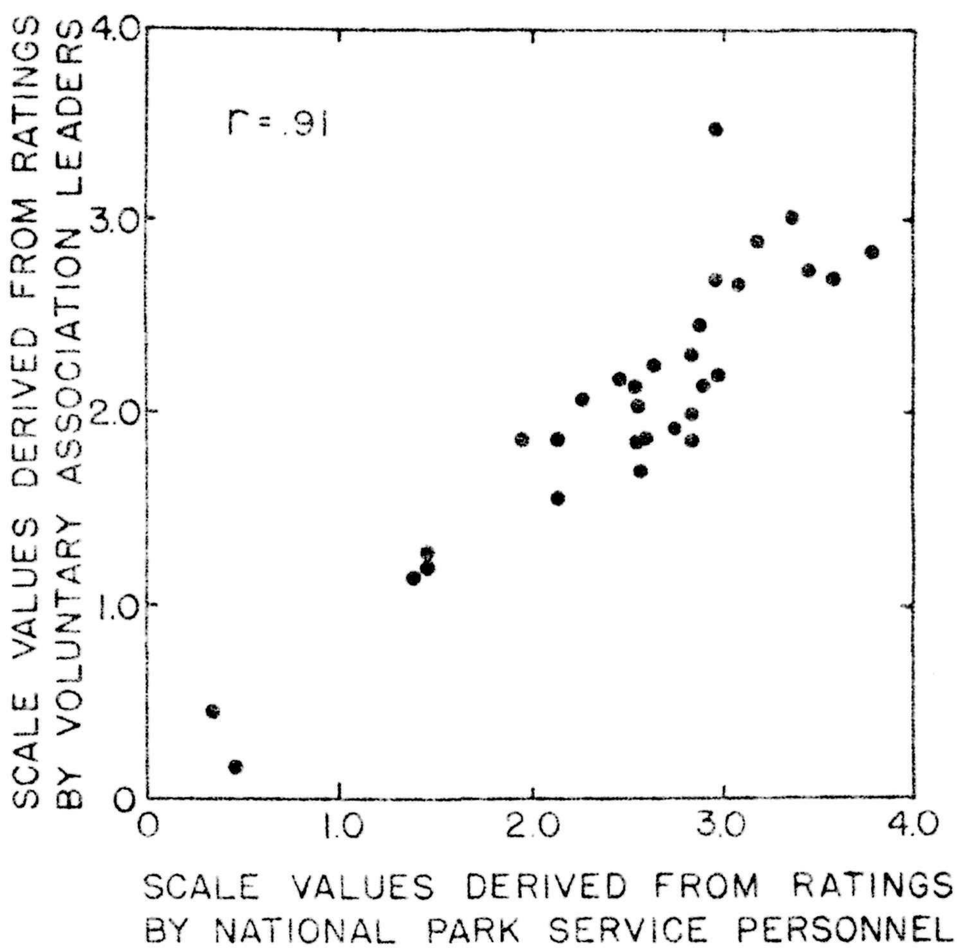
Table 1

Scale Values Obtained by the Method of Successive Intervals Measuring Attractiveness of 31 National Parks

	From ratings by National Park Service personnel	From ratings by leaders of voluntary associations	Mean
Acadia	2.588	1.872	2.230
Big Bend	2.129	1.872	2.000
Bryce Canyon . . .	2.615	2.256	2.436
Carlsbad Caverns .	2.129	1.585	1.857
Crater Lake. . . .	2.457	2.196	2.326
Everglades	2.588	1.703	2.146
Glacier.	3.773	2.836	3.304
Grand Canyon . . .	3.163	2.902	3.032
Grand Teton. . . .	3.432	2.752	3.092
Great Smoky Mtns .	2.830	2.003	2.416
Haleakala.	2.749	1.913	2.331
Hawaii Volcanoes .	2.830	1.862	2.346
Hot Springs. . . .	.340	.447	.394
Isle Royale. . . .	2.535	2.168	2.352
Kings Canyon . . .	2.878	2.463	2.670
Lassen Volcanic. .	2.569	2.030	2.300
Mammoth Cave . . .	1.440	1.208	1.324
Mesa Verde	2.238	2.071	2.154
Mt. McKinley . . .	2.950	3.466	3.208
Mt. Rainier. . . .	2.970	2.200	2.585
Olympic.	3.071	2.680	2.876
Petrified Forest .	1.442	1.268	1.355
Platt.	.470	.173	.322
Rocky Mountain . .	2.887	2.169	2.528
Sequoia.	2.960	2.706	2.833
Shenandoah	1.967	1.872	1.920
Virgin Islands . .	2.588	1.872	2.230
Wind Cave.	1.390	1.169	1.280
Yellowstone. . . .	3.589	2.704	3.146
Yosemite	3.341	3.022	3.182
Zion	2.814	2.313	2.564

