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PLANNING AN URBAN RECREATION SYSTEM: A SYSTEMATIC APPROACH

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INTRODUCTION

One of the critical decisions to be made in planning a system of urban recreation centers[1] relates to the spatial distribution of recreation resources. The alternatives range from the highly concentrated to the diffused. As a guide in making his decision, the planner usually uses recreation standards which represent the judgment of experienced planners and administrators on such matters. The standard-setting process seldom includes a statement of specific objectives nor an evaluation of the implications of alternative spatial arrangements for the achievement of the objectives.

The purpose of this paper is to present the results of research by the author in developing a systematic approach for selecting the size and spacing of urban recreation centers.[2] There are numerous dimensions to the question; this paper concentrates on one: the trade-offs between a system of a few large and evenly-spaced centers and a system of many, small and evenly-spaced centers, holding constant the budget for development and operation. Two extremes along the spectrum of alternatives are shown graphically in Figure 1. Figure 1A shows an aerial view of an urban region served by three large, evenly-spaced recreation centers. Figure 1B shows the same region served by many small, evenly-spaced centers.

A systematic approach to analyzing the trade-offs follows, illustrated by examples of the results obtained by applying the analysis to an area of Los Angeles.

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1. The conceptual framework presented in this study applies to all types of urban recreation facilities. The empirical analysis reported in subsequent sections covered neighborhood and community recreation centers that provided for such activities as indoor and outdoor basketball, baseball, football, volleyball, gymnastics, child play, and picnicking.

2. The paper is based upon research which is more fully described in D. McAllister, Evaluating the Size and Spacing of Urban Public Service Centers: The Case of Local Recreation Facilities (Ph.D. Dissertation, University of California, Los Angeles, 1970). For an excellent discussion of public facility location in general, see Teitz, *Toward A Theory of Urban Public Facility Location,* 21 Papers of the Regional Science Association 35 (1968).

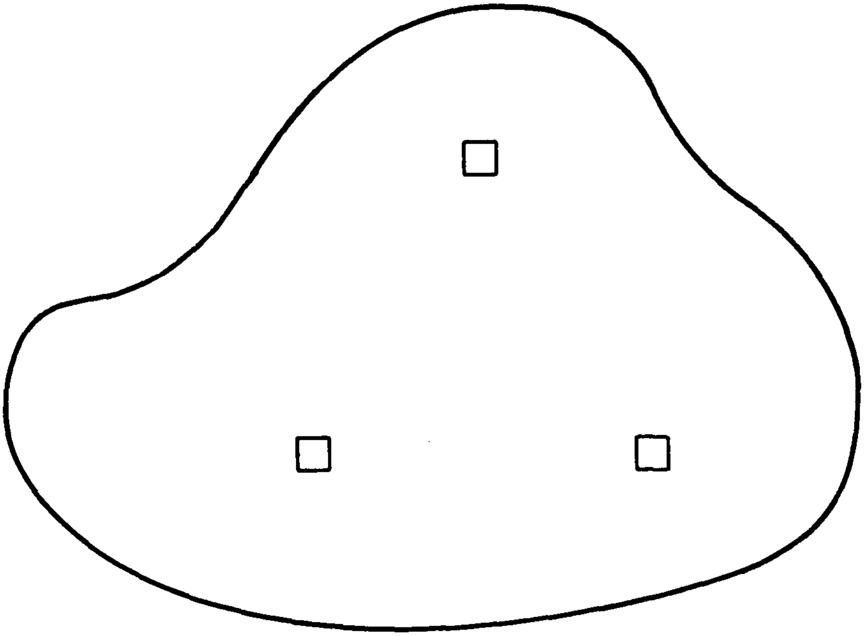

FIGURE 1A

Aerial View of an Urban Region, Served by Three Large, Evenly-Spaced Recreation Centers

ASSUMPTIONS AND DEFINITIONS

Before proceeding, it will be helpful to review a few assumptions and definitions. Several assumptions are made in order to maintain clarity of exposition: one is that population density in the subject region is uniform; a second is that all recreation centers are the same size; a third is that the centers are evenly spaced. Variations in population density and multiple hierarchies of recreation centers are easily added to the analysis.

