Research On

Economic and Social Effects
of
Highway Improvements

ANALYSES OF THE GEOGRAPHICAL PATTERNS OF GROSS LAND USES AND CHANGES IN NUMBERS OF STRUCTURES IN RELATION TO MAJOR HIGHWAYS IN THE LOWER HALF OF THE LOWER PENINSULA OF MICHIGAN

by

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and
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THE RESEARCH PROGRAM

This report represents one study which was part of a joint research program on the Economic and Social Effects of Highway Improvements made possible through financial support from Highway Planning Survey funds, under an agreement between Michigan State University Highway Traffic Safety Center and the Michigan State Highway Department with the participation of the U. S. Department of Commerce, Bureau of Public Roads. The research program was administered by the Michigan State University Highway Traffic Safety Center and was made possible through the cooperation and interest of a large number of university departments, both in planning the research and in making available competent research staff qualified in different subject matter areas.

The research program included some 17 studies in the following areas:

An Inventory of the Economic Factors Influenced by a Highway Development Program

Effects of Highway Development on Rural Lands and Communities

Land and Property Values in Relation to an Urban Highway Improvement

Small Communities and Controlled Access Highways

Effects on Businesses in Small Cities of By-Pass Highways

Effects of Highway Development on Social Groups and Interactions

Geographical Analysis of Land Use Changes in Relation to Highway Development

PREFACE

The author of this report has had a continuing interest in the study of the dispersion of urban phenomena. At the University of Chicago from 1950-56 and from 1956 to date at Michigan State University he has vigorously pushed field work toward the development of a visual record of the differential impact of the large and small cities of the Middle West upon the agricultural lands surrounding them.

The opportunity, therefore, in 1958 to apply this interest and a ready research method to the project, for which this document is one result, was most welcome. The application of a broadly conceived system of land-use notation to the study of the impact of people through highways upon an economy over a large region is a most sensible procedure. In no other way can so graphic a perspective of what is happening to the distribution of our economy be so quickly achieved. This is one of the specialized contributions of the professional geographer. The inventory of the uses of land is only exceeded in importance to the geographer by the spatial interpretation of the resulting mass of geographically localized information thus acquired. The data afforded by the completion of the land-use mapping in the field were supplemented by detailed quarter section-by-quarter section tallies of culture symbols on two separate series of Michigan State Highway Department County Transportation Maps. The latter inventories in the laboratory afforded quantitative measurement of the changes in numbers of structures upon the land, localized in relation to the State's major highways, over a given time period. The interpretation of the resulting patterns has been done by visual comparison of relatively simple enumerations within different kinds of unit areas devised to generalize the data, on the one hand, and to bring it into meaningful relationship to the pattern of highways over a large area, on the other hand. Additional manipulation of the data, particularly by applying additional statistical tools, could produce other meaningful relationships and formulations of conclusions. It is expected that these and other kinds of analysis of the large body of residual data resulting from this research project would serve a useful purpose. Personnel, time, and financial support are all that would be required to insure continuation of the direction of the present research along the lines outlined.

The land-use mapping in the field was done personally by the author of this report. It was supplemented, however, by secondary source materials in many places. The excellent land-use information made available by the city plan commissions of Flint,

Grand Rapids, Lansing, Muskegon, Midland, Bay City, Saginaw, Kalamazoo, Battle Creek, Detroit, and Jackson is gratefully acknowledged; assistance of the Washtenaw County Planning Commission, the Macomb County Planning Commission, and of the Detroit Regional Planning Commission is also acknowledged.

The base maps upon which the land-use mapping was recorded are the product of the Michigan State Highway Department. Without such an adequate basic series of maps as the 1950 decade and 1940 series of maps, the research--both in the field and in the laboratory--upon which the present report is based, could not have been as effectively completed.

The work of many persons contributed to the success of this project. Mention should first of all be made of the half-time graduate assistants who labored long and diligently in the processing of data for analysis. In 1958 and 1959 these were Mr. Robert Vogel and Mr. Thomas Niedringhaus. In 1960 they were Mr. Niedringhaus and Mr. John Pawling. The author is indebted to these men. In addition to the above, Mr. Yasuo Massai, Mr. Robert Janke, Miss Patricia Asiala, Mr. Wendell Jacobs, Mr. Klaus Hartmann, Mr. Robert Wagner, and Mr. Charles Hess rendered important additional assistance in processing data and in making research maps as well as in the preparation of the presentation maps in this document.

A special note of thanks goes for the organizing task performed so well by the administrators of this entire research project. The author would like to thank Mr. Gordon H. Sheehe, Director of the Highway Traffic Safety Center, and Dr. Theodore W. Forbes, Assistant Director of Research of the Highway Traffic Safety Center, for their unstinting efforts in support of this research. The cooperation and encouragement of Dr. Lawrence M. Sommers, Head of the Department of Geography, to which department of the University the author has the pleasure of belonging, is also gratefully acknowledged.

Allen K. Philbrick

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ANALYSES OF THE GEOGRAPHICAL PATTERNS OF GROSS LAND USES AND CHANGES IN NUMBERS OF STRUCTURES IN RELATION TO MAJOR HIGHWAYS IN THE LOWER HALF OF THE LOWER PENINSULA OF THE STATE OF MICHIGAN

PART I

INTRODUCTION

It is well known that the impact of the automobile is transforming the American countryside. Such terms as "urban sprawl", "land pollution", "magalopolis", and others are frequently used to refer to this circumstance. These terms reflect the fact that a population "explosion" and the technological revolution of the mass-produced automobile have had a dramatic impact within the past half century upon the geographical pattern of settlement.

While the existence of this impact is obvious to anyone using the automobile as a means of transportation in the vicinity of our cities or in travel from city to city, the precise visualization of this complex pattern on a map and the quantitative analysis of its spatial arrangement in relation to highways has never been attempted over a large region such as the major portion of a state.

Nature of the Study and Statement of Purpose

It is the purpose of this report to record the findings of a two-fold project of research with the above objectives in mind. Both parts of the research were mapping projects, one in the field and the other in the laboratory. This report states the basic concepts for both phases of the project, demonstrates the methods utilized in field work and in the laboratory, and records and interprets the findings.

Expansion of Urban Land Uses and Structures in Relation to Highways

A geographical analysis proceeds from the basis of the pattern represented by the distribution of phenomena. In the present case the primary phenomena of interest in each phase of the study are the wide range of non-agricultural establishments associated with the expansion of cities. These include non-farm residences and a wide variety of other non-agricultural livelihood establishments. The latter may be grouped under the two major headings of commercial and non-agricultural industrial enterprise.

Most Americans are aware of the background of cultural heritage within which the present pattern of settlement is developing. Reference is here made to the township and range survey system by which the public lands of the great interior lowlands of the continent were made available for settlement. The provision for town roads every mile in the Northwest Territorial Ordinance of 1789 set the pattern of accessibility to the four 160 acre farms per square mile of land envisaged as the basic pattern of farm settlement. Within this pattern of square-mile sections of land the people have settled in horizon-reaching uniformity--forming a checkerboard continuity within the agricultural lands of the Humid East, of which Michigan is a substantial part.

The relatively uniform distribution of either farms or of forest land in Michigan over which this grid of square-mile section lines was superimposed is interrupted by two other major types of land use. By contrast these latter have an uneven or discontinuous distribution pattern. They are (1) the land uses associated with urban type establishments, and (2) land uses associated with particularly localized natural resources other than the soil itself. Land uses of this second type include mining, quarrying, and the recovery of gas and petroleum products, as well as certain recreational activities.

This study is primarily concerned with the distribution of urban-type uses of the land and urban-type structures. Answers are sought to the question, to what degree is the expansion of urban land uses and structures within our pattern of settlement related to the pattern of highways?

The Dispersed City

The simple answer is that our highways have become the streets of a dispersed city. They were designed to be bridges across the spaces between the cities, and as the means of connecting the city and the country. They have now become the alignments along which the impact of the city has penetrated unevenly but far outward into the more uniformly distributed agricultural and forested lands of the State. This new pattern has not yet been recognized for what it actually is. It is an entirely new phenomenon of settlement. It is a new kind of city - THE DISPERSED CITY. The term "dispersed" is preferred over such words as "sprawl" or "pollution", since it does not imply the value judgment that "dispersal" is in itself shameful or inherently bad. "Dispersed" is preferable to the term "megalopolis" since it is intended to be specifically descriptive of the pattern of land uses.

Highways are prime assets of our physical plant, providing accessibility to people and goods. No proof is needed that individual decisions to locate residences, business, and industries have been

made for decades with reference to these assets. The present task is to examine the extent to which this process of growth and response on the part of the population to past highway improvements and technological advances in automobile transportation is fashioning an ever more complex pattern of human settlement. If the concept of the author is correct, the new patterns of the dispersed city require new concepts of planning and development, possibly including concepts of highway development, adequately to service and to guide the shape of things to come. Taking the measure of past growth in the initial processes of the development of the dispersed city is vital. It is hoped that the quantitative analysis of a gross land-use map covering a major portion of the State's total area, and the quantitative analysis of the changes in numbers of structures recorded on highway maps between the 1930s and 1950s can provide some of the required perspective for both highway and urban, as well as metropolitan, regional, statewide, and national planning for that future.

Two Phases of the Project

The two phases of the project are (1) the geographical pattern of structures in relation to highways, and (2) the geographical pattern of gross land uses in relation to highways.

The Geographical Pattern of Structures in Relation to Highways

This phase of the study is based upon a comparative map inventory made in the laboratory from the culture symbols representing farns, non-farm dwellings, and stores or small business establishments on two series of general highway maps of Michigan counties. The first series represents conditions in the late 1930s and was published bearing the date 1940. The other series represents conditions in the post World War II period. It was published bearing various dates from 1950 through 1958. By comparison of the numbers of symbols representing each type of structures on the respective county maps of each period, it is possible to enumerate the change in number of structures for the period between the field observations upon which each map was actually based. It is, of course, not known precisely when these observations were recorded. The period represented presumably varies from county to county. Accordingly the results can be used to gauge only the relative change or growth in the pattern of structures with reference to highway location, rather than absolute numbers of structures at any given date. The purpose of this phase of the study is to quantify the relative change in number of structures with reference to distance from highways during the ranges of time varying from 10 to 20 years. In reporting the findings it was decided to quantify the change in terms

of non-farm dwellings only. Non-farm dwellings increased markedly. Farm structures decreased slightly. Total structures tended therefore to mask these opposing trends. Total number of business establishments increased, but the numbers involved are much smaller than in the category of non-farm dwellings. Techniques of the inventory and its interpretation will be discussed in greater detail in the section devoted to methodology.

