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Great Plains-Rocky Mountain Camping: A spatial analysis

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GREAT PLAINS - ROCKY MOUNTAIN CAMPING
A SPATIAL ANALYSIS

A Thesis

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by

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THESIS ACCEPTANCE

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INTRODUCTION

As our society becomes increasingly leisure-oriented with the growth of disposable personal income and shorter work periods, the need for recreation facilities continues to rise. Government agencies have attempted to meet this demand by the expansion of public facilities within the total outdoor recreation resource complex. Similarly, commercial entrepreneurs have recognized the profit potential of specific recreation elements with a resulting increase in facilities such as commercial campgrounds. Because of the difficulties in obtaining data, economic demand and supply studies have been limited mostly to the public sector. An early study (Merewitz, 1966) stated that variables affecting public and commercial recreation facilities were not interchangeable in meeting the recreation demand, however, it has recently been proven (Hoffman and Romsa, 1972) that the variables controlling attendance are applicable to both facility types.

The demand for recreation facilities in an area is dependent on the following elements: (1) the population of the area; (2) the mobility of the population; (3) the

age and income structure of the population; (4) the recreation activities desired by the population; and (5) the availability of opportunities for the population to engage in the desired recreation activities (Mercer, 1970). One recreation activity is participation in outdoor camping. Commercial, private, and public recreation facilities exist for this purpose, and differences in their respective spatial patterns and density distributions do exist.

This thesis examines the spatial distribution pattern of the commercial and public sectors of the camping market in the Great Plains - Rocky Mountain states. Commercial and public campgrounds are both defined as recreation units that provide outdoor camping experiences which attempt to satisfy the wants, needs, and desires of the general public.

Campground units within those Great Plains - Rocky Mountain states that contain some portion of the Missouri River tributary system have been studied. This area was chosen because of the great abundance and diversity of cultural and physical landscape features, each purportedly having some impact on the location of the individual units. Specifically, campgrounds in the states of Colorado, Iowa, Kansas, Minnesota, Missouri, Montana, Nebraska, North Dakota, South Dakota, and Wyoming are included in the

context of the study.

Definition of Terms

A glossary of terms found to be useful and relevant is presented to alleviate the necessity of defining a term as presented in the body of the report. The terms are defined in as simple a statement as possible while attempting to maintain a reasonable degree of accuracy.

Term	Definition
AMENITIES CAPACITY	See Campground Facility Amenities Capacity.
CAMPGROUND	The basic data collection unit. A single recreation facility providing an outdoor camping experience.
CAMPGROUND ATTRIBUTE	Specific data elements related to the campground unit. Consists of a variety of recreation activities and campground facility amenities.
CAMPGROUND CAPACITY	Measurement of the number of camping sites at a campground multiplied by the length of season for the campground.
CAMPGROUND FACILITY AMENITIES	Data elements within one mile of a campground which serve to attract users to the campground.
CAMPGROUND FACILITY AMENITIES CAPACITY	Measurement of the number of camping sites at a campground multiplied by the summation of the campground facility amenities.

Term	Definition
CAMPGROUND SET	One of the three aggregations of campgrounds in a given state. It may be the commercial campground set, the public campground set, or a combination of both sets.
CAMPGROUND UNIT	See Campground.
CAMPGROUND UNIT SET	See Campground Set.
DENSITY DISTRIBUTION	See Spatial Density Distribution Pattern.
DENSITY DISTRIBUTION PATTERN	See Spatial Density Distribution Pattern.
DENSITY PATTERN	See Spatial Density Distribution Pattern.
DISTRIBUTION PATTERN	See Spatial Distribution Pattern.
FACILITY CAPACITY	See Campground Facility Amenities Capacity.
MAXIMUM ATTRACTION	See Maximum Campground Attraction.
MAXIMUM CAMPGROUND ATTRACTION	Measurement of the campground capacity multiplied by the summation of the campground attributes.
RECREATION ACTIVITIES	Data elements within five miles of the campground which are related to recreation and serve to attract users to the campground.
RECREATION ACTIVITIES CAPACITY	Measurement of the number of camping sites at a campground multiplied by the summation of the recreation activities.

Term	Definition
REFERENCE NODE	A major population center or a major tourism attraction within a given state.
SPATIAL DENSITY	See Spatial Density Distribution Pattern.
SPATIAL DENSITY DISTRIBUTION	See Spatial Density Distribution Pattern.
SPATIAL DENSITY DISTRIBUTION PATTERN	The arrangement of the campground data after aggregation of the elements at the county level within a given state.
SPATIAL DISTRIBUTION	See Spatial Distribution Pattern.
SPATIAL DISTRIBUTION PATTERN	The arrangement of the point pattern of the campground locations within a given state.
SPATIAL PATTERN	See Spatial Distribution Pattern.
UNIT	See Campground.
UNIT SET	See Campground Set.
WEIGHTED ELEMENT	One of the five variables used in the analysis of the campground data. Includes the number of camping sites, the campground capacity, the campground facility amenities capacity, the maximum campground attraction, and the recreation activities capacity.

Classification of Campground Units

A campground is identified either by its orientation towards the specific needs of a user-population, or by its

ownership and management philosophy. User-population studies have identified seven campground unit classes (Wagar, 1963; Jubenville, 1976), called the transient or traveler, the central, the long-term, the forest, the peak-load or overflow, the back-country, and the wilderness campground unit. The ownership and management philosophy approach identifies three campground unit classes: commercial, private, and public campgrounds.

The transient, or traveler, campground unit, oriented towards the most heavily-used travel routes, is generally designed for small areas of intensive use. It emphasizes minimal development with provision of only those essential services needed to accommodate the overnight visitor.

The central campground unit, oriented towards major tourism attractions, generally provides maximum services in large-scale developments, emphasizing its use as a home-base for its clients, thus permitting them to enjoy the nearby points of interest and to participate in day-use activities away from the campground area.

The long-term campground unit is similar to the central campground except that numerous day-use activities are provided within the areal limits of the campground.

The forest campground unit provides services and

facilities considered attractive to single-family groups, with an emphasis on the natural landscape features of a region.

The peak-load, or overflow, campground unit provides minimal services and short-term accommodations in locations served by forest or central campground units, and is designed to protect the natural environment of the area by providing additional facilities during peak usage periods of the camping season.

The back-country campground unit emphasizes primitive facilities in roadless areas, whereas the wilderness campground unit, also in the roadless areas, has no established facilities or services.

The commercial campground unit is generally independently owned, although about one-fourth of these campground units are affiliated with some national franchise chain. The commercial campground unit is open to any user-group that pays its facility-use fees, and its operations are strictly profit-oriented.

The private campground unit is usually operated by some tax-exempt organization serving a special interest group population. Minimal charges may be levied for use of the private campground facilities, and its operations may or may not generate a profit.

The public campground unit is operated by a government agency at the local, county, district, regional, state, or national level. It provides outdoor recreation opportunities to the general public at little or no cost, and may or may not operate at a profit.

Because both commercial and public campgrounds are available to the general public, all of these units within the Great Plains - Rocky Mountain study area have been identified. The private campgrounds were not considered for this report because their clientele is generally restricted to special interest groups.

Based on the various data sources used to obtain material regarding campground units, there are 2,115 commercial campgrounds with 106,335 individual camping sites, and 2,861 public campgrounds with 97,252 individual camping sites within the study area. Table 1 shows the division of the commercial and public campgrounds by state. Table 2 includes the division of the commercial and public camping sites by state.

Literature Review

This thesis is not intended as an economic analysis of the campground market, but rather as a geographic study of the spatial patterns of the campground units in a given

TABLE 1

COMMERCIAL AND PUBLIC CAMPGROUND UNITS

State	Commercial	Public	Total	Percent of Total
Colorado	266	438	704	14.1
Iowa	207	374	581	11.7
Kansas	113	350	463	9.3
Minnesota	587	311	898	18.0
Missouri	260	142	402	8.1
Montana	238	419	657	13.2
Nebraska	82	166	248	5.0
North Dakota	47	219	266	5.3
South Dakota	126	176	302	6.1
Wyoming	189	266	455	9.1
Total	2,115	2,861	4,976	

area. It was necessary to review many of the works pertaining to the economics of campground operation. However, only a small segment of this literature related to spatial distribution studies. Thus, only a very small portion of the economic literature was actually used in the study.

The public agency sector, at all levels, was the primary supplier of campground units at the beginning of the 1960's (Outdoor Recreation Resources Review Commission,

TABLE 2

COMMERCIAL AND PUBLIC CAMPING SITES

State	Commercial	Public	Total	Percent of Total
Colorado	16,971	11,696	28,667	14.1
Iowa	9,910	20,613	30,523	15.0
Kansas	3,548	9,714	13,262	6.5
Minnesota	22,235	9,996	32,231	15.8
Missouri	16,607	9,452	26,059	12.8
Montana	11,995	7,621	19,616	9.6
Nebraska	3,695	7,399	11,094	5.4
North Dakota	3,050	6,536	9,586	4.7
South Dakota	8,454	5,126	13,580	6.7
Wyoming	9,870	9,099	18,969	9.3
Total	106,335	97,252	203,587	

1962), but this situation, as shown by the data in Tables 1 and 2, is no longer true. Commercial campgrounds now comprise nearly half of the total campground market within the study area.

It has been recommended (Lime, 1974) that the public agency sector form a cooperative arrangement with the commercial campground operators for the purpose of assigning responsibility for development of specific campground types in a given area. This recommendation

resulted from interpretation of findings showing that as demand for specific outdoor camping experiences increase and exceed the public agency sector capacity, the commercial campground operators enter the market (Angus, Corssmit, and Foster, 1971). In many cases these commercial facilities are constructed without considering the desires of the increasingly diverse camping population. In order for such a cooperative arrangement to be successful, some idea of the spatial distribution pattern of the existing commercial and public campgrounds in a given area must be available to both groups.

It has been suggested that commercial and public campground units appear to have different spatial orientation biases (Deasy and Griess, 1966; Thompson, 1971), according to their ownership and management philosophies, and that some of this difference is associated with their relationship to urban population centers and major tourist attractions.

In considering the attractiveness of a given campground location, its proximity to urban population centers must be noted (Trotter, 1965), although other items are also important. Some of these include the physical attributes of the campground, the amenities at the campground, the recreation opportunities available

to the users of the campground, the size and age of the campground, and the distance from the campground to nearby scenic attractions (Bond, 1974; Hoffman and Romsa, 1972; Linton, 1968; Schulman, 1964; Seneca and Cicchetti, 1969; Ungar, 1967; VanDoren, 1965). Many of these items are treated as integral parts of this study.

Measures of the capacity of a given campground unit have been difficult to develop because of the problem associated with identifying the effect of specific elements on the campground. However, direct measurement of the number of camping sites available at a campground unit and the number of days that the campground unit is available to its user-population group has been suggested (Goldin, 1972) and used in conjunction with other campground attributes to measure and study the attractive capacity of a campground unit. This procedure is used throughout this report.

Statement of Problem

Three interrelated questions about different aspects of the spatial distribution pattern of the commercial and public campgrounds within the study area have been considered. Three data arrangements are used for each state. The commercial campground units and the

public campground units are each considered as separate data sets, and then both sets are combined to obtain a third composite data set. During analysis the spatial point pattern distributions are considered first. This is followed by an intensive study of the centrographic measurements developed from the point patterns. Finally, the analysis concludes with an examination of the density distributions after aggregation of the data according to the counties within each state.

The degree of departure from a theoretical distribution pattern has been studied first, seeking answers to the following questions for each unit set:

(1) What is the spatial distribution pattern of the given set of campground units? (2) Does the same pattern obtain for all sets of campground units within the state? (3) Are there significant differences in the patterns for the ten states? (4) Do the patterns readily relate to identifiable cultural or physical landscape features?

Centrographic measurements of dispersion and spatial bias are examined second, to obtain answers to the following questions:

(1) What is the mean center of the given campground unit set? (2) What measurements of spatial directional

bias, spatial distance bias, and spatial sectoral bias are exhibited by the spatial distribution pattern of the given campground unit set in relation to the specified reference node? (3) What degree of ellipsoidal tendency is exhibited by the campground unit set? (4) Do the elements of the spatial pattern remain the same when the weighted element factor is introduced?

Spatial density distributions of selected variables derived from the data for a given campground unit set are then studied, after aggregation of the data to the county level, seeking answers to the following:

(1) What is the density distribution pattern of the number of camping sites? (2) Does this density pattern exhibit similarities to the density distribution patterns for the campground capacity values of the campground units? for the recreation activities capacity values of the campground units? for the campground facility amenities capacity values of the campground units? for the maximum campground attraction values of the campground units? (3) What level of concentration is exhibited by each of the density distributions? (4) What differences exist for these items when the states are compared?

Data Source Materials

Much of the information pertaining to the commercial and public campground units has been taken from published campground directories or promotional materials obtained from governmental agencies within each state.

Essential data about the various recreation activities associated with individual campground units were primarily compiled from the Rand McNally Campground Directory. Campground facility amenities were generally compiled from the Woodall's Trailering Parks and Campgrounds Directory, although portions were developed from a combination of both directories.

Approximately fifteen percent of the total commercial and public campground units within the study area are identified solely from the promotional literature obtained. (See the Data Source section of the Bibliography for a complete listing of these promotional materials).

Two extensive field camping trips were made in the study area during the summers of 1975 and 1976 to verify the source data collected. Visits, mostly during daylight hours, were made to about ten percent of the total commercial and public campground units within the study area. Only minor discrepancies between the published and actual on-site data were noted, with most involving

campground attributes that had been added to the unit after publication of the data source material.

Data Collection

For each commercial and public campground the following items were collected: the name of the campground, directions for locating the campground, the number of camping sites, the opening and closing dates for the campground, and a listing of campground attributes, identified as recreation activities or campground facility amenities.

Recreation activities include those items available to the user-population within a five-mile radius of the campground unit. Specific items in this category are: boating facilities, fishing facilities, golf courses, hiking trails, playgrounds, riding trails, snowmobile trails, snow ski slopes, swimming facilities, and water ski facilities.

Campground facility amenities include those items available to the user-population, either within a one-mile radius of the campground unit, or directly at the unit. Specific items in this category are: basketball courts, cafes or snack bars, electrical hook-up facilities, flush toilet facilities, grocery stores, hot water showers, ice skating rinks, laundry or laundromat facilities, picnic

tables, recreation halls, sanitary dump areas, separate open fire areas, sewage hook-up facilities, shuffleboard areas, swimming pools, tennis courts, and water hook-up facilities.

Preliminary Data Organization

All data items were made compatible to computer manipulation during the data collection process. This involved several procedural steps, each briefly described in the following paragraphs.

The name of the campground unit and verbal directions for its location were used, as an initial control, to eliminate the duplication of entries between the various data sources.

As each commercial and public campground was identified, values were encoded to identify the campground unit set and state location. At the same time, a sequential number was assigned to each campground unit.

The verbal directions for the campground locations were traced, using state highway road maps, to obtain an approximate location of the unit. This was then plotted on a set of Air Navigation Charts at a scale of 1:500,000 for the study region. This campground unit plot was then used as a second check to eliminate duplication of entries. The latitude and longitude of the unit were derived from

the Air Navigation Charts to the nearest tenth of a minute of arc. At the same time a value was encoded that identified the specific county containing the campground.

The opening and closing date for the campground was converted to a numerical entry.

Each campground attribute was encoded as one if the item met the availability criteria outlined, or as zero if the item was not available. No attempt was made to retain the quantities of each attribute available, such as the number of picnic tables or electrical hook-up facilities.

The total number of camping sites at each campground was recorded, without distinguishing between tent camping and recreation vehicle use sites.

Preliminary Computer Manipulations

After the data collection and organization steps, certain preliminary computer manipulations were accomplished before application of the analytical-level computer programs. These lower-level procedures and programs were used essentially to divide the data into the proper aggregations or formats for use by the analytical programs. The low-level techniques used included the following:

1. A simple counting routine to tally the number

of campgrounds within each unit set of each state, as well as providing separate tallies for each county within a state

2. Subtraction of the closing date from the opening date for the unit was used to obtain the length of its season

3. A simple maximum-minimum algorithm was used to convert the latitude and longitude coordinates of the campground to a rectangular Cartesian coordinate system, when required by the analytical programs

4. Assignment of a minimum value of one to a campground when the number of separate camping sites could not be derived from the data source material was used to permit this element to be considered in the analytical programs

5. A total recreation activities value was obtained for each campground unit by summation of the entries for each of the recreation activities

6. A total campground facility amenities value was obtained for each campground unit by summation of the entries for each of the campground facility amenities

7. A campground capacity value was obtained for each campground by multiplying the number of camping sites at the unit by the length of the season for the

campground

8. A recreation activities capacity value was obtained for each campground by multiplication of the number of camping sites at the unit by the total recreation activities value of the unit

9. A campground facility amenities capacity value was obtained for each campground unit by multiplication of the number of camping sites at the unit by the total campground facility amenities value of the unit

10. A maximum campground attraction value was obtained for each campground by multiplying the campground capacity value for the unit by the summation of all the campground attributes available with the unit.

After completion of these preliminary computer procedures, the various analytical programs were applied to the campground data. Chapter 2 describes the deviation from theoretical distribution patterns as exhibited by the spatial point patterns of the campground unit sets.

Chapter 3 details the centrographic measures obtained from the spatial point patterns, using both weighted and non-weighted data elements. Chapter 4 describes the spatial density distribution patterns after aggregation of the campground information to the county

level within each state. The final section of this chapter contains a brief summarization of the analytical results obtained. Recommendations are made concerning future applications of the methodology used as part of these concluding comments.

Chapter 2

POINT PATTERN ANALYSIS

The spatial distribution of the individual campground locations was the first element regarding commercial and public campgrounds in the thesis area to be subjected to analysis. The amount and degree of clustering or dispersion of the campground units in relation to major tourist or recreation attractions provided a fundamental understanding about the spacing of these recreation facilities. The nearest neighbor method of point pattern analysis was chosen to measure the spatial distributions in each state because of the availability of a computer program easily adapted for use with the collected data.

Nearest Neighbor Procedures

The nearest neighbor concept provides a quantitative definition of the degree of departure from a theoretical spatial distribution pattern (Clark and Evans, 1954; Dacey, 1960; Dacey, 1963; King, 1969). The distance from each campground of a unit set to its nearest neighbor, irrespective of direction, was computed

separately for each of the four nearest neighbors. The areal extent of the unit set was obtained by conversion of the latitude and longitude of the individual campgrounds to a rectangular Cartesian coordinate system. The range between the maximum and minimum values for each of the coordinate sets was then used to calculate the area of the unit set.

The distance values and the area of the unit set were used to compute indices of randomness. An Index of Randomness identifies the degree of departure from a theoretical pattern. The index was obtained for each of the four nearest neighbor aggregations. A Total Randomness Index was then constructed from the four separate indices of randomness to explain the total degree of departure for the unit set.

Randomness index values between zero and one are interpreted as meaning that the unit set distribution is trending from a theoretical random pattern towards a clustered pattern. Values between one and 2.1491 mean the distribution is trending from the theoretical random pattern towards a uniform pattern.

The spatial distribution pattern of the unit set was derived by computation of total deviation indices for clustering, randomness, and uniformity. The lowest value

obtained for the three deviation indices represents a single word statement of the mathematical analysis of the spatial distribution pattern.

The nearest neighbor computer program was used to obtain these indices for each state in three parts, the commercial campgrounds, the public campgrounds, and both campground sets combined. The indices are comparatively reviewed from a regional viewpoint, followed by an analysis of the point patterns based on their interface with tourist or recreation attractions within the state.

Mathematical Analysis

The results of the mathematical analysis of the combined campground units are shown in Table 3. No state exhibits a uniform distribution pattern. All indices of randomness indicate varying degrees of trends from randomness towards clustering, however, the deviation indices indicate a dichotomy within the study area. Five states, Colorado, Minnesota, Missouri, South Dakota, and Wyoming, represent spatial distributions which are clustered, and five states, Iowa, Kansas, Montana, Nebraska, and North Dakota, represent spatial distributions which are random.

TABLE 3

COMBINED CAMPGROUND UNITS

INDICES OF RANDOMNESS

State	Nearest Neighbor First	Second	Third	Fourth	Total
Colorado	.597	.661	.688	.711	.676
Iowa	.713	.758	.822	.849	.800
Kansas	.757	.814	.871	.890	.847
Minnesota	.611	.641	.678	.702	.667
Missouri	.591	.623	.633	.643	.628
Montana	.556	.636	.706	.734	.676
Nebraska	.708	.797	.841	.856	.816
North Dakota	.807	.868	.887	.915	.880
South Dakota	.528	.582	.611	.630	.598
Wyoming	.528	.592	.649	.680	.628

DEVIATION INDICES

State	Clustered	Randomness	Uniformity	Pattern is
Colorado	.072	.105	.215	Clustered
Iowa	.088	.061	.172	Random
Kansas	.144	.055	.194	Random
Minnesota	.078	.117	.233	Clustered
Missouri	.098	.159	.294	Clustered
Montana	.159	.151	.314	Random
Nebraska	.256	.094	.287	Random
North Dakota	.252	.057	.241	Random
South Dakota	.143	.208	.375	Clustered
Wyoming	.104	.152	.290	Clustered

TABLE 4

COMMERCIAL CAMPGROUND UNITS

INDICES OF RANDOMNESS

State	Nearest Neighbor First	Second	Third	Fourth	Total
Colorado	.552	.631	.666	.675	.643
Iowa	.696	.777	.834	.871	.812
Kansas	.661	.856	.971	1.019	.914
Minnesota	.568	.596	.629	.654	.621
Missouri	.560	.655	.685	.715	.669
Montana	.527	.545	.667	.729	.639
Nebraska	.674	.724	.814	.862	.788
North Dakota	.708	.915	.925	.978	.907
South Dakota	.437	.466	.561	.573	.525
Wyoming	.419	.507	.585	.649	.563

DEVIATION INDICES

State	Clustered	Randomness	Uniformity	Pattern is
Colorado	.154	.176	.341	Clustered
Iowa	.243	.093	.281	Random
Kansas	.511	.088	.377	Random
Minnesota	.103	.163	.302	Clustered
Missouri	.187	.172	.351	Random
Montana	.338	.275	.540	Random
Nebraska	.524	.181	.501	Random
North Dakota	.863	.117	.561	Random
South Dakota	.257	.376	.630	Clustered
Wyoming	.205	.272	.483	Clustered

TABLE 5

PUBLIC CAMPGROUND UNITS

INDICES OF RANDOMNESS

State	Nearest Neighbor First	Second	Third	Fourth	Total
Colorado	.633	.661	.710	.748	.700
Iowa	.818	.853	.862	.896	.865
Kansas	.870	.902	.937	.943	.921
Minnesota	.756	.777	.782	.811	.787
Missouri	.615	.621	.624	.658	.639
Montana	.676	.747	.776	.797	.761
Nebraska	.819	.888	.915	.922	.890
North Dakota	.860	.908	.935	.980	.932
South Dakota	.669	.756	.756	.783	.752
Wyoming	.600	.693	.713	.742	.701

DEVIATION INDICES

State	Clustered	Randomness	Uniformity	Pattern is
Colorado	.125	.123	.265	Random
Iowa	.252	.066	.249	Random
Kansas	.210	.033	.195	Random
Minnesota	.293	.127	.335	Random
Missouri	.239	.240	.445	Clustered
Montana	.280	.140	.348	Random
Nebraska	.393	.070	.311	Random
North Dakota	.323	.037	.248	Random
South Dakota	.288	.151	.363	Random
Wyoming	.209	.159	.344	Random

The results for the commercial campground units are shown in Table 4. One state, Kansas, exhibits a trend towards uniformity, but only at the fourth nearest neighbor aggregation. The remaining indices of randomness show varying degrees of trend towards clustering. The deviation indices identify patterns similar to the combined campground units, except for Missouri, which is now identified as being random in distribution.

The results for the public campground units are given in Table 5. All indices of randomness show varying degrees of trend from randomness towards clustering. Only Missouri can be classified as having a clustered distribution pattern based on the deviation indices, with all other states identified as being randomly distributed.

Map Pattern Analysis

The actual spatial distribution of the commercial and public campgrounds is shown in a series of map sets. The nearest neighbor mathematical indices are analyzed according to their explanation of the patterns displayed on the separate maps.