FIGURE 1

RELIABILITY OF ATTRACTIVENESS SCALE VALUES OBTAINED BY THE METHOD OF SUCCESSIVE INTERVALS APPLIED TO 31 NATIONAL PARKS



by Park Service personnel. It is evident that the two sets of scale values are linearly related, and their intercorrelation is high. It can be said, then, that park attractiveness can be scaled with high reliability.

Scale values computed by the method of successive intervals can be treated as cardinal (rather than merely ordinal) numbers, except that they refer to an arbitrary (rather than an intrinsic or natural) zero point. Thus, we know how much greater the attractiveness of one park is than that of another park, but not the absolute attractiveness of either. In the same way, of course, other familiar measures are made in relation to merely arbitrary zero points. If the temperature on Monday were 40° and it warmed up to 60° on Tuesday and to 80° on Wednesday, we could say that it had warmed up twice as much from Monday to Wednesday as from Monday to Tuesday, but we could not say it was "twice as warm" on Wednesday as on Monday, since zero on the Fahrenheit scale is not absolute zero.

In Figure 2, a step in the direction of establishing the real zero point is attempted. The twelve dots represent the twelve parks for which k's were obtainable from visitation rates by equation 1. Their successive intervals scale values have been plotted against those k's (where each k equals the mean $R_{ij}\sqrt{D_{ij}^{3}}$ for a given park). While there is no one simple relationship between the scale values and the k's, they are not obviously unrelated either.

If we consider the twelve dots as consisting of two distinct series of parks, the four dots with white centers can be fitted with one regression line, and the other eight with another, less steep. In each series separately, then, an approximately linear relationship between the apparent "gravitational mass" of the parks and their successive intervals scale values can be assumed.

For the parks for which no comparable visitation data were available, so that k's could not be calculated, estimates of what those k's would have been can be graphically projected, or calculated from the regression equations given at