The Geographical Pattern of Gross Land Uses in Relation to Highways

This phase of the study is based upon a gross land use map of 47 counties made substantially in the field and during the summers of 1958 and 1959. The difficulty of mapping land-uses over very extensive areas of complex human development is perhaps aptly illustrated by the fact that to map the City of Chicago's 211 square-mile area on a parcel-by-parcel basis in 1939-42 cost approximately three million dollars and consumed three years' time on the part of a considerable staff of people. To map land uses over an area of 47 counties comprising some 29,364 square miles of land area cheaply, relatively quickly, and with a minimum of staff, required a different technique than that usually employed in mapping land uses. The technique employed was that devised by the author of this report for just such a purpose as this. It is described in a paper delivered at the International Geographical Union meetings at Washington, D. C., in 1952.[1]

It will be sufficient initially to point out that the essence of the technique is recognition in the field of land use associations within previously defined unit areas. The unit areas employed are the "quarter section" in the open country and the "city block" where a pattern of streets and blocks exists. The pattern of sections subdivisible into quarter sections is provided by the township and range survey system referred to previously. Access for the purpose of observing land use associations is provided by streets, section line roads, other roads, and major highways. The recognition of land use associations within the unit areas is accomplished by making use of a classification designed at once to facilitate the recording of each association, using colored pencils, and at the same time to reveal the pattern of urban-type land uses dispersed into the countryside. A separate color was used for each association or mixture of land uses. Accordingly,

[1]Allen K. Philbrick, "A Unit Area Method of Mapping Gross Land-Use Associations in Urban Regions." Proceedings, Eighth General Assembly and Seventeenth International Congress, International Geographical Union, Washington, D. C., 1952, pp 758-764.

each unit area is recorded by that single color standing for that one particular combination of land uses observed within the unit area. Observation was by automobile traverse.

The techniques and classification employed in making the land-use map and the methods of interpreting it will be summarized in some detail in the section devoted to methodology.

Organization of the Report of Findings

The raw materials for analysis are the county land use patterns resulting from mapping land use associations in 47 counties; materials also are provided by the tabulation of the inventory of changes in number of non-farm dwellings by quarter sections for 29 counties shown by two series of county highway transportation maps printed, respectively, in 1940 and during the 1950s.

The report of findings will discuss first the Pattern of Land Use Associations. The county land-use-association maps were combined into a single map of the study area which is shown in Figure 1.

Appraisal of this map revealed a number of significant types of relationships for which findings will be reported as follows:

1. Comparison of selected counties by statistical compilation of land uses by quarter sections.

2. Comparison by strip areas to test numerically the apparent impact of highways as an agency through which people have gained access for the development of land uses with varying intensity at varying distances from highway frontage.

3. Computation of factors from the percentages of quarter sections having non-farm land uses per cell. A cell is defined as a territory bounded by intersecting Michigan State and U. S. highways. Such factors are the bases for defining the web of highway impact for the 47 county study area.

4. Measurement of the length of Michigan highways exhibiting varying depths of the zone of impact by regions and for the study area as a whole.

5. Measurement of the proportion of the total urban-type quarter sections within the web of highway impact, by regions and study area.

6. Measurement of the proportion of the web of highway impact to the total area in numbers of quarter sections, by regions and for the study area as a whole.

7. Definition of eleven Dispersed-City Regions as major traffic generating areas of the State.

The report will then analyze changes in the geographical pattern of structures in relation to highways. The tallies of changes in non-farm dwellings by quarter sections were consolidated into the same strip areas used in analyzing the map of gross land uses. Compilation of this data was completed for 29 counties. A map showing the change in number of non-farm dwellings by strips related to highway frontages is shown in Figure 3. Analysis of this data will be reported in a section headed:

8. Non-farm dwellings per square mile constructed in and out of the web of highway impact from the late 1930s to the 1950s.

The report will end with a section on methodology and one on conclusions.

9. Methodology and techniques employed in the two phases of the project.

10. Conclusions and recommendations.

PART II

LAND USES IN RELATION TO HIGHWAYS

The land use pattern resulting from the mapping of land use associations in 47 counties is shown in Figure 1. It is a composite generalization of more detailed information recorded on the original land use maps made in the field. In the construction of this map, all quarter sections outside of city-block patterns which contain non-farm land uses are inked in black. All city-block patterns and Michigan and U.S. Highways are left white, as also were all purely agricultural or forested lands. Each block quarter section contains, in addition to agricultural or forest land, at least two non-farm residences or at least one non-farm livelihood establishment. One can distinguish city and highway areas from farm-forest lands by their position. The distinction between purely agricultural and forested quarter sections could have been made with a distinctive stipple pattern for forest land; but due to the reduction in size necessary to fit this map upon a single page, this distinction was omitted.

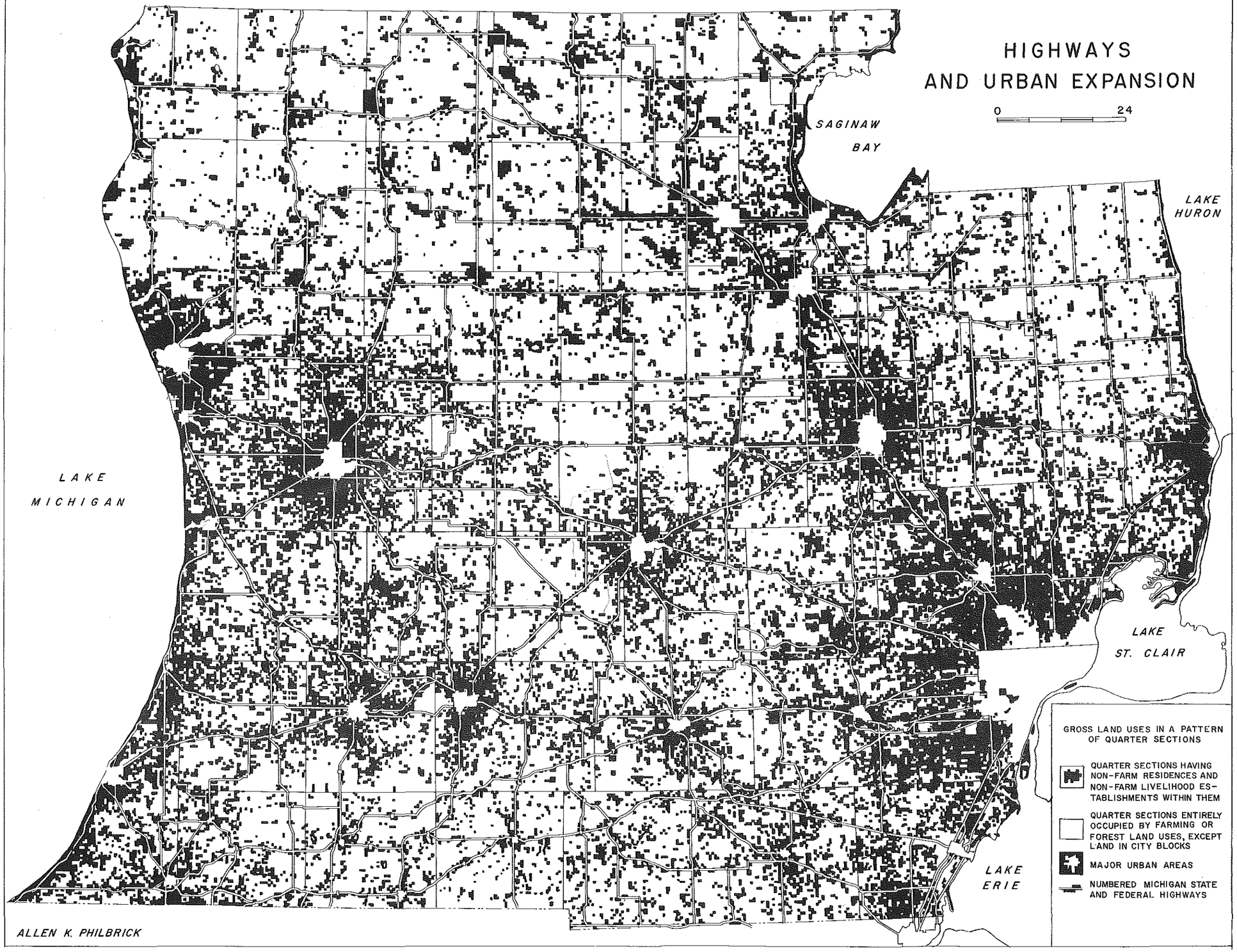
The great overall extent of black squares recording presence of non-farm or urban-type land uses within the extensive farm and forested lands of the study area is the most striking feature of the map. It reveals the basic pattern of the new settlement form called the DISPERSED CITY. The double association of such non-farm land uses with urban centers on the one hand and with the major highways on the other hand is clearly visible. It is this double association which is responsible for the map title - HIGHWAYS AND URBAN EXPANSION.

From visual appraisal of the map in Figure 1, and from study of the original county maps from which it was derived, it is possible to define four major kinds of areas in terms of generalized dominance of land use associations. These are as follow:

(1) Areas predominantly agricultural with some admixture of non-farm land uses.

(2) Areas predominantly forested with some admixture of non-farm land uses.

(3) Areas predominantly agricultural but within which a combination of farm and non-farm uses of land occurs at sufficient frequenty to characterize them as territory <u>experiencing urban expansion or dispersal</u>.


HIGHWAYS
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GROSS LAND USES IN A PATTERN OF QUARTER SECTIONS
QUARTER SECTIONS HAVING NON-FARM RESIDENCES AND NON-FARM LIVELIHOOD ESTABLISHMENTS WITHIN THEM
QUARTER SECTIONS ENTIRELY OCCUPIED BY FARMING OR FOREST LAND USES, EXCEPT LAND IN CITY BLOCKS
MAJOR URBAN AREAS
NUMBERED MICHIGAN STATE AND FEDERAL HIGHWAYS
ALLEN K. PHILBRICK

Figure 1

(4) Areas within city block pattern or from which agriculture has disappeared although not subdivided into units and small as blocks which are predominantly urban.

Statistical Comparison of Land Use Associations by Quarter Sections in Five Sample Areas

Four counties and one county-sized arbitrary area have been selected for analysis and comparison.

Selection of Samples

The five areas were selected as representative of land use combinations illustrating the four major types listed above. Analysis by county employs a traditional unit in order to establish some basis of comparison with the strip and highway-bounded cell units employed later to test the impact of highways. Areas which are predominantly urban (type 4) will be included only incidentally within areas of type 3, as the core of the sample area of urban expansion and dispersion.

The Tri-County Region comprising Eaton, Clinton, and Ingham counties with the City of Lansing as its major focus provides a sample of urban expansion. The sample is perhaps midway in the range from the largest and most complex area affected by the dispersion of urbanism from the State's largest metropolitan area, Detroit, and the smaller areas affected by cities of lesser size than Lansing within the State. At the same time two of the counties in the Tri-County Region, Eaton, and Clinton, aside from Ingham County which contains the City of Lansing itself, are examples of the more homogeneously agricultural parts of the State. The Tri-County Region provides, therefore, examples of three out of the four major types of land use dominance listed above. The fourth sample, Clare County, provides an example of forest land use. The fifth sample area is designated as "County L". It is an equivalent county-sized rectangular territory composed of townships taken from four actual counties, Ingham, Eaton, Shiawassee and Clinton. This arbitrary unit has the City of Lansing in its approximate geometric center.