Each map was prepared by approximating the actual location of the campground units, with each symbol representing a single campground. The Standard

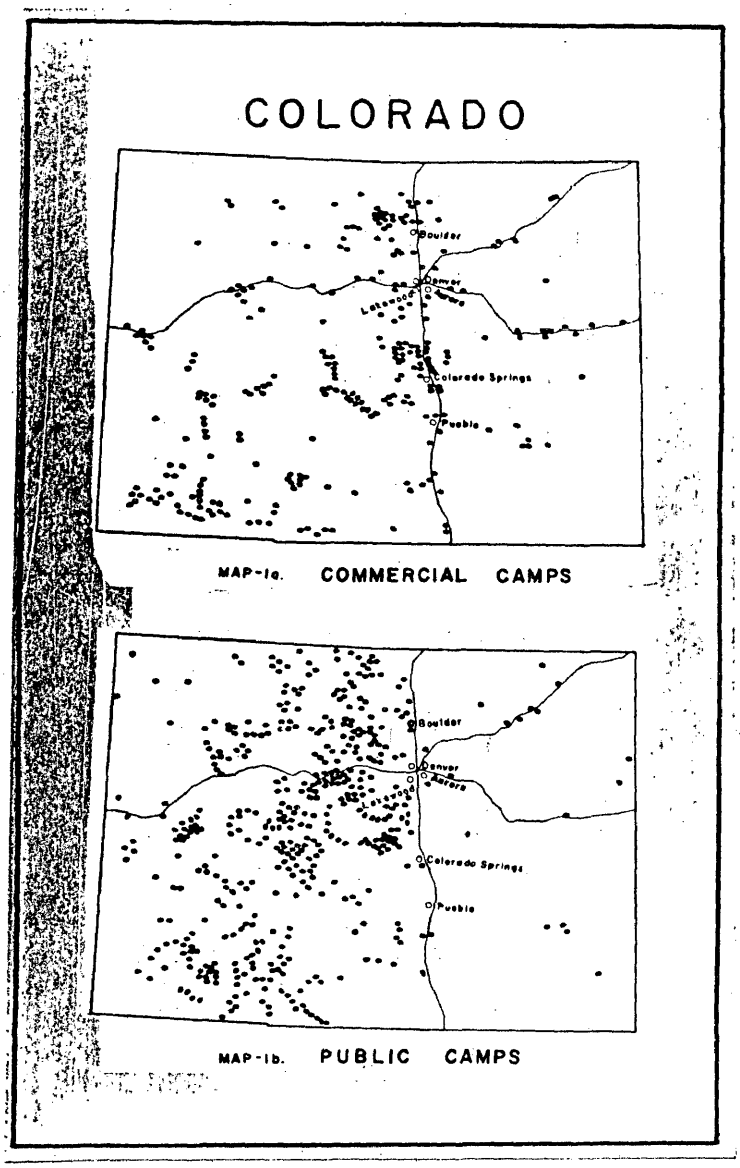
Metropolitan Statistical Areas and urban areas over 100,000 population, and the interstate highway routes within each state were added to provide ease of orientation to the maps.

Each state was considered separately for analysis. The commercial and public campground maps have been related to the mathematical indices derived, and then each map is discussed as it either confirms or differs from the indices. Points of clustering or distinctive pattern arrangements have been identified for the various maps.

Colorado Pattern Analysis

Very few campgrounds are found in the eastern third of the state. Commercial campgrounds have lower indices of randomness values than public campgrounds, indicating a greater trend towards clustering for the commercial units. Deviation indices identify commercial camps as being clustered, with public camps indicated as random, however, this identification is based on an index difference which becomes significant at the third decimal position.

Map 1a reveals four commercial campground clusters. The most obvious is near Colorado Springs, representing


COLORADO
Boulder
Denver
Colorado Springs
Pueblo
MAP-1a. COMMERCIAL CAMPS
Boulder
Denver
Aurora
Colorado Springs
Pueblo
MAP-1b. PUBLIC CAMPS

the attractive power of Pikes Peak and the Air Force Academy. Another cluster near Boulder indicates the approaches to the Rocky Mountain National Park. A third cluster west of Pueblo shows the drawing power of the Royal Gorge and Cripple Creek areas. Finally, a cluster in the southwestern part of the state is related to the nearness of Mesa Verde National Park.

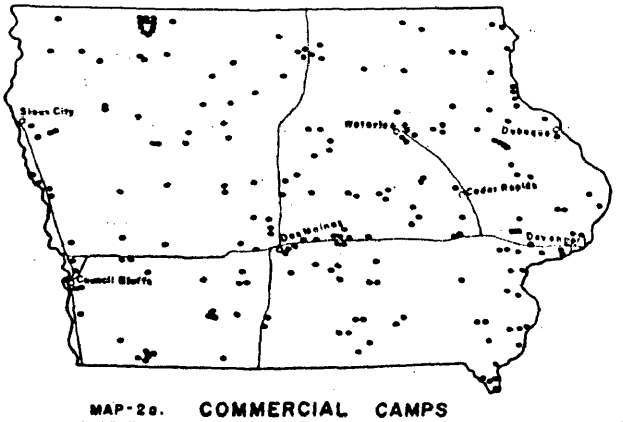
Map 1b directs attention to the numerous clusters of public campground units, which may generally be associated with the many National Forests in the western half of the state. This map would support a finding that the spatial distribution pattern for public campgrounds is clustered, even though mathematically it was found to be random when considering the pattern over the entire state.

Iowa Pattern Analysis

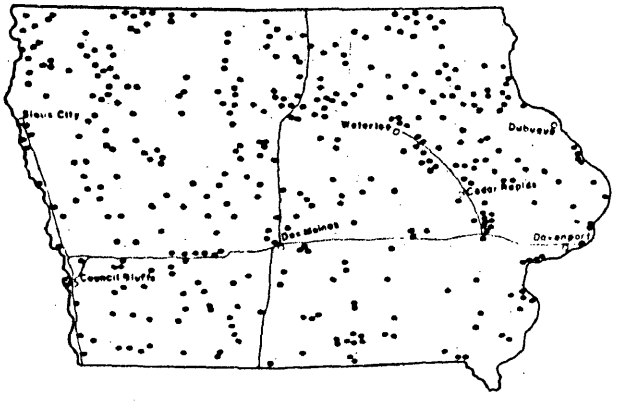
Commercial campgrounds have lower indices of randomness than public campgrounds, indicating some degree of clustering for the commercial units. Both unit sets are identified as random by the deviation indices.

Map 2a shows the widely dispersed nature of the commercial campgrounds in Iowa. The Lake Okoboji recreation complex, in the northwestern part of the state, is the

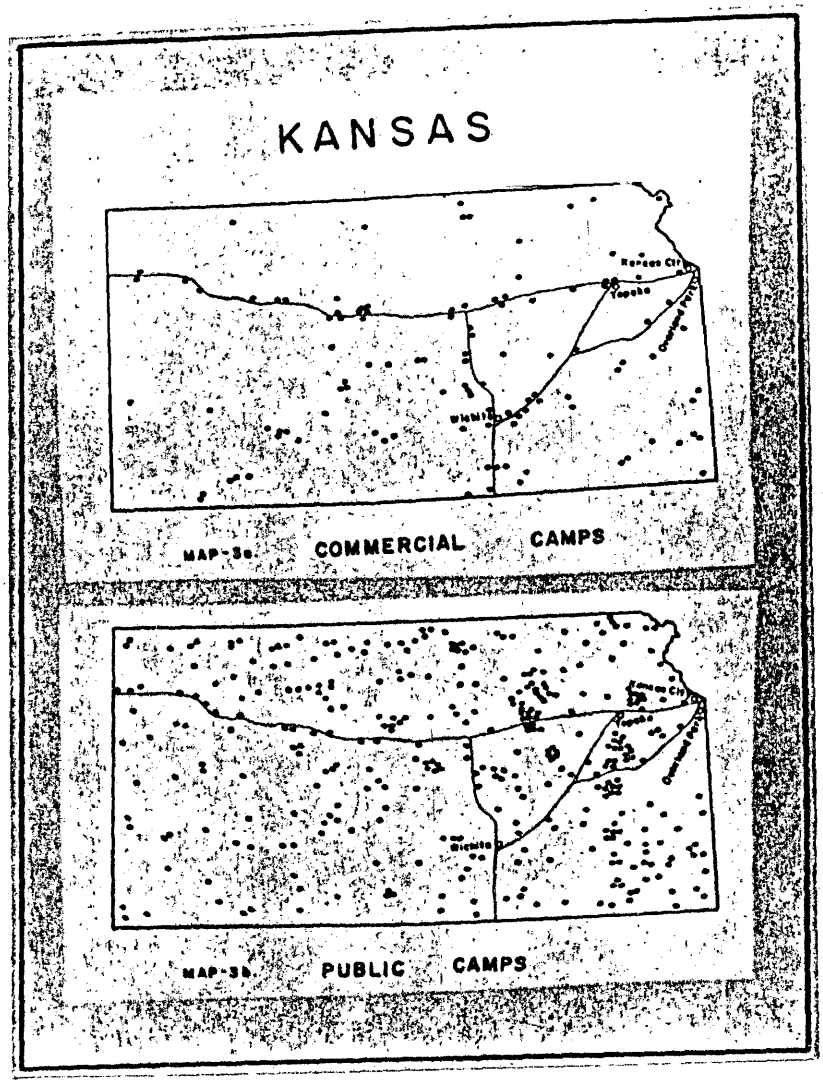
IOWA



MAP-2a. COMMERCIAL CAMPS



MAP-2b. PUBLIC CAMPS


KANSAS
Kansas City
Topeka
Wichita
MAP-3a. COMMERCIAL CAMPS
Kansas City
Topeka
Wichita
MAP-3b. PUBLIC CAMPS

only identifiable cluster.

Map 2b indicates that the public campgrounds appear to be evenly distributed throughout the state, however, because of the non-uniformity of the distribution the pattern is classified mathematically as random. No distinctive clusters or patterns can be identified.

Kansas Pattern Analysis

There is a large range in the indices of randomness for the commercial campgrounds, with the fourth nearest neighbor aggregation starting to trend towards uniformity. In comparison the public campgrounds exhibit a very small range of values in the indices of randomness. Both campground sets are classified as random according to the deviation indices.

Map 3a points out that the commercial campgrounds tend to align themselves along the interstate routes across the state. The linear string of commercial camps west of Wichita extending in a southwesterly direction are following the major highways through that part of the state.

Map 3b displays the dispersion of the public campgrounds in the western half of the state. Five obvious clusters in eastern Kansas represent the north to

south orientation of the five Corps of Engineers reservoirs--Council Grove, John Redmond, Milford, Pomona, and Tuttle Creek--and their associated recreation attractions.

Minnesota Pattern Analysis

The indices of randomness have very narrow ranges for both categories of campground units, with the commercial campgrounds showing the largest amount of trend towards clustering. The deviation indices confirm the tendency for commercial campgrounds to be clustered and public campgrounds to be random in dispersion.

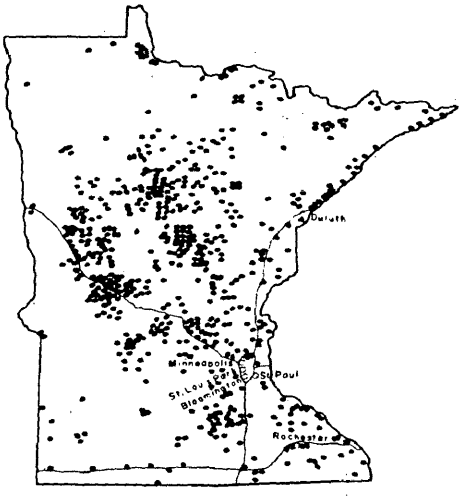
Map 4a directs attention to the many large clusters of commercial campgrounds to the north and northwest of Minneapolis. These are connected with the large number of recreation lakes near Aitkin, Alexandria, Brainerd, Detroit Lakes, Park Rapids, and Walker.

Map 4b shows that some clustering of public campgrounds occurs in the northeastern part of the state, related to the Superior National Forest and Voyageur's National Park areas.

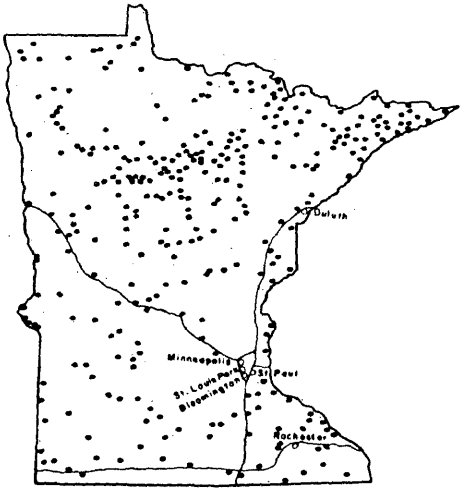
Missouri Pattern Analysis

Public campground indices of randomness all show

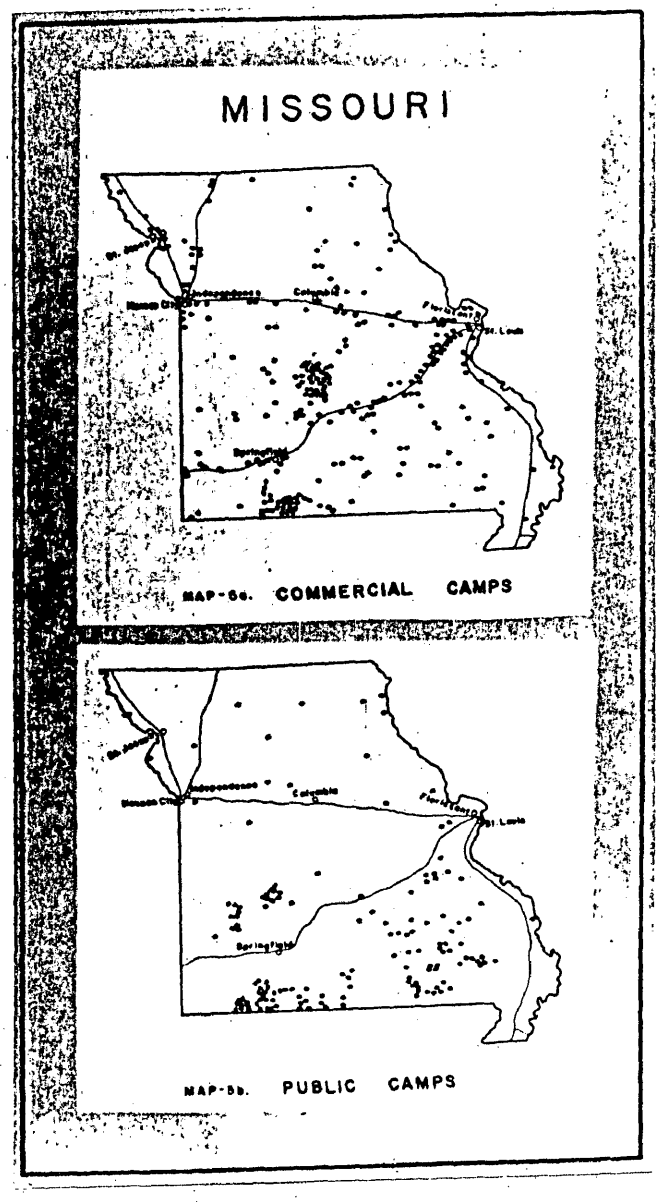
MINNESOTA



MAP-4a. COMMERCIAL CAMPS



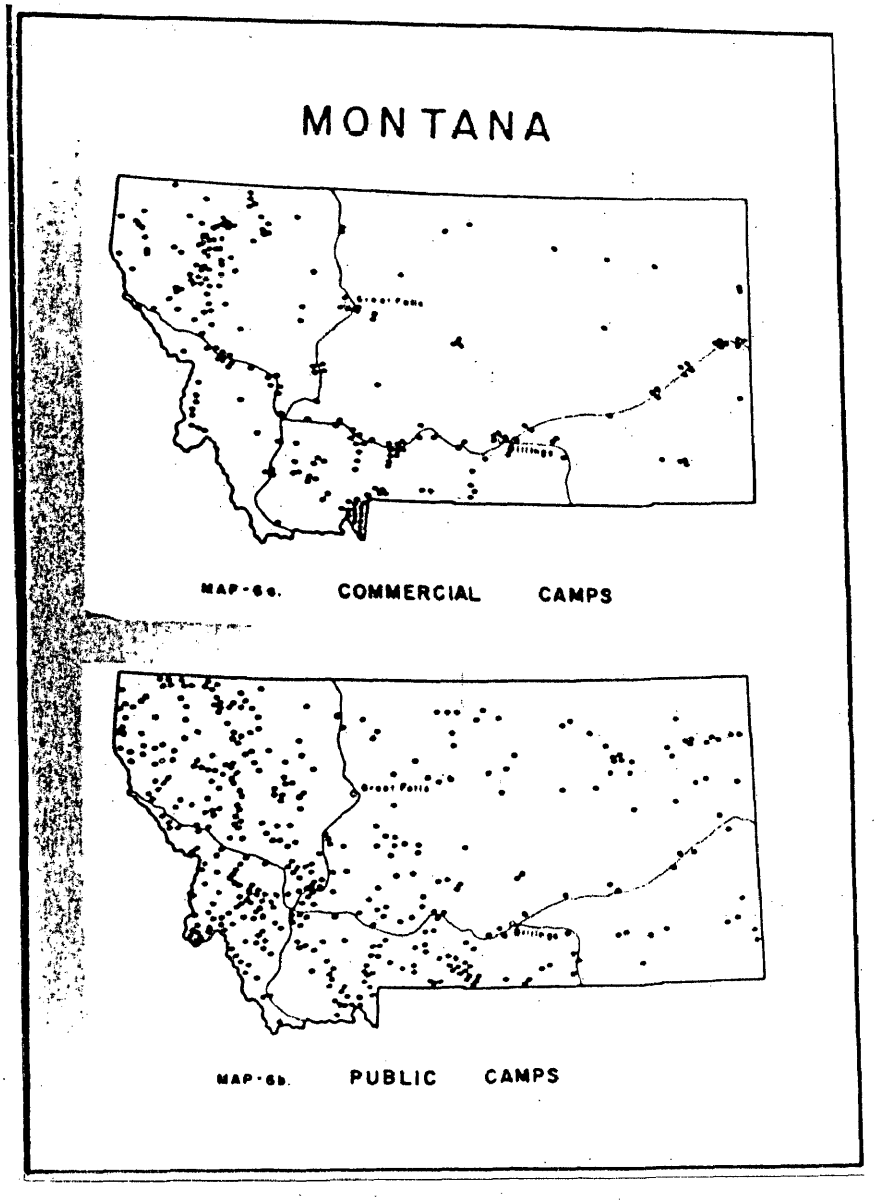
MAP-4b. PUBLIC CAMPS


MISSOURI
MAP-6a. COMMERCIAL CAMPS
MAP-6b. PUBLIC CAMPS

evidences of trends towards clustering. The commercial campgrounds have a stronger tendency towards clustering at the first nearest neighbor, but by the fourth nearest neighbor aggregation this tendency has weakened considerably. Public campgrounds are classed as clustered based on a deviation index which distinguishes between clustered and random at the third decimal position. The commercial campgrounds are considered randomly distributed, but there is very little difference between the clustered and randomness deviation indices.

Map 5a points out the scattering of commercial campgrounds throughout the state, with three exceptions. North and south of Springfield are two very large clusters, one representing the Lake of the Ozarks area, and the other representing the Table Rock Reservoir area. A distinctive linear pattern along the interstate from St. Louis towards Springfield is also evident. These would, if considered separately from the rest of the state, result in a high degree of clustering for commercial campgrounds.

Map 5b distinctly displays the clustering of the public campgrounds. The Table Rock Reservoir area south of Springfield and the clusters in the National Forest areas in the southeastern part of the state are the


MONTANA
MAP-6a. COMMERCIAL CAMPS
MAP-6b. PUBLIC CAMPS

major clusters.

Montana Pattern Analysis

There are very few campgrounds in the eastern half of the state. Although all indices of randomness indicate some tendency towards clustering, the deviation indices show a strong random spatial distribution pattern.

Map 6a shows the commercial campground cluster in southwestern Montana, near the entrances to Yellowstone National Park. Another cluster in the northwest represents Glacier National Park. Additional clusters of three or more commercial campgrounds are widely dispersed throughout the remainder of the state.

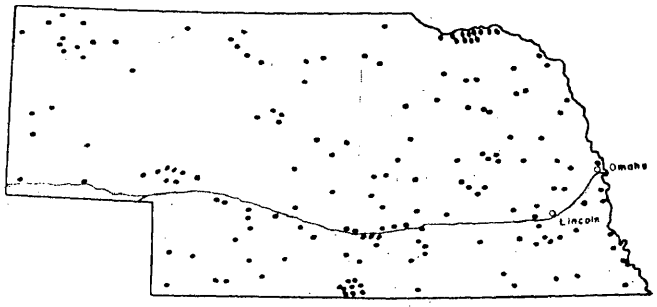
Map 6b indicates that the public campgrounds are strongly concentrated in the western half of the state, in connection with the National Forests and National Park areas. It is very possible that if only the western part of the state were considered the distribution pattern for public campgrounds would approach uniformity.

Nebraska Pattern Analysis

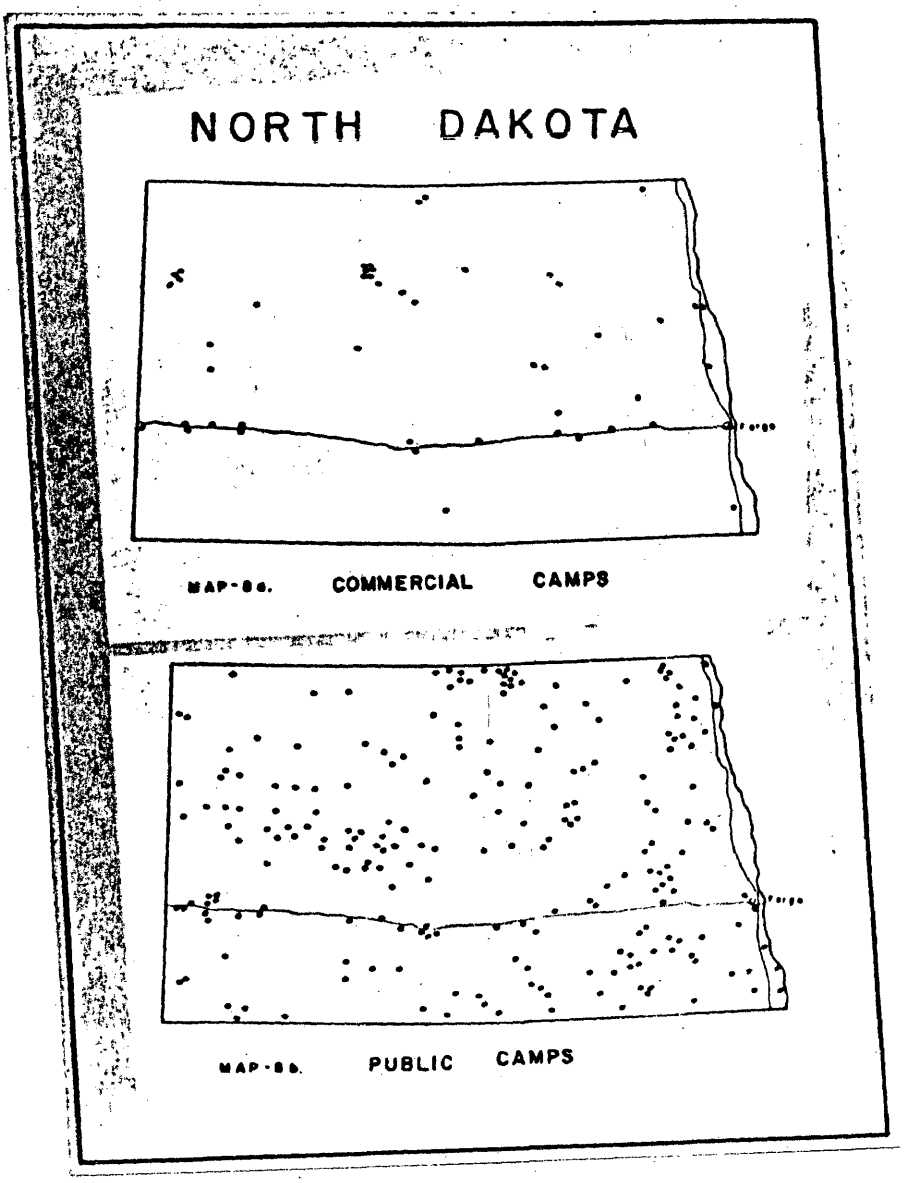
Commercial campgrounds indicate a greater tendency towards clustering than the public campgrounds, however, both sets are easily categorized as random distributions

NEBRASKA

MAP-7a. COMMERCIAL CAMPS



MAP-7b PUBLIC CAMPS


NORTH DAKOTA
MAP-86. COMMERCIAL CAMPS
MAP-86. PUBLIC CAMPS

by the deviation indices.