The "size" of a recreation center is discussed in terms of land area, measured in acres, but it should be understood that land area is only a proxy for the quantity of land, recreation facilities and supervision. "Spacing" refers to the straight-line distance, measured in miles, between adjacent recreation centers.

The analysis of trade-offs focuses on two major dimensions of social welfare: equity and efficiency. Equity can be defined in many ways. The operational definition chosen for this study is equality of opportunity in receiving recreation services; the lack of equality is measured by the variation, between people, in distance to the nearest

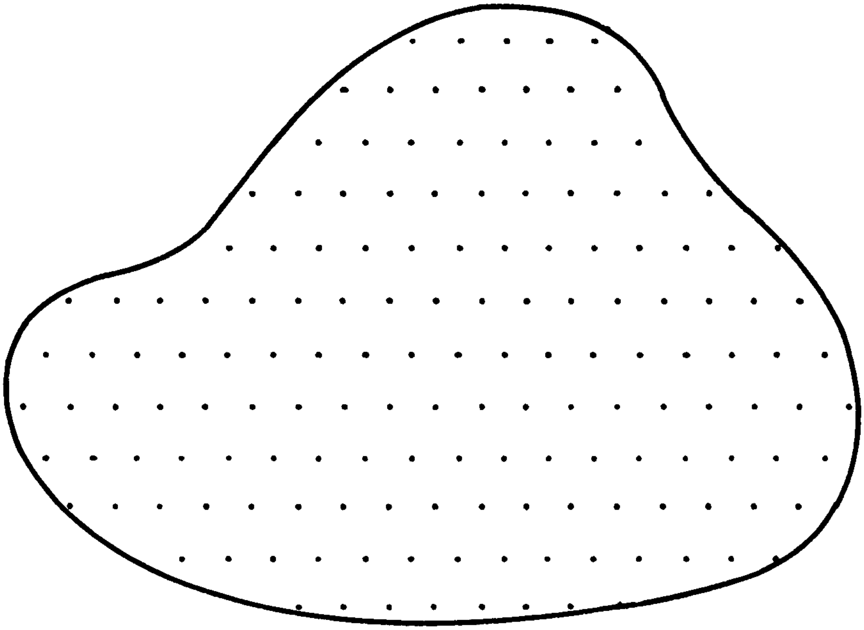

FIGURE 1B

Aerial View of the Same Urban Region, Served by Many Small, Evenly-Spaced Recreation Centers

recreation facility. Using this definition of equity, the most equitable system would be one in which there is a recreation center next door to every home. In other words, the most equitable system is one in which centers are very closely spaced. As the spacing increases, equity declines.

Efficiency can also be defined in many ways. It is defined here in terms of the consumption of recreation services as measured by attendance at recreation centers. The "most efficient" system is that which maximizes total attendance in the system.[3]

3. It should be noted that this measure of efficiency represents a cost-effective rather than a benefit-cost criterion. The benefit-cost question of the optimal budget for a recreation system is not addressed because of the theoretical and operational difficulties in measuring the benefits of urban recreation services. The Clawson method of measuring recreation benefits, which relies on information regarding the monetary cost of traveling to recreation facilities, applies primarily to regional recreation facilities to which the vast majority of users must travel long distances involving substantial expenses for operating an automobile or purchasing bus or plane tickets. The method is not readily applicable to urban recreation centers because the majority who use these facilities either walk or ride bicycles to them and, therefore, incur almost no transportation expense.

Many other studies of public facility location have sought to minimize transportation

The remainder of the paper will be devoted to an analysis of the equity and efficiency implications of alternative spatial patterns of recreation centers.

