A SUGGESTED METHOD FOR THE DELIMITATION OF POPULATION CLUSTERS

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A settlement pattern can be imagined in units of people, or in units of the places where people collect. In this paper the latter approach is used and the basic unit of the study is called the "stead." The farmstead and homestead is a familiar and well used notion in this country. It generally means the principal building, related structures, and areas directly related to the use of the stead. That notion has not been changed in its use in this paper. The use of the combining form "stead" has been expanded beyond farmstead to include each single unit of activity such as storestead, schoolstead, theaterstead, filling station stead and so on.

Steads are the locuses, or focal points of the activity of people. Each of us has a set of steads within which we circulate, spending most of our time at one stead or enroute to another. The home, work place, church, store, school, theater, post office and other special steads constitute a normal set of steads. Some busy people have additional steads, such as this and similar type meeting rooms.

The total pattern of steads in a landscape is a very useful index to the distribution of the population. If the steads can be isolated, and mapped, the raw-material or basic unit of the settlement pattern will become available in correct position and ready for further analysis.

Individual steads can be identified on aerial photography at a scale of 1:20 000 and symbolized with a dot. The true shape of a stead could be retained but, it has been found that if the work is to be used at scales smaller than 1:250 000, the shapes will blur and lose their identity.[1] A large dot 140 feet in diameter[2] is used to symbolize each stead, and is shown reduced to one-sixth its linear or one-thirty-sixth its area on Figure 2.

Each dot is a dispersed stead. Very large and prominent steads such as golf clubs, stone quarries, drive-in theaters and others are shown separately at true size and shape by a distinctive tonal pattern. Steads which are in clusters, close together and even piled on top of each other are isolated and delimited in what has been called a nucleated area. It is unnecessary to separately identify each stead within such areas. Therefore, many of the problems of photo interpretation of steads in congested areas are relieved for it is not always possible to single out a stead in such conditions.

The mapping of a nucleated area is the first level in the generalization of steads, and also the first cluster of population to be delimited. The nucleated areas have important characteristics as follows: first, the shape of the area conforms to the shapes of the steads enclosed; second, the areal extent is determined by the number and shape of the steads enclosed; third, the number and classification of steads enclosed must be determined separately and usually by field investigation if it is necessary; fourth, the criteria used in establishing the areas can be varied as changing conditions arise.

A nucleated area is characteristically the nucleus aroundwhich additional growth occurs in an urbanizing population. In quantitative terms a nucleated area is the area enclosing a minimum of 5 steads with the distance between any two steads no more than 250 feet, measured from center to center. When minimum conditions are established, nucleated areas are extended when steads lie within 250 feet of the edge. Notice on Figure 2 that nucleated areas vary both in size and, shape. The largest is the Borough of Gettysburg, and the smallest is often 5 steads compactly spaced at a road junction. Some areas have extended fingers, others seem to jump back and forth across the road. In some cases, only a few more steads located in the gaps would be enough for the nucleated areas to coalesce into a long string.

The criteria of 5 steads and a spacing of 250 feet between steads are based upon previous studies as cited below. Further investigation into each dimension would be most desirable and in one almost a necessity.

The spacing distance of 250 feet is from work by the Census Bureau.[3] In the definition of "urbanized area," certain areas are included if they have a group of 100 dwelling units or more with a density of 500 or more per square mile. If the 100 units (steads) were evenly dispersed as far apart as possible over one-fifth of a square mile they would be at a density equivalent of 500 per square mile. The distance between the units in such a dispersant would be 250 feet.[4] This distance is used in forming nucleated areas and in each area therefore, the steads are at a density equivalent to, or greater than the urban density used by the census.

The minimum number of 5 steads rests on the work of Trewartha at the University of Wisconsin.[5] His study of the Unincorporated Hamlet is an important work on the beginnings of nucleation in the settlement pattern. The work is based on intensive field study in Wisconsin, followed by an organized study over the United States with cooperating scholars and institutions. Trewartha concluded that a hamlet must have at least 5 steads. In addition, he suggested that the hamlet have some non-farm activity and that the maximum linear distance between outermost buildings be no greater than 1/4 mile. It is interesting to note the close relationship between the 1/4 mile and the 250 feet of the census. If 5 steads are in a string each 250 feet apart the distance from center to center of the end steads would be 1 000 feet. By measuring from outside to outside rather than the center, the distance could easily be 1 300 feet, just 20 feet short of 1/4 mile.