Map 7a identifies a strong linear distribution of commercial campgrounds. Most of them are parallel to the interstate highway crossing south central Nebraska from east to west.

Map 7b points out the wide dispersion of the public campgrounds throughout the state. Only the cluster around Harlan Reservoir in the south central, and near Lewis and Clark Lake in the northeast, are easily identifiable.

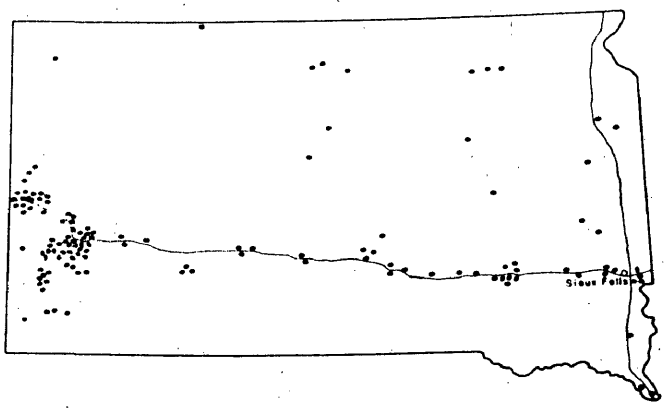
North Dakota Pattern Analysis

Both commercial and public campgrounds have indices of randomness which are strongly indicative of a random distribution pattern. The deviation indices confirm these findings.

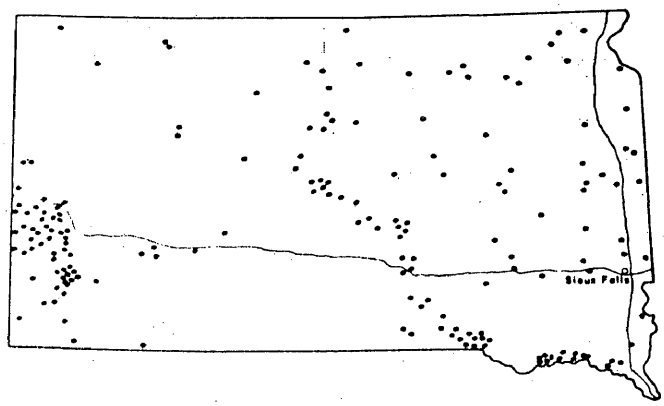
Map 8a shows that the few commercial campgrounds are grouped two or three to a cluster, with some linearity east to west across the state with the interstate highway.

Map 8b indicates the wide dispersion of the public campgrounds in North Dakota. No identifiable clusters or patterns are evident.

SOUTH DAKOTA

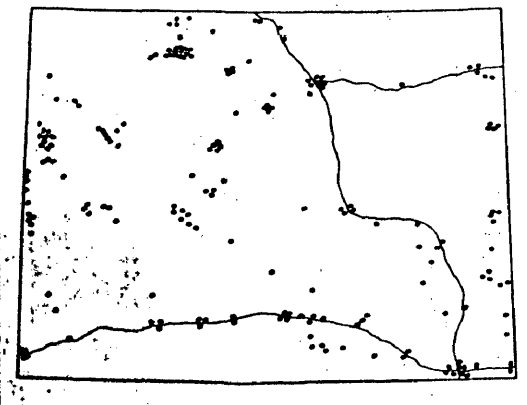


MAP-9a. COMMERCIAL CAMPS

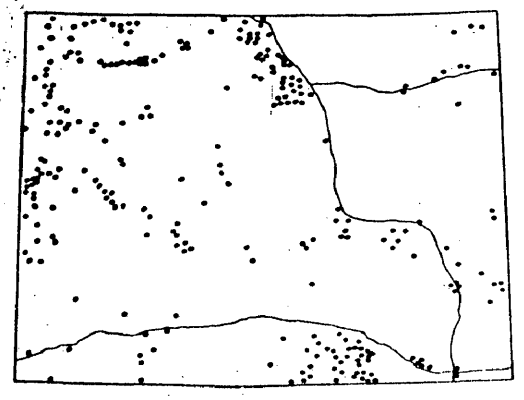


MAP-9b. PUBLIC CAMPS

WYOMING



MAP-10a. COMMERCIAL CAMPS



MAP-10b. PUBLIC CAMPS

South Dakota Pattern Analysis

Commercial campgrounds have the strongest indicators of clustering within the region. Based on the indices of randomness the public camps are trending towards clustering, but according to the deviation indices they are randomly distributed.

Map 9a directs attention to the large cluster of commercial campgrounds in southwestern South Dakota, representing the attractive power of the Black Hills. Additionally, a linear pattern parallel to the interstate highway crosses the state from east to west.

Map 9b shows two groupings of public campgrounds. The Black Hills National Forest cluster is easily identified in the western half of the state. A strong linear clustering pattern, from north to south, traces the Missouri River through the various reservoirs in the state.

Wyoming Pattern Analysis

Large areas of the state have no campgrounds, resulting in some distortion of the mathematical pattern analysis. Indices of randomness for commercial campgrounds indicate stronger clustering tendencies than for public camps. The deviation indices indicate that public

campgrounds are randomly distributed.

Map 10a highlights the clustering of the commercial campgrounds. The eastern and southern approaches to Yellowstone National Park, in northwestern Wyoming, are easily identified. In the southeast there is a large cluster near Cheyenne. Also present is a linear pattern of commercial campgrounds along the various interstate highways.

Map 10b indicates that the public campgrounds are randomly clustered throughout the state. The clustering in the north central and south central sections is related to National Forest campgrounds. There is a strong linear pattern associated with the major road approaches to the Yellowstone National Park area.

Conclusions

For most states in the Great Plains - Rocky Mountain study area, the nearest neighbor mathematical analysis does provide an understanding of the spatial distribution of the campground units. Easy identification of tourist attractions, based on the significant clustering of commercial campgrounds, can be done in Colorado, Minnesota, South Dakota, and Wyoming.

Care must be exercised in the analysis of those

states having large areas with few campgrounds. For example, Montana campgrounds are random according to the deviation index, but examination of the distributional patterns on Map set 6 clearly reveals the strong clustering of campgrounds in the western part of the state.

The close association of many commercial campgrounds and the interstate highway system is pointed out in the many linear patterns noted. Kansas, Missouri, Nebraska, and North Dakota have strong linear dispersal patterns which result in the commercial campgrounds in these states being identified as having random distributions.

The second step in the analysis of the point patterns of the various campground unit sets was accomplished by the use of a centrographic measures computer program. Chapter 3 details the procedures used in conjunction with this program, and then indicates how the mathematical values are interpreted. A complete analysis of these values for the commercial and public campground unit sets of each state is given, with special attention to the interface between the campgrounds and the recreation or tourist attractions of the state.

Chapter 3

CENTROGRAPHIC MEASURES

Centrographic measures derive from the spacing or distance between the individual campgrounds of a given unit set. Various manipulations of the distance value are accomplished as a first step. The spatial characteristics of directional, distance, and sectoral bias are then ascertained from the results. Ellipsoidal functions, standard distance deviation spacing, and spatial density values are also obtained to provide a visual interpretation of the centrographic measurements. Program CENTRO (Hultquist, 1971) was used for this after slight modifications to accommodate the campground data.

This program permits the use of weighted and non-weighted elements. The non-weighted element of the campground unit set consists of the individual campground location coordinates. These are combined separately with the values for the number of camping sites, the campground capacity, the recreation activities capacity, the campground facility amenities capacity, and the maximum campground attraction to form the weighted elements

for the unit set.

Output from program CENTRO is used to develop answers to questions about the spatial distribution pattern of the campground unit set. The centrographic measurements obtained are used to explain: (1) the relative dispersal of the campground pattern about the mean center or the reference node of the unit set; (2) the directional spread of the pattern; (3) the spatial directional bias exerted by the attraction or repulsion force of the reference node; (4) the spatial distance bias of the pattern around the mean center; (5) the degree of ellipsoidal tendency shown by the pattern; and (6) the degree of spatial sectoral bias.

Modifications to Program CENTRO

Certain modifications to program CENTRO were necessitated by the manner used to encode the campground unit data. Two short routines were placed at the beginning of the program and the print output for the distribution matrix was modified.

First, the routine to convert the latitude and longitude coordinates to a rectangular Cartesian coordinate system was inserted. Second, after formation of the weighted elements, they were converted to logarithmic

equivalents. This reduced their dimensions within the individual matrix cells and permitted retention of the readability of the distribution matrix when it was printed.

Additionally, matrix output was altered by replacement of certain features. The standard distance deviation around the mean center was divided into fourths, instead of tenths. The number of rows was reduced to twenty-five from forty. Some external identification features of the matrix were rearranged to assist in the interpretation of the values.

Interpretation of Spatial Statistics

The following guidelines for interpretation of the centrographic summary and detailed level spatial distribution statistics obtained from program CENTRO are drawn from several sources (Bachi, 1962; Brown and Holmes, 1971; Cole and King, 1968; Duncan, Cuzzort, and Duncan, 1961; Lee, 1967; Lefever, 1926; Neft, 1966; Warntz and Neft, 1960). Mathematical derivations for the respective statistics are not included herein, because they are completely outlined in the above sources.

The relative dispersal of the spatial distribution pattern for the campground unit set is derived from the standard distance deviations about the mean center and

TABLE 6

REFERENCE NODES

State	Reference Node
Colorado	Denver
Iowa	Des Moines
Kansas	Kansas City
Minnesota	Minneapolis-St. Paul
Missouri	St. Louis
Montana	Glacier National Park
Nebraska	Omaha
North Dakota	Theodore Roosevelt National Park
South Dakota	The Badlands - Black Hills Area
Wyoming	Yellowstone National Park

the reference node. Values below 2.00 are identified as an indication of a narrow dispersal pattern, between 2.01 and 3.00 they represent a regular pattern, and above 3.00 they denote a wide dispersal pattern.

Reference nodes were pre-selected because of their probable influence on campground locations within a state. These nodes represent either the largest population center of the state or the most significant tourist attraction of the state. Selection of the nodes was accomplished prior to completion of the data set compilation, and only one

node was studied for each state. Table 6 identifies the reference node used for each state of the thesis study area.

A general indication of the directional spread of the spatial distribution pattern of the campground unit set is obtained from examination of the standard deviations for the x-, or latitude, and the y-, or longitude coordinates. The lower of the two values represents the main direction of the unit set, that is, the spread is either east to west along the parallels of latitude, or north to south along the meridians of longitude. Because of the difference in the length of degrees of latitude and longitude, the standard deviations were converted to kilometric lengths. The smaller distance is then interpreted as the main directional spread.

The spatial directional bias is summarized by examination of the difference between the necessary rotation angle and 90 degrees. If the necessary rotation angle is between zero and 89.999 degrees the spatial directional bias is trending towards the reference node, and if it is between 90.001 and 180 degrees the bias is trending away from the reference node. The bias differences have been converted to percentage values, which reflect the amount of attractive or repulsive influence that the

reference node represents on the individual campground locations.

A further refinement of the spatial directional bias is made by using the distance displacement and angle of displacement measurements. The distance displacement was determined by the difference between the x-coordinate of the mean center and that of the reference node. The angle of displacement was determined by the difference between the y-coordinate of the mean center and that of the reference node.

Distance displacement values, based on latitudinal differences, are interpreted according to the following: (1) from zero to 1.00 denotes a moderate repulsion by the reference node; (2) above 1.00 denotes a strong repulsion; (3) from -0.01 to -1.00 denotes a moderate degree of attraction by the reference node; and (4) above -1.00 denotes a strong attraction.

The angle of displacement values, based on longitudinal differences, are interpreted according to the following: (1) from zero to 2.00 denotes a strong attraction by the reference node; (2) above 2.00 denotes a moderate level of attraction; (3) from -0.01 to -2.00 denotes a strong repulsive influence by the reference node; and (4) above -2.00 denotes a moderate repulsion.

Spatial sectoral bias is summarized by a Coefficient of Circularity. This expresses the ratio of the length of the minor axis of the ellipsoidal function to the length of the major axis. The coefficient has a range from zero to one. A high degree of spatial sectoral bias is indicated by a coefficient close to zero, whereas, a low degree of bias is indicated when the value approaches one. Ellipsoidal functions displaying a low degree of bias are nearly circular in shape. Those showing high levels of sectoral bias are elongated and flattened.

Spatial distance bias is measured by use of the standard distance deviation representing the dispersal of the individual campgrounds about the mean center of the unit set. When the dispersal pattern of the values has a wide range the standard distance deviation value is large, and when the dispersal pattern of the values is closely grouped near the mean the standard distance deviation is small. For normally distributed populations 66.67 percent of the total values can be expected to be within one standard distance deviation of the mean center, and 95 percent of the total values should be within two standard distance deviations of the mean center.

The distribution matrix produced by program CENTRO contains a break-down of the spatial distribution pattern

values by standard distance deviation and sector. This matrix divides the pattern values into fourths of a standard distance deviation, in twelve sectors of thirty degrees of arc. Density measurements as well as sector and distance bias information are derived from the matrix.

Although program CENTRO provided many centrographic measurements, only those essential to the analysis of the problem questions have been examined in detail. These items include: (1) standard deviations for the x- and the y-coordinates; (2) the necessary rotation angle; (3) the coefficient of circularity; and (4) the standard distance deviations about the mean center and the reference node. Other elements which have been computed for purposes of the analysis include: (1) the kilometric length for the latitudinal and longitudinal standard deviations; (2) the percent of influence exerted by the reference node on the distribution pattern; (3) the distance displacement; (4) the angle of displacement; and (5) the percent of the values contained within one and two standard distance deviations around the mean center. All of the above data elements have been tabulated for each state of the thesis region. The non-weighted and the five weighted elements are each included in these tabulations for the commercial, the public, and the composite combined

campground unit sets. In addition, the mean for each data element is provided.

The ellipsoidal function which condenses the density arrangements of the distribution pattern has been presented on a series of maps, one for each campground unit set of each state in the thesis region. Ellipse templates were used to construct the maps, according to the mean coefficient of circularity values. A fifteen degree ellipse represented coefficient values from .001 to .200; a thirty degree ellipse represented values from .201 to .400; a forty-five degree ellipse represented values from .401 to .600; a sixty degree ellipse represented values from .601 to .800; and a ninety degree circular function was used to represent values between .801 and one.

The maps were constructed as follows: (1) the state outline was traced to form a base; (2) an ellipse was drawn for each of the standard distance deviations around the mean center which contained over four percent of the values in one of the twelve sectors; (3) the ellipses were constructed so that the entire function would be contained within the state outline, using the mean center of the state as the centroid of the ellipse; (4) the reference node was marked by a large darkened circle; (5) the mean center for the campground unit set

was plotted; (6) a new horizontal axis was constructed by extending a line through the mean center and the reference node; (7) the ellipse function was rotated from this new axis to reflect its orientation towards or away from the reference node; (8) the twelve sectors were prepared for each standard distance deviation; and (9) all sectors having over four percent of the values within them were then shaded to reflect increasing density distribution values.

Analysis of the tabulated elements and the ellipsoidal function maps is accomplished for each state. Each campground unit set is studied to derive responses to the thesis problem questions.

Colorado Centrographic Statistic Interpretation

Table 7 contains the centrographic measurements for the three unit sets, and Map series 11 displays the orientation and density of the spatial distribution pattern for the mean values of the weighted and non-weighted data sets. After rotation, the ellipsoidal functions of the three unit sets extend outside the state outline, an indication of the positional shift of the mean distributional centers from the state centroid.

Commercial campgrounds are narrowly dispersed

TABLE 7

COLORADO CENTROGRAPHIC MEASURES

	Commercial, Public, and Combined Campground Units Data Sets						
	1	2	3	4	5	6	Mean
Relative Dispersal							
Mean SDD	1.78	1.75	1.77	1.74	1.76	1.77	1.76
	1.55	1.60	1.58	1.61	1.61	1.58	1.59
	1.66	1.69	1.68	1.69	1.70	1.69	1.69
Reference Node SDD	1.83	1.82	1.82	1.82	1.82	1.82	1.82
	2.16	2.17	2.10	2.14	2.15	2.11	2.14
	1.87	1.89	1.87	1.90	1.88	1.87	1.88
Directional Spread							
SD of X	1.05	1.04	1.04	1.04	1.05	1.05	1.05
	1.05	1.08	1.06	1.09	1.08	1.06	1.07
	1.06	1.07	1.06	1.08	1.07	1.06	1.07
SD of Y	1.44	1.41	1.43	1.39	1.42	1.43	1.42
	1.14	1.18	1.17	1.19	1.19	1.17	1.17
	1.28	1.31	1.30	1.30	1.32	1.31	1.30
Latitude Length	232	232	232	232	232	232	232
	234	240	236	241	241	236	238
	235	238	236	239	238	236	237
Longitude Length	256	251	255	247	252	254	252
	197	204	203	206	206	203	203
	225	229	229	229	233	230	229
Distance Bias							
Percent in one SDD	60.6	59.4	60.1	59.6	60.5	60.1	60.1
	64.0	63.0	63.6	62.7	62.8	63.8	63.3
	62.5	60.6	61.3	60.6	59.9	60.9	61.0
Percent in two SDD	99.6	99.7	99.6	99.6	99.7	99.7	99.6
	97.3	96.8	97.0	96.6	96.8	97.0	96.9
	98.0	98.1	97.8	97.8	98.6	97.9	97.9

TABLE 7 Continued

COLORADO CENTROGRAPHIC MEASURES

	1	2	3	4	5	6	Mean
Directional Bias							
Rotation	115.9	117.4	116.2	118.1	117.0	115.3	116.8
Angle in	127.2	126.4	125.3	125.5	126.0	125.4	126.0
Degrees	119.1	119.2	118.3	119.4	118.8	118.4	118.9
Percent of	-47	-49	-47	-51	-49	-47	-48
Influence	-67	-66	-64	-64	-65	-64	-65
	-52	-53	-51	-53	-52	-51	-52
Distance	1.05	1.05	1.05	1.04	1.05	1.05	1.05
Displace-	.78	.76	.78	.76	.78	.78	.77
ment	.89	.89	.89	.89	.91	.90	.89
Angle of	-1.05	-1.02	-1.04	-1.05	-1.03	-1.04	-1.04
Displace-	-1.50	-1.47	-1.48	-1.49	-1.46	-1.48	-1.48
ment	-1.33	-1.27	-1.30	-1.29	-1.25	-1.29	-1.29
Sectoral Bias							
Coefficient	.581	.574	.577	.580	.576	.578	.578
of	.742	.740	.737	.746	.728	.736	.738
Circularity	.691	.680	.681	.684	.666	.679	.680

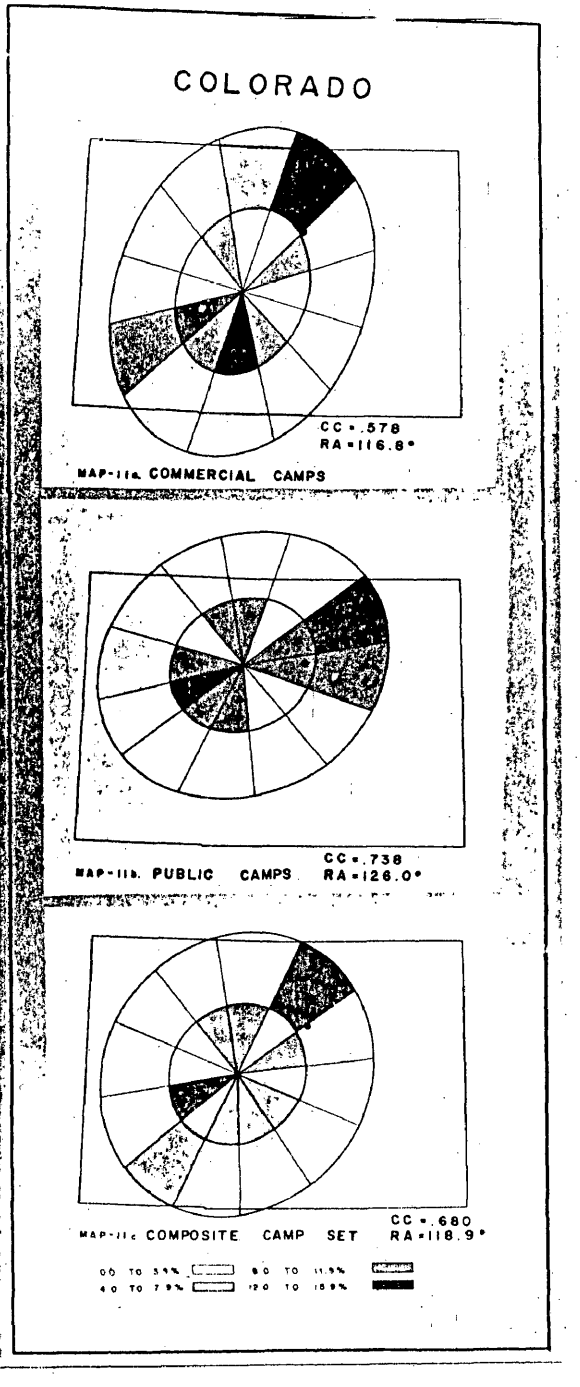
Commercial campground values are presented on the first line of each entry. Public campground values are presented on the second line of each entry. The combined campground values are presented on the third line of each entry.

SDD = Standard Distance Deviation
SD = Standard Deviation

Data sets are numbered as follows:
1 = Non-weighted location coordinates
2 = Number of individual camping sites
3 = Campground capacity
4 = Recreation activities capacity
5 = Campground facility amenities capacity
6 = Maximum campground attraction

about the mean center or reference node. Two sectors have over twelve percent each of the total values. The one north of Denver has 14.0 percent and the one south of the mean center has 13.4 percent. The main directional spread is east to west along the latitudinal parallels. Directional bias trends away from the reference node, with the largest amount to the southwest of Denver. Latitudinal and longitudinal movement away from the reference node is strong, with up to forty-eight percent of the location decisions having been made so as to avoid the Denver area. Sixty percent of the unit set values are within one standard distance deviation of the mean center, considerably below the norm. Sectoral bias approaches an equilibrium point.

Public campgrounds are narrowly dispersed around the mean center, although demonstrating regularity around the reference node. One sector to the west of both the mean center and Denver has 13.2 percent of the values. Directional spread, according to the standard deviations of the coordinate system, is east to west, however, the kilometric length function verifies the spatial directional spread as being north to south. There is a strong trend away from the reference node, especially west of Denver. This is divided between a


COLORADO
CC = .578
RA = 116.8°
MAP-11a. COMMERCIAL CAMPS
CC = .738
RA = 126.0°
MAP-11b. PUBLIC CAMPS
CC = .680
RA = 118.9°
MAP-11c COMPOSITE CAMP SET
0.0 TO 3.9%
4.0 TO 7.9%
8.0 TO 11.9%
12.0 TO 15.9%

moderate latitudinal component and a strong longitudinal component. Sixty-five percent of the public campground location decisions have been made to avoid the Denver area. Very little sectoral bias can be identified, indicative of the random distribution pattern of the unit set.

The composite campground set is narrowly and evenly dispersed about the mean center and reference node, with no sectors having over twelve percent of the values. Directional spread is slightly north to south, with a strong repulsive force being exerted by Denver. A moderate negative latitudinal influence is complemented by a very strong longitudinal displacement.