Statistical Comparison of the Differences Among the Five Sample Areas

The statistical comparison for various categories of land use among the five sample areas are shown by number and percent of quarter sections in Table 1. The categories of land uses depend

Table I

ANALYSIS OF SAMPLE COUNTIES BY QUARTER SECTIONS HAVING VARYING COMBINATIONS OF LAND USE IN THEM

Land Use Associations within Quarter Sections	Ingham		Clinton		Eaton		Clare		Arbitrary "L"	
	Number	%	Number	%	Number	%	Number	%	Number	%
Area in square miles	559		571		567		572		622	
Number of quarter sections*	2238	100	2304	100	2304	100	2304	100	2490	100
Agriculture	1346	60.1	1773	76.9	1793	77.8	575	24.9	1300	52.2
Forest	-	-	1	.04	-	-	1163	50.5	-	-
Total non-farm mixed with farm and forest	654	29.2	486	21.1	425	18.4	473	20.5	903	36.3
Total non-farm mixed with forest	-	-	-	-	-	-	317	13.8	-	-
Total non-farm not combined with farm or forest	238	10.6	44	1.91	86	3.7	68	2.9	287	11.4
Total all totals		99.9		99.95		99.9		98.8		99.9
Total Farm and Forest	1346	60.1	1774	77.3	1793	77.8	1765	77.6	1300	52.2
Total Farm and Forest and non-farm mixed with farm or forest (i.e., all units w/some farming or forest)	2000	89.3	2269	98.0	2218	96.2	2236	97.1	2203	88.5
Total quarter sections with some non-farm land uses	892	39.8	530	23.0	511	22.2	541	23.4	1190	47.8
Agriculture and non-farm residences	538	24.0	390	16.9	320	13.9	62	2.7	750	30.1
Agriculture and non-farm livelihood	40	1.8	41	1.8	47	2.0	58	2.5	59	2.4
Agr., non-farm residences and non-farm livelihood	76	3.4	55	2.4	58	2.5	36	1.6	94	3.8
Non-farm residence	60	2.7	2	.1	16	.7	26	1.1	68	2.7
Non-farm livelihood	1	.04	4	.2	-	-	3	.1	5	.2
Non-farm residences and non-farm livelihood	13	.6	9	.4	19	.8	21	.9	32	1.3
City block pattern	164	7.3	29	1.3	51	2.2	18	.8	182	7.3
Forest & non-farm residences	-	-	-	-	-	-	167	7.3	-	-
Forest & non-farm livelihood	-	-	-	-	-	-	117	5.1	-	-
Forest, non-farm residences & forest, non-farm livelihood	-	-	-	-	-	-	33	1.4	-	-

*Theoretically square miles times 4 should equal the number of quarter sections. The square miles in this table do not include water area and are therefore not total area.

The data on which this table is based were collected at various times during the years 1957 through 1958.

upon the classification employed in making the observations on which the gross land use map is based. Discussion of these terms will be found in Part IV of this report entitled Methodology and Techniques.

As indicated by the data in Table 1, agriculture (except for forest in Clare County) dominates the total number of quarter sections in each of the four counties. Ingham County with 60 percent of the quarter sections wholly devoted to farming is the most urbanized of the four sample counties. Clare County is the least agricultural of the four by virtue of the fact that so much of its area is in forest. Just under one-fourth of the quarter sections of that county are occupied by farms, while slightly more than half the unit areas in Clare County are forested.

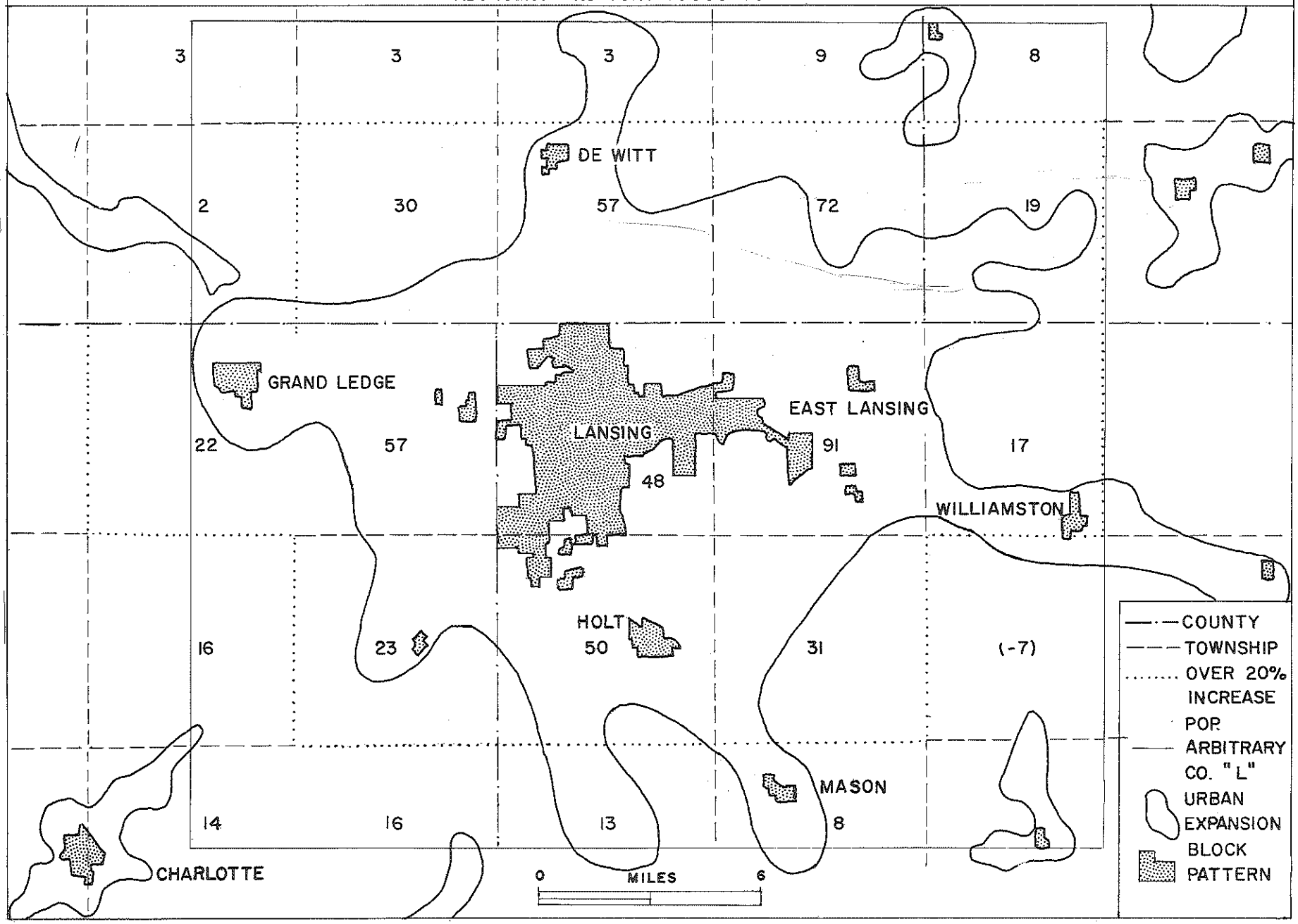
Line 10 in Table 1 shows the number and percent of quarter sections having some farming within them. As a measure of the extent of agriculture it is significant that Clinton and Eaton counties are farmed in parts of 98 and 96 percent, respectively, of the total number of quarter sections within them. In most of these quarter sections, by area, farming is overwhelmingly predominant. Counting forest land along with farm land, the comparable figure for Clare County is 97 percent. The number of quarter sections having some farming in them in Ingham County is 90 percent of the total. Wayne County which contains Detroit, yet has 1,006 of its 2,428 quarter sections with some agricultural land use. This is 41.4 percent of the quarter sections in the State's most urbanized county. Agricultural and forest land uses are truly the most nearly universally dispersed uses of land in Michigan.

On the other hand, very nearly 40 percent (39.8 percent) of the quarter section units within Ingham County have some admixture of non-farm activity within them. This is true in spite of the off-centered position of the City of Lansing in the northwestern-most township of the county. A glance at the map in Figure 1 indicates the territory for which 40 percent is the numerical expression. It is the dispersed and scattered pattern of small black squares representing urbanized or partially non-agricultural quarter sections. This pattern demonstrates the degree of dispersion of the city in the county, and the percentage number 40 only partially quantifies it because, as shown by the map, at least half of the urban dispersion around Lansing is in neighboring counties.

Better to measure this dispersion percentage in terms of a county-sized area with Lansing as its geometric center, arbitrary "County L" was created. The method of its definition is illustrated by the map in Figure 2. On this map the area enclosed by

Figure 2

GENERALIZED URBAN EXPANSION IN THE LANSING AREA BASED UPON CONTIGUOUS QUARTER SECTIONS WITH NON-FARM LAND USES ADJACENT AND CONTIGUOUS TO THE CENTRAL CITY



a continuous line is the irregularly radial shape of contiguous quarter sections of an urban character and those having some non-farm land uses mixed with agriculture. Isolated groups of non-farm land-use-quarter sections were ignored. An equivalent county-sized rectangular territory was defined by enclosing the urban dispersion zone around Lansing along township and half township boundaries coinciding with the approximate ends of the radiating alignments of urban dispersion outward from the city. Arbitrary "County L" has 622 square miles. Within this territory, as recorded in Table 1, nearly half of the quarter sections (47.8 percent) have some non-farm land uses within them.

The figures 40 and 48 percent for Ingham and arbitrary "L" counties are in relative contrast to the proportions 23, 22, and 23 percent of the quarter sections having some non-farm land uses within the three more rural counties sampled. Even in the more rural counties, however, it is suggestive of considerable penetration of non-farming activities that more than one-fifth of the quarter section units in each county dominated by farm and farm-forest land uses should have urbanized or non-farm and non-forest land uses within them. At the other extreme, in Wayne County, 2,254 quarter sections or 92.8 percent of the county's 2,428 land quarter sections are devoted to cities or are urbanized or have some non-farm land uses within them.

The data in Table 1 provide a numerical "handle" with which to characterize and differentiate counties. A moderately urban county will be one in which from 40-50 percent of the quarter sections exhibit dispersion of urban-type land uses within them. perhaps fifty percent would be a convenient index of the urban county on this basis. An agricultural county will have less than one-fourth of its unit areas with such evidence of urban dispersion, while more than 95 percent of all quarter sections will contain some farming. A forest county may be defined as one in which 50 percent or more of the total quarter sections are wholly devoted to the forest land-use association, while less than 25 percent are wholly agricultural. A county with 25-40 percent of the quarter sections exhibiting dispersion of urban-type land use might be designated as sparsely urbanized.

While the complete tabulation in this manner for each of the 47 counties of the study area would provide interesting information of value in itself, the author of this report did not feel justified in pursuing this line of analysis beyond this point since it did not directly measure the proportionality of non-farming land uses in relation to highways.