Further work is certainly needed in the problem of the minimum number of units in the smallest of population clusters. While Trewartha found 5 to be significant, further study may find some other number, or a combination of factors to be more significant.

Figure 2 presents the settlement pattern of most of Adams County, Pennsylvania at the first stage of compilation and generaliztion. It was originally compiled at a large scale of 1 inch equals 1 667 feet and subsequently reduced by photography to its present scale. It is really the basic data compiled for further generalization and analysis. Figures 5, 6 and 7 are the end products of this stage in the research and are generalizations of Figure 2.

A major development of the project has been the D-Line Method of analyzing a distribution. The D-Line Method has been developed by Klimm[6] as a tool in the grouping, delimiting and generalizing of dispersants. The technique is fully explained in Technical Report 3 of this project, however, it can be explained here briefly as it is applied to points. Only when it is applied to units having area, do several complications arise.

Figure 4 shows the various types of agglomerations produced by applying the D-Line to a set of points. D is applied to a set of points and lines are drawn connecting each pair of points which lie within D. Three types of agglomerations are formed in this matter; linkages, hollow agglomerations and agglomerated areas.

A linkage is two steads connected by a line D or less in length and, linkages can occur singly or in a series. If a series of linkages closes in on itself like a string of beads a hollow agglomeration is formed. Notice example K on Figure 4. The distance across the center between any 2 steads is more than D, and therefore cannot form an agglomerated area.

An agglomerated area is formed by 3 steads each within D of the other 2. In Figure 4, H is a single agglomerated area, an isosceles triangle exactly D on each side. Groups of agglomerated areas occur as at J or E. In practical use the lines connecting individual agglomerated areas are not shown, and only the outer edges as at N are shown. But, it must be remembered that agglomerated areas of three or more steads are really a compounding of triangles.

While the technique of using D is independent of the length of D, the selection of D to be used depends on several factors. The choice of D is critical and, a search for <u>the</u> D seems futile. Because regions are different, and because study objectives do vary, a flexible D suited to varying demands is probably the best answer. Furthermore, there is the question of scale. The smaller the D the less agglomeration of steads with a resulting large scale generalization. As D increases more steads are agglomerated and a smaller scale of generalization is accomplished. A decision on the length of D must consider the region, the objective, and the scale of work and presentation.

Three different D's were applied to the same data on Figure 2. The D's used were 1 000 feet, 1 900 feet, and 1 mile. The first was arbitrarily selected, the second induced from the data on Figure 2, and the third used because it related to other studies in the project.

The empirical D of 1 900 feet is the distance between the dispersed steads on Figure 2 if all such steads were uniformaly spaced over that area. There are 3 835 dispersed steads on Figure 2, and the gross area of the map is 460.2 square miles. The steads within the nucleated areas are not included and neither is the area of all such nucleated areas. The total area of the nucleated areas is estimated to be 4.6 square miles. If the 3 835 steads were uniformaly spaced, each the center of a hexagon, over the 455.5 square miles, the distance between any two would be 1 900 feet.[7]

The 1 900 foot D used on Figure 6 pulls together into agglomerated areas groups of steads which are closer together than the uniform distance. Many steads lie within D of one stead, but not within D of 2. Such cases appear as linkages. There are a number of dispersed steads more than 1 900 feet from their nearest neighbor. They appear as dots. Finally, there are empty areas without steads.

The nucleated areas are usually associated with, or the center of an agglomerated area. In the actual agglomerating technique each nucleated area is considered to be a mass of steads and the D distance is measured from the edge to the nearest stead. Notice examples M and L on Figure 4. The distance of the stead from the area determines whether a linkage, or an agglomerated area will be formed. In fact, when D becomes a mile in this area, as on Figure 7, the nucleated areas are submerged within the entire agglomerated area.