ALTERNATIVE GEOMETRIES

One of the decisions to be made in recreation planning is the choice of the geometric pattern to be used in locating recreation centers. Examples of three alternative geometries for a system of equally-spaced centers are shown in Figure 2. In Figure 2A the centers are arranged so that the principal service area of each is triangular. Square and hexagonal service areas are shown in Figures 2B and 2C. The population (and land area) within the principal service area of all three patterns is equal.

Lösch has shown that, among these and all other patterns composed of regular polygons, the hexagonal pattern yields the greatest demand for the subject service (or good).[4] Hence, the hexagonal

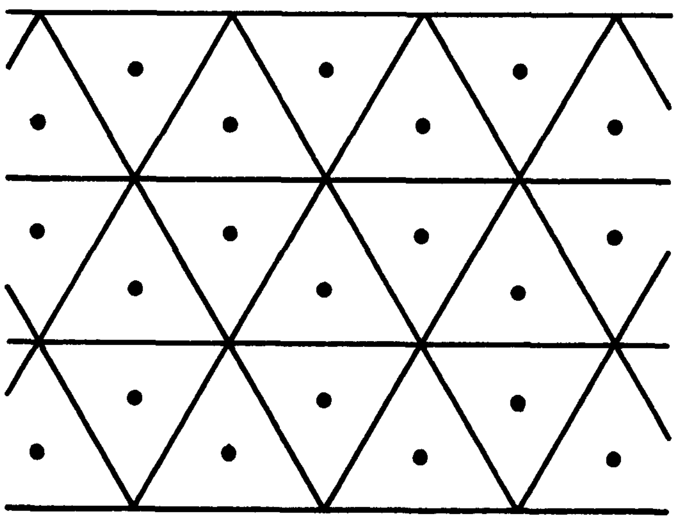

FIGURE 2A

A system of recreation centers in which the principal service area is triangular

costs (rather than maximize the consumption of service). This approach is warranted when it can be shown that the minimum-transportation-cost solution also maximizes the consumption of service. The transportation cost criterion is inappropriate for locating recreation centers because it fails to consider scale economies and the effect of size on usage.

4. A. Lösch, The Economics of Location 109-123 (2d rev. ed. W. Woglam & W. Stolper transl. 1967).

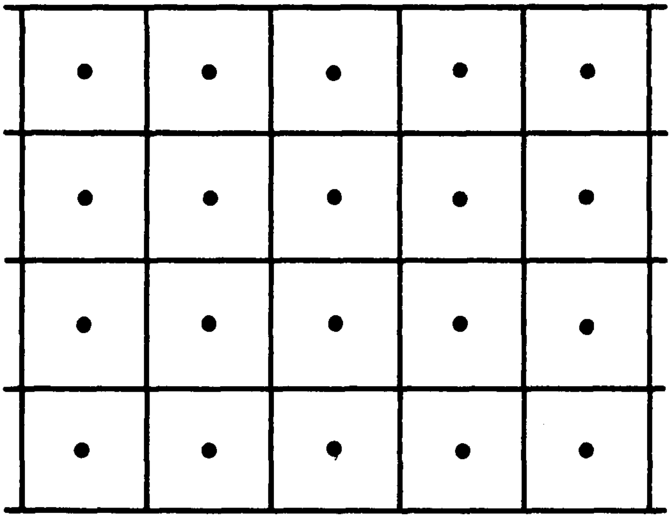

FIGURE 2B

A system of recreation centers in which the principal service area is square

pattern is the most efficient because it will give rise to the highest attendance. The reason for this is that the average distance to the nearest center is least for the hexagonal pattern.