Strip Area Enumeration of Impact Through Highways Upon Land Uses

Visual study of the map of gross land-use associations in Figure 1 demonstrates that land uses are related by position to the highways interconnecting the State's urban areas, both large and small.

Creation of a Pattern of Arbitrary Strip Areas

In order to measure this relationship quantitatively, a pattern of arbitrary strip areas of a constant one-mile width at successively increasing distance from Michigan state and federal highways was created. In order to save space, no copy of the original map of such strip unit areas is reproduced. An idea of the character of these units can be obtained from the maps in Figures 3 and 26 on which findings of map analysis are reported, although on these presentation maps the strips have been generalized, particularly those paralleling diagonal highways. On the original research maps the strips followed specific quarter-section outlines which produced a "zig-zag" or "staircase" appearance paralleling diagonal highways.

The problem in designing this type of unit area pattern was to achieve a balance between each frontage to the territory enclosed by highways. It was desired that each frontage have its share of strips at one, two, three, etc. miles depth from the highway in proportion to the length of the side of the territory enclosed by highways. In effect, the resulting pattern of strips divide each "cell" of territory created by the highway grid within the study area into "concentric" mile-wide bands. Each concentric band is subdivided into lengths defined as "strip areas". These two terms, "cell" for a territory bounded by intersecting state and federal highways, and "strip area" for a segment of a one mile band of quarter sections parallel to a highway are both arbitrary ones adopted for use in this report. Since each strip is intended to represent one mile of depth back from a line paralleling a highway, each is composed internally of two rows of quarter sections. It was not possible to make the segments of these bands of one mile depth paralleling highways defined as strips equal in length in all cases. The emphasis is upon having as many as possible of them six miles in length, allowing some to be smaller or longer where necessary within fixed limits. The limits are such that the shortest strip is three miles and the longest nine miles. Since each strip consists of two rows of quarter sections, the numbers of unit areas per strip ranges from 12 to 36. The majority have 24 unit areas.

An overlay containing the outlines of this pattern of highway-oriented strip areas was placed over the land-use maps. The percentage of quarter sections within each strip having non-farm land uses to total number of quarter sections was computed. Expressed in 10 percent intervals, or combinations thereof, these ratios are recorded on a map covering the entire study area shown in Figure 3.

Diminution of Urban-Type Land Uses with Distance from both Cities and Highways

Examination of these maps reveals a rather pronounced progression of percentages with distance from highways as well as similar progression of percentages with distance from cities. It is clear upon examination of these maps that analysis of the changes in proportions of non-farm land uses per quarter sections by strip areas varies rather regularly with respect to these two variables simultaneously. The two variables, again, are distance from highway frontage and distance outward from cities.

The relative darkness of patterns in Figure 3 expresses this change in percentages of urban-type establishments quantitatively with distances from the city. At the same time it is apparent that the same progression from darker to lighter patterns expresses the difference in the application of some force or forces to the uses of land in varying degree with distance from highway frontage. One may think, accordingly, of the consistent variations of these two sorts as measurement of a force or forces in two directions simultaneously. The directions are along or parallel to highways, i.e., outward from city centers, and back from, i.e., perpendicular to highway frontages.

The significance of measurement of the force or forces involved in land-use development in accordance with these two directional variables can better be appreciated by more detailed examination of the data for selected highway-bounded areas or cells. These are of all shapes and sizes, from very small units within cities where three or four state highways do not quite intersect but bound small areas of cities of a block or more in size to quite sizeable territories out in the country. This means from a quarter square mile in size to the largest cell in the study area containing 774.5 square miles. This area, larger than most counties, is bounded by U. S. 10 and 31 and Michigan highways 37, 20, and 82 in Mason, Lake, Oceana, and Newaygo counties. Ideally, as in the case of counties and for the study area as a whole, statistical computation for each of the cells should be made and analyzed individually for all of the cells, and in various regional combinations. Time was available only for selected samples.

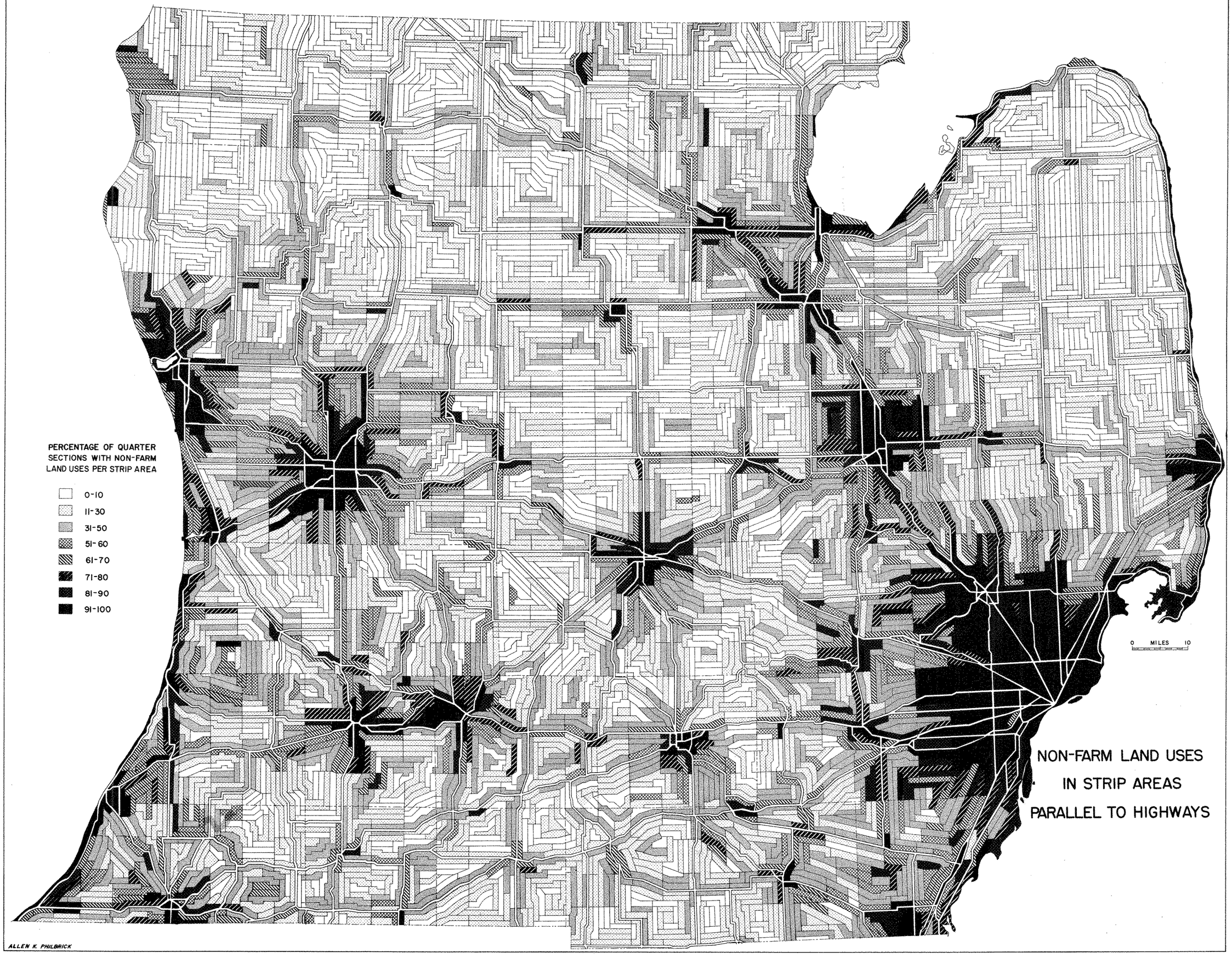

PERCENTAGE OF QUARTER SECTIONS WITH NON-FARM LAND USES PER STRIP AREA
0-10
11-30
31-50
51-60
61-70
71-80
81-90
91-100
0 MILES 10
NON-FARM LAND USES
IN STRIP AREAS
PARALLEL TO HIGHWAYS
ALLEN K. PHILBRICK

Figure 3

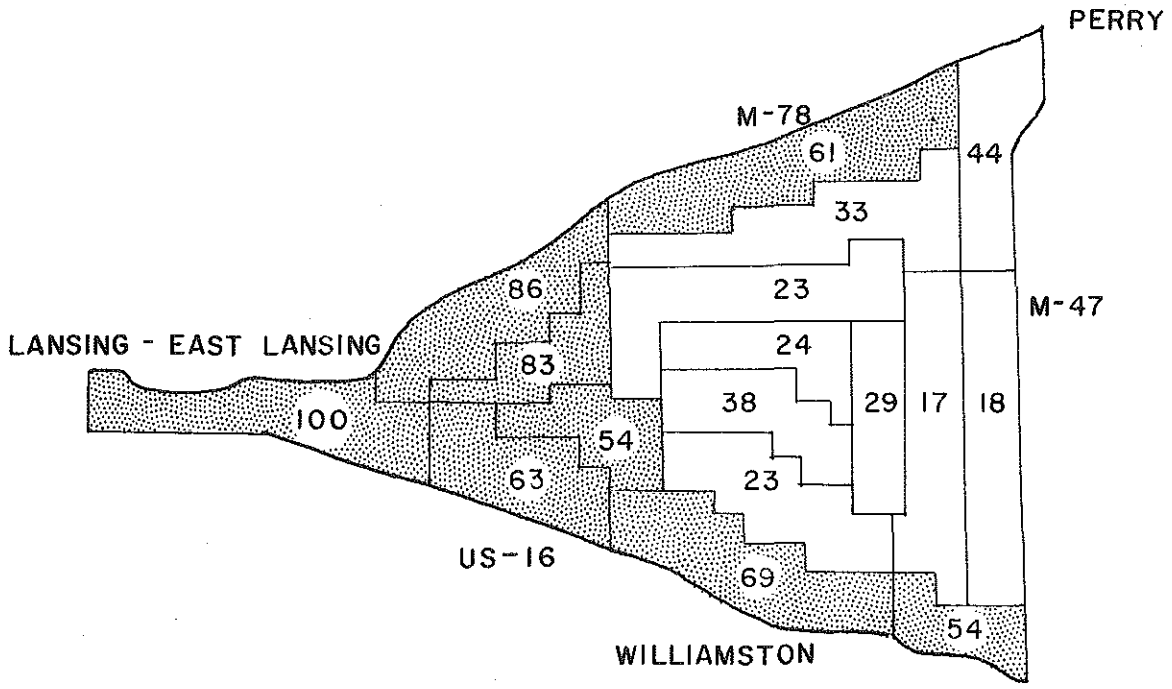
The size and shape of each cell is determined by the direction and length of the highways on each edge. Each is geographically unique in the identity of its highway combinations and location. Two examples will be used to illustrate the kinds of results obtainable from such detailed analysis.