Iowa Centrographic Statistic Interpretation

Table 8 contains the centrographic measurements for the three campground sets, and Map series 12 shows the spatial distribution pattern orientation and density. The position of the reference node to the southwest of the mean distributional centers combined with the rotational requirements of the ellipsoids results in some extension of the functions beyond the state outline.

Commercial campgrounds are narrowly dispersed around both the mean center and Des Moines. Two sectors

TABLE 8

IOWA CENTROGRAPHIC MEASURES

	Commercial, Public, and Combined Campground Units Data Sets						
	1	2	3	4	5	6	Mean
Relative Dispersal							
Mean SDD	1.84	1.87	1.85	1.88	1.86	1.85	1.86
	1.84	1.81	1.83	1.81	1.81	1.83	1.82
	1.85	1.83	1.84	1.83	1.83	1.84	1.84
Reference Node SDD	1.89	1.90	1.86	1.90	1.88	1.86	1.88
	1.86	1.87	1.88	1.87	1.86	1.88	1.87
	1.87	1.87	1.87	1.87	1.86	1.86	1.87
Directional Spread							
SD of X	.82	.80	.81	.82	.81	.81	.81
	.80	.79	.80	.79	.80	.80	.79
	.81	.79	.81	.80	.80	.81	.80
SD of Y	1.65	1.69	1.66	1.69	1.67	1.66	1.67
	1.66	1.63	1.65	1.62	1.62	1.64	1.64
	1.66	1.65	1.66	1.65	1.64	1.65	1.65
Latitude Length	182	177	180	182	180	181	180
	177	176	177	176	177	177	176
	180	176	179	178	178	179	178
Longitude Length	273	280	275	281	277	275	277
	275	270	273	269	269	272	271
	275	274	274	273	272	274	274
Distance Bias							
Percent in one SDD	52.2	52.5	52.7	51.4	53.3	52.6	52.5
	55.3	61.0	56.0	61.6	57.2	55.8	57.8
	54.8	58.2	56.6	58.0	58.1	56.9	57.1
Percent in two SDD	100	100	100	100	100	100	100
	100	100	100	100	100	100	100
	100	100	100	100	100	100	100

TABLE 8 Continued

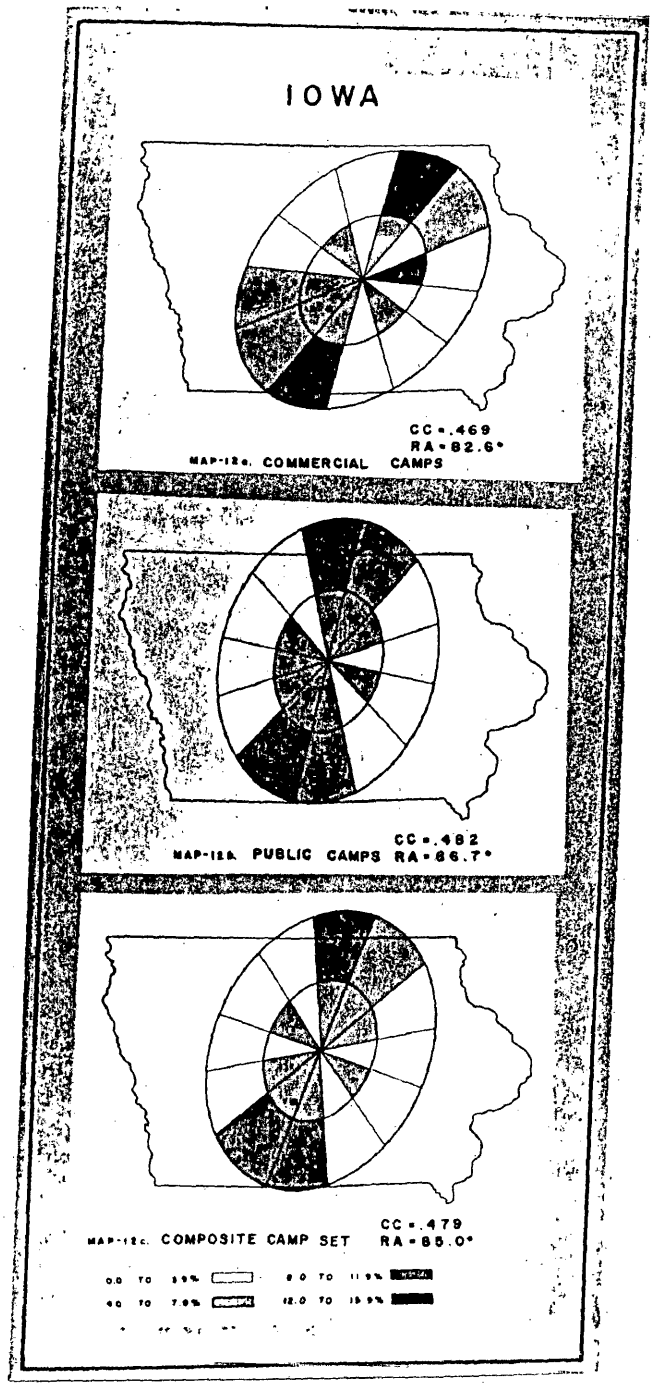
IOWA CENTROGRAPHIC MEASURES

	1	2	3	4	5	6	Mean
Directional Bias							
Rotation Angle in Degrees	83.0 86.6 85.0	82.5 86.9 85.2	83.1 86.5 85.0	81.5 86.9 84.9	82.5 86.8 84.9	82.8 86.5 84.9	82.6 86.7 85.0
Percent of Influence	13 6 9	14 6 9	12 6 9	15 6 9	14 6 9	13 6 9	13 6 9
Distance Displacement	-.45 -.65 -.58	-.50 -.59 -.55	-.45 -.62 -.56	-.53 -.60 -.58	-.49 -.60 -.55	-.46 -.62 -.57	-.48 -.61 -.57
Angle of Displacement	.39 .13 .22	.51 .30 .37	.42 .18 .27	.48 .31 .37	.47 .22 .32	.42 .18 .27	.45 .22 .30
Sectoral Bias							
Coefficient of Circularity	.482 .477 .481	.455 .483 .474	.475 .480 .479	.460 .484 .477	.467 .487 .480	.476 .480 .480	.469 .482 .479

Commercial campground values are presented on the first line of each entry. Public campground values are presented on the second line of each entry. The combined campground values are presented on the third line of each entry.

SDD = Standard Distance Deviation
SD = Standard Deviation

Data sets are numbered as follows:
1 = Non-weighted location coordinates
2 = Number of individual camping sites
3 = Campground capacity
4 = Recreation activities capacity
5 = Campground facility amenities capacity
6 = Maximum campground attraction


IOWA
CC = .469
RA = 82.6°
MAP-12c. COMMERCIAL CAMPS
CC = .482
MAP-12b. PUBLIC CAMPS RA = 86.7°
CC = .479
MAP-12c. COMPOSITE CAMP SET RA = 85.0°
0.0 TO 3.9%
4.0 TO 7.9%
8.0 TO 11.9%
12.0 TO 15.9%

have over twelve percent of the values, the one in the northeast with 13.2 percent and the one in the southwest with 12.2 percent. Both sectors are two standard distance deviations removed from the mean center. There is an east to west directional spread with moderate latitudinal and strong longitudinal attractions towards the reference node. Only 52.5 percent of the values are within one standard distance deviation of the mean center, but the entire distribution is within two standard distance deviations. Sectoral bias to the northeast and southwest almost completely balance the ellipsoidal function.

The public campground unit set and the composite camp set have nearly the same centrographic measurements. They are narrowly dispersed around Des Moines, with no sectors having twelve percent of the distribution. Just over fifty-seven percent of the values are within one standard distance deviation of the mean. A very small attractive force is exerted by Des Moines on the campground locations, with moderate latitudinal and stronger longitudinal components contained in the east to west directional spread. Sectoral bias is almost completely balanced.

Kansas Centrographic Statistic Interpretation

Table 9 contains the centrographic measurements for the three campground sets, and Map series 13 shows the density and orientation of the spatial distribution pattern. Because the new axis between the distributional mean center and the reference node is only slightly removed from the perpendicular, and because of the very small amount of deviation from the horizontal as represented by the necessary rotation angle, all ellipsoidal functions are contained within the state outline.

Commercial campgrounds are narrowly dispersed around the mean distributional center. Since Kansas City is in the extreme eastern part of the state, the dispersal is very wide from this point. One sector to the southwest of the mean center has 12.0 percent of the values. Directional spread is east to west with only a very small degree of attractive force exerted by the reference node, based on the necessary rotation angle. Refinement of this spatial statistic indicates that moderate latitudinal and longitudinal repulsion forces are actually being exerted by Kansas City. Only 60.8 percent of the values are within one standard distance deviation of the mean, which is below the norm. Some sectoral bias can be

TABLE 9

KANSAS CENTROGRAPHIC MEASURES

	Commercial, Public, and Combined Campground Units Data Sets						
	1	2	3	4	5	6	Mean
Relative Dispersal							
Mean SDD	1.99	1.96	1.98	1.95	1.98	1.98	1.97
	2.15	1.87	2.10	1.86	1.99	2.10	2.01
	2.11	1.92	2.07	1.91	2.00	2.07	2.01
Reference Node SDD	3.72	3.74	3.72	3.69	3.74	3.72	3.72
	3.81	3.32	3.72	3.34	3.57	3.72	3.58
	3.79	3.48	3.72	3.46	3.63	3.72	3.63
Directional Spread							
SD of X	.79	.77	.78	.77	.77	.78	.78
	.84	.73	.82	.75	.78	.82	.79
	.84	.75	.82	.76	.78	.82	.79
SD of Y	1.82	1.81	1.81	1.79	1.82	1.82	1.81
	1.98	1.72	1.93	1.70	1.83	1.93	1.85
	1.94	1.77	1.90	1.75	1.84	1.90	1.85
Latitude Length	175	171	174	171	171	173	172
	186	163	182	166	173	182	175
	186	167	182	168	173	182	176
Longitude Length	320	317	319	315	320	319	318
	347	301	340	299	322	339	325
	341	311	334	308	323	334	325
Distance Bias							
Percent in one SDD	61.0	61.0	60.5	61.5	60.4	60.4	60.8
	61.7	66.4	63.5	66.3	64.9	63.7	64.4
	62.0	67.3	63.2	67.3	64.6	63.3	64.6
Percent in two SDD	97.3	96.2	97.0	96.4	96.4	97.0	96.7
	97.7	97.3	97.0	97.2	97.4	97.0	97.2
	98.3	97.2	96.9	96.7	97.1	96.9	97.2

TABLE 9 Continued

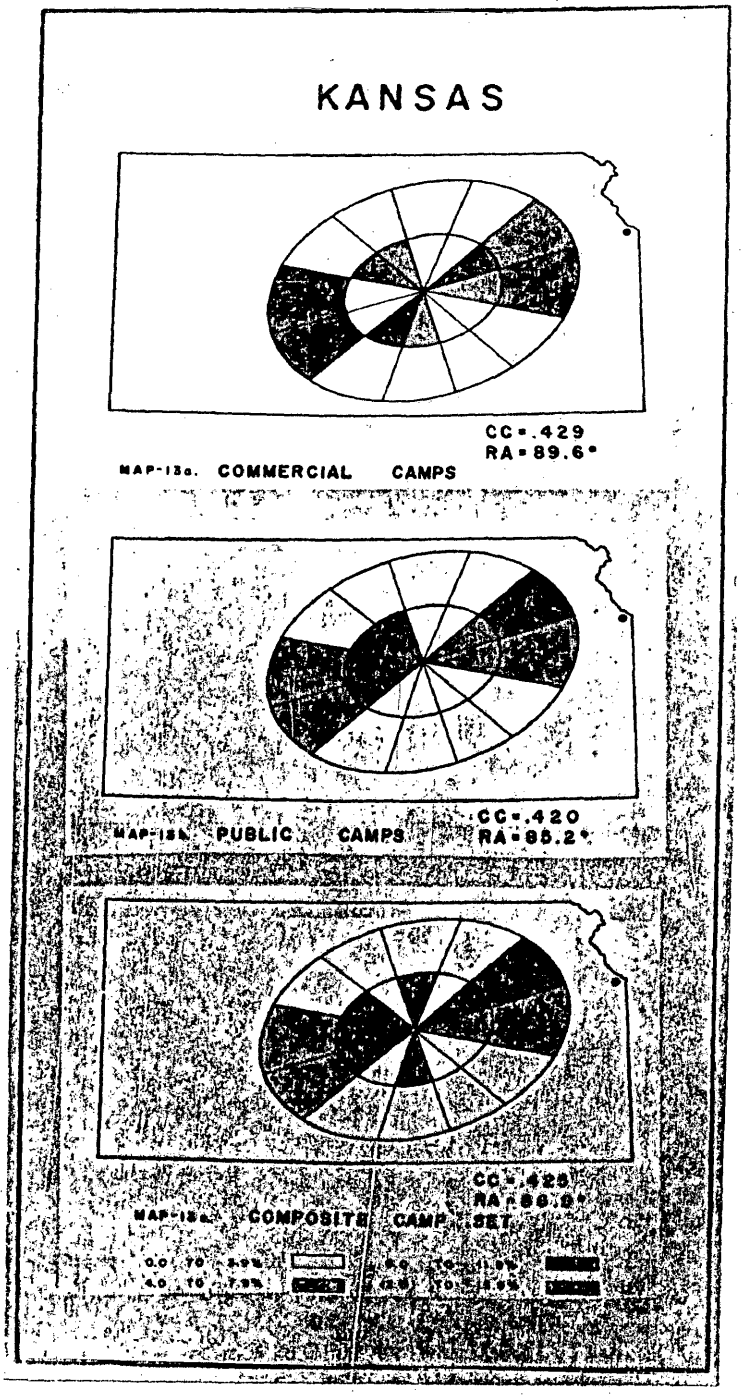
KANSAS CENTROGRAPHIC MEASURES

	1	2	3	4	5	6	Mean
Directional Bias							
Rotation	89.4	89.3	89.4	89.5	90.3	89.8	89.6
Angle in	85.1	86.0	85.2	85.2	84.8	85.0	85.2
Degrees	86.1	87.8	86.4	87.3	87.2	86.5	86.9
Percent of	1	1	1	1	-1	None	1
Influence	9	7	9	9	9	9	9
	7	4	6	5	5	6	6
Distance	.81	.70	.78	.67	.71	.77	.74
Displace-	.50	.57	.52	.56	.54	.51	.53
ment	.58	.62	.59	.60	.61	.59	.60
Angle of	-3.02	-3.08	-3.03	-3.05	-3.10	-3.05	-3.05
Displace-	-2.92	-2.53	-2.85	-2.54	-2.71	-2.84	-2.73
ment	-2.95	-2.75	-2.90	-2.72	-2.86	-2.90	-2.85
Sectoral Bias							
Coefficient	.431	.427	.432	.429	.423	.429	.429
of	.416	.422	.416	.432	.416	.417	.420
Circularity	.426	.422	.426	.430	.422	.426	.425

Commercial campground values are presented on the first line of each entry. Public campground values are presented on the second line of each entry. The combined campground values are presented on the third line of each entry.

SDD = Standard Distance Deviation
SD = Standard Deviation

Data sets are numbered as follows:
1 = Non-weighted location coordinates
2 = Number of individual camping sites
3 = Campground capacity
4 = Recreation activities capacity
5 = Campground facility amenities capacity
6 = Maximum campground attraction


KANSAS
CC=.429
RA=89.6°
MAP-13a. COMMERCIAL CAMPS
CC=.420
RA=85.2°
MAP-13b. PUBLIC CAMPS
MAP-13c. COMPOSITE CAMP SET

postulated from the coefficient of circularity.

Public campgrounds and the composite camp set are just above the minimum value that identifies their dispersal patterns as regular. Both are widely dispersed around the reference node, with no sectors having twelve percent of the values. The small degree of attractive force exerted by Kansas City, based on the rotation angle, is corrected to a moderate repulsive force when the refinement of the directional bias is developed. Some degree of sectoral bias is evident for both sets.

Minnesota Centrographic Statistic Interpretation

Table 10 contains the centrographic measurements for the three unit sets, with Map series 14 showing the distributional patterns. The ellipsoidal functions are smaller than for some of the states, because of the narrowness of the state in an east to west direction and the method used in preparation of the original ellipsoidal function prior to application of the rotation angle to the new axis line. Circular forms are used to display the function for each campground unit set because of the high values for the respective coefficients of circularity.

Commercial camps are narrowly dispersed around

TABLE 10

MINNESOTA CENTROGRAPHIC MEASURES

	Commercial, Public, and Combined Campground Units Data Sets						
	1	2	3	4	5	6	Mean
Relative Dispersal							
Mean SDD	1.76	1.77	1.77	1.75	1.77	1.76	1.76
	2.22	2.25	2.23	2.22	2.26	2.23	2.23
	1.95	1.95	1.95	1.92	1.94	1.94	1.94
Reference Node SDD	2.57	2.99	2.78	2.90	2.88	2.73	2.81
	3.74	3.85	3.75	3.88	3.70	3.73	3.77
	2.93	2.50	2.72	2.58	2.46	2.71	2.65
Directional Spread							
SD of X	1.22	1.23	1.23	1.22	1.23	1.23	1.23
	1.45	1.50	1.47	1.48	1.50	1.47	1.48
	1.32	1.34	1.33	1.32	1.33	1.33	1.33
SD of Y	1.27	1.27	1.27	1.25	1.27	1.27	1.27
	1.68	1.67	1.67	1.65	1.69	1.68	1.67
	1.43	1.41	1.42	1.40	1.41	1.42	1.42
Latitude Length	271	274	273	271	274	272	273
	322	333	328	330	333	327	329
	294	298	296	293	295	295	295
Longitude Length	197	196	197	194	197	197	196
	260	259	259	256	262	260	259
	222	219	221	216	218	220	219
Distance Bias							
Percent in one SDD	66.1	64.5	65.6	65.9	65.1	65.9	65.5
	57.9	56.2	57.5	57.3	56.1	56.7	57.0
	61.7	60.7	61.3	61.8	61.4	61.8	61.5
Percent in two SDD	98.1	98.2	98.2	98.2	98.2	98.2	98.1
	100	100	100	100	100	100	100
	98.6	98.5	98.5	98.3	98.3	98.4	98.4

TABLE 10 Continued

MINNESOTA CENTROGRAPHIC MEASURES

	1	2	3	4	5	6	Mean
Directional Bias							
Rotation	62.2	52.3	56.9	54.4	54.7	57.9	56.4
Angle in	107.8	111.6	108.9	112.3	108.8	108.6	109.7
Degrees	99.3	90.0	94.9	92.2	87.9	94.7	93.2
Percent of	50	68	60	64	64	58	60
Influence	-32	-38	-34	-40	-34	-33	-35
	-17	None	- 9	- 4	4	- 8	- 6
Distance	-1.35	-1.28	-1.32	-1.32	-1.31	-1.33	-1.32
Displace-	-1.82	-1.69	-1.76	-1.70	-1.68	-1.75	-1.73
ment	-1.52	-1.41	-1.47	-1.44	-1.42	-1.47	-1.45
Angle of	-.85	-.79	-.82	-.83	-.81	-.82	-.82
Displace-	-.62	-.57	-.61	-.60	-.64	-.63	-.61
ment	-.77	-.73	-.75	-.76	-.76	-.76	-.75
Sectoral Bias							
Coefficient	.926	.903	.918	.911	.916	.922	.916
of	.831	.861	.851	.857	.857	.848	.851
Circularity	.919	.948	.936	.944	.942	.934	.937

Commercial campground values are presented on the first line of each entry. Public campground values are presented on the second line of each entry. The combined campground values are presented on the third line of each entry.

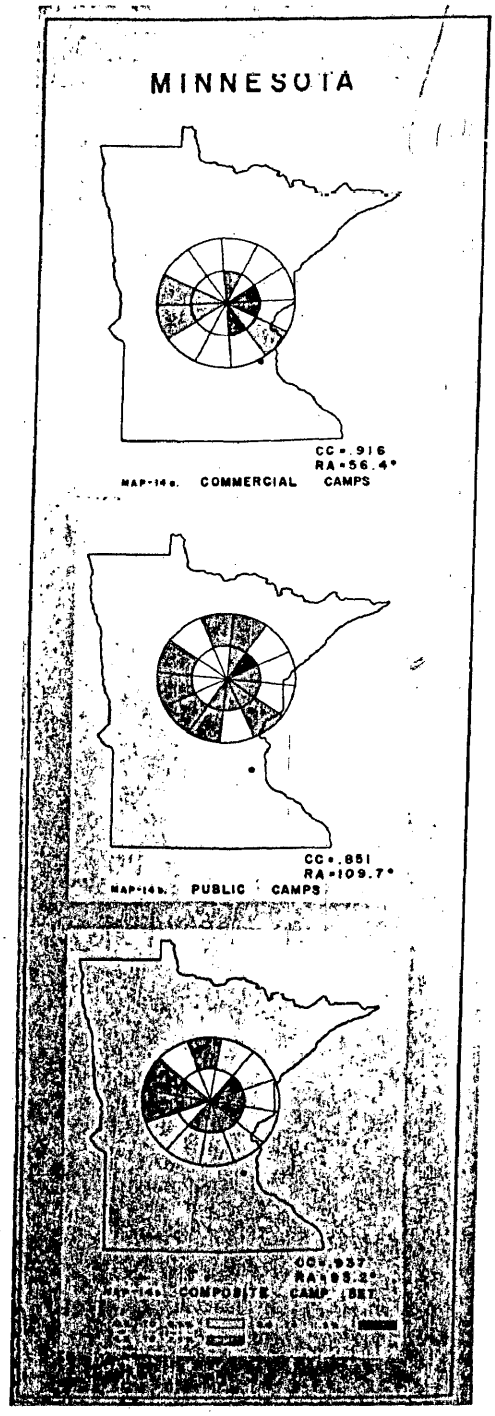
SDD = Standard Distance Deviation
SD = Standard Deviation

Data sets are numbered as follows:
1 = Non-weighted location coordinates
2 = Number of individual camping sites
3 = Campground capacity
4 = Recreation activities capacity
5 = Campground facility amenities capacity
6 = Maximum campground attraction

the mean center, becoming very regular in their dispersion about the reference node. Directional spread is north to south even though the Cartesian coordinate system defines a slight east to west spread. An extremely high degree of attraction is shown by Minneapolis, with sixty percent of the location decisions having been affected by the reference node. A strong latitudinal attraction is contrasted by an equally strong longitudinal repulsion. Sectoral bias is very limited and no sector has twelve percent of the values.

Public campgrounds are regularly dispersed around the mean center. Because of the northerly position of the mean centroid, only fifty-seven percent of the distribution is within one standard distance deviation of the mean. The unit set is widely dispersed around the reference node. Directional spread is north to south, based on the kilometric length function. A thirty-five percent repulsion force from Minneapolis is predominately a longitudinal force, because the distance displacement indicates a strong latitudinal attraction. Very little sectoral bias is evident.

The composite camp set is narrowly dispersed about the mean center, and regularly about the reference node. A large north to south directional spread is


MINNESOTA
CC=.916
RA=56.4°
MAP-14a. COMMERCIAL CAMPS
CC=.851
RA=109.7°
MAP-14b. PUBLIC CAMPS
CC=.937
RA=83.2°
MAP-14c. COMPOSITE CAMP SET

matched with a weak repulsion force. The strong latitudinal attraction of Minneapolis is offset by a strong longitudinal repulsion. An extremely low degree of sectoral bias prevails, and no sector contains twelve percent of the total distributional values.

Missouri Centrographic Statistic Interpretation

Centrographic measures for the three campground unit sets are in Table 11, and Map series 15 displays their ellipsoidal functions. The strong displacement of the public campground centroid in the southwestern part of the state causes this ellipsoid to extend beyond the state outline.