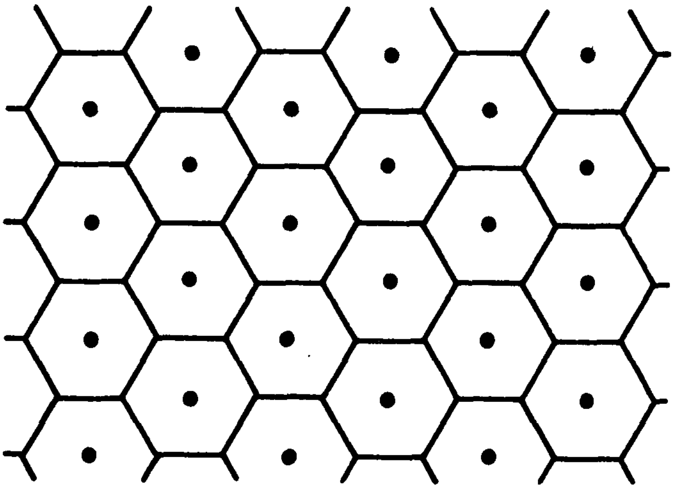

FIGURE 2C

A system of recreation centers in which the principal service area is hexagonal

It can also be shown tha the hexagonal pattern is the most equitable. As can be seen in Figure 2, the hexagon provides for the most compact service area. Since the distance from a center to the furthest point within its primary service area is greatest for the triangle and least for the hexagon, the variation in distance to the nearest center is least for the hexagon and greatest for the triangle.

It is concluded that the hexagonal geometry is the best for locating urban recreation centers, because it is both the most efficient and the most equitable. All subsequent analysis will be based upon this pattern.

THE BUDGET CONSTRAINT

The size and spacing combinations available to the planner are limited by the size of the recreation budget. For a given budget, the larger the size of an individual center, the greater must be the spacing. The exact relationship can be derived from the following equation which equates the budget for each center (the left side of the equation) to the annual cost of operating each center and amortizing its development cost (the right side).

$$k_1 \ k_2 \ k_3 \ d^2 = C_0 + C_1 \ S \qquad (1)$$

where:

- k_1 = the per capita recreation budget,
- k_2 = the population density of the region (measured as people per square mile),
- k_3 = the constant, $\frac{\sqrt{3}}{2}$, which, when multiplied by the square of spacing, is equal to the area of an individual hexagon (in square miles),
- d = the spacing between adjacent centers, in miles,
- C_0, C_1 = the parameters of a linear cost equation that relates the size of an individual center to its annual cost (including the payment to amortize the initial capital cost),
- S = the acreage of an individual center.

Solving equation (1) for size gives the budget constraint, equation (2), which is shown graphically

$$S = \frac{k_1 \ k_2 \ k_3 d^2}{C_1} - \frac{C_0}{C_1} \qquad (2)$$

in Figure 3. Only those size and spacing combinations on the curve satisfy the budget constraint. Points above the line represent combinations that would cost more than the budget would allow; points below the line would leave a budget surplus. An example of allow-

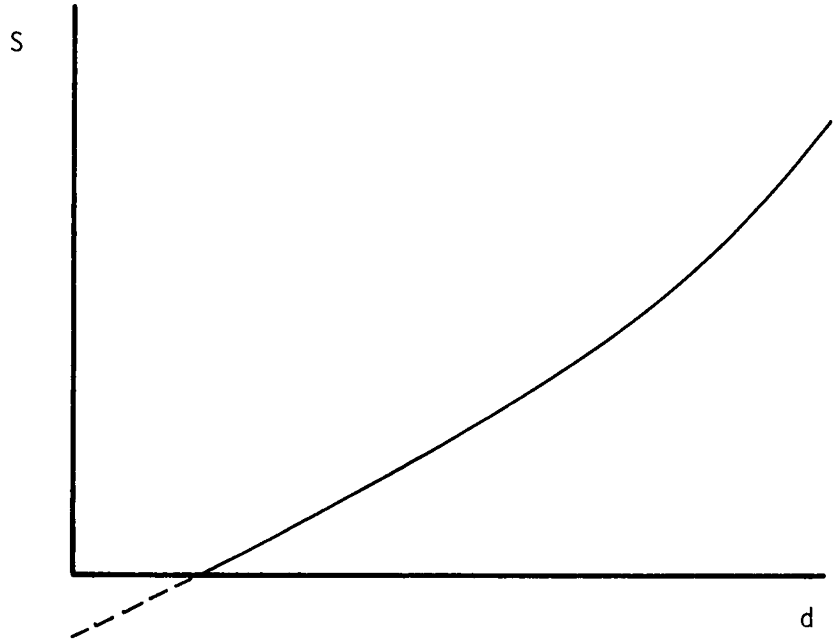

FIGURE 3

The Budget Constraint

able size and spacing combinations, derived from a study of recreation centers in South Central Los Angeles is shown in Figure 4.