Statistical Comparison of the Changes with Distance from Cities and Highway Frontages of the Percentages of Quarter Sections with Non-Farm Land Uses

The diagram and graphs shown in Figure 4 refer to the generally triangular cell bounded by highways M 78, U. S. 16 and M 47. It lies just east of Lansing-East Lansing, Michigan. The percentages of quarter sections per unit area having some non-farm land uses within them are plotted within the respective unit areas. The approximate locations of the principal settlements affecting the totals are indicated by black dots within or adjacent to the principal unit in which each is located. Thus Lansing-East Lansing is located at the west apex of the triangle. Perry is at the upper right-hand corner. Williamston lies in the unit area next to the southeast corner-unit. The progression of percentages by unit areas along the M 78 side of the triangle is 100 - 86 - 61 - and 44. That of the U. S. 16 side is 100 - 63 - 69 - 54. The evenness of the progression to the southeast is interrupted by the concentration of non-farm land uses associated with Williamston within the unit area showing the percentage 69. The two progressions are plotted as lines within graph A of Figure 8. The general similarity of the down-curve for the two diagonal stretches of highway moving away from their junction just west of East Lansing is shown by the graph.

The unit areas in the second-mile zone back from the highways show a similar progression away from the city in percentage of unit areas having non-farm uses within them. In this case the figures for the second mile back of highway 16 are 54 - 23 - and 17 percent respectively for the first, second and third units counting from the end of the second-mile zone nearest Lansing-East Lansing and moving away from the cities toward the southeast. There is one significant difference, however! The percentage of each unit in the second-mile row, back from the highway, is markedly lower than that of the corresponding unit at approximately the same distance from the cities in the first-mile row. The numbers, as can be seen from the diagram in Figure 8, are 63 and 54, respectively, between corresponding unit areas in the first and second rows. In the next unit to the right-hand, (southeast of the first example) the percentage rises to 69 percent in the first row because of the presence of the City of Williamston, as already noted. The figure in the corresponding unit (at the same distance along route 16 from Lansing) falls to 23 percent.

STATISTICAL AND MAP ANALYSIS BY HIGHWAY ORIENTED UNIT AREAS OF TERRITORY BOUNDED BY HIGHWAYS - US-16 - M-78 - M-47



GRAPHS OF PERCENTAGE PROGRESSIONS BY DISTANCE FROM HIGHWAYS AND DISTANCE FROM LANSING-EAST LANSING

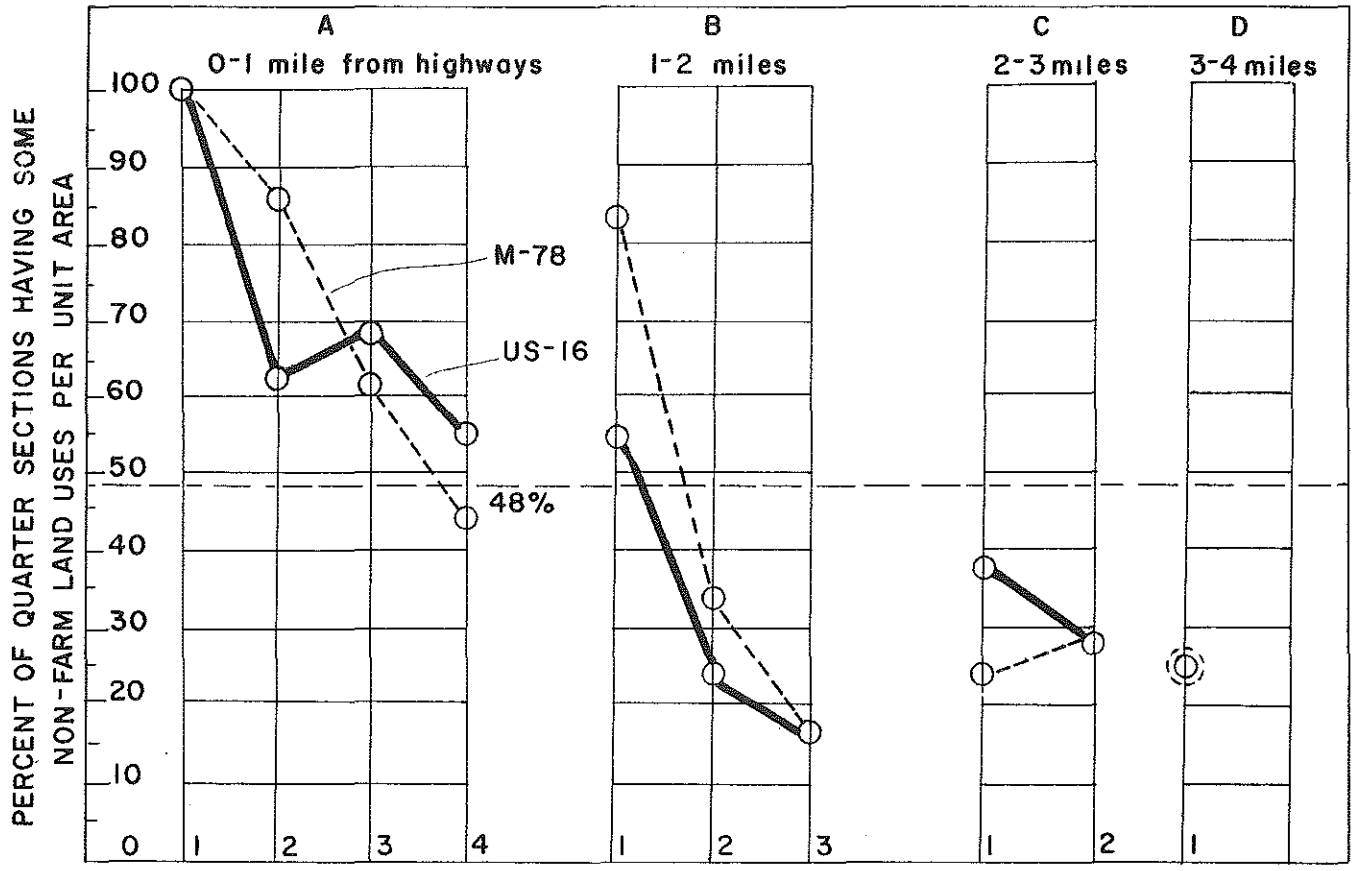


Figure 4

The double progression (with distance along the highway and at each respective distance back from the highway) is depicted linearly in graphs A to D of Figure 4. Beginning at the left, graph A, already referred to, shows the progression along routes 16 and 78 in the first mile back from highway frontage. The graph B shows the same parallel-to-the highway progression (somewhat lower in percentages) for the second mile back from the highway, and so on for the third and fourth graphs labelled C and D.

In reading these graphs, it should, of course, be realized that with each successive mile back from the highway the number of unit areas in length parallel to the highways becomes less. Along U. S. 16, for example, there are four units of frontage in the first mile, two and a portion of a third in the second mile, and only a single unit in the third and fourth miles.

It should also be borne in mind that a number of other elements are present which affect the percentages besides distance from city and highway frontage. It is difficult to eliminate all but the two variables which it is intended to measure. Quarter sections showing non-farm land use as the result of quarrying, mining, and oil or gas production have been eliminated from the totals. There remain, however, resort establishments related to lakes and streams, the non-farm establishments located with reference to roads and highways not part of the Michigan trunk line and Federal highway systems. Finally there remain the indeterminate factors of location attributable to the vagaries of human nature aside from rational economic and social choices.

An additional qualification is needed also. In interpreting the graphs it is necessary to point out that the level of significance of the percentages is of a relatively coarse or low order because they are based in each unit area upon a rather small number of cases. The number may be as low as 12 and is never more than 36. Accordingly, taking the most numerous case of 24 quarter sections per unit area, differences of four or five percentage numbers are the result of change by only one in the number of quarter sections having non-farm land uses within them. On the other hand, if the small totals upon which percentages are based is felt to impair the significance of the trends established by the figures, the reader is directed to examine the diagrams shown in Figure 5. In diagram A, the average for each mile in depth from highway frontage is shown for the total strip fronting on each of the highways bounding the triangular-shaped territory. The larger number of quarter sections for each frontage is as follows: M 78 - 72; U. S. 16 - 74; M 47 - 30, in the first mile.

PERCENT OF QUARTER SECTIONS HAVING SOME NON-FARM LAND USES
BY FRONTAGE ORIENTED STRIPS AT ONE MILE INCREMENTS AND
BY CONCENTRIC ZONES AT ONE MILE INCREMENTS IN THE TERRITORY
BOUNDED BY HIGHWAYS US-16 M-78 M-47

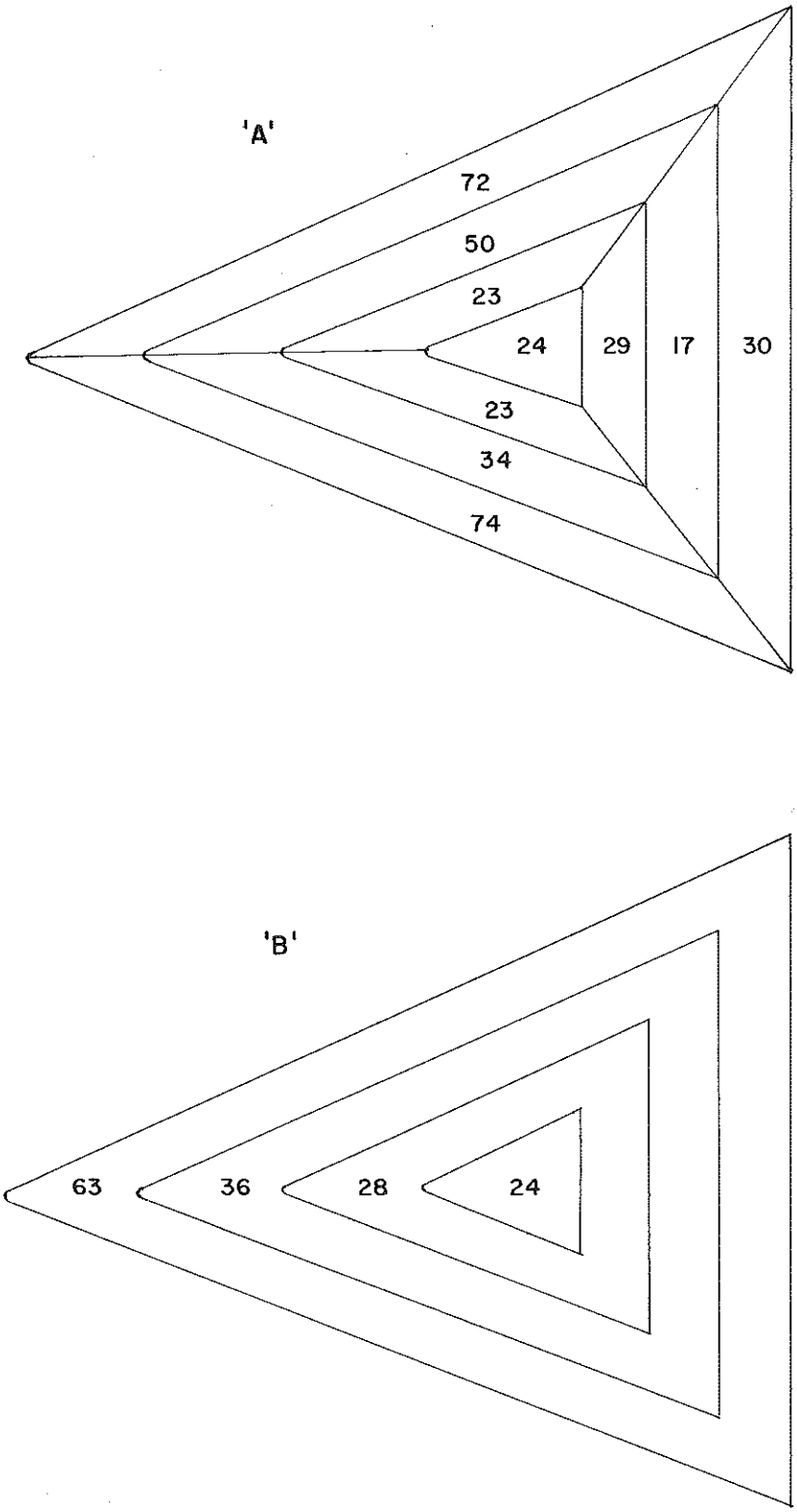


Figure 5

Along the side fronting upon U. S. highway 16, the figures for the average for the whole first to fourth miles are 74 - 34 - 23 - and 24. The analagous trend from M 78 shows a reduction at successive miles from 72 - 50 - 23 - to 24 percent. The small increase in the last mile in both cases is not significant.