The commercial and composite campground sets demonstrate similar characteristics. Both are narrowly dispersed around their mean centers, and are widely dispersed about St. Louis. Both have east to west directional spreads, with eighteen percent positive influence being exerted from the reference node. However, upon refinement, this attractive force is identified as being composed of counteracting moderate latitudinal and longitudinal repulsions. Small sectoral bias can be found, with no sectors having twelve percent of the values. The clustering of these campground unit

TABLE 11

MISSOURI CENTROGRAPHIC MEASURES

	Commercial, Public, and Combined Campground Units Data Sets						
	1	2	3	4	5	6	Mean
Relative Dispersal							
Mean SDD	1.64	1.63	1.64	1.61	1.63	1.63	1.63
	1.60	1.62	1.61	1.62	1.63	1.61	1.61
	1.66	1.65	1.66	1.64	1.65	1.66	1.65
Reference Node SDD	3.21	3.04	3.13	2.99	3.06	3.12	3.09
	2.98	2.98	2.98	3.07	3.05	3.01	3.01
	3.27	3.07	3.17	3.06	3.11	3.18	3.14
Directional Spread							
SD of X	1.01	.99	1.00	.99	1.00	1.00	1.00
	.95	.96	.95	.96	.97	.96	.96
	1.04	1.02	1.03	1.02	1.03	1.03	1.03
SD of Y	1.29	1.29	1.30	1.28	1.29	1.29	1.29
	1.28	1.30	1.30	1.30	1.31	1.30	1.30
	1.29	1.30	1.30	1.28	1.30	1.30	1.29
Latitude Length	224	220	222	219	221	222	221
	211	214	212	214	215	212	213
	230	227	229	227	228	229	228
Longitude Length	227	227	228	224	226	227	227
	229	232	231	231	234	231	231
	230	231	231	229	231	231	230
Distance Bias							
Percent in one SDD	55.3	55.8	55.4	55.2	55.4	55.1	55.4
	70.3	68.8	70.3	68.7	69.7	71.0	69.8
	62.0	62.1	61.8	63.0	62.0	62.0	62.2
Percent in two SDD	98.8	99.0	98.9	98.7	99.0	98.9	98.8
	98.6	98.4	98.5	98.4	98.3	98.5	98.4
	99.0	99.0	99.0	99.0	98.9	99.0	99.0

TABLE 11 Continued

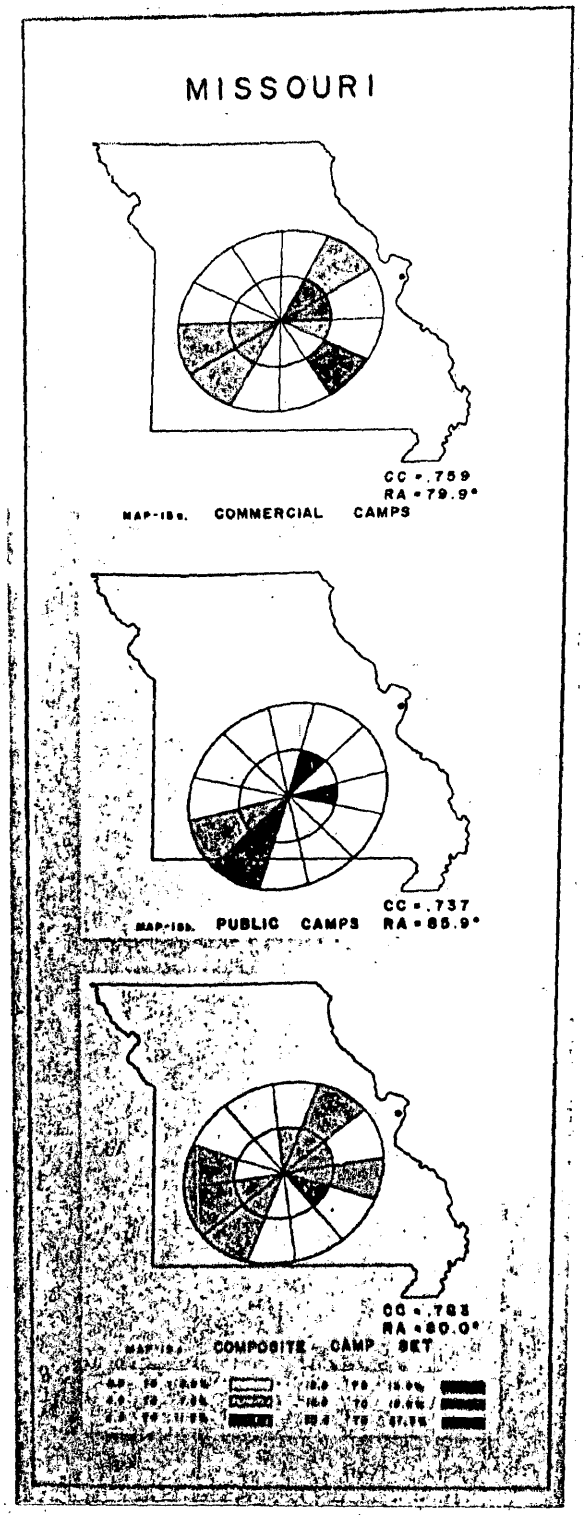
MISSOURI CENTROGRAPHIC MEASURES

	1	2	3	4	5	6	Mean
Directional Bias							
Rotation	77.5	80.8	79.1	82.1	80.5	79.3	79.9
Angle in	85.3	87.2	86.3	85.5	85.3	85.7	85.9
Degrees	76.7	81.9	79.2	82.4	80.8	79.2	80.0
Percent of	23	17	20	14	17	19	18
Influence	8	5	7	8	8	8	7
	24	15	19	14	17	19	18
Distance	.63	.64	.64	.66	.64	.64	.64
Displace-	1.33	1.29	1.31	1.31	1.27	1.31	1.30
ment	.90	.89	.89	.92	.87	.89	.89
Angle of	-2.10	-2.04	-2.07	-2.04	-2.06	-2.07	-2.06
Displace-	-1.91	-2.01	-1.96	-2.04	-2.01	-1.96	-1.98
ment	-2.03	-2.03	-2.03	-2.04	-2.04	-2.04	-2.04
Sectoral Bias							
Coefficient	.759	.755	.756	.763	.761	.759	.759
of	.736	.740	.734	.741	.735	.734	.737
Circularity	.781	.782	.781	.789	.781	.782	.783

Commercial campground values are presented on the first line of each entry. Public campground values are presented on the second line of each entry. The combined campground values are presented on the third line of each entry.

SDD = Standard Distance Deviation
SD = Standard Deviation

Data sets are numbered as follows:
1 = Non-weighted location coordinates
2 = Number of individual camping sites
3 = Campground capacity
4 = Recreation activities capacity
5 = Campground facility amenities capacity
6 = Maximum campground attraction


MISSOURI
CC = .759
RA = 79.9°
MAP-15a. COMMERCIAL CAMPS
CC = .737
RA = 85.9°
PUBLIC CAMPS
CC = .783
RA = 80.0°
COMPOSITE CAMP SET

sets causes a low concentration of the values near the mean centroid. Only fifty-five percent of the commercial camps and sixty-two percent of the composite camp set are within the first standard distance deviation of the mean.

Public campgrounds are widely dispersed around St. Louis, but are very narrowly dispersed about their mean center. Nearly seventy percent of the distribution is within one standard distance deviation of the centroid, further indication of the narrowness of the dispersal pattern. An east to west directional spread is matched with a small attractive force from the reference node. Refinement of the spatial directional bias statistic indicates the existence of strong latitudinal and longitudinal repulsive forces being exerted by St. Louis. The low degree of sectoral bias indicated by the coefficient of circularity is negated by the presence of three sectors having over twelve percent of the total distributional values. A northeastern sector has 13.8 percent, a southwestern sector has 14.3 percent, and the southeastern sector has 22.6 percent of the total.

Montana Centrographic Statistic Interpretation

Centrographic measures for the three campground unit sets are contained in Table 12, and Map series 16 shows the ellipsoidal functions representing the density and orientation for the respective patterns. Montana is the only state requiring inclusion of three standard distance deviations about the mean center as part of its ellipsoidal functions. The extreme westward displacement of the distributional centroid positions each ellipsoid across the western half of the state, leaving the east completely barren. Because of their similarity, the three unit sets are discussed together.

All sets have wide dispersal patterns around their mean center and reference node positions. Directional spread is east to west, with some moderate attractive force being exerted by Glacier National Park. Commercial campgrounds have been located more as a result of their attraction to this reference point than the other sets. Longitudinal attraction is more dominant since the refinement provided by the distance displacement indicates the existence of strong repulsive forces east to west along the latitudinal parallels. Montana has the largest concentration of distributional values within one standard distance deviation of the

TABLE 12

MONTANA CENTROGRAPHIC MEASURES

	Commercial, Public, and Combined Campground Units Data Sets						
	1	2	3	4	5	6	Mean
Relative Dispersal							
Mean SDD	3.16	3.11	3.15	3.07	3.13	3.15	3.13
	3.10	3.03	3.11	3.06	3.07	3.11	3.08
	3.12	3.07	3.12	3.07	3.10	3.12	3.10
Reference Node SDD	4.98	4.98	4.98	5.01	4.99	4.98	4.99
	4.51	4.35	4.49	4.36	4.35	4.48	4.42
	4.68	4.68	4.69	4.68	4.71	4.70	4.69
Directional Spread							
SD of X	1.25	1.25	1.24	1.25	1.24	1.24	1.24
	1.21	1.24	1.22	1.25	1.24	1.22	1.23
	1.22	1.25	1.23	1.25	1.24	1.23	1.24
SD of Y	2.91	2.85	2.89	2.81	2.88	2.89	2.87
	2.86	2.76	2.86	2.79	2.80	2.86	2.82
	2.88	2.81	2.87	2.80	2.84	2.87	2.85
Latitude Length	277	277	275	277	276	275	276
	269	277	270	279	276	271	274
	272	277	272	278	277	273	275
Longitude Length	450	442	448	435	446	448	445
	443	427	443	433	434	443	437
	445	435	445	434	441	445	441
Distance Bias							
Percent in one SDD	76.5	76.6	75.5	77.6	75.9	75.7	76.3
	72.2	73.2	72.3	73.4	73.1	72.3	72.8
	73.8	75.3	74.3	75.7	75.2	74.3	74.8
Percent in two SDD	92.8	93.4	92.9	93.5	93.1	92.9	93.1
	94.2	94.3	94.0	94.4	94.0	94.1	94.2
	94.0	93.7	93.9	93.9	93.5	93.8	93.8

TABLE 12 Continued

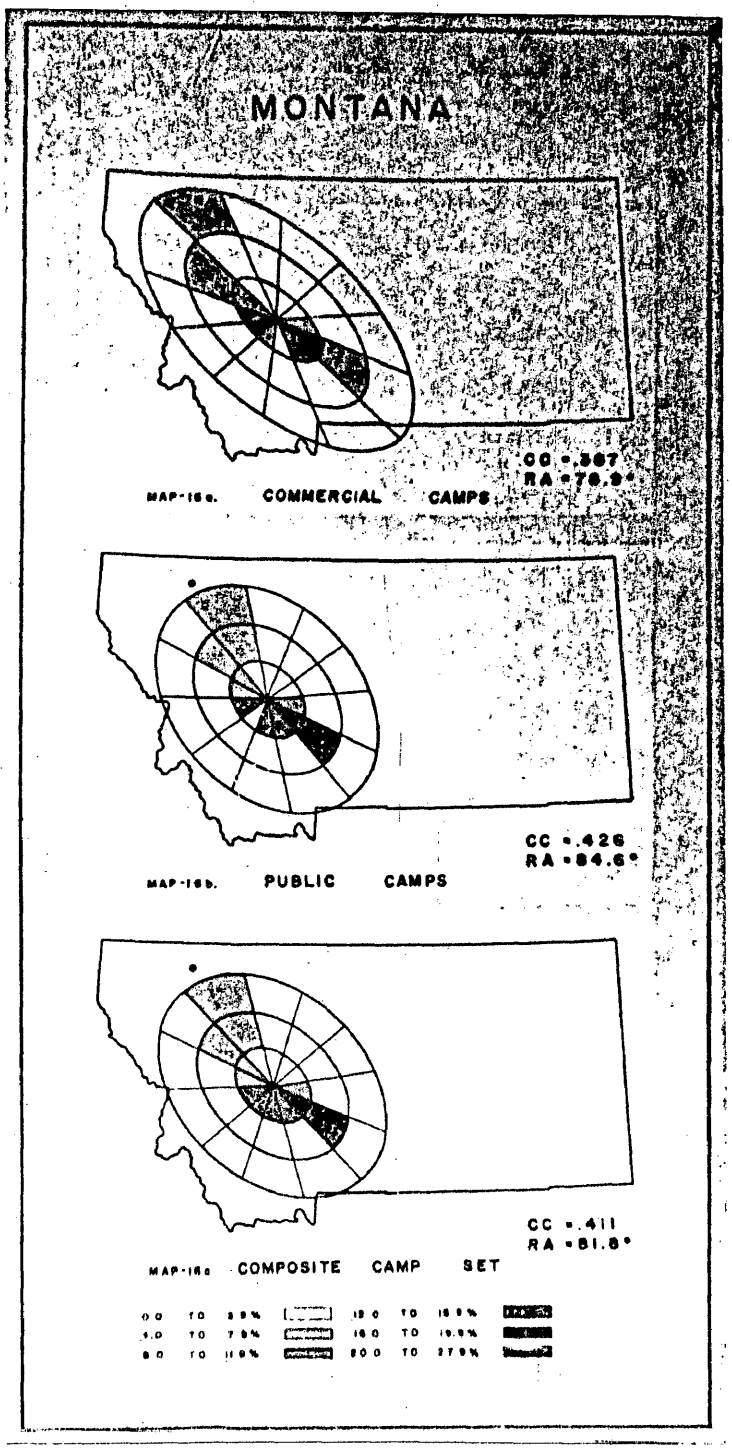
MONTANA CENTROGRAPHIC MEASURES

	1	2	3	4	5	6	Mean
Directional Bias							
Rotation	79.1	78.8	79.2	78.0	79.1	79.2	78.9
Angle in	84.1	84.7	84.4	84.7	85.3	84.5	84.6
Degrees	82.2	81.5	82.2	81.1	81.6	82.0	81.8
Percent of	20	20	19	22	20	19	20
Influence	11	10	10	10	8	10	10
	14	15	14	16	15	14	15
Distance	1.81	1.83	1.83	1.83	1.84	1.83	1.83
Displace-	1.76	1.70	1.74	1.68	1.69	1.74	1.72
ment	1.78	1.77	1.78	1.75	1.77	1.78	1.77
Angle of	2.29	2.27	2.31	2.20	2.31	2.31	2.28
Displace-	2.23	2.14	2.24	2.15	2.17	2.23	2.20
ment	2.25	2.21	2.27	2.18	2.25	2.27	2.24
Sectoral Bias							
Coefficient	.384	.391	.385	.391	.388	.384	.387
of	.410	.442	.414	.439	.436	.416	.426
Circularity	.403	.419	.405	.420	.413	.405	.411

Commercial campground values are presented on the first line of each entry. Public campground values are presented on the second line of each entry. The combined campground values are presented on the third line of each entry.

SDD = Standard Distance Deviation
SD = Standard Deviation

Data sets are numbered as follows:
1 = Non-weighted location coordinates
2 = Number of individual camping sites
3 = Campground capacity
4 = Recreation activities capacity
5 = Campground facility amenities capacity
6 = Maximum campground attraction


MONTANA
CC = .387
RA = 78.2°
MAP-16a. COMMERCIAL CAMPS
CC = .426
RA = 84.6°
MAP-16b. PUBLIC CAMPS
CC = .411
RA = 81.8°
MAP-16c COMPOSITE CAMP SET
0.0 TO 3.9%
4.0 TO 7.9%
8.0 TO 11.9%
12.0 TO 15.9%
16.0 TO 19.9%
20.0 TO 27.9%

mean, with between seventy-two and seventy-seven percent of the unit sets in this region. There is a moderately high degree of sector bias for each set.

In the commercial campground unit set, one sector to the southeast has 20.0 percent of the total, and one sector to the southwest has 12.5 percent of the values. In the public campground set the same southeastern sector has 13.7 percent of the total. The composite camp set sector to the southeast contains 17.8 percent of the values. This particular sector is directly related to the concentration of campgrounds along the northern approaches to Yellowstone National Park, the reference node for Wyoming, the state to the south.

Each campground set has a sector in the northwest with over four percent of the values in the third standard distance deviation from the mean. This particular sector represents Glacier National Park, and contains 5.9 percent of the commercial camp values, 4.9 percent of the public values, and 5.5 percent of the composite values.

Nebraska Centrographic Statistic Interpretation

Table 13 contains the various centrographic measurements for the three campground unit sets, and Map series 17 displays their ellipsoidal functions.

Two of the ellipsoids extend beyond the state outline, because of the western displacement of the mean centroid for the unit sets.

The commercial and composite campground sets exhibit similar centrographic measures. Both are regularly dispersed around their mean centers, but widely dispersed about the reference node. There are strong east to west directional spreads with some slight attractive tendency towards Omaha. Both sets, upon refinement of the directional bias, possess a moderate degree of latitudinal and longitudinal repulsion. Between sixty and sixty-two percent of the values are within one standard distance deviation of the mean. A high degree of spatial sectoral bias is evident, as the coefficient of circularity values for both sets are approaching zero.

The commercial camp set has one sector west of the mean center that contains 18.0 percent of the distribution. This same sector has 12.5 percent of the composite camp values. In addition, another western sector, two standard distance deviations removed from the mean, has 12.2 percent of the commercial campground distributional values.

Public campgrounds are regularly dispersed about the mean, but widely dispersed from Omaha. A strong

TABLE 13

NEBRASKA CENTROGRAPHIC MEASURES

	Commercial, Public, and Combined Campground Units Data Sets						
	1	2	3	4	5	6	Mean
Relative Dispersal							
Mean SDD	2.49	2.46	2.47	2.44	2.47	2.48	2.47
	2.33	2.29	2.32	2.28	2.29	2.31	2.30
	2.39	2.36	2.37	2.35	2.37	2.37	2.37
Reference Node SDD	4.27	4.27	4.26	4.30	4.27	4.27	4.27
	3.99	3.89	3.96	3.90	3.91	3.95	3.93
	4.09	4.04	4.07	4.05	4.07	4.07	4.06
Directional Spread							
SD of X	.70	.67	.69	.68	.68	.69	.69
	.89	.87	.89	.88	.88	.89	.88
	.84	.81	.83	.82	.81	.82	.82
SD of Y	2.39	2.36	2.38	2.35	2.37	2.38	2.37
	2.16	2.11	2.14	2.10	2.11	2.13	2.13
	2.24	2.21	2.23	2.20	2.23	2.23	2.22
Latitude Length	156	149	153	150	150	153	152
	198	194	197	195	196	197	196
	186	179	184	181	179	183	182
Longitude Length	402	398	400	395	400	400	399
	363	355	360	354	356	359	358
	377	373	375	370	375	375	374
Distance Bias							
Percent in one SDD	61.0	58.5	60.5	60.5	59.3	60.4	60.0
	64.5	67.5	65.3	64.9	65.8	64.6	65.4
	62.9	62.5	62.8	61.1	62.0	61.7	62.2
Percent in two SDD	100	100	100	100	100	100	100
	99.4	97.5	98.2	97.9	98.5	98.3	98.3
	99.6	99.6	99.6	99.7	99.7	99.6	99.6

TABLE 13 Continued

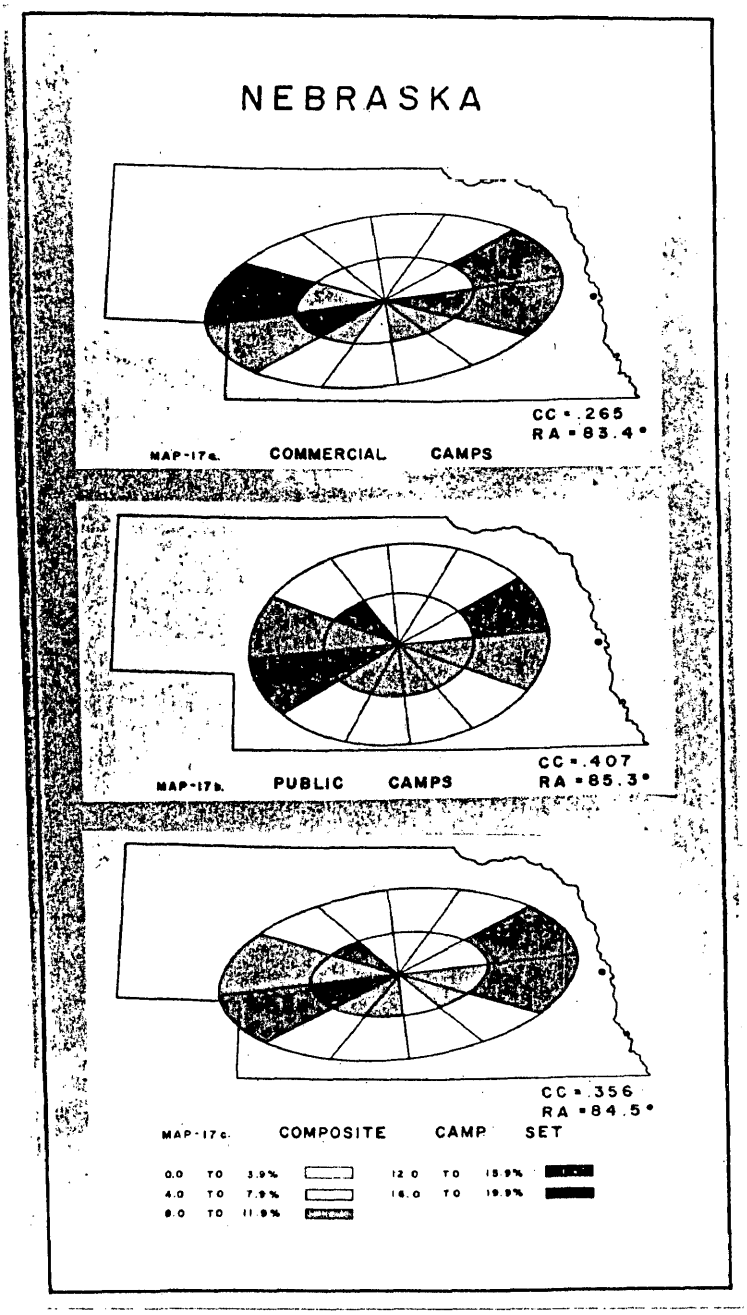
NEBRASKA CENTROGRAPHIC MEASURES

	1	2	3	4	5	6	Mean
Directional Bias							
Rotation	83.2	83.6	83.4	83.6	83.5	83.3	83.4
Angle in	84.5	85.4	84.7	85.9	85.9	85.1	85.3
Degrees	84.0	84.7	84.2	85.1	84.8	84.4	84.5
Percent of	12	12	12	12	12	12	12
Influence	10	8	10	7	7	9	9
	11	10	10	9	9	10	10
Distance	.07	.12	.09	.12	.12	.10	.10
Displace-	-.03	.01	-.01	.01	-.02	-.01	-.01
ment	.01	.05	.03	.04	.04	.03	.03
Angle of	-3.31	-3.35	-3.32	-3.39	-3.33	-3.32	-3.34
Displace-	-3.11	-3.04	-3.08	-3.07	-3.07	-3.09	-3.08
ment	-3.18	-3.16	-3.16	-3.18	-3.18	-3.17	-3.17
Sectoral Bias							
Coefficient	.270	.261	.266	.266	.261	.266	.265
of	.402	.406	.405	.411	.410	.407	.407
Circularity	.359	.352	.357	.361	.349	.357	.356

Commercial campground values are presented on the first line of each entry. Public campground values are presented on the second line of each entry. The combined campground values are presented on the third line of each entry.

SDD = Standard Distance Deviation
SD = Standard Deviation

Data sets are numbered as follows:
1 = Non-weighted location coordinates
2 = Number of individual camping sites
3 = Campground capacity
4 = Recreation activities capacity
5 = Campground facility amenities capacity
6 = Maximum campground attraction


NEBRASKA
CC = .265
RA = 83.4°
MAP-17a. COMMERCIAL CAMPS
PUBLIC CAMPS
CC = .407
RA = 85.3°
MAP-17b.
CC = .356
RA = 84.5°
MAP-17c. COMPOSITE CAMP SET
0.0 TO 3.9%
4.0 TO 7.9%
8.0 TO 11.9%
12.0 TO 15.9%
16.0 TO 19.9%

east to west directional spread is combined with a slight attractive force exerted from the reference node. Refinement of the directional bias indicates that this attractive force is a combination of a moderate latitudinal attraction and a low amount of longitudinal repulsion. One sector, to the northwest of the mean, has 12.1 percent of the values. A moderate degree of sectoral bias exists.