Now that we have developed a methodology for identifying allowable combinations of size and spacing, we can proceed to evaluate their implications for equity and efficiency.

EQUITY

Equity was defined earlier in terms of the variation in distance to the nearest facility. If the variation is measured by the standard deviation, then it can be shown that equity is inversely proportional to spacing.[5] Hence, using this measure, equity is halved by each doubling of spacing. A problem with this measure is that it is difficult to relate to, since there are no obvious guide posts that one could use to judge the desirability of any given level of equity.

Another measure of variation is the range; that is, the difference between the maximum and the minimum distance. Each alternative spacing has the same minimum distance (i.e., some people will be living next to a recreation center in all situations); therefore, the

5. McAllister, *supra* note 2, at 223-224.

Spacing (Straight-line mileage between adjacent recreation centers)	*Size* (Acreage of an individual center)
1.2	1.7
1.4	3.6
1.6	5.9
1.8	8.5
2.0	11.4
2.2	14.6
2.4	18.0
2.6	21.8
2.8	25.9
3.0	30.3

FIGURE 4

Allowable Size and Spacing Combinations Derived from Study of Recreation in South Central Los Angeles

Source: McAllister, op. cit. Evaluating the Size and Spacing of Urban Public Service Centers: The Case of Local Recreation Facilities (Ph.D. Dissertation, University of California, Los Angeles, 1970).

maximum distance can be used by itself as an indicator of equity. This measure corresponds to the concept of maximum walking distance, which is a commonly used planning criterion in recreation standards. Because of its widespread usage, maximum walking distance will be used here as the indicator of equity. Naturally, shorter distances are more equitable.

The relationship between maximum walking distance and spacing is easily calculated by trigonometry. The straight line distance from the corner of a hexagon to the center is approximately .578 of the spacing. However, it will be assumed here that development patterns do not permit one to walk a straight line; rather, they require one to walk the two legs of a right triangle. Accordingly, maximum walking distance is approximately .789 of the spacing. Hence, if a recreation system has a spacing of two miles, the maximum walking distance would be 1.578 miles (.789 x 2). If the spacing is cut by 50 percent (e.g., from two miles to one), maximum walking distance would be reduced by 50 percent (from 1.578 miles to .789).

EFFICIENCY

The most efficient recreation system has been defined as that which maximizes attendance. There are opposing forces affecting attendance levels among the alternative recreation systems lying along the size-and-spacing spectrum. The major forces favoring a system of large, distantly-spaced centers are scale economies and the greater attractiveness of large-center services.

Economies of large scale are present in site-planning (i.e., making the most of each acre of land), construction of facilities, maintenance, and recreation supervision. The existence of these economies means that a greater quantity of recreation services can be offered in a system of large centers. The greater power of attraction of large centers derives from the wider variety of recreational opportunities and the shorter average time spent by people waiting in lines. On the other hand, a system of closely spaced centers is favored by its greater accessibility.

These factors are incorporated into a model of efficient size and spacing described in the appendix. The model is designed to predict attendance as a function of the size and distance to recreation centers. It can be used to derive curves which identify different size and spacing combinations that correspond to the same level of attendance, referred to subsequently as "iso-attendance curves."[6] A series of iso-attendance curves are overlaid on a budget constraint in Figure 5. The positive slope of each curve suggests that as recreation centers are spaced further apart, the size of each must be increased in order to maintain a constant attendance. Higher numbered iso-attendance curves represent higher attendance levels.

The most efficient size and spacing corresponds to the point where the budget constraint is tangent to the highest iso-attendance line.