Figure 7, with its mile D, is really a map of the empty areas. The emptiness of South Mountain on the West, and its foot hills, as well as scattered empty areas south and northeast of Gettysburg are well brought out. The State Park, and the institution on the western edge are oasis of settlement in a sea of emptiness. To the south is a finger of settlement poking up a valley into the mountain. The scalloped edge is due to the limits of the map. As D is increased a large proportion of the area is agglomerated and the degree of generalization increased so as to exclude only direct and relatively pure areas of opposite characteristics.

The effects of a successively increasing D, are illustrated in Figures 5 to 6 to 7. These maps could be altered by dropping the road net work, the linkages, and the dispersed steads thereby making a clearer map. There is also the possibility of generalizing nucleated, or agglomerated areas by applying a D-Line analysis to them rather than to steads. It must also be remembered that this test area around Gettysburg is well developed. The average density is about 85 persons per square mile. These techniques would have different effects applied to areas of different densities, or to areas with a more urban population.

The work reported on here was supported by the Geography Branch of the Office of Naval Research. The basic research project into principles and methods of generalization in geography was conducted at the University of Pennsylvania, and directed by Professor Lester E. Klimm. This particular section concentrated on the problem of generalizing features in a landscape which could be represented as points. Other sections of the project sought to generalize single features with areal extent such as cropland; and, multi-feature combinations such as a combination of woodland and pasture. The results have been reported to the Office of Naval Research under contract Nonr 551 (01).

FOOT NOTES

1. Arthur F. Loeben, 'Geographic Representation of Rural Settlement," an unpublished paper read before Section E of the 1956 Annual Meeting of the American Association for the Advancement of Science.

2. The dimension of 140 feet was selected after studying the average size of stead, and the visual retention of a dot upon several reductions.

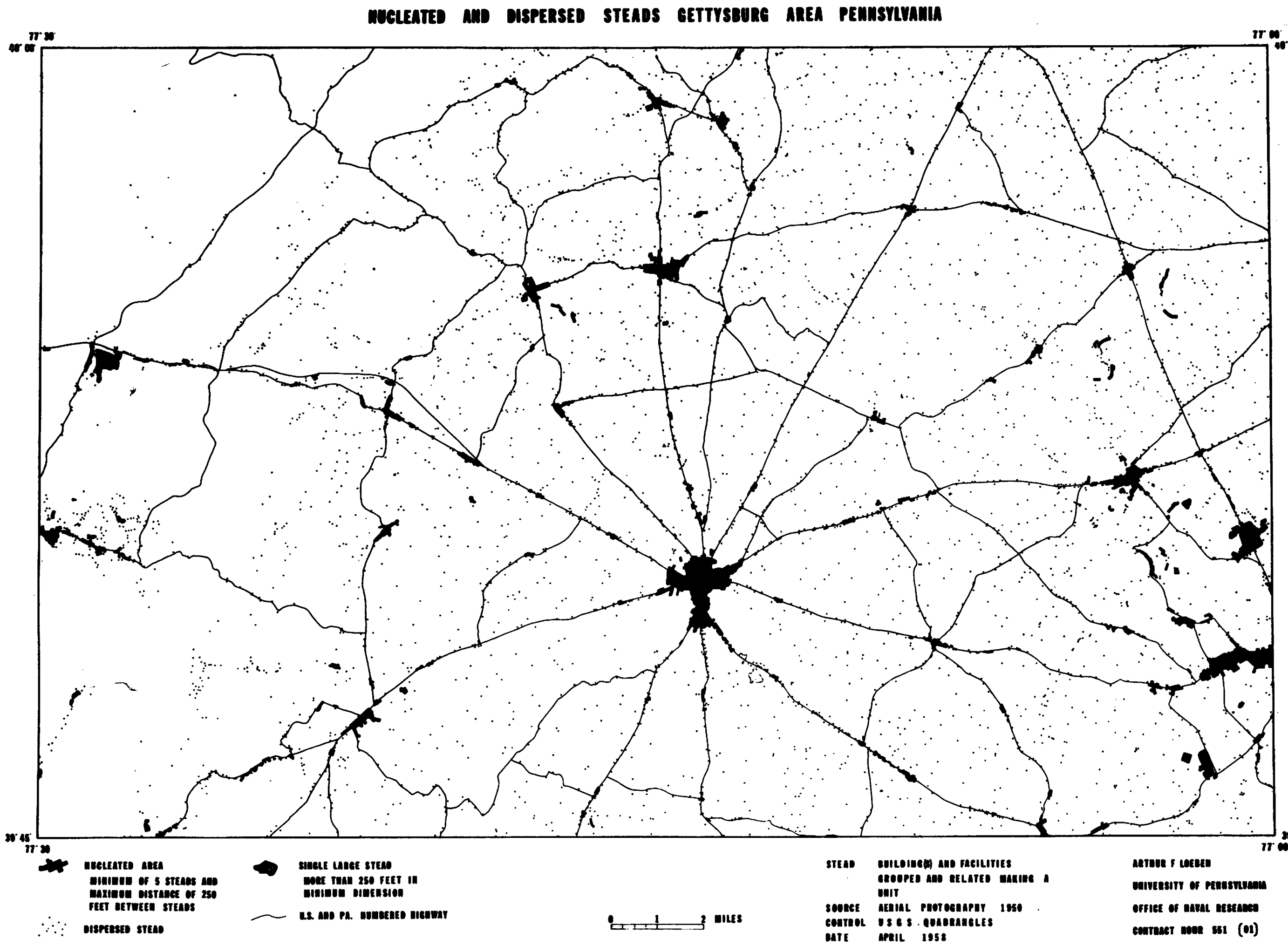
3. Bureau of the Census, U. S. Census of Population: 1950, Vol. 1, Number of Inhabitants, p. XXVII.