FIGURE 2

PARK "MASS" IN RELATION TO SCALE VALUE

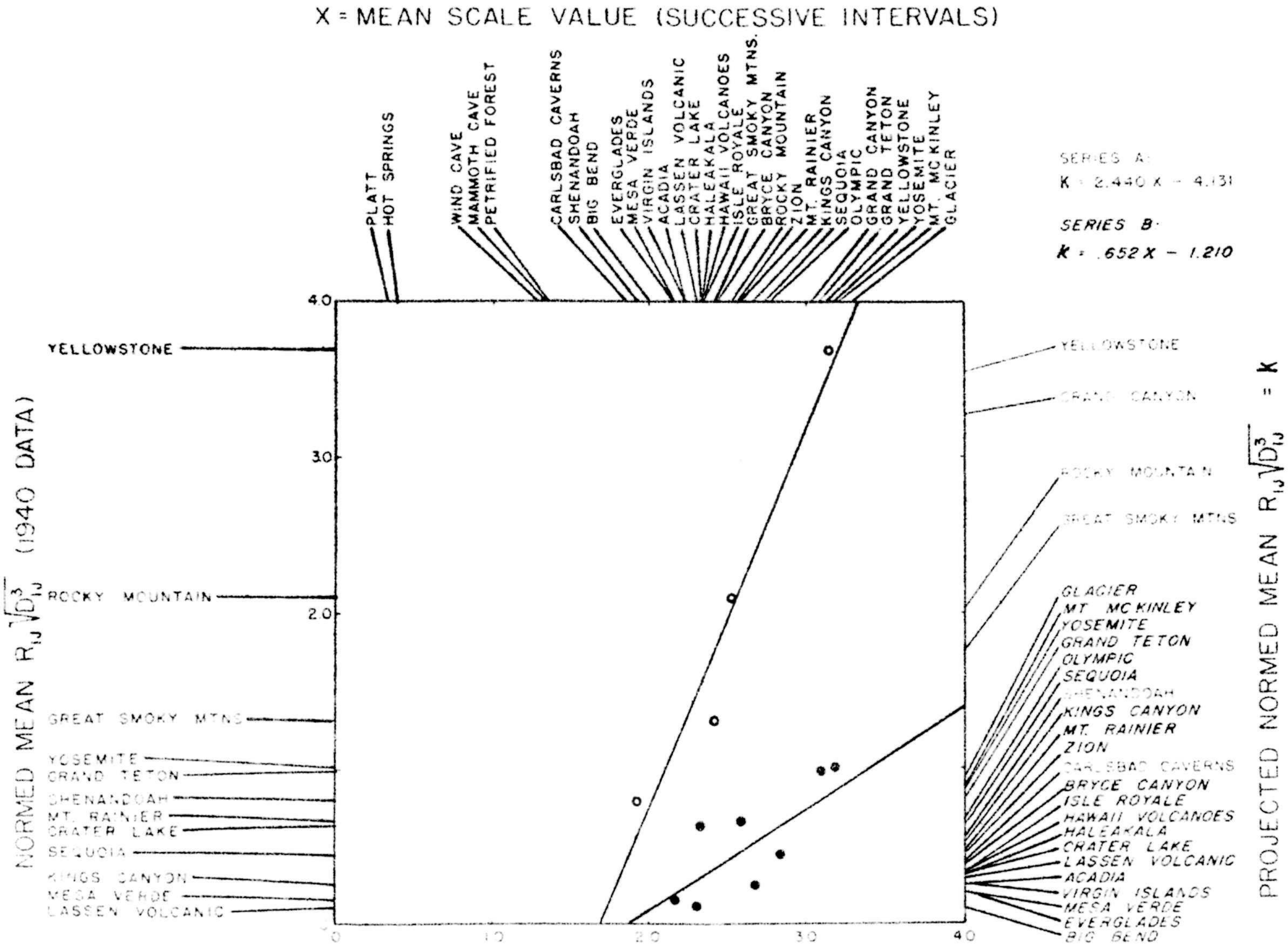


Table 2

Projected k's Based On Successive Intervals Scale Values, And Actual k's Calculated From 1940 Visitation Data

		Series A Projection	Series B Projection	1940 Actual k
Series A parks	Yellowstone. . . .	3.545 *	.841	3.693
	Grand Canyon . . .	3.267 *	.767	
	Rocky Mountain . .	2.037 *	.438	2.108
	Great Smoky Mtns .	1.764 *	.365	1.313
	Shenandoah	.554 *	.042	.786
	Carlsbad Caverns .	.400 *	.001	
Series B parks	Glacier.	3.931	.944 *	
	Mt. McKinley . . .	3.697	.882 *	
	Yosemite	3.633	.865 *	1.023
	Grand Teton. . . .	3.413	.806 *	.797
	Olympic.	2.886	.665 *	
	Sequoia.	2.782	.637 *	.453
	Kings Canyon . . .	2.384	.531 *	.254
	Mt. Rainier. . . .	2.176	.475 *	.664
	Zion	2.125	.462 *	
	Bryce Canyon . . .	1.813	.378 *	
	Isle Royale. . . .	1.608	.324 *	
	Hawaii Volcanoes .	1.593	.320 *	
	Haleakala.	1.557	.310 *	
	Crater Lake. . . .	1.544	.307 *	.636
	Lassen Volcanic. .	1.481	.290 *	.117
	Acadia	1.310	.244 *	
	Virgin Islands . .	1.310	.244 *	
	Mesa Verde	1.125	.194 *	.156
	Everglades	1.105	.189 *	
	Big Bend	.749	.094 *	
Series C parks	Petrified Forest .	- .825	- .327	
	Mammoth Cave . . .	- .900	- .347	
	Wind Cave.	-1.008	- .376	
	Hot Springs. . . .	-3.170	- .953	
	Platt.	-3.345	-1.000	

* Denotes the projected k judged to be more probable.

the upper right in Figure 2. Since we have two regression equations, two estimates of k can be obtained for each park -- one considerably larger than the other. A tentative choice of the better estimate in each case is indicated graphically at the right side of Figure 2, and is stated numerically in Table 2. These choices simply carry through the division of the parks into two distinct series. The implication is that the parks in one series have something in common which sets them collectively apart from the other series and by which they can be quantitatively compared.