The most interesting aspect of the graphical analysis is the fact that both the budget constraint and the iso-attendance curves are convex from below. This indicates that attendance may not be affected greatly by movements along the budget curve within a wide range. An empirical analysis of attendance patterns in South Central Los Angeles and a sensitivity testing of the attendance model supports this view.

THE TRADE-OFF BETWEEN EQUITY AND EFFICIENCY

Now we are in a position to compare the equity and efficiency implications of allowable size and spacing alternatives. The comparison cannot be made for the general case, because budgetary and behavioral factors can vary considerably from area to area. It will be made here for the South Central Los Angeles area and followed by some general policy conclusions.

6. The iso-attendance equation can be derived from equation (6) in the Appendix by solving it for S.

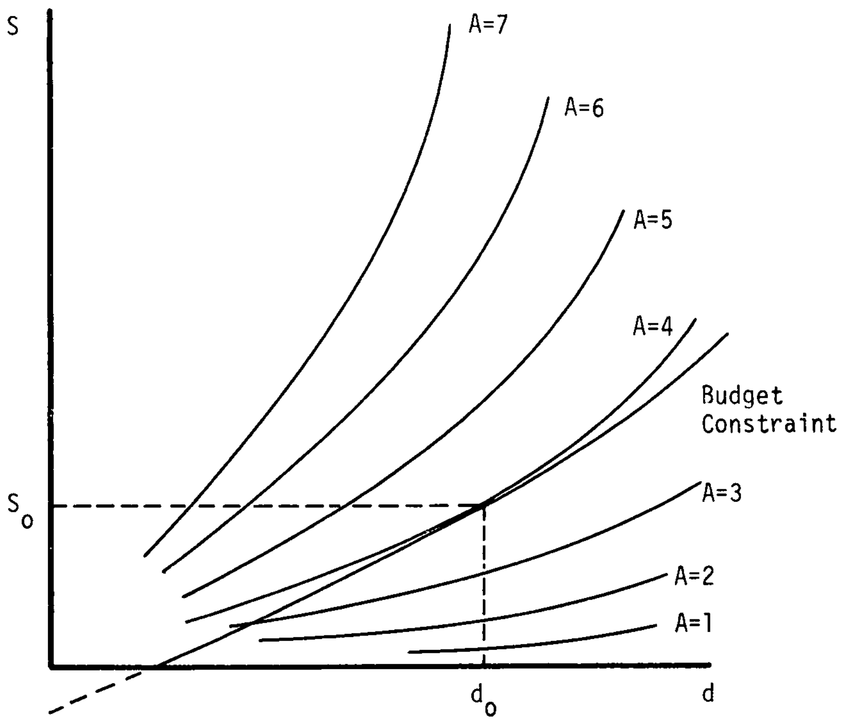

FIGURE 5

A graphical solution of the "most efficient" size and spacing

The effects of size and spacing on efficiency and equity are graphed in Figure 6. Maximum walking distance (the indicator of equity) is a simple linear function of spacing. It rises from .789 miles at a one-mile spacing to 2.367 miles at a three-mile spacing.

The attendance index (the measure of efficiency) is scaled so that the maximum attendance is equal to 100. The attendance curve shows that attendance rises very rapidly as spacing increases from its minimum of one mile. Then it begins to rise more gradually, reaches its maximum at a spacing of 1.8 miles (and a size of 8.5 acres) and slowly declines thereafter.

The graphical analsysis reveals that, as usual, equity and efficiency are at odds: equity is highest but efficiency is low in a system of very closed spaced centers. Unfortunately, there are no objective standards which can be used to assess the tradeoffs between the two criteria. In other words, there is no objective method of determining