4. In such a uniform distribution each stead is assumed to be the center of a hexagon. The distance between steads can be determined by the formula $D = 1.0746\sqrt{\frac{A}{N}}$ where D is the distance, A the area, and N the number of steads. The formula was introduced in: James A Barnes, and Arthur H. Robinson, "A New Method for the Representation of Dispersed Rural Population," Geographical Review, Vol. XXX (1940), pp. 134-37.

5. Glenn T. Trewartha, "The Unincorporated Hamlet," Annals of the Association of American Geographers, Vol. XXXIII (1943), pp. 32-81.

6. Lester E. Klimm, The D-Line Method of Analyzing a Distribution, Technical Report 3, Office of Naval Research, Contract Nonr 551 (01), 1958.

7. Barnes and Robinson, op. cit.


NUCLEATED AND DISPERSED STEADS GETTYSBURG AREA PENNSYLVANIA
77° 30'
40° 00'
77° 00'
40° 00'
39° 45'
77° 30'
39° 45'
77° 00'
NUCLEATED AREA
MINIMUM OF 5 STEADS AND MAXIMUM DISTANCE OF 250 FEET BETWEEN STEADS
DISPERSED STEAD
SINGLE LARGE STEAD
MORE THAN 250 FEET IN MINIMUM DIMENSION
U.S. AND PA. NUMBERED HIGHWAY
0 1 2 MILES
STEAD BUILDING(S) AND FACILITIES GROUPED AND RELATED MAKING A UNIT
SOURCE AERIAL PHOTOGRAPHY 1950
CONTROL U S G S . QUADRANGLES
DATE APRIL 1958
ARTHUR F LOEBEN
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CONTRACT NONR 551 (01)

Figure 2

TYPES OF AGGLOMERATIONS

Horizontal Scale.... 1 inch = 1 mile

D = 0.5 inches

H	Single Agglomerated Area
J, E	Group of Agglomerated Areas
N	Agglomerated and Nucleated Area
M	Linkage, Exactly D in Length
L	Agglomerated Area Attached to a Nucleated Area
G	Series of Linkages
A, F	Linkages to Agglomerated and Nucleated Areas
B, C	Hollow Agglomerations Attached to Agglomerated and Nucleated Areas
K	Hollow Agglomeration