Tentatively, Series A is thought to comprise Yellowstone, Grand Canyon, Rocky Mountain, Great Smoky Mountains, Shenandoah, and Carlsbad Caverns. It might be said that these are the parks that receive great numbers of visitors for non-park reasons as well as because they are national parks. They are either more famous (in some stereotyped way) or closer to main travel routes, or closer to large population sources. Consider, for example, the many tourists who think of Estes Park or Skyline Drive, rather than of Rocky Mountain National Park or Shenandoah National Park. Some may even be oblivious of the national park concept.

Series B, tentatively, would include Glacier, Mt. McKinley, Yosemite, Grand Teton, Olympic, Sequoia, Kings Canyon, Mt. Rainier, Zion, Bryce Canyon, Isle Royale, Hawaii Volcanoes, Haleakala, Crater Lake, Lassen Volcanic, Acadia, Virgin Islands, Mesa Verde, Everglades, and Big Bend. If we are correct in grouping these into one series, distinct from the others, it might be hypothesized that further research would find a higher proportion of the visitors to these areas have a clearer awareness of "the national park idea." Proportionately fewer visitors would be found there who came for extraneous reasons.

Interestingly, there are five parks whose projected k's would require minus signs <u>by either regression equation</u>. Evidently they should be considered as constituting a third distinct set, Series C. They are: Petrified Forest, Mammoth

Cave, Wind Cave, Hot Springs, and Platt. In general, what distinguishes these from Series A and B is that they are small in size or small in variety of features.

Once we know the value of k for a given park, since its distances from the various states are fixed, and since the populations of those states can be easily known or estimated in any given year, using equation 1 again it would be a simple matter to estimate the number of visitors to be expected at a given park from each state _in proportion to those to be expected at any other particular park_. Suppose, then, that we wished to estimate the probable future use of a _proposed addition_ to the National Park System. We could take the following steps. (1) Have the proposed area rated in comparison with existing parks by a panel of persons familiar with it and with an assortment of existing parks. (2) Convert the frequency distributions of their ratings into successive intervals scale values. (3) Obtain from the scale value an estimate of k for that new area. (4) With the estimated k, and the requisite distance and population figures, equation 1 could provide a reasonable forecast of the expected visitation if the area were established and administered as a national park.

Though it was alleged that park attractiveness could not be meaningfully rated, the approach taken in this study did yield scale values which reliably measure it. Its principal ingredient seems to be the degree to which nature has been preserved untrammeled though rendered accessible. Moreover, these scale values provide a basis for objectively assessing the probable use of any proposed addition to the National Park System. To know the volume of probable use is at least to know _one factor_ that would play a part in justifying establishment of the new park. Such knowledge would also be relevant to assessing the threat to the natural values that would tend to arise from human intrusion.

While the formulae used in this study may have seemed physicalistic, and the attempt to scale intangible values might appear irreverent, there is really nothing in this research which is fundamentally incompatible with the conviction that national parks are attractive in proportion to their capacity for providing spiritual enrichment or their power to ennoble the human beings who visit them.

Footnotes:

1. When we speak of park visitation rates, we mean the number of visitors from state i entering park j, per 100,000 residents of state i. In some instances, available data required that these rates be calculated as number of autos from state i entering park j per 100,000 auto registrations in state i. We are indebted to numerous individuals in the National Park Service for their splendid cooperation in making data available from their files. Our thanks go to the Chief Ranger or Assistant Chief Ranger in several of the parks, and to Mr. Rendel Alldredge, Chief of Statistics Analysis, N.P.S., Washington, D.C.

2. Samuel A. Stouffer, "Intervening Opportunities: A Theory Relating Mobility and Distance," American Sociological Review, 5 (December, 1940), pp. 845-867.

3. Joseph A. Cavanaugh, Formulation, Analysis and Testing the Interactance Hypothesis, unpublished PhD dissertation, University of Washington, 1950.

4. A similar insistence that comparisons could not be made at all, or would be meaningless if attempted, was voiced by a number of clergymen who were asked to choose between a series of "infinite" values. The choices they did make, however, were patterned and the items proved highly scalable. See William R. Catton, Jr., "Exploring Techniques for Measuring Human Values," American Sociological Review, 19 (February, 1954), pp. 49-55.

5. For a step by step explanation of the method of successive intervals, see Allen L. Edwards, Techniques of Attitude Scale Construction, New York: Appleton-Century-Crofts, 1957, Chapter 5.

The enclosed report, which we hope will be of interest, is being sent to the Superintendent of each of the National Parks. It is also being sent to those questionnaire recipients who requested a copy of the findings of this study.

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