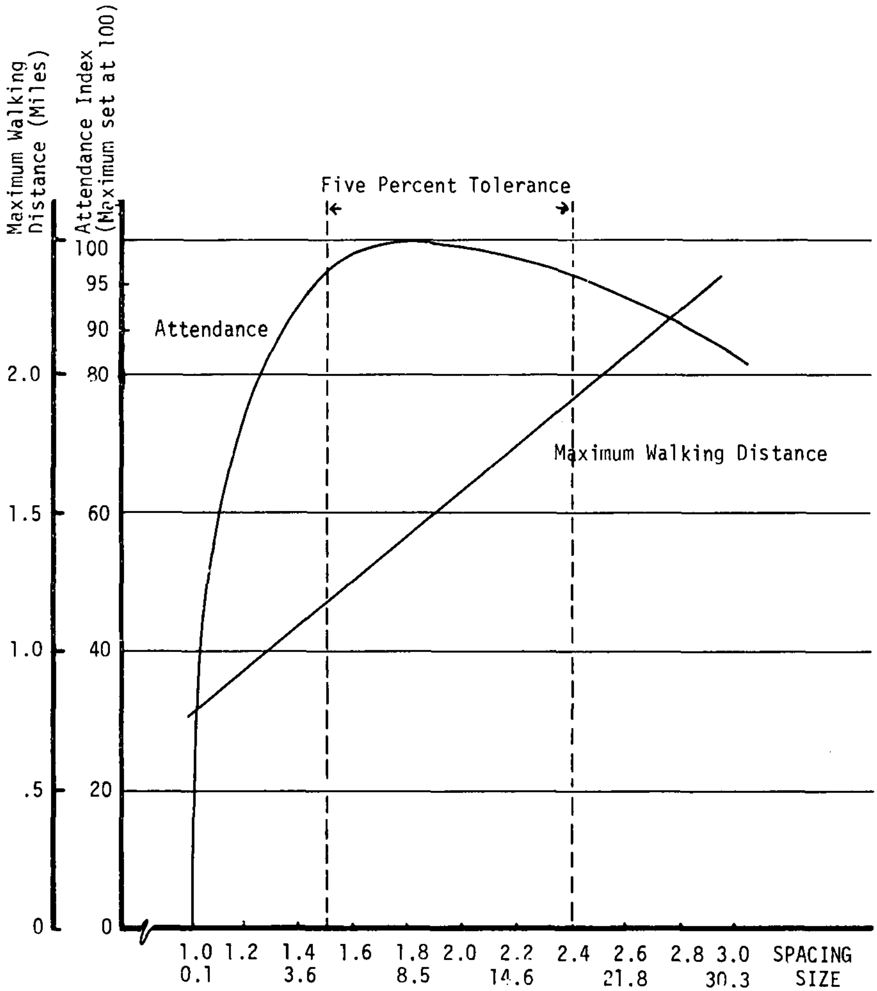

FIGURE 6

The Effect of Size and Spacing on Attendance and Maximum Walking Distance

Source: McAllister

the "optimal" size and spacing of urban recreation centers.[7] However, the range of relative insensitivity in the attendance curve would appear to reduce the difficulty of the assessment. For example, the

7. The impossibility of objectively assessing the tradeoffs between equity and efficiency has long been recognized in the field of welfare economics. For a discussion of this problem, see G. Myrdal, The Political Element in the Development of Economic Theory (1969), or J. de V. Graff, Theoretical Welfare Economics (1967).

attendance range of 95 to 100 (noted on Figure 6 as the range of "5% tolerance") includes spacings of 1.5 to 2.4 miles and the respective sizes of 4.7 to 18.0 acres, which cover most current standards for neighborhood and community recreation centers. Similar results were obtained from sensitivity testing of the attendance equation. Therefore, the insensitivity of attendance noted above for the case of South Central Los Angeles is not unique to the conditions of this area; instead, it is probably quite general.

Within the broad range of insensitivity to attendance, it would be argued that the equity criterion should predominate. Clearly, a 1.5 mile spacing is preferred to 2.4 miles, since attendance is the same in each and maximum walking distance is 37 percent lower for the shorter distance. In choosing a spacing of 1.5 miles instead of the most efficient spacing (1.8 miles) one sacrifices 5% in efficiency to gain 16% in equity. Further reductions in spacing yield smaller gains in equity at the sacrifice of larger losses in efficiency.