Diagram B, in Figure 9, shows the total ratio in terms of percentage for each concentric mile of frontage for the whole cell. In this instance, where all the quarter sections within mile zero to one, one to two, etc. are used, interruptions to the trend are masked and the progression reads from 63 - 36 - 28 - 24 percent. This means that 63 percent of the quarter sections within one mile of the three highways bounding this area have some non-farm land uses in them. In the second mile this percentage declines to an average of 36 percent for all of the territory between mile one and mile two, etc. Total numbers of quarter sections are for the first mile - 192; second mile - 82; third mile - 60; fourth mile - 16.

The average for the entire territory regardless of distance is 48 percent, a figure which will be of use somewhat later in the discussion.

Returning to diagram A, in Figure 5, again, changes of percent back from M 47 show very little trend of significance. The percentage drops from 30 to 17 from the first to the second mile, then rises again to 29 and falls slightly to 24 percent. Thus the percentage figures of both the third and fourth miles are within a few percentage numbers of that for the first mile. One might be tempted to think that the drop from the first to the second mile from 30 to 17 percent was significant. But when one refers back to the diagram in Figure 4 gain, it becomes clear that the data does not justify this conclusion. The first unit of frontage along the west side of M 47 at the latter route's junction with U. S. 16 shows a percentage of 18. The second mile back from the highway shows a percentage of 17. These are almost identical, considering the sizes of the samples upon which they are based, and accordingly show no trend. The next unit northward along the west side of M 47 shows a much larger spread with the second mile back from the highway, between 44 and 17 percent. It is the localized non-farm land uses in the vicinity of Perry which are responsible for this increase. For this both Perry and the highway share in significance to some extent; but the amount, when averaged over the total distance from Perry to the junction of highway 47 with highway 16 is not enough to be statistically significant.