North Dakota Centrographic Statistic Interpretation

Centrographic measures for the three campground sets are in Table 14, with Map series 18 displaying the respective ellipsoidal functions. The small amount of rotation from the horizontal axis, the location of the reference node, and the position of the distributional centroids, work together to retain the functions within the state outline.

The three unit sets are similar, as described by their centrographic statistics. Each set has a regular dispersal about its mean center, and a wide dispersal around the reference node. There are strong east to west directional spread indications, with a slight attraction being effected from the Theodore Roosevelt National Park area. Moderate latitudinal and longitudinal elements of attraction are defined for the three

TABLE 14

NORTH DAKOTA CENTROGRAPHIC MEASURES

	Commercial, Public, and Combined Campground Units Data Sets						
	1	2	3	4	5	6	Mean
Relative Dispersal							
Mean SDD	2.26	2.30	2.29	2.32	2.29	2.29	2.29
	2.23	2.30	2.25	2.27	2.29	2.25	2.26
	2.24	2.31	2.26	2.29	2.30	2.26	2.28
Reference Node SDD	3.59	3.55	3.59	3.54	3.56	3.59	3.57
	3.91	3.88	3.89	3.90	3.92	3.91	3.90
	3.85	3.81	3.83	3.83	3.84	3.85	3.83
Directional Spread							
SD of X	.70	.70	.71	.71	.70	.71	.70
	.89	.86	.88	.87	.87	.88	.88
	.86	.83	.85	.84	.84	.85	.85
SD of Y	2.15	2.19	2.17	2.21	2.18	2.17	2.18
	2.05	2.13	2.07	2.09	2.12	2.07	2.09
	2.07	2.15	2.10	2.13	2.14	2.09	2.11
Latitude Length	157	155	157	158	155	157	156
	198	192	196	194	194	196	195
	192	185	190	188	186	190	188
Longitude Length	327	333	331	336	332	331	332
	312	324	315	319	322	314	318
	315	327	319	324	326	319	322
Distance Bias							
Percent in one SDD	55.4	57.4	53.5	57.2	55.7	53.8	55.5
	60.8	57.2	59.6	58.4	58.2	59.7	59.0
	59.0	56.4	58.0	56.8	57.6	58.0	57.6
Percent in two SDD	100	100	100	100	100	100	100
	100	100	100	100	100	100	100
	100	100	100	100	100	100	100

TABLE 14 Continued

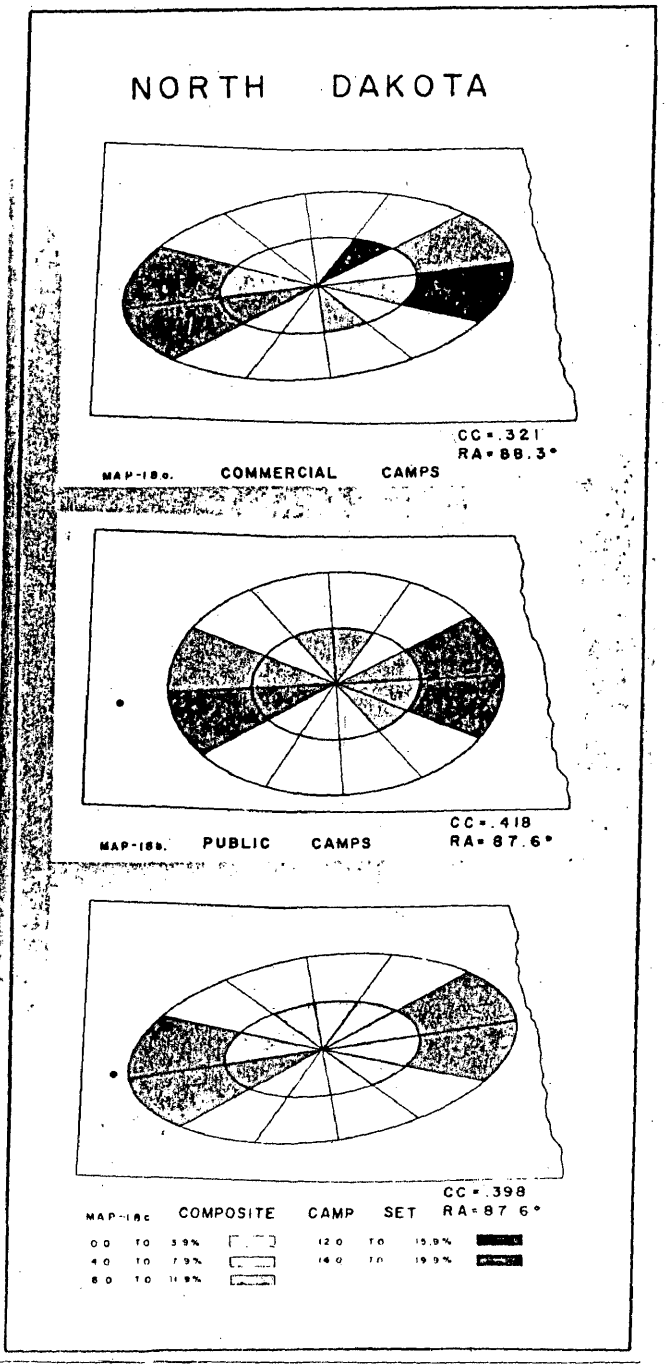
NORTH DAKOTA CENTROGRAPHIC MEASURES

	1	2	3	4	5	6	Mean
Directional Bias							
Rotation	88.2	88.3	88.3	88.2	88.5	88.3	88.3
Angle in	88.6	86.8	88.0	87.0	87.0	88.0	87.6
Degrees	88.4	87.0	87.9	87.2	87.2	87.9	87.6
Percent of	3	3	3	3	3	3	3
Influence	3	6	4	5	5	4	4
	3	5	4	5	5	4	4
Distance	-.29	-.27	-.29	-.26	-.27	-.28	-.28
Displace-	-.15	-.15	-.15	-.15	-.14	-.15	-.15
ment	-.17	-.18	-.17	-.18	-.17	-.17	-.17
Angle of	2.83	2.75	2.81	2.71	2.76	2.80	2.78
Displace-	3.24	3.20	3.23	3.25	3.25	3.25	3.24
ment	3.17	3.10	3.15	3.14	3.14	3.16	3.14
Sectoral Bias							
Coefficient	.326	.317	.323	.320	.318	.323	.321
of	.433	.401	.424	.414	.407	.426	.418
Circularity	.414	.383	.405	.393	.387	.406	.398

Commercial campground values are presented on the first line of each entry. Public campground values are presented on the second line of each entry. The combined campground values are presented on the third line of each entry.

SDD = Standard Distance Deviation
SD = Standard Deviation

Data sets are numbered as follows:
1 = Non-weighted location coordinates
2 = Number of individual camping sites
3 = Campground capacity
4 = Recreation activities capacity
5 = Campground facility amenities capacity
6 = Maximum campground attraction


NORTH DAKOTA
CC=.321
RA=88.3°
MAP-18a. COMMERCIAL CAMPS
CC=.418
RA=87.6°
MAP-18b. PUBLIC CAMPS
CC=.398
RA=87.6°
MAP-18c COMPOSITE CAMP SET
0.0 TO 3.9%
4.0 TO 7.9%
8.0 TO 11.9%
12.0 TO 15.9%
16.0 TO 19.9%

campground sets.

High degrees of sectoral bias are identified, and between fifty-five and fifty-seven percent of the respective distributions are within one standard distance deviation of the mean, well below the norm. The public and composite camp sets have no sectors containing over twelve percent of the values, but the commercial camp set does. A northeastern sector has 17.7 percent of the values, and an eastern sector that is also two standard distance deviations removed from the mean has 14.7 percent of the distributional values.

South Dakota Centrographic Statistic Interpretation

Centrographic measures for the unit sets are in Table 15, with Map series 19 displaying the spatial density and orientation of the respective ellipsoidal functions. The westward displacement of the commercial unit set mean center and the narrowness of the ellipse because of the large sectoral bias results in extension of this function beyond the state outline.

Commercial camps are regularly dispersed about their mean, but widely dispersed around the reference node. There is a strong directional spread from east to west, with a slight attraction to the Black Hills area

TABLE 15

SOUTH DAKOTA CENTROGRAPHIC MEASURES

	Commercial, Public, and Combined Campground Units Data Sets						
	1	2	3	4	5	6	Mean
Relative Dispersal							
Mean SDD	2.67	2.63	2.66	2.62	2.64	2.66	2.65
	2.67	2.67	2.66	2.64	2.68	2.66	2.66
	2.72	2.72	2.72	2.72	2.73	2.72	2.72
Reference Node SDD	3.33	3.21	3.31	3.20	3.24	3.31	3.27
	4.10	4.13	4.12	4.24	4.19	4.16	4.16
	3.79	3.69	3.78	3.77	3.71	3.79	3.76
Directional Spread							
SD of X	.56	.50	.54	.50	.51	.54	.52
	.79	.78	.79	.79	.78	.79	.79
	.71	.66	.69	.67	.65	.69	.68
SD of Y	2.61	2.58	2.60	2.58	2.59	2.60	2.59
	2.55	2.56	2.54	2.52	2.57	2.54	2.55
	2.63	2.64	2.63	2.64	2.65	2.63	2.64
Latitude Length	124	111	121	110	113	120	117
	177	173	176	177	173	176	175
	157	146	154	149	145	153	151
Longitude Length	418	414	418	413	415	418	416
	409	410	408	404	412	407	408
	421	423	421	423	425	422	423
Distance Bias							
Percent in one SDD	74.7	75.5	74.5	75.5	75.4	74.7	75.1
	45.4	43.3	45.9	47.5	44.6	46.0	45.5
	54.3	60.8	55.4	56.5	60.5	55.1	57.1
Percent in two SDD	100	98.2	100	98.2	99.2	100	99.3
	100	100	100	100	100	100	100
	100	100	100	100	100	100	100

TABLE 15 Continued

SOUTH DAKOTA CENTROGRAPHIC MEASURES

	1	2	3	4	5	6	Mean
Directional Bias							
Rotation Angle in Degrees	88.1 88.8 88.6	86.9 90.0 88.7	87.7 89.2 88.7	87.0 89.8 88.8	87.1 90.0 88.8	87.6 89.2 88.7	87.4 89.5 88.7
Percent of Influence	3 2 3	6 None 2	4 1 2	5 None 2	5 None 2	4 1 2	5 1 2
Distance Displacement	-.32 -.36 -.34	-.26 -.35 -.31	-.30 -.36 -.33	-.26 -.37 -.32	-.26 -.37 -.31	-.29 -.36 -.33	-.28 -.36 -.32
Angle of Displacement	2.06 3.12 2.68	1.94 3.13 2.53	2.05 3.15 2.66	1.92 3.31 2.64	1.97 3.19 2.55	2.04 3.20 2.67	2.00 3.18 2.62
Sectoral Bias							
Coefficient of Circularity	.211 .311 .268	.186 .304 .247	.205 .311 .262	.185 .315 .253	.190 .303 .246	.202 .311 .261	.197 .309 .256

Commercial campground values are presented on the first line of each entry. Public campground values are presented on the second line of each entry. The combined campground values are presented on the third line of each entry.

SDD = Standard Distance Deviation
SD = Standard Deviation

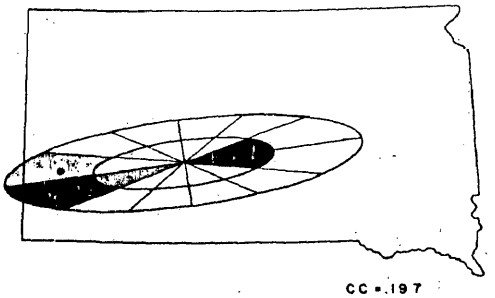
Data sets are numbered as follows:
1 = Non-weighted location coordinates
2 = Number of individual camping sites
3 = Campground capacity
4 = Recreation activities capacity
5 = Campground facility amenities capacity
6 = Maximum campground attraction

noted from the rotational requirements. Refinement of this attractive force indicates that it consists of moderate latitudinal and strong longitudinal components. South Dakota commercial camps demonstrate the highest degree of sectoral bias in the thesis region. There are 75.1 percent of the values within one standard distance deviation of the mean center.

Two sectors in the eastern part of the first standard distance deviation area have 20.2 and 38.2 percent, respectively, of the total values. These sectors are related to the commercialization of the approaches to the various Missouri River recreation attractions in the large impoundment areas through the central part of the state. In addition, a southwestern sector in the second standard distance deviation area has 17.8 percent of the values. This sector is in close proximity to the position used for the reference node, and does overlap the Badlands-Black Hills area.

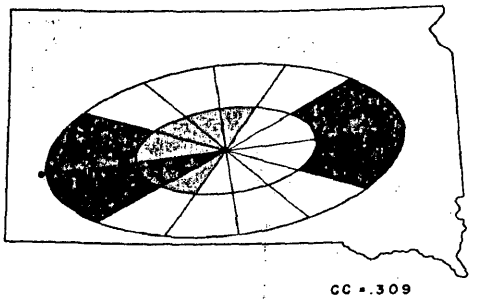
Public and composite unit sets are similarly described by the centrographic measures. Both are regularly dispersed around their centroids. Both are widely dispersed about the reference node. Both have strong east to west directional spreads, with only small

SOUTH DAKOTA



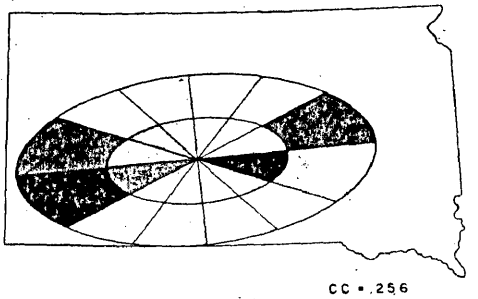
CC = .197
RA = 87.4°

MAP-19a. COMMERCIAL CAMPS



CC = .309
RA = 89.5°

MAP-19b. PUBLIC CAMPS



CC = .256
RA = 88.7°

MAP-19c COMPOSITE CAMP SET

0.0	TO	3.9%	16.0	TO	19.9%
4.0	TO	7.9%	20.0	TO	27.9%
8.0	TO	11.9%	OVER		27.9%
12.0	TO	15.9%			

degrees of attraction being exerted by the reference node. Both have moderate latitudinal and longitudinal attractive components.

Both public and composite sets have very high degrees of sector bias. Public camps of South Dakota have the lowest percentage of values in the first standard distance deviation, only 45.5 percent. Only 57.1 percent of the combined camps are within one deviation of the mean center. Both sets have a western sector in the second standard distance deviation with over twelve percent, 13.4 percent for the public, and 16.0 percent for the composite. These are representative of the reference node area. Both sets also have an eastern sector with large totals. The public camp set has a sector in the second standard distance deviation with 22.6 percent, and the composite set has a sector with 26.1 percent. These represent the extensive campground developments along the Missouri River reservoir system in the state.

Wyoming Centrographic Statistic Interpretation

Table 16 contains the unit set centrographic measurements and Map series 20 displays their ellipsoidal functions. The slight northward displacement of the mean

TABLE 16

WYOMING CENTROGRAPHIC MEASURES

	Commercial, Public, and Combined Campground Units Data Sets						
	1	2	3	4	5	6	Mean
Relative Dispersal							
Mean SDD	2.49	2.46	2.48	2.45	2.47	2.48	2.47
	2.40	2.45	2.42	2.44	2.44	2.42	2.43
	2.44	2.47	2.46	2.45	2.46	2.45	2.45
Reference Node SDD	4.07	3.97	4.06	3.92	3.97	4.04	4.01
	3.98	3.96	3.98	3.92	3.96	3.98	3.96
	3.99	3.95	4.00	3.90	3.95	3.99	3.96
Directional Spread							
SD of X	1.16	1.17	1.17	1.16	1.16	1.16	1.16
	1.28	1.27	1.27	1.26	1.27	1.27	1.27
	1.23	1.23	1.23	1.21	1.22	1.22	1.23
SD of Y	2.20	2.17	2.19	2.16	2.18	2.19	2.18
	2.03	2.10	2.06	2.09	2.09	2.06	2.07
	2.11	2.14	2.13	2.12	2.14	2.13	2.13
Latitude Length	257	259	259	257	257	258	258
	284	283	283	279	282	282	282
	274	273	273	270	271	272	272
Longitude Length	359	354	357	352	356	358	356
	330	342	336	341	341	336	338
	344	349	347	346	349	347	348
Distance Bias							
Percent in one SDD	59.2	59.1	59.4	59.4	58.5	58.8	59.1
	52.7	50.5	52.1	52.1	48.8	51.9	51.4
	56.8	54.7	56.2	54.8	55.5	56.1	55.7
Percent in two SDD	100	100	100	100	100	100	100
	100	100	100	100	100	100	100
	100	100	100	100	100	100	100

TABLE 16 Continued

WYOMING CENTROGRAPHIC MEASURES

	1	2	3	4	5	6	Mean
Directional Bias							
Rotation	80.0	80.2	79.7	80.1	80.5	79.9	80.1
Angle in	73.4	72.7	73.2	73.4	72.5	73.2	73.1
Degrees	76.3	76.1	76.2	76.6	76.5	76.4	76.4
Percent of	18	18	19	18	17	18	18
Influence	30	31	30	30	32	30	30
	25	25	25	24	24	24	25
Distance	1.47	1.45	1.48	1.43	1.45	1.47	1.46
Displace-	1.30	1.22	1.27	1.25	1.21	1.27	1.25
ment	1.37	1.33	1.37	1.33	1.33	1.36	1.35
Angle of	2.66	2.54	2.64	2.46	2.55	2.62	2.58
Displace-	2.36	2.26	2.35	2.21	2.29	2.34	2.30
ment	2.49	2.39	2.48	2.32	2.42	2.47	2.43
Sectoral Bias							
Coefficient	.496	.511	.502	.510	.505	.501	.504
of	.567	.530	.548	.530	.530	.548	.542
Circularity	.538	.525	.529	.524	.522	.527	.528

Commercial campground values are presented on the first line of each entry. Public campground values are presented on the second line of each entry. The combined campground values are presented on the third line of each entry.

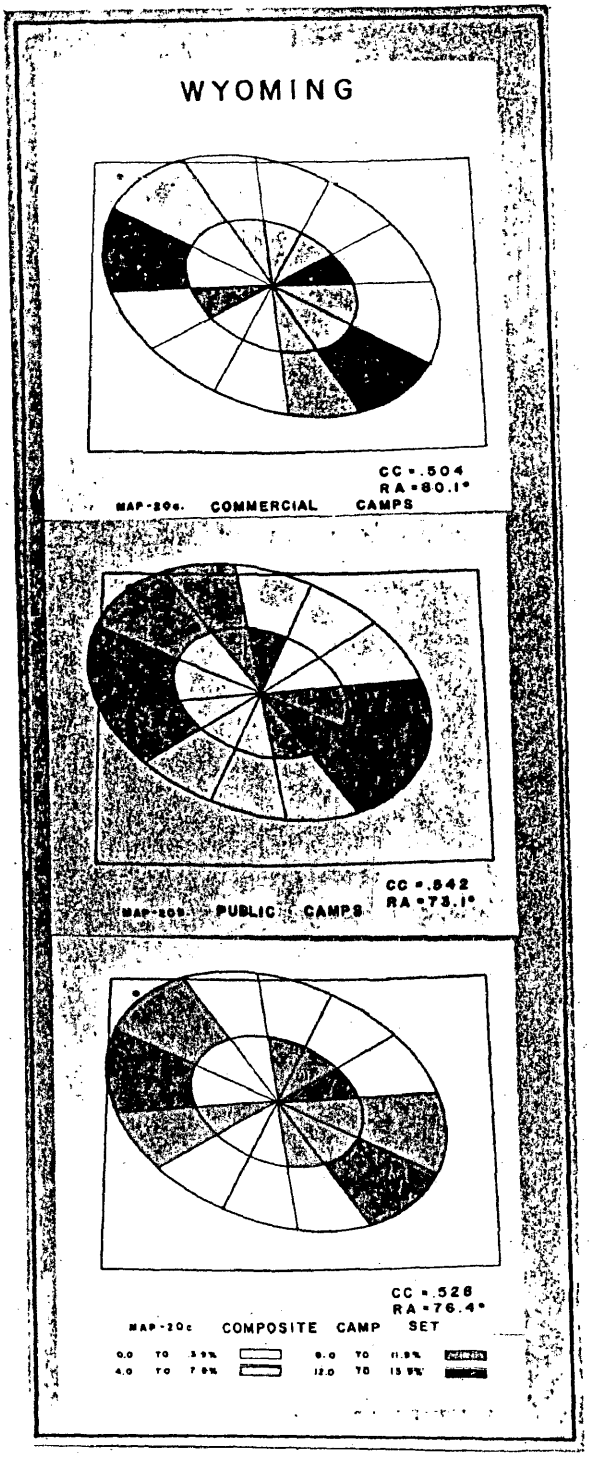
SDD = Standard Distance Deviation
SD = Standard Deviation

Data sets are numbered as follows:
1 = Non-weighted location coordinates
2 = Number of individual camping sites
3 = Campground capacity
4 = Recreation activities capacity
5 = Campground facility amenities capacity
6 = Maximum campground attraction

center combined with a new axis drawn from the reference node in extreme northwest Wyoming causes the ellipsoids to extend slightly beyond the state outline. All three unit sets have similar centrographic measures.

They are regularly dispersed around their mean centers, with wide dispersal about the Yellowstone National Park nodal area. There is a strong attractive force exerted by the reference node, with an east to west directional spread. Between eighteen and thirty percent of the location decisions have been influenced by the Yellowstone Park area. Refinement of the directional bias indicates it is composed of a moderate longitudinal attraction with some latitudinal repulsion. Sectoral bias is nearly balanced for all sets.

Public camps have 51.4 percent of their values within one standard distance deviation of the mean, with commercial camps having 59.1 percent in the same section. Both are well below the norm. The commercial camp set has the only sectors with over twelve percent of the values. A central sector, to the northeast, has 14.2 percent; a southeastern sector, in the second distance deviation, has 12.0 percent; and a northwestern sector, also in the second distance deviation, has 13.0 percent of the values.


WYOMING
CC = .504
RA = 80.1°
MAP-20a. COMMERCIAL CAMPS
CC = .542
RA = 73.1°
MAP-20b. PUBLIC CAMPS
CC = .526
RA = 76.4°
MAP-20c COMPOSITE CAMP SET
0.0 TO 3.9%
4.0 TO 7.9%
8.0 TO 11.9%
12.0 TO 15.9%

Conclusions

The many centrographic measurements derived from the computer analysis of the distance or spacing between campground units have provided some answers to the thesis question areas. Directional spread is identified as east to west for most unit sets. Essentially, this is related to the greater east to west dimensions of the areas studied. The spatial directional bias, as measured in this study, is the least reliable centrographic procedure. As noted in the individual state reviews, an attractive or repulsive force generally consisted of conflicting latitudinal and longitudinal components. This leads to confusion when the overall bias is identified as attractive, yet each of the components is indicated as being repulsive in their attractive force.

Dispersal patterns of the campgrounds are mostly regular around the centroid, but wide in relation to the selected reference nodes. Distance bias can be inferred for most states by noting the percentage of campgrounds within the first standard distance deviation of the mean. Only Missouri public camps, South Dakota commercial camps, and Montana camps have higher than normal groupings of units near their centroids.

Coefficients of circularity can be compared to some degree between the states, although most of the other centrographic measurements do not easily lend themselves to comparison. South Dakota, Nebraska, and North Dakota have elongated and flattened ellipsoidal functions with high levels of sectoral bias. These states had strong linear patterns for most of their campgrounds, and also represented the last three states in number of available camping sites. Minnesota, Colorado, and Missouri display the greatest degree of circularity. These states also rank first, third, and fourth in the number of camping units available.

The various pieces of information about the individual campgrounds were aggregated at the county level for each state before commencing the next analytical series. Chapter 4 directs attention to the density distribution patterns within and between the states. Its main thrust is the analysis of the interface between campgrounds and the recreation and tourist attractions of the state. Chapter 4 then concludes with a summarization of the major thesis findings and some recommendations about future studies.