CONCLUSIONS

The choice of the "best" size and spacing of urban recreation centers is ultimately subjective. It will not be determined by an equation but by planners using their judgment in weighing the important factors. However, these judgments should be based upon much more factual information regarding the implications of alternatives than has been the common practice in the past.

The systematic approach to recreation planning, described in this paper, provides a concrete framework for selecting, organizing, creating and analyzing information which bears directly on these decisions. It appears to be a valuable tool for planning at all levels, from the setting of national standards to the selection of sites for new recreation facilities.

A more specific conclusion is that the results of the analysis lend theoretical and empirical support to the popular view that accessibility deserves special attention in the planning of all types of urban recreation facilities, whether they be neighborhood playgrounds, community recreation centers, or regional parks. The services of each should be provided with the maximum of access, without serious loss of scale economies. In planning the development of or additions to each type of facility, planners should constantly question the advisability of large size, for it can only be achieved at the sacrifice of greater accessibility in the recreation system. As the reserves of nonrenewable energy resources are further depleted, the importance of accessibility will become even more urgent.

APPENDIX

A Model of Recreation Attendance

The purpose in this appendix is to present the derivation of a model that relates attendance in a recreation system to the size and spacing of the system.

The model is designed to predict average per capita attendance rather than total attendance. This permits the results to be stated independently of the size of the region to be served, and without reference to the number of recreation centers in the system. No sacrifice in accuracy is made in the process, because total attendance is a simple multiple of per capita attendance.

The desired relationship is derived from equation (3) below, which has been shown by empirical analysis to be a good estimator of per capita attendance on a zone-by-zone basis (using census tracts as zones).[8] Socio-economic variables and a complex distance exponent should be included in a statistical analysis, but they are excluded here in order to avoid unnecessarily complicating the presentation of the derivation.

$$A_i = \gamma \left(\sum_{j=1}^{n} \frac{S_j^\alpha}{D_{ij}^\beta} \right)^\theta \tag{3}$$

where

A_i = the annual per capita attendance at all public recreation centers by residents of zone i,

S_j = the size of recreation center j measured by the amount of land, and containing an "optimal" mix of land, labor and capital,

D_{ij} = the distance between zone i and center j,

$\alpha, \beta, \theta, \gamma$ = constants to be estimated empirically.

The average attendance rate, $\bar{A}$, for all zones in the subject region is found by taking the weighted average of the A_i's divided by the number of zones, which are equally sized and equally populated.

$$\bar{A} = \frac{\gamma}{m} \sum_{i=1}^{m} \left(\sum_{j=1}^{n} \frac{S_j^\alpha}{D_{ij}^\beta} \right)^\theta \tag{4}$$

8. McAllister, *supra* note 2.

Two alterations in equation (4) are appropriate. First, S_j can be taken outside the summations, because size is constant for all j's in our hypothetical system; second, all distances can be measured as distances between adjacent recreation centers.

$$\bar{A} = \frac{\gamma\, S^{\alpha\theta}}{m} \sum_i \left(\sum_j 1/\,(d\lambda_{ij})^{\beta} \right)^{\theta} \tag{5}$$

where

d = the distance between one recreation center and an adjacent center in the hypothetical system where the spatial distribution of recreation centers is identical to that of a single hierarchy in a Löschian net, and

λ_{ij} = the distance between i and j measured in units of d.

Since d is a constant for all i's and j's, it can also be brought outside the summations to yield the general relationship between attendance, size and spacing:

$$\bar{A} = \frac{\gamma S^{\alpha\theta}}{m\, d^{\beta\theta}} \sum_i \left(\sum_j 1/\lambda_{ij}^{\beta} \right)^{\theta} \tag{6}$$

The solution to equation (6) for size yields the equation for iso-attendance curves. By substituting the budget constraint, equation (2), into equation (6), one obtains the constrained attendance equation that relates attendance to spacing, such as is shown in Figure 6. The most efficient spacing can be derived from equation (6) by taking the partial derivative with respect to d, setting the result equal to zero and solving for d.