STATISTICAL AND MAP ANALYSIS BY HIGHWAY-ORIENTED UNIT AREAS
OF TERRITORY BOUNDED BY HIGHWAYS US-27, M-21, M-47, M-78

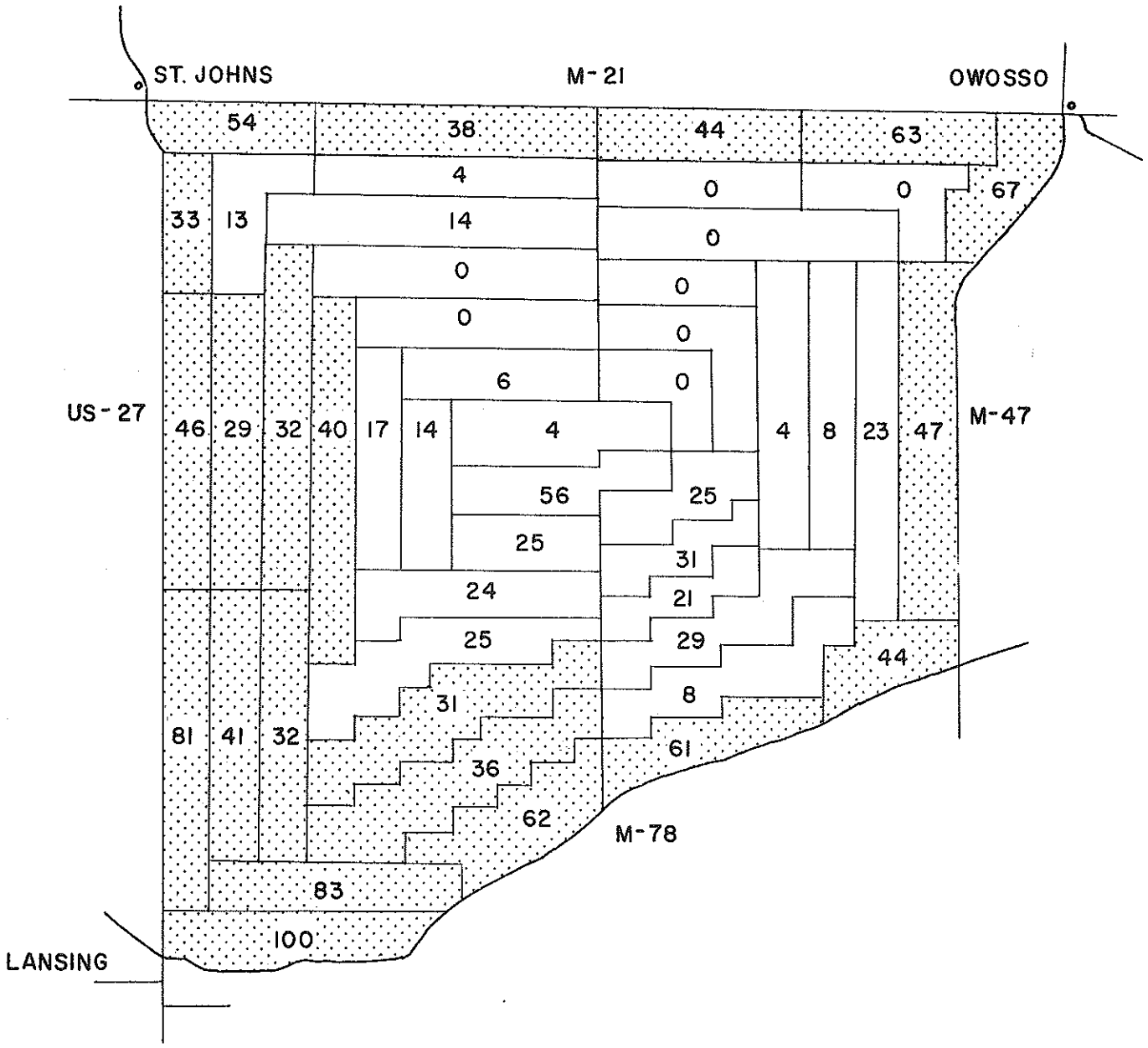


Figure 6

GRAPHS OF PERCENTAGE PROGRESSIONS BY DISTANCE FROM HIGHWAYS AND DISTANCE FROM LANSING, ST. JOHNS, AND OWOSSO

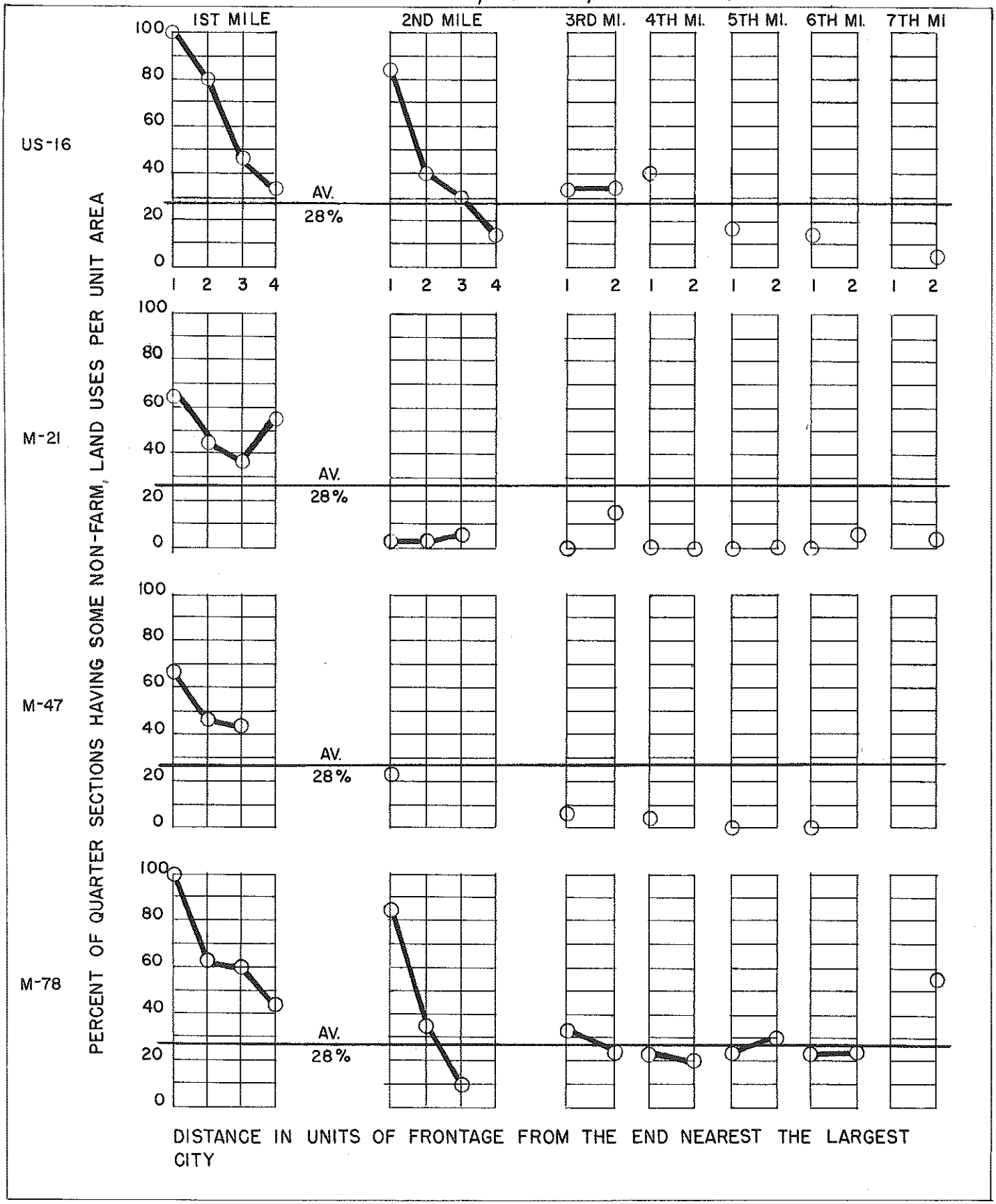
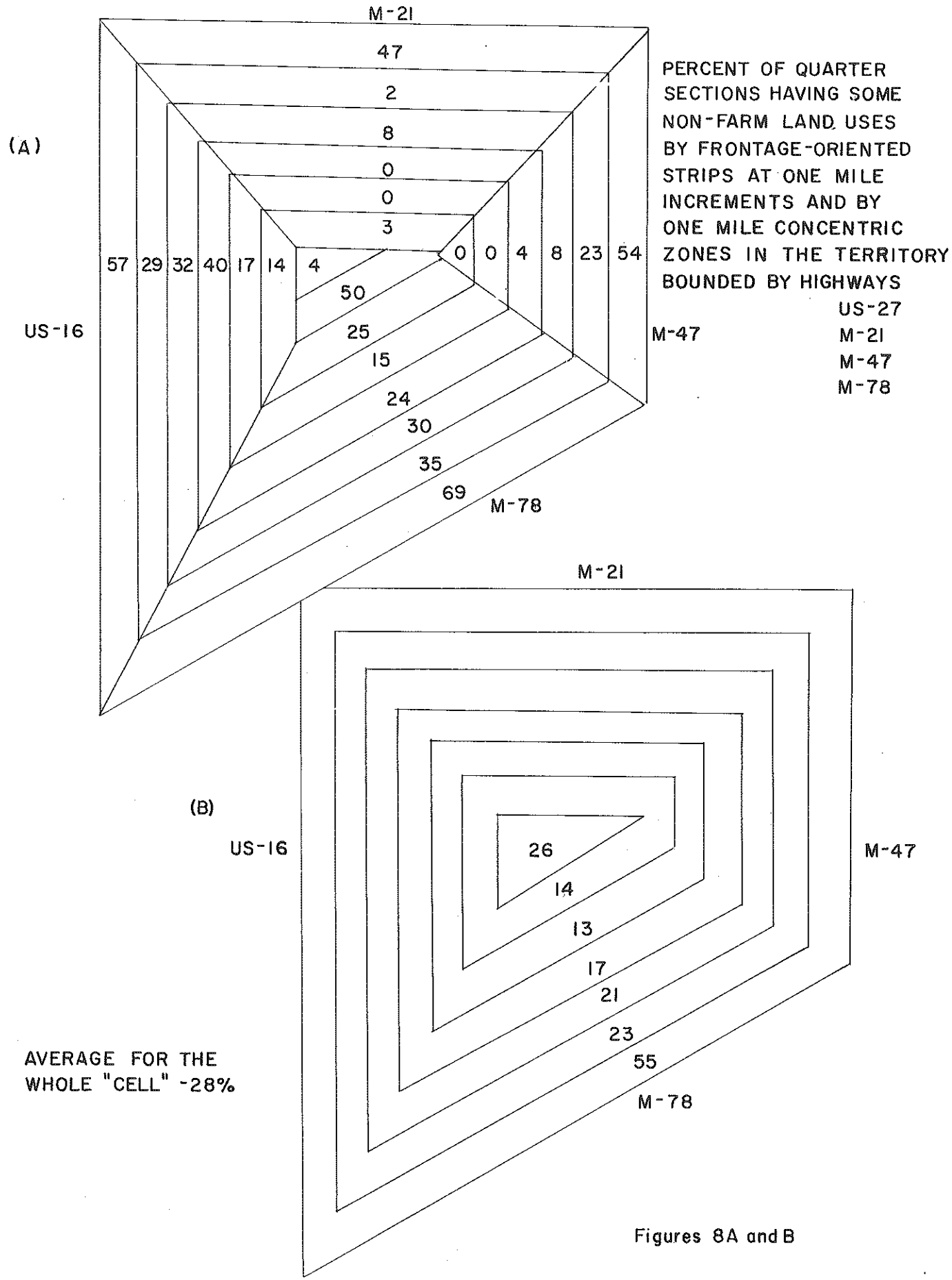


Figure 7

It is accordingly possible to formulate the hypothesis from the diagram in Figure 5 that the impact of people using the highway for access to land back from the edges of this triangular cell is demonstrable to a depth of from one to two miles back of the frontage along highways 16 and 78, but not at all back from the frontage along M 47. It is further possible to formulate the hypothesis in the same vein from more detailed information in the diagram of Figure 8 that the impact of the highways is demonstrable up to two miles back from U.S. 16 within a distance of a dozen miles southeast of Lansing-East Lansing, but that before Williamston this impact declines to one mile. Along M 78 impact is perhaps two miles deep for the first half of the distance to the junction of M 47 and M 78. Thereafter it is from zero to one mile. Along M 47 south of Perry, impact is less than one mile and within a short distance south of the junction falls well below the average for the cell. These hypotheses are partially confirmed by one further step of graphical analysis. The average proportion for the entire cell bounded by segments of the three highways under discussion was previously recorded as 48 percent. If all unit areas having a percentage of quarter section with some non-farm land uses within them larger than the average for the entire cell are regarded as showing evidence of the impact through highways upon land use, the results are exactly the same as shown above. These results are shown graphically by the shading on unit areas in the diagram of Figure 4. It, of course, must be remembered that "highway impact" referred to in this relationship is not a direct cause and effect relationship but one of complex associations between highways and people who use land for non-farm purposes.

The cell just analyzed is rather small in size. What are the results when this approach is applied to a larger area? The diagram in Figure 6 shows the same type of highway-oriented strips within the territory bounded by U.S. 27, M 21, M 47, and M 78. This territory lies immediately northeast of Lansing. It covers the distance from Lansing to St. Johns to the north, from St. Johns east to Owosso, thence south to the junction of M 47 with M 78 and back along the latter highway to Lansing. In this area there are seven tiers or rows of unit areas each one mile deep paralleling each highway frontage.

The percentages of non-farm land uses by quarter sections with respect to the total number of quarter sections per unit area are again plotted in the respective units. Analagous type progressions occur. For example, the first mile of frontage on U.S. 27 from Lansing to St. Johns shows a progression from 100 - 81 - 46 - 33 percent. The second row parallel to the first shows a corresponding progression of 83 - 41 - 29 - 13. Similarly to the east along the north side of M 78 from Lansing to the junction of routes M 78 and M 47, percentages for the unit areas show a progression from 100 - 62 - 61 - 44 percent. In the second mile,



Figures 8A and B

parallel to the first, the progression again falls off to that from 83 - 36 - 8 percent. Along the north side of the cell from St. Johns to Owosso the progression starts from 54 percent, declines to 38, and then climbs to 44 and then 63 percent approaching Owosso. Is the difference between 54 percent leaving St. Johns and 63 percent approaching Owosso representative of the difference between the relative impacts of smaller St. Johns and larger Owosso? Since St. Johns is the smaller of the two, it is perhaps suggestive that the low point in the data (38 percent) occurs closer to St. Johns than to Owosso. The second mile between St. Johns and Owosso shows a progression from 13 to 4 to 0.

The average percentage of all quarter sections within the cell which have some non-farm land uses is 28. The heavy horizontal line through the four graphs in Figure 7 occurs at 28 percent. The graphs in Figure 7 show the progressions by unit areas along the highways. Each graph is for a successive mile interval back from the highway, from left to right, from 'A to D'. There is a tier of graphs representing the data along and back from each of the four highways. Those unit areas exceeding 28 percent are with one exception those contiguous to the highways or other unit areas which are contiguous to the highways. The variation in depth back from the highway is from one to four miles. Such units are shown by shading on the diagrammatic map in Figure 6.

Again, it is possible to hypothesize that for a dozen miles north and northeast of Lansing the impact through the highway into the back country is from three to four miles in depth. Thereafter, all the way around the cell-like territory the impact is from zero to one mile. The progression by entire frontages, combining the totals for all unit areas paralleling a given highway at successive mile intervals is shown in Figure 8a. The averages for concentric rows, representing the totals at successive depths from all four highways for the area as a whole, are shown in Figure 8b. Numbers of quarter sections involved in the percentages by frontage totals are as follows, for example, for the first mile: U. S. 16 - 62; M 78 - 87; M 21 - 69; M 47 - 48. Numbers of quarter sections for the entire circuit at successive mile intervals back from the highway frontages is as follows: one mile - 266; two miles - 218; three miles - 182; four miles - 133; five miles - 90; six miles - 72; seven miles - 42.

Similar analysis could be made for each of the 254 cells in the study area. An interesting and significant composite expression of the proportions of quarter sections having non-farm land uses by ranges of distance outward from cities and back from highway frontages could be made. Various combinations could be worked out in terms of strips located in relation to cities of different

sizes and functions to test for possible correlations in the size and functions of cities and their distance and depths of urban dispersal. Again, however, lack of time, personnel, and funds, militated against the following of these paths of research, although in the opinion of the author these would be additional avenues of analysis based upon the data collected which would be worthy of implementation.

The Web of Highway Impact and the Dispersed City

Tabulation, however, was made for each cell to ascertain the percentage of the total quarter sections exhibiting land uses other than agriculture or forest. These variable factors were used to establish the zone or depth of highway impact according to the hypothesis discussed above, for each of the 254 cells. All those unit areas having percentages of non-farm land uses higher than the average for each cell, and which form a compact group contiguous to one of the highway frontages, were shaded on a map of the study area. This map was designated the Web of Highway Impact.

At the same time, however, it was ascertained that the average for the entire study area was 34 percent. This means that approximately one-third of the quarter sections of the study area as a whole are urbanized or possess some mixture of land uses other than agriculture or forest. A second Web of Highway Impact map was made employing this constant factor rather than the variable factors for each of the 254 cells into which the grid of Michigan state and U. S. highways divide the study area. To conserve space, these two research maps are not presented separately. The combination of both are presented on the map in Figure 9. An appreciation of the extent of the web of impact by each set of criteria separately and in combination may be gained by examination of this map.

The Composite Web of Highway Impact

There are three patterns of grey on the map in Figure 9, A; B; and C. Patterns A and B together comprise the web of impact defined in terms of the variable criteria for each cell. Under these circumstances the web was more extensive in the rural areas at great distances from cities. This is true because in less populated cells the lower percentages as factors for rural cells permitted the strip areas there with lower percentages of non-farm quarter sections to be counted. In the same vein, higher percentages in cells near cities made the web of impact defined on the basis of local factors less extensive near the larger cities.