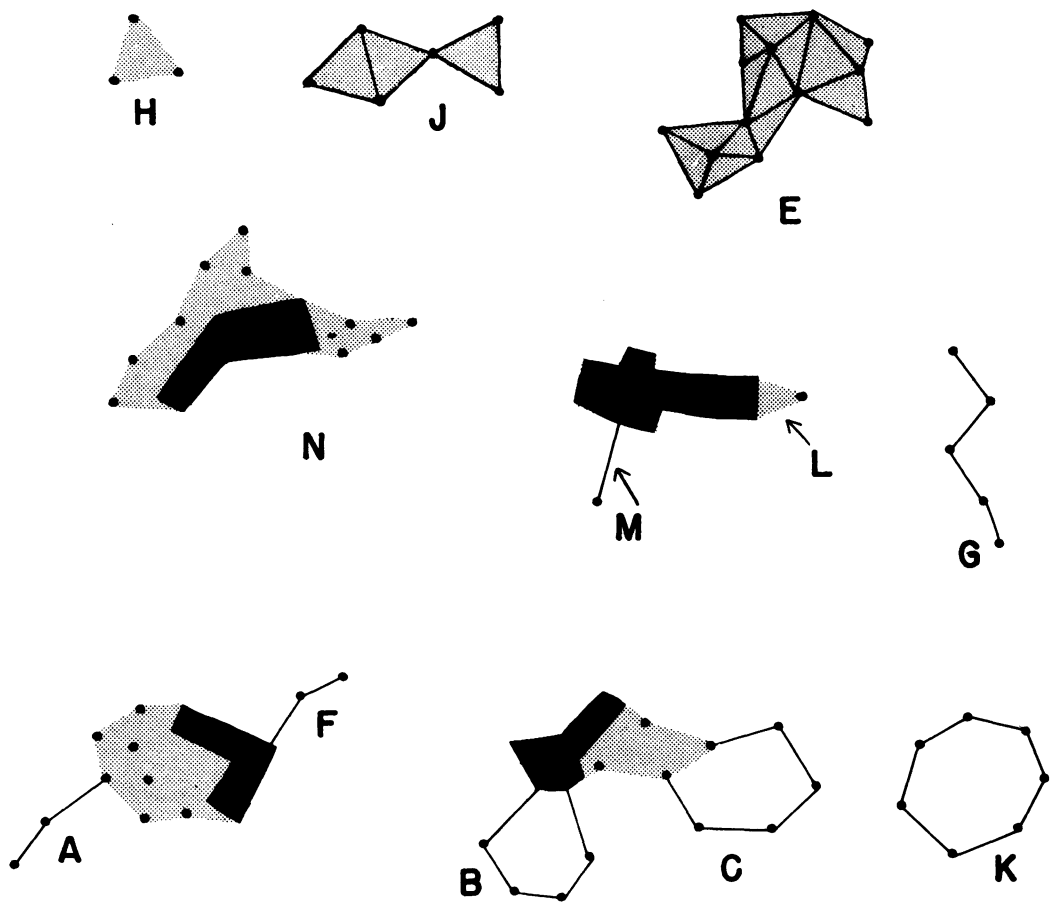