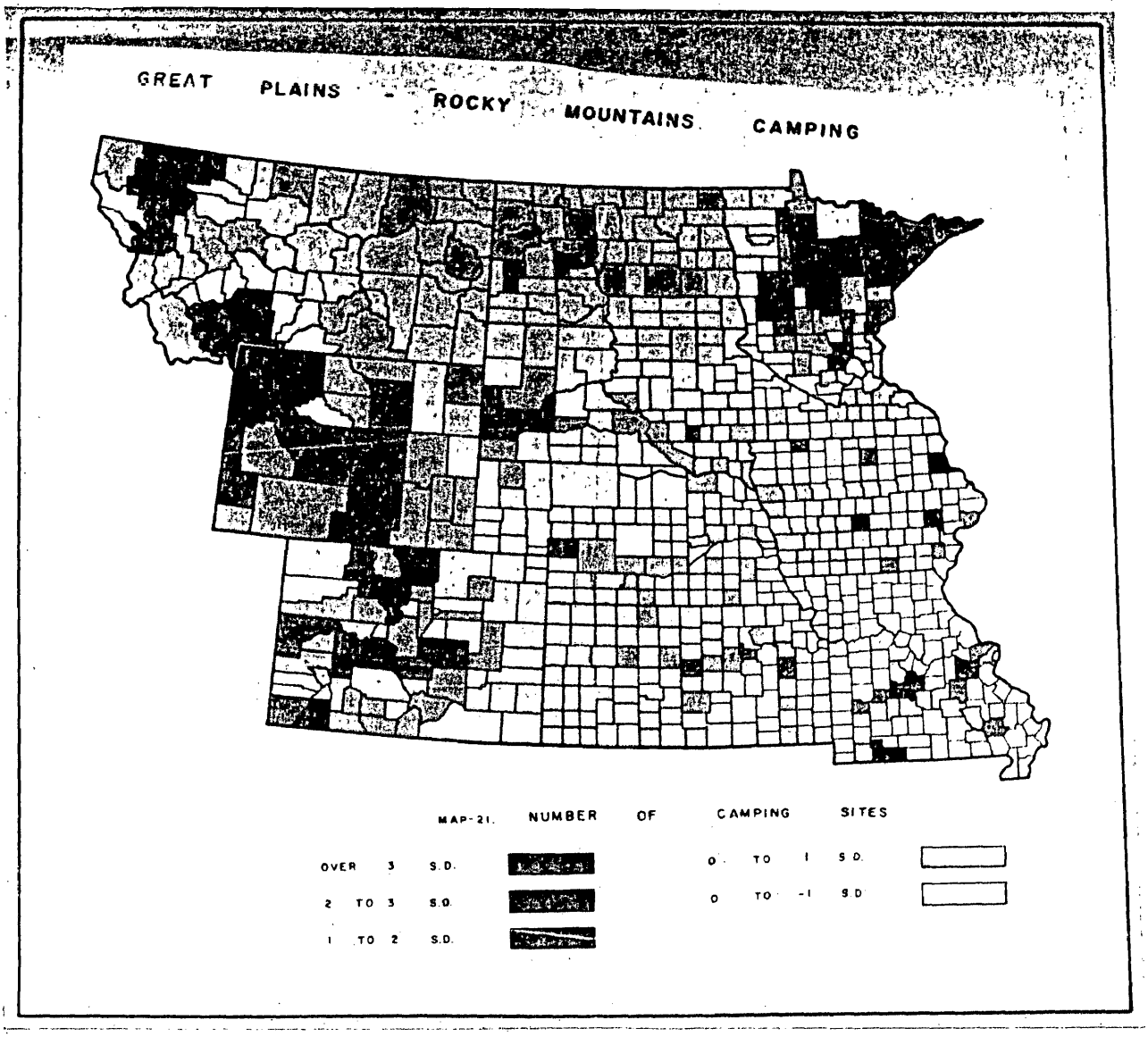
Chapter 4

DENSITY MEASURES

Having completed an analysis of the spatial distribution pattern elements associated with the point locations of the campground units, the data elements have been aggregated at the county level to determine spatial density patterns. Most of the following analysis is accomplished by comparing the states on a regional basis.

Density Pattern Analysis

The Great Plains-Rocky Mountain camping environment is described by Map 21. The number of commercial and public camping sites, by county, has been standardized and presented on this map. The 762 counties of the thesis region have 203,587 individual camping sites, an average of 267 sites per county. There are 80 counties that have no campgrounds, and 26 counties have over 1,000 individual camping sites. The 4,976 campgrounds in the study area average 41 sites each. Examination of Map 21 provides ready identification of the major recreation


GREAT PLAINS - ROCKY MOUNTAINS CAMPING
MAP-21. NUMBER OF CAMPING SITES
OVER 3 S.D.
2 TO 3 S.D.
1 TO 2 S.D.
0 TO 1 S.D.
0 TO -1 S.D.

complexes in the Great Plains-Rocky Mountain study area.

The large Rocky Mountain attractions extend from western Colorado through Wyoming into western Montana. The heaviest concentrations include: (1) the Mesa Verde National Park area of southwestern Colorado; (2) the commercial attractions near Colorado Springs; (3) the extensive national forest camping sites in western and northern Colorado; (4) the Rocky Mountain National Park in north central Colorado; (5) the Yellowstone National Park area and its approaches in northwestern Wyoming and southwestern Montana; and (6) the Glacier National Park area in northwestern Montana.

The relative scarcity of camping sites in the central states of the region is very obvious from Map 21. Only 25.7 percent of the campgrounds and 23.6 percent of the camping sites are in the states of Kansas, Nebraska, North Dakota, and South Dakota. The Black Hills area of western South Dakota is the only identifiable concentration of camping sites in the central portion of the study area.

The eastern states include several identifiable concentrations: (1) the Ozarks area in central and southern Missouri; (2) the commercial Six Flags over Mid-America attraction near St. Louis; (3) three isolated peaks in Iowa, related to individual campgrounds; and

(4) the northern Minnesota lake area and national forest camping sites.

Two mathematical indices of density pattern analysis have been used, one the index of contiguity, and the other an index of concentration. Each is analyzed separately as it provides an understanding of the data elements associated with the campground unit sets.

Index of Contiguity Analysis

The weighted data elements of each campground unit set have been subjected to an index of contiguity analysis (Anderson, 1965; Cliff and Ord, 1975; Dacey, 1968; King, 1969). This index provides a measurement of the dispersion of the respective weighted elements around their means. Each state is considered separately.

The index of contiguity for each weighted element is derived in the same manner. First, the values for the element are summed, and the average value is determined. Next, each county value is compared to this average. Those with higher values are classified as black, or numerically by two. Those with lower values are identified as white, or numerically by one. The third step is the determination of the linkages between the counties, that is, the manner in which the counties

abut each other. From this linkage information the number of black-black, black-white, and white-white joins can be determined. After completion of these steps the formulas specified by Cliff and Ord are applied to obtain the index.

Table 17 contains the indices of contiguity for each state, according to campground unit set and weighted data element. Additionally, a mean value is shown for each unit set. Interpretation of the index value is similar to nearest neighbor analysis, except that values from zero to one denote a trend towards uniformity, and that values from one to 2.1491 denote a trend towards clustering.

Maps 22 through 31 have been prepared, one per state, to display the mean of the indices of contiguity for each state. These maps have been developed from a combination of all indices obtained for a given state. Preparation of the maps was accomplished in four shades, thus providing an illustration of how the spatial density distribution pattern of the state can be effectively used to differentiate contiguous and non-contiguous areas of clustering.

Colorado, on Map 22, is trending towards clustering. Four highly concentrated areas can be

TABLE 17

INDICES OF CONTIGUITY

	Commercial, Public, and Combined Campground Units Data Sets					
	1	2	3	4	5	Mean
Colorado	1.81	1.75	1.76	1.76	1.74	1.79
	1.65	1.74	1.69	1.74	1.77	1.70
	1.72	1.74	1.76	1.78	1.79	1.76
Iowa	1.30	1.33	1.33	1.28	1.35	1.34
	1.46	1.46	1.47	1.49	1.53	1.52
	1.35	1.40	1.30	1.42	1.37	1.38
Kansas	1.55	1.58	1.50	1.53	1.54	1.54
	1.53	1.53	1.49	1.48	1.49	1.49
	1.65	1.62	1.56	1.64	1.62	1.62
Minnesota	1.61	1.61	1.65	1.60	1.57	1.60
	1.65	1.59	1.58	1.59	1.59	1.58
	1.62	1.59	1.62	1.58	1.61	1.63
Missouri	1.64	1.65	1.64	1.64	1.66	1.64
	1.55	1.53	1.55	1.55	1.55	1.55
	1.63	1.64	1.58	1.64	1.62	1.62
Montana	1.75	1.73	1.70	1.75	1.73	1.73
	1.75	1.81	1.79	1.80	1.79	1.81
	1.67	1.75	1.73	1.70	1.75	1.72
Nebraska	1.62	1.63	1.60	1.58	1.57	1.62
	1.66	1.68	1.66	1.64	1.60	1.64
	1.67	1.68	1.64	1.62	1.64	1.64
North Dakota	1.28	1.36	1.28	1.26	1.28	1.28
	1.32	1.26	1.33	1.34	1.28	1.32
	1.37	1.36	1.38	1.41	1.39	1.39

TABLE 17 Continued

INDICES OF CONTIGUITY

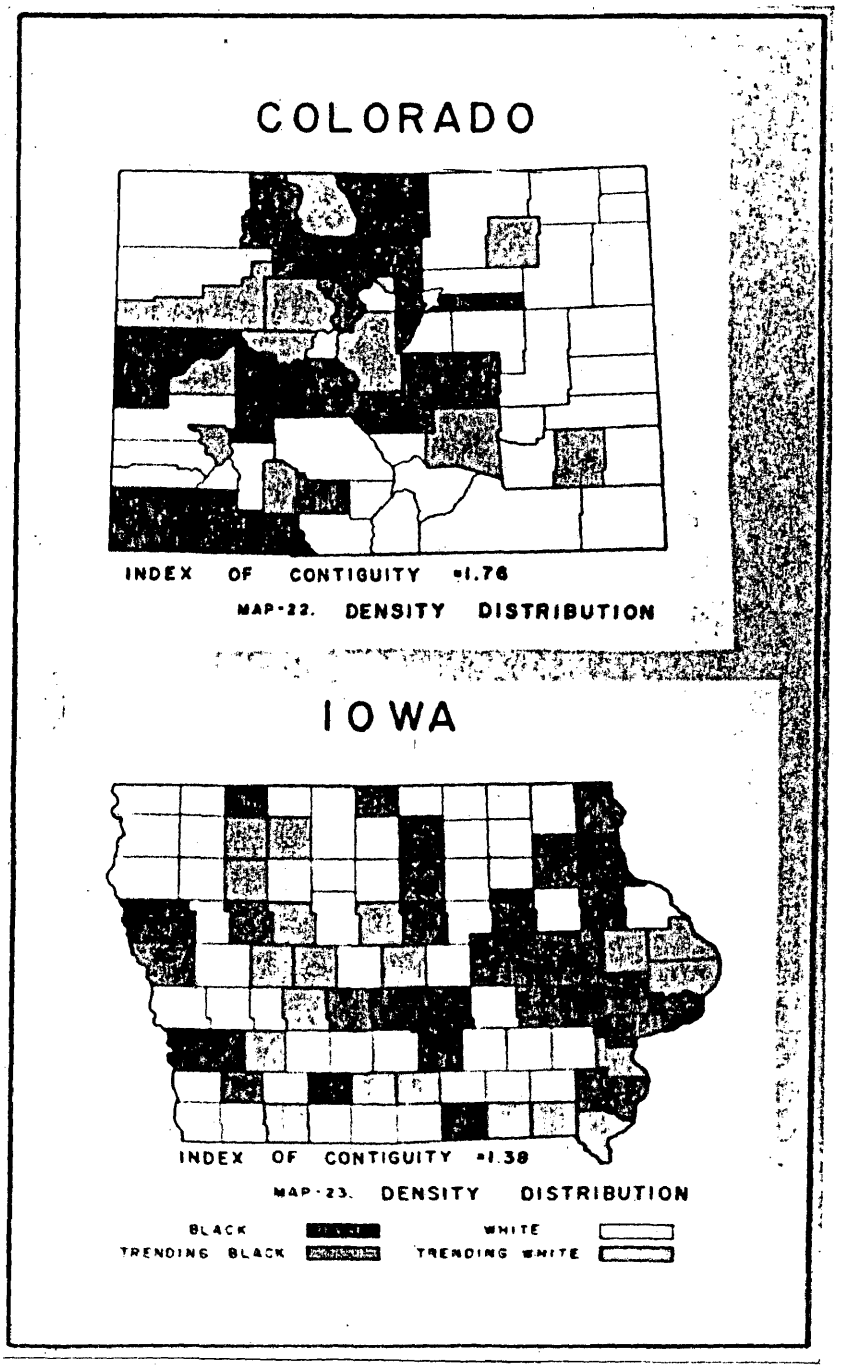
	1	2	3	4	5	Mean
South Dakota	1.63	1.66	1.65	1.63	1.65	1.66
	1.77	1.65	1.81	1.85	1.83	1.80
	1.73	1.72	1.76	1.68	1.71	1.72
Wyoming	.95	.95	.84	.95	.95	.95
	.51	.59	.51	.51	.70	.51
	.70	.97	.70	.84	.97	.86

Commercial campground values are presented on the first line of each entry. Public campground values are presented on the second line of each entry. The combined campground values are presented on the third line of each entry.

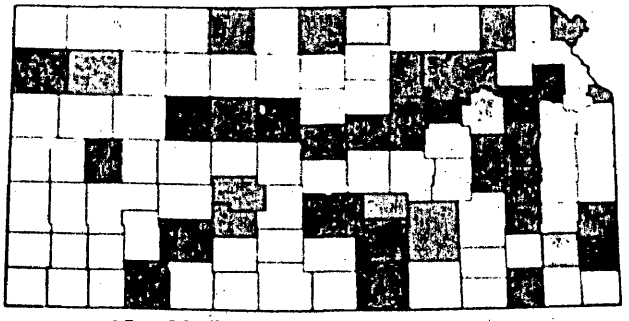
Data sets are numbered as follows:
1 = Number of individual camping sites
2 = Campground capacity
3 = Recreation activities capacity
4 = Campground facility amenities capacity
5 = Maximum campground attraction

identified: the southwestern Mesa Verde area, the western national forest sites, the north central Rocky Mountain National Park area, and an area around Denver, the state reference node. Surprisingly, the Colorado Springs area previously identified as a major cluster area is not designated as such with this method of analysis.

Iowa, on Map 23, has a moderate trend towards clustering. Ten separate areas, uniformly dispersed throughout the state, are denoted as concentrated areas.


COLORADO
INDEX OF CONTIGUITY =1.76
MAP-22. DENSITY DISTRIBUTION
IOWA
INDEX OF CONTIGUITY =1.38
MAP-23. DENSITY DISTRIBUTION
BLACK
WHITE
TRENDING BLACK
TRENDING WHITE

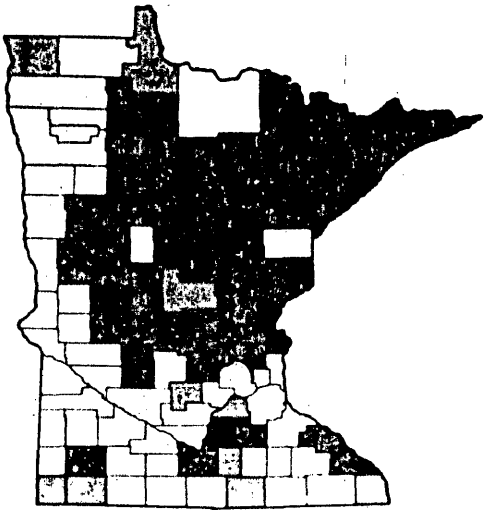
KANSAS



INDEX OF CONTIGUITY =1.62

MAP-24. DENSITY DISTRIBUTION

MINNESOTA

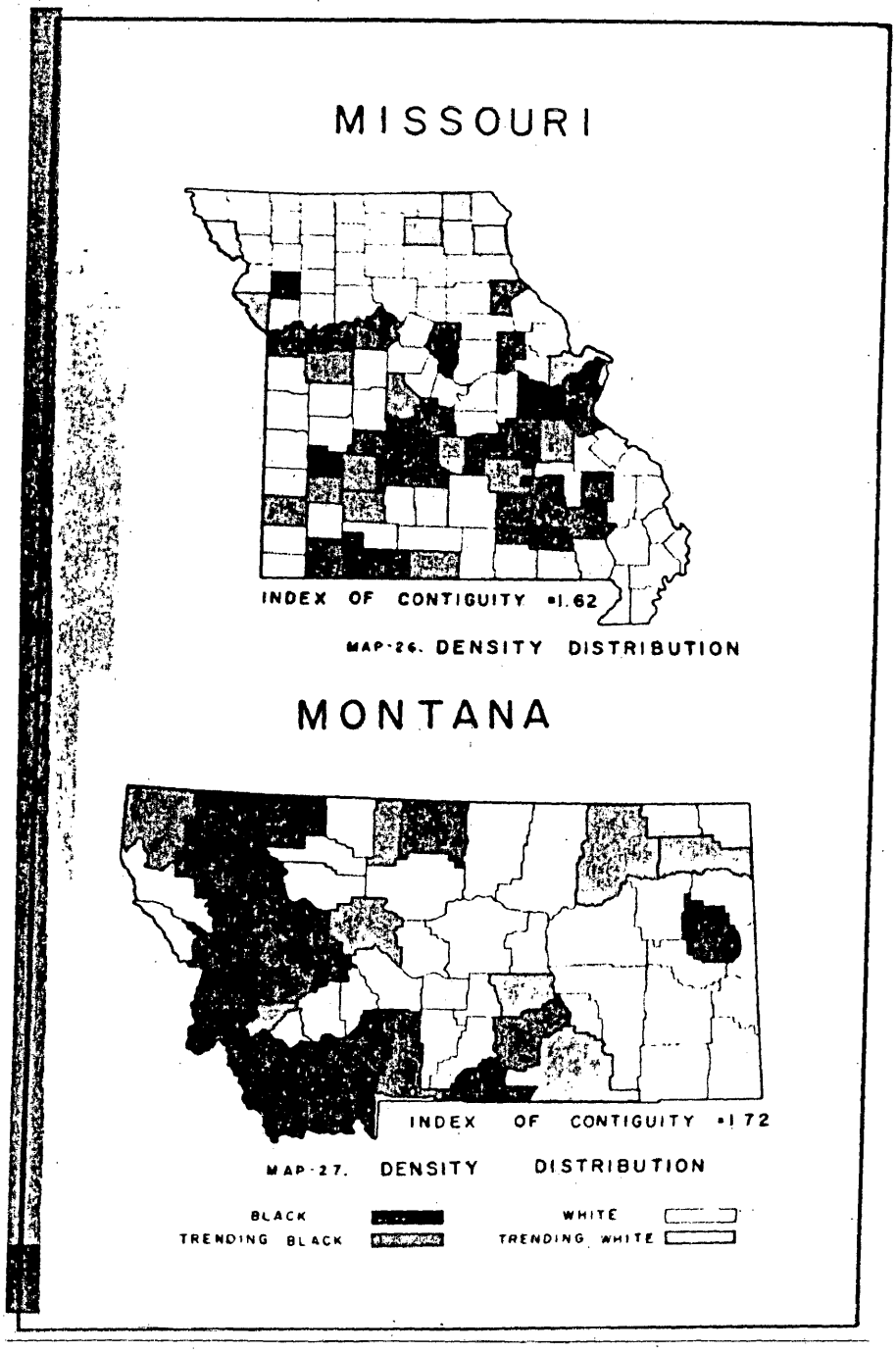


INDEX OF CONTIGUITY =1.63

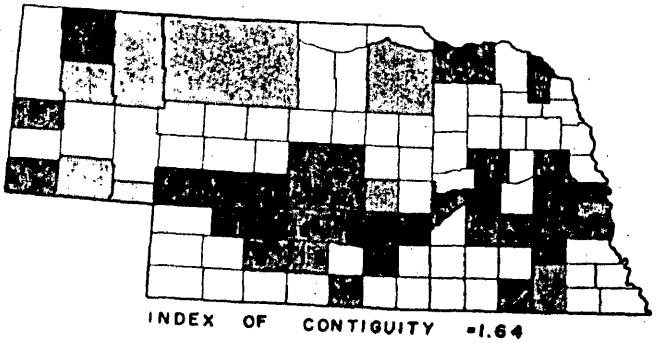
MAP-25. DENSITY DISTRIBUTION

BLACK WHITE

TRENDING BLACK TRENDING WHITE


MISSOURI
INDEX OF CONTIGUITY •1.62
MAP-26. DENSITY DISTRIBUTION
MONTANA
INDEX OF CONTIGUITY •1.72
MAP-27. DENSITY DISTRIBUTION
BLACK
TRENDING BLACK
WHITE
TRENDING WHITE

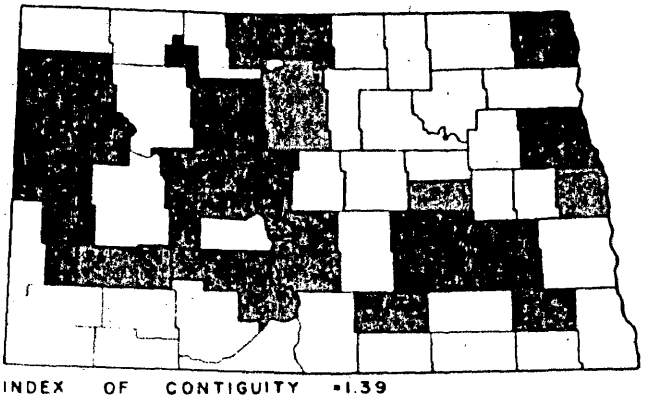
NEBRASKA



INDEX OF CONTIGUITY =1.64

MAP-28. DENSITY DISTRIBUTION

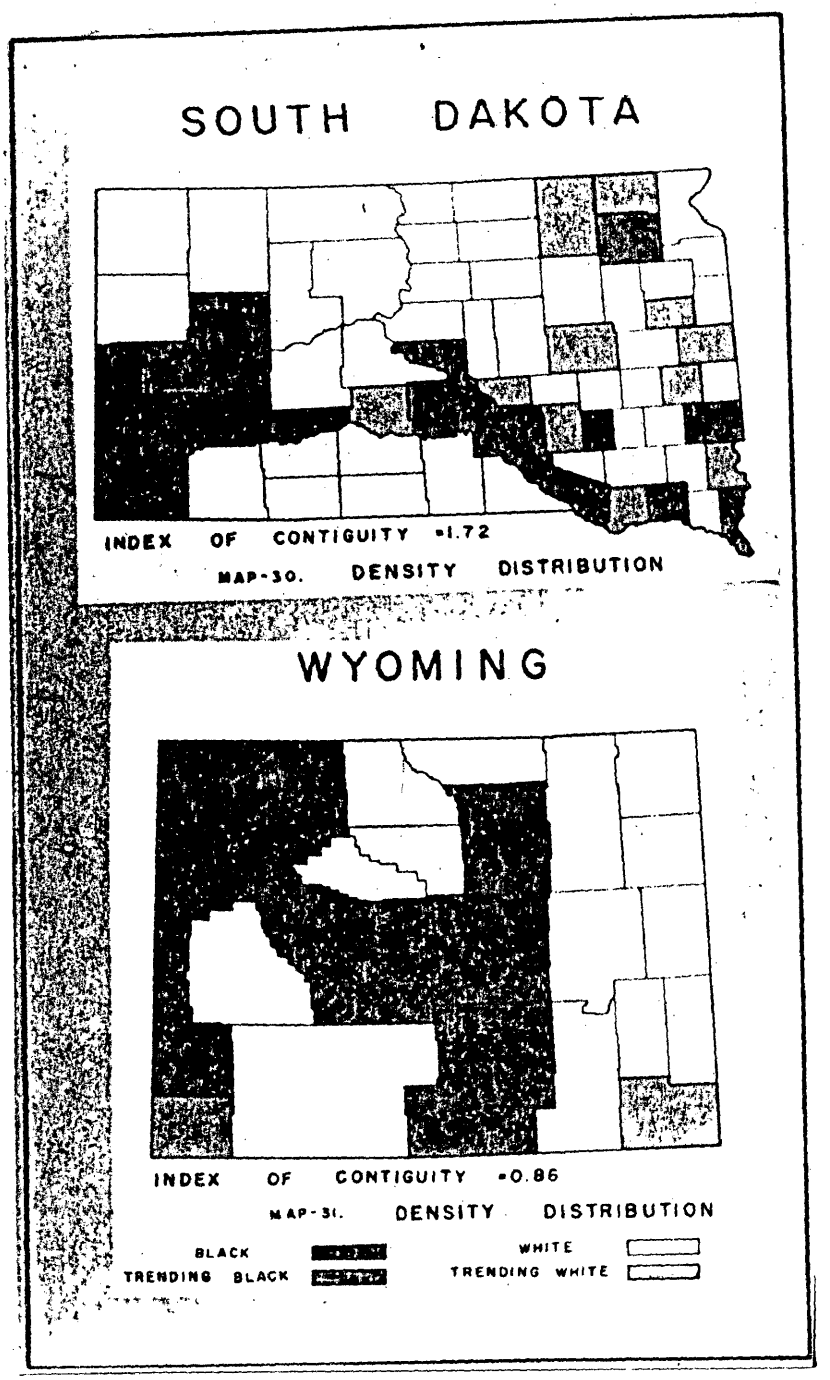
NORTH DAKOTA



INDEX OF CONTIGUITY =1.39

MAP-29. DENSITY DISTRIBUTION

BLACK
TRENDING BLACK
WHITE
TRENDING WHITE


SOUTH DAKOTA
INDEX OF CONTIGUITY =1.72
MAP-30. DENSITY DISTRIBUTION
WYOMING
INDEX OF CONTIGUITY =0.86
MAP-31. DENSITY DISTRIBUTION
BLACK
TRENDING BLACK
WHITE
TRENDING WHITE

Only the Des Moines segment in the center of Iowa consists of more than one county.