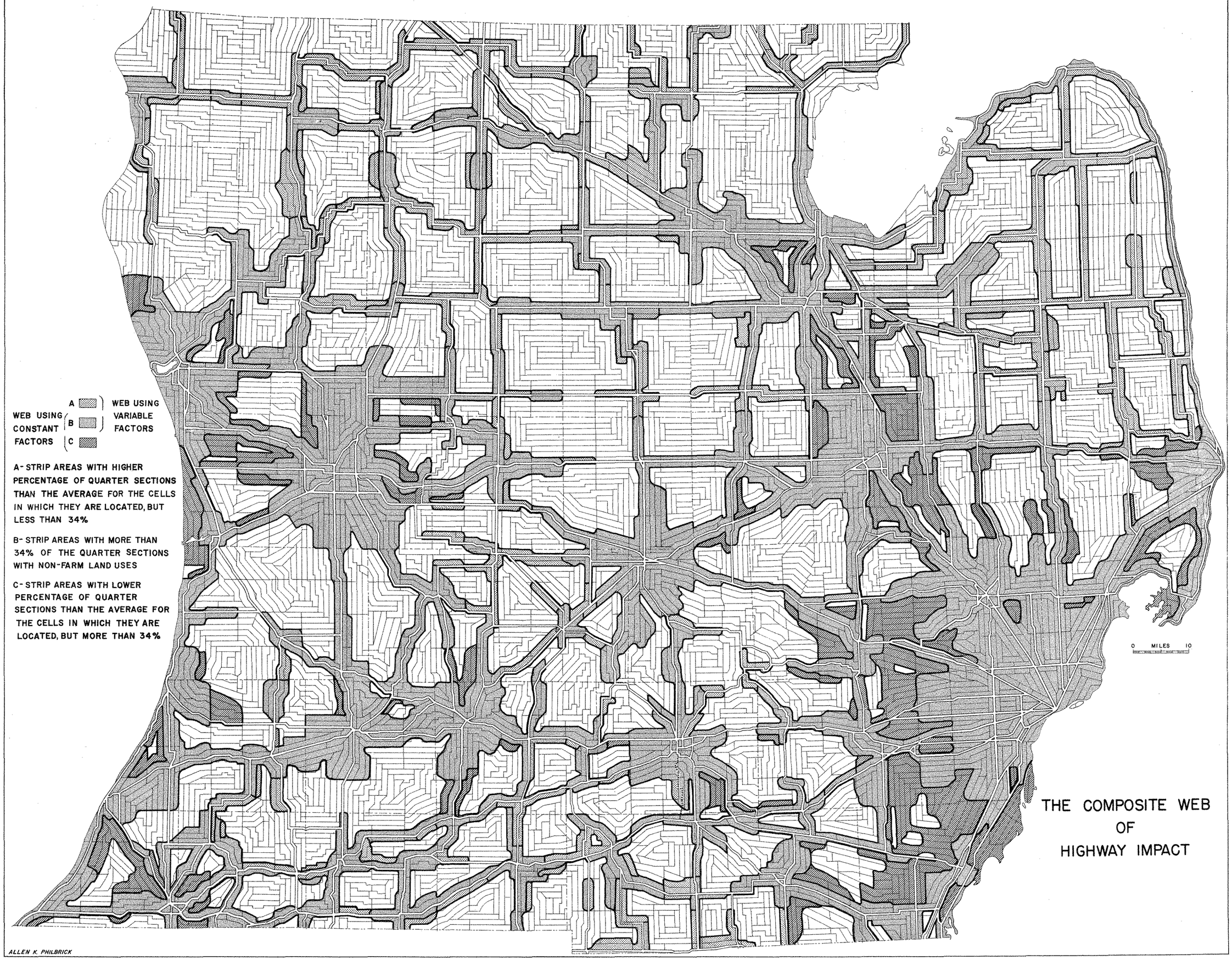

WEB USING CONSTANT FACTORS
A
B
C
WEB USING VARIABLE FACTORS
A- STRIP AREAS WITH HIGHER PERCENTAGE OF QUARTER SECTIONS THAN THE AVERAGE FOR THE CELLS IN WHICH THEY ARE LOCATED, BUT LESS THAN 34%
B- STRIP AREAS WITH MORE THAN 34% OF THE QUARTER SECTIONS WITH NON-FARM LAND USES
C- STRIP AREAS WITH LOWER PERCENTAGE OF QUARTER SECTIONS THAN THE AVERAGE FOR THE CELLS IN WHICH THEY ARE LOCATED, BUT MORE THAN 34%
0 MILES 10
THE COMPOSITE WEB OF HIGHWAY IMPACT
ALLEN K. PHILBRICK

Figure 9

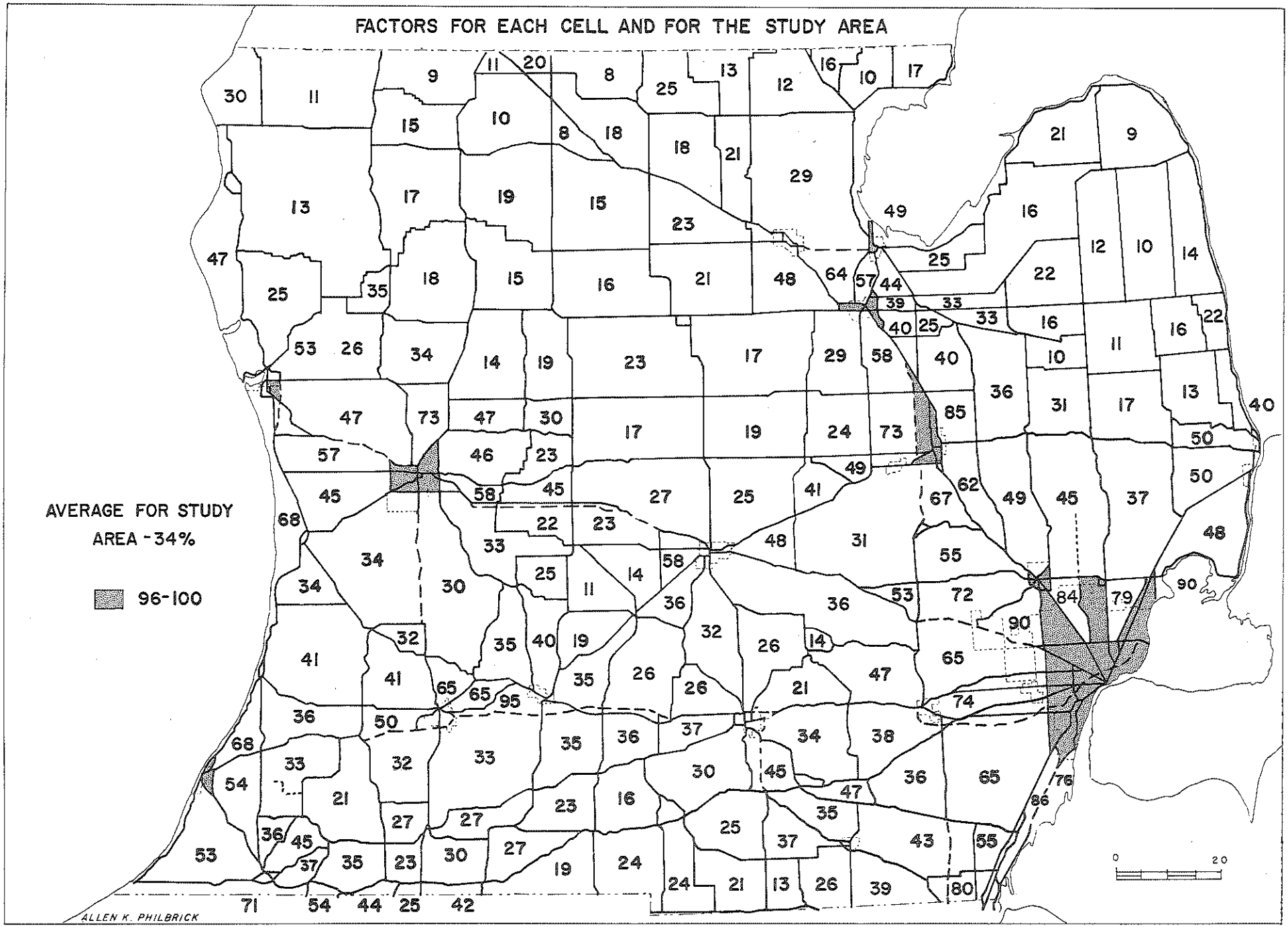

FACTORS FOR EACH CELL AND FOR THE STUDY AREA
AVERAGE FOR STUDY AREA - 34%
96-100
0
20
ALLEN K. PHILBRICK

Figure 9a

Patterns B and C comprise the web of impact defined in terms of the constant factor, i.e., the percentage of quarter sections with some non-farm land uses for the study area as a whole (34 percent). The map in Figure 9a shows the variable factors for each cell, and in the legend the constant factor for the 47 county study area. The variable factors range from a low of 13 percent, for the largest cell in the study area, to 100 percent for cells encompassed by metropolitan areas. If partial cells are counted, there are several along the northern edge of the study area less than 13 percent. The lowest is 8 percent.

A remarkable fact is the relative sizes of the area of the two versions of the web of highway impact which overlap. Pattern B is common to both webs, that of the A-B and that of the B-C criteria. In by far the largest portion of the combined web of impact, its extent remained the same whether the variable or the constant factors were used to define it. The constant factor had the effect of extending the web of impact near the cities and reducing its coverage in the areas for the most part far away from cities, and particularly north of an east-west line north of Grand Rapids and Flint.

The composite web of highway impact in Figure 9 is presented as one of the major findings of this report. It clearly and unequivocally demonstrates the relationship between the Dispersed-City in Michigan and the major highways of the state. It illustrates what the words say in the sentence, "The highways have become the streets of a dispersed city."

Tabulation of the Length of Highways in the Study Area with Varying Depths of Impact Through Highways upon Land Use

There are 5,457 miles of state and federal highways in the study area. These highways have 10,914 miles of frontage. One of the more interesting facts coming from this report is the small proportion (less than 20 percent) of this frontage which fails to show impact through highways upon the pattern of land use in non-agricultural ways. The exact figure is 17.9 percent. This means that 8,960 miles of highway frontage have given some evidence of impact to a depth of one mile or more. If one includes both sides under consideration and makes calculation based upon miles of road rather than separate frontage at a time, only 7.2 percent of the 5,457 miles of highway in the study area are without impact on at least one side of the highway to a depth of one mile or more. This is a total highway mileage of 5,107 with at least one mile of impact. Totals for the study area by frontage and by miles of highway are given in Table II.

Table II

Impact on Land Use Through Highways by Miles of Frontage and of Highway at Successive Mile Depths Back from Highways in the Study Area

Miles of Depth of Impact	0	1	2	3	4	5	6	7**
Miles Frontage	1958	6127-	1963	576	199	50	27	14
Percent Frontage	17.9	56.1	18.0	5.3	1.8	.5	.3	.1
Cumulative Total,	1958	8085	10048	10624	10823	10873	10900	10914
%	17.9	74.0	92.0	97.3	99.1	99.6	99.9	100.0
Negative Cumulative Total	10914	8956	2829	866	290	91	41	14
	100.0	82.1	26.0	8.0	2.7	.9	.4	.1
Miles of