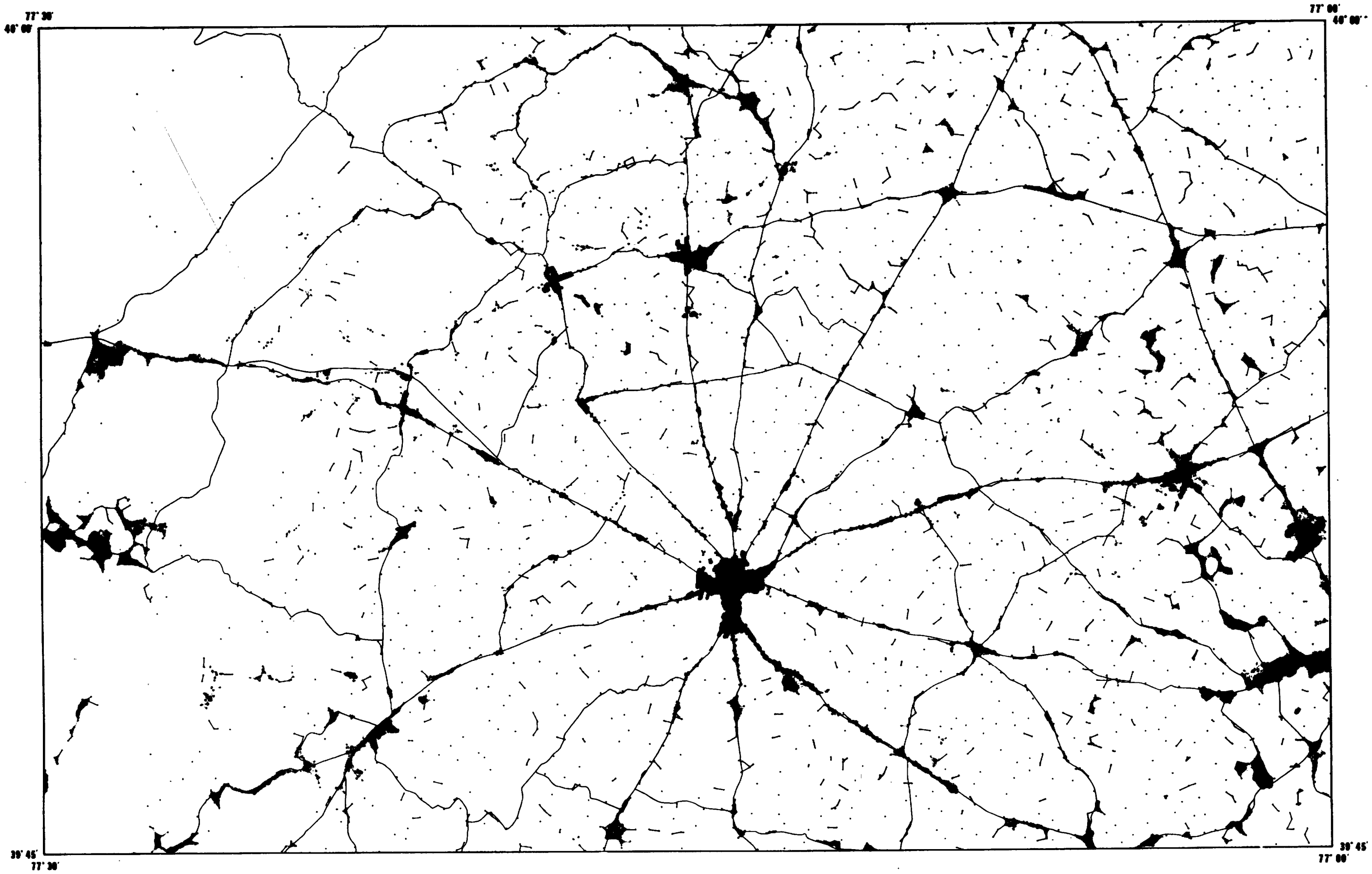