Kansas, on Map 24, is trending towards clustering. Five areas of concentration are identified. The two segments in the northeastern section are associated with Corps of Engineers reservoirs. The other three segments reflect commercial clusters along major highway routes in Kansas.

Minnesota, on Map 25, demonstrates a strong tendency towards clustering according to the indices of contiguity. There is a large contiguous concentration in the north, representative of the many recreation lakes in the area and the national forest sites. Three single county segments identify southerly extensions of the recreation lake region.

Missouri, on Map 26, has a tendency towards clustering. Six areas of concentration are denoted. Three in the central and southern part of Missouri are associated with the Ozarks. A southeastern segment represents national forest sites. The two county segment adjacent to St. Louis represents the pulling power of the Six Flags over Mid-America commercial recreation complex. The single county segment near Kansas City in the western part of the state is associated with the

Worlds of Fun commercial recreation complex.

Montana, on Map 27, displays a moderately strong trend towards clustering. The large contiguous segment in the west represents the attraction of Yellowstone National Park, Glacier National Park, and the several national forests between the two. The single county segment in the south central part is an extension of the attraction from Yellowstone National Park. The lone segment in eastern Montana is associated with facilities near the Missouri River tributary system.

Nebraska, on Map 28, has a tendency towards clustering. The four concentrated segments across central Nebraska are related to the various public and commercial recreation facilities in conjunction with the major highway route across the state. The lone segment in northwestern Nebraska is associated with the approaches to the Black Hills area of South Dakota, to the north.

North Dakota, on Map 29, shows a very low trend towards clustering. The large contiguous area of concentration in western North Dakota is the Theodore Roosevelt National Park and its approaches. The other three segments are clusters of campgrounds around the more populous portions of the state.

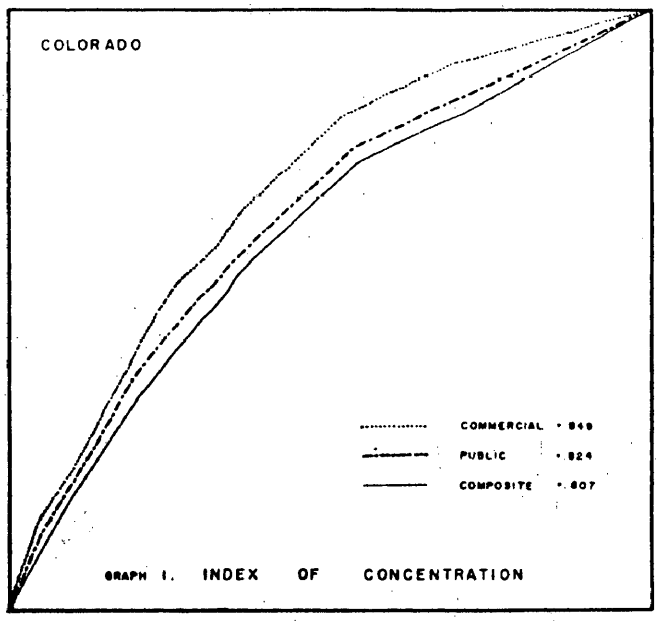
South Dakota, on Map 30, has a moderately high trend towards clustering. The large contiguous concentration area in the west is the Badlands-Black Hills reference node. The segment in the east is localized around a population center.

Wyoming, on Map 31, is the only state of the thesis study region to display a trend towards uniformity according to the indices of contiguity. The only area of high concentration is in the northwest, the Yellowstone National Park reference node.

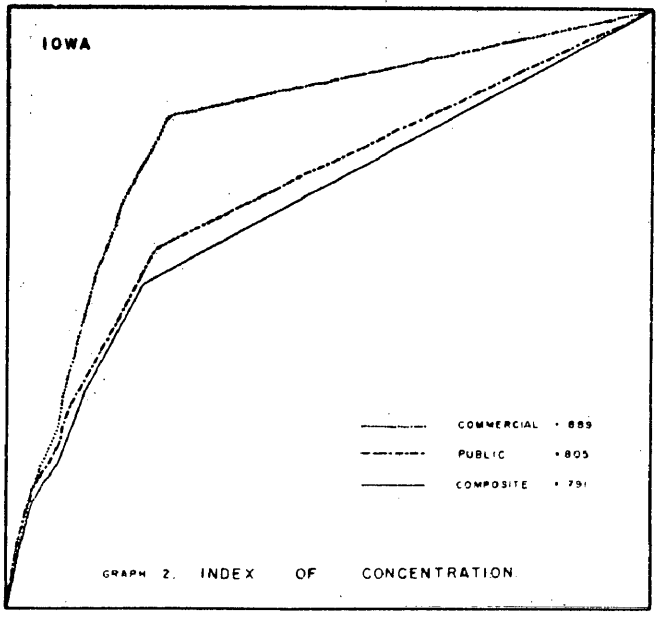
Overall, nine of the ten states in the study area have some trending towards clustering. Interfaces between the campground distribution density and the recreation sites in the individual states are easily identified by comparing the index of contiguity maps with any map which provides either physical or cultural features.

Index of Concentration Analysis

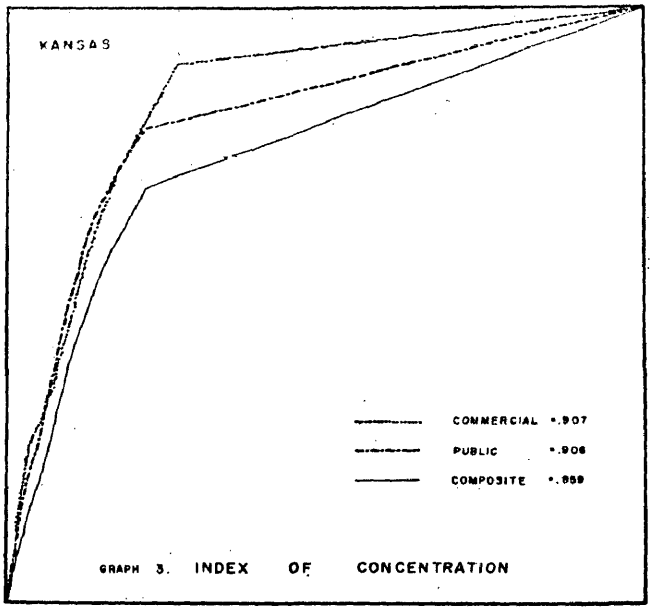
A further refinement of the analysis of the spatial density pattern of the campground units in the thesis study area is accomplished by use of a measurement known as the index of concentration (Cole and King, 1968; Hammond and McCullagh, 1975). This index measures how an



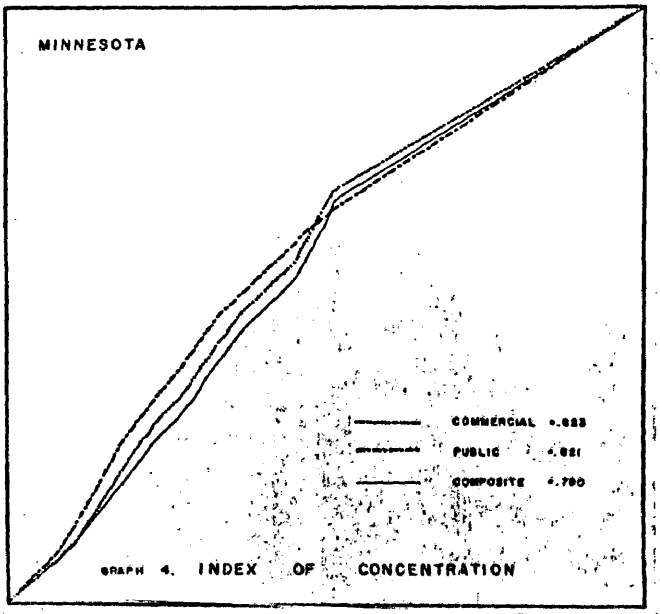
GRAPH 1. INDEX OF CONCENTRATION



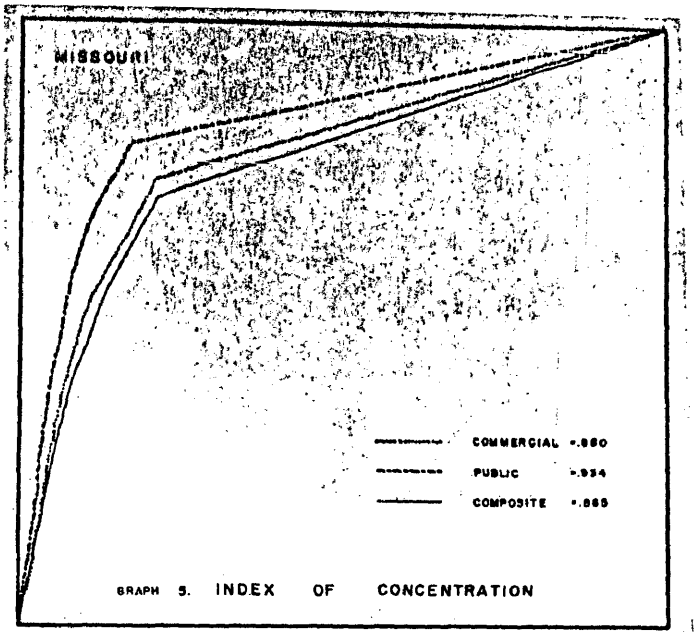
GRAPH 2. INDEX OF CONCENTRATION



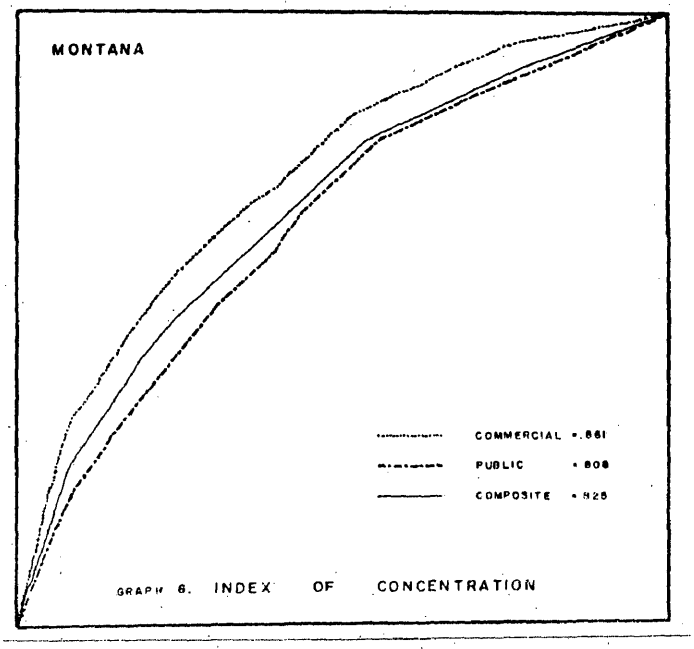
GRAPH 3. INDEX OF CONCENTRATION



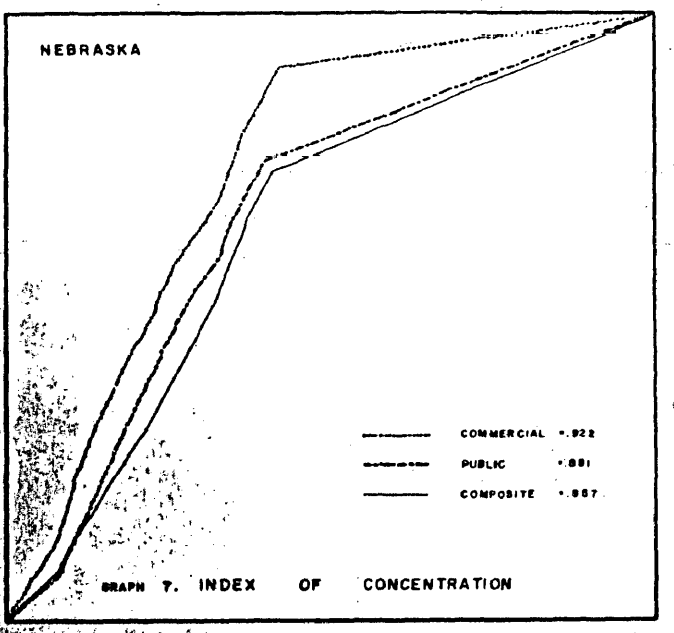
GRAPH 4. INDEX OF CONCENTRATION



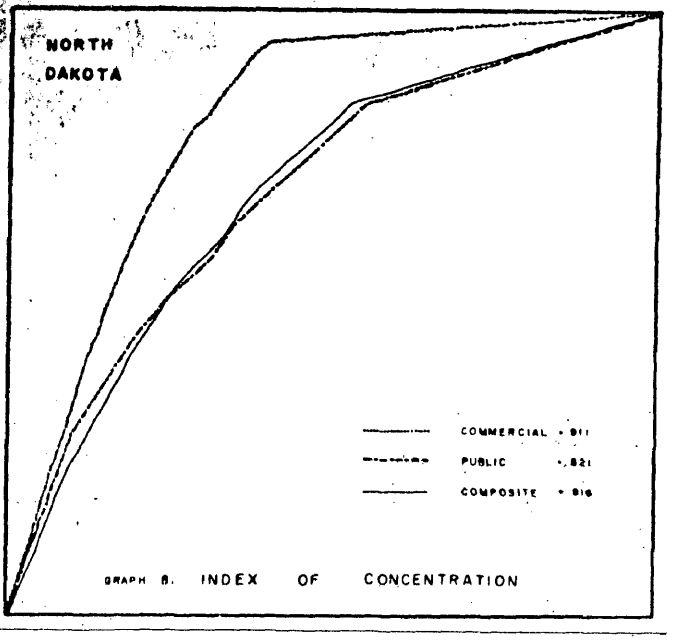
GRAPH 5. INDEX OF CONCENTRATION



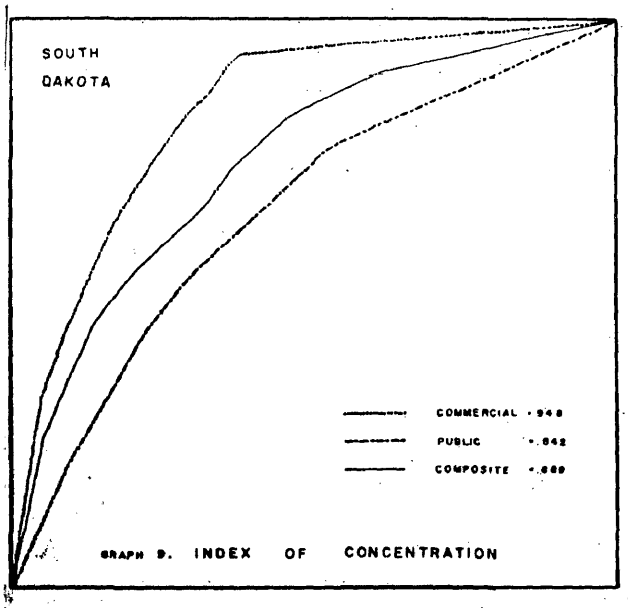
GRAPH 6. INDEX OF CONCENTRATION



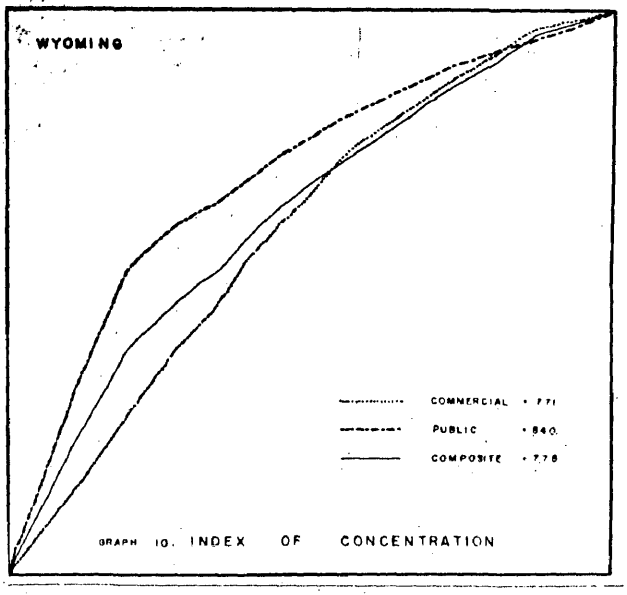
GRAPH 7. INDEX OF CONCENTRATION



GRAPH 8. INDEX OF CONCENTRATION



GRAPH 9. INDEX OF CONCENTRATION



GRAPH 10. INDEX OF CONCENTRATION

element deviates from a theoretical position, by relating the spatial density distribution to the areal extent of the study region. In effect, it is a measure of the displacement of an element being tested, taken in conjunction with the differences in areal extent of smaller segments of a region.

Lorenz-type curves, Graphs 1 through 10, have been constructed to present the mean indices of concentration for each state, according to campground unit set. Table 18 contains a listing of the indices according to unit set and weighted data element for all states of the thesis region.

Interpretation of the index is as follows: (1) the range of the index is from .50 to one; (2) values between .50 and .67 indicate a random and non-concentrated distribution; (3) values between .68 and .82 indicate a uniformly concentrated pattern; and (4) values between .83 and one designate increasing degrees of concentration and clustering.

Colorado commercial camps are clustered, with the public and composite sets displaying more of a tendency towards a uniform concentration. Iowa commercial camps have a high degree of clustering, but the public and composite units are more uniformly concentrated. All

TABLE 18

INDICES OF CONCENTRATION

	Commercial, Public, and Combined Campground Units Data Sets					
	1	2	3	4	5	Mean
Colorado	.840	.844	.862	.847	.854	.849
	.813	.815	.843	.815	.835	.824
	.788	.793	.816	.817	.820	.807
Iowa	.876	.874	.900	.894	.900	.889
	.786	.797	.815	.808	.821	.805
	.772	.777	.801	.800	.807	.791
Kansas	.899	.898	.921	.908	.910	.907
	.896	.893	.908	.920	.915	.906
	.850	.847	.866	.867	.865	.859
Minnesota	.815	.812	.833	.824	.829	.823
	.810	.810	.829	.826	.828	.821
	.783	.777	.801	.794	.795	.790
Missouri	.876	.873	.887	.881	.882	.880
	.925	.932	.937	.934	.940	.934
	.857	.859	.875	.865	.869	.865
Montana	.857	.848	.880	.862	.858	.861
	.795	.788	.826	.816	.815	.808
	.810	.804	.837	.840	.832	.825
Nebraska	.914	.921	.929	.921	.927	.922
	.863	.871	.888	.889	.894	.881
	.842	.850	.863	.863	.867	.857
North Dakota	.904	.909	.915	.912	.913	.911
	.808	.817	.825	.825	.830	.821
	.804	.808	.820	.819	.827	.816

TABLE 18 Continued

INDICES OF CONCENTRATION

	1	2	3	4	5	Mean
South Dakota	.947	.945	.949	.950	.948	.948
	.837	.828	.848	.857	.838	.842
	.882	.877	.877	.910	.898	.889
Wyoming	.757	.758	.808	.760	.774	.771
	.833	.832	.824	.861	.851	.840
	.775	.767	.797	.777	.776	.778

Commercial campground values are presented on the first line of each entry. Public campground values are presented on the second line of each entry. The combined campground values are presented on the third line of each entry.

Data sets are numbered as follows:
1 = Number of individual camping sites
2 = Campground capacity
3 = Recreation activities capacity
4 = Campground facility amenities capacity
5 = Maximum campground attraction

campgrounds in Kansas demonstrate high levels of clustered concentration, although it is weakened somewhat in the composite unit set.

Minnesota camps are uniformly concentrated throughout the state. Missouri camps are highly clustered, especially the public camp set. Montana commercial camps show a degree of clustering, although the public set is more uniformly distributed.

The three unit sets in Nebraska are highly clustered, although the composite set does display a

weakening of the tendency. North Dakota commercial campgrounds are clustered, but the public and composite sets are more uniform.

South Dakota commercial camps have the highest level of clustering in the thesis region. Its public and composite sets also demonstrate clustering trends. Wyoming public campgrounds are somewhat clustered, but the other two unit sets are uniformly distributed.

Concluding Remarks

Three analytical methods have been used in examining the spatial distribution pattern of the commercial and public campgrounds of the Great Plains - Rocky Mountain area.

First, the nearest neighbor analysis in Chapter 2 attempted to define the basic point patterns and their relationship to the cultural and physical landscape. Five states are identified as having clustered campground patterns, denoting the presence of major recreation or tourist attractions. The other states are designated as having randomly distributed campground patterns. This signifies either the absence of major attractions, or the presence of several competing attractions. None of the states had a uniform pattern, which can be

interpreted as confirmation of statements that campgrounds need to have some attractive reason for their individual locations.

Second, the centrographic measurements in Chapter 3 provided a total analysis of each type of spatial bias. Distance and sectoral bias explanations are easily developed from the statistics provided during the computer analysis, however, directional bias statistics provided numerous conflicting results. Use of the weighted data elements did not affect the centrographic measures obtained, indicating that the various attributes used were aggregated in such a complementary fashion that their individual influences were offset during the analysis.

Third, the density distribution analysis in the first sections of this chapter have shown how the campground market relates quite readily to the presence of cultural or natural phenomena. Contiguity and concentration indices helped to indicate that some of the thesis area is well supplied with camping opportunities, and that several states, especially the central part of the region, have a distinct lack of campgrounds.

Recommendations for Future Studies

Centrographic measures should only be developed when the greatest detail is required. There is a wealth of information to be gleaned from them, however, the difficulty of interpretation of directional bias creates a major analytical problem. Also, the computer program used provided such a volume of statistics that the generalizations being sought were buried beneath the multitude of specifics.

Any future studies of campground distributions should concentrate on the point pattern analysis used in Chapter 2 and the density distribution analysis used in the earlier sections of this chapter. Combined, they provide an easily understood explanation of the campground distributions within a state. Centrographic measures should be undertaken only for a highly detailed analysis, and care must be employed in their interpretation.

The method of regional comparison of the camping environment, as used in this thesis, should be applied to other groupings of states. Such studies would then provide the recreation planners the necessary background to make better use of the available fundings, and they would permit better usage of the existing campground facilities.

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