Figure 4

AGGLOMERATED AREAS AND LINKAGES GETTYSBURG AREA, PENNSYLVANIA

D = 1000 FEET



AGGLOMERATED AREA
NUCLEATED AREA
SINGLE LARGE STEAD
SINGLE DISPERSED STEAD
LINKAGE
U.S. AND PA. NUMBERED HIGHWAY

0 1 2 3 MILES

Figure 5

LINKAGE: A LINE CONNECTING 2 STEADS WITHIN D DISTANCE OF EACH OTHER.
AGGLOMERATED AREA: THE AREA ENCLOSED BY LINES CONNECTING 3 STEADS, EACH WITHIN D DISTANCE OF THE OTHER 2.

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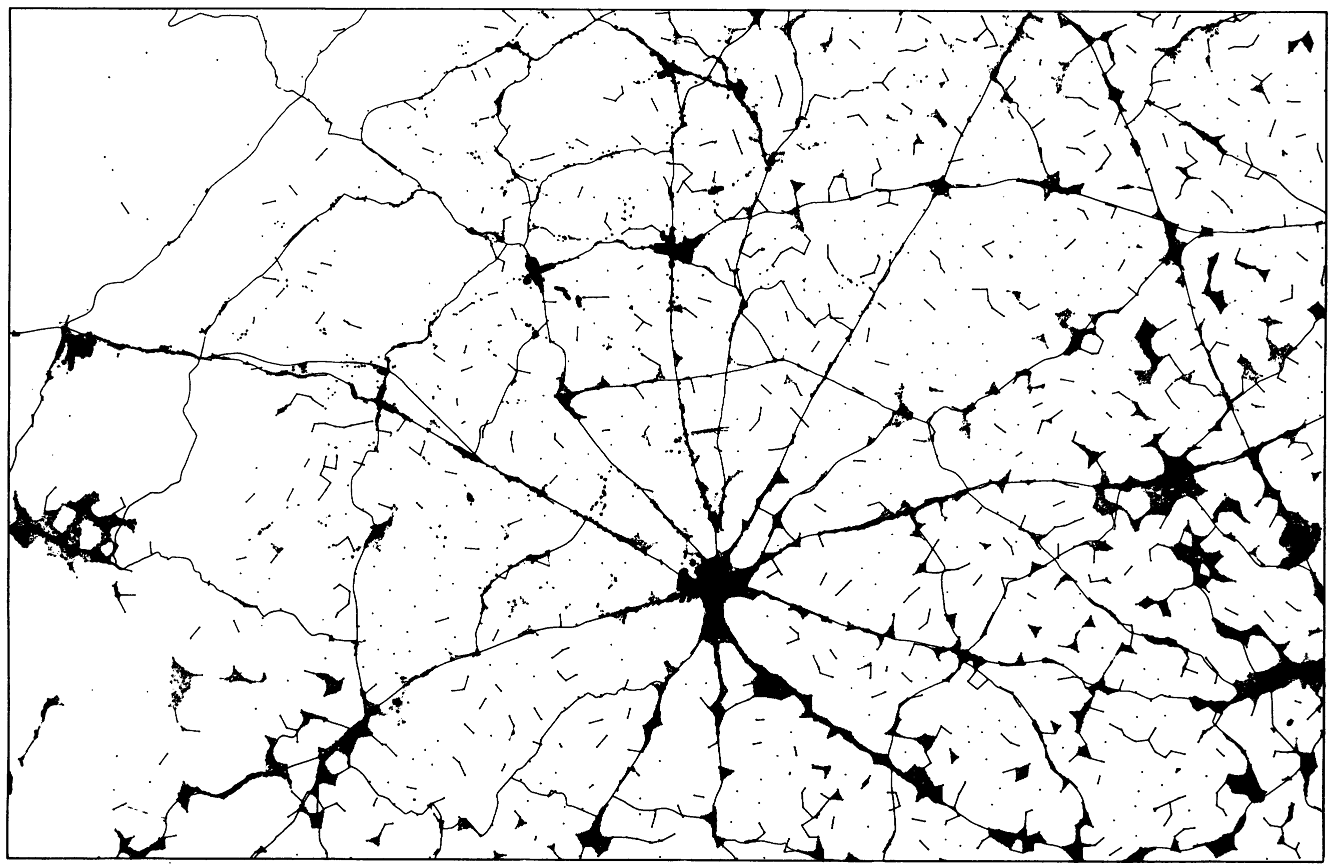
AGGLOMERATED AREAS AND LINKAGES GETTYSBURG AREA, PENNSYLVANIA

D = 1900 FEET



LINKAGE: A LINE CONNECTING 2 STEADS WITHIN D DISTANCE OF EACH OTHER.
AGGLOMERATED AREA THE AREA ENCLOSED BY LINES CONNECTING 3 STEADS, EACH WITHIN D DISTANCE OF THE OTHER 2.

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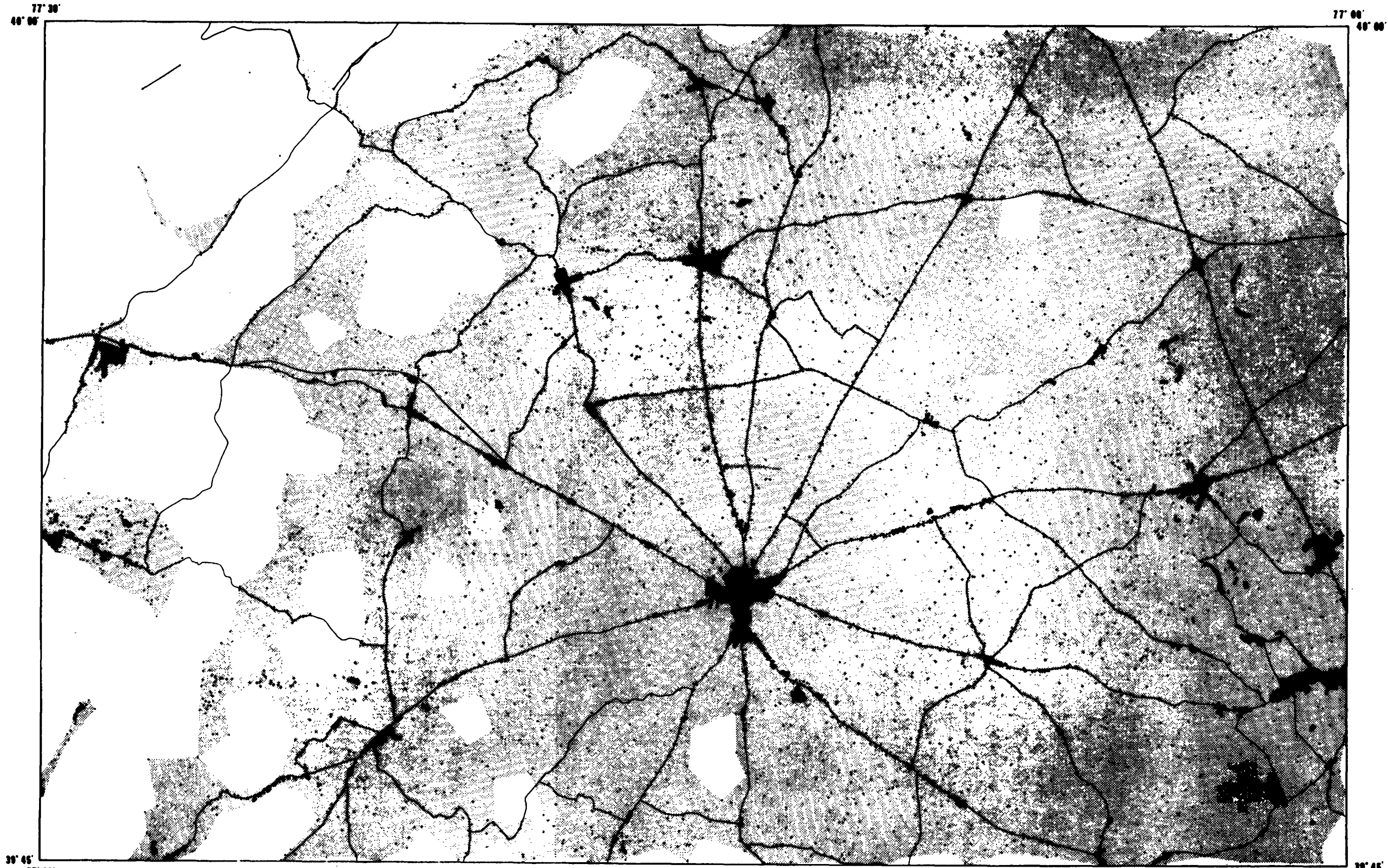
Figure 6

AGGLOMERATED AREAS AND LINKAGES GETTYSBURG AREA, PENNSYLVANIA

D = 1 MILE



AGGLOMERATED AREA
NUCLEATED AREA
SINGLE LARGE STEAD
SINGLE DISPERSED STEAD
LINKAGE
U.S. AND PA. NUMBERED HIGHWAY

0 1 2 3 MILES

Figure 7

LINKAGE · A LINE CONNECTING 2 STEADS WITHIN D DISTANCE OF EACH OTHER.
AGGLOMERATED AREA · THE AREA ENCLOSED BY LINES CONNECTING 3 STEADS, EACH WITHIN D DISTANCE OF THE OTHER 2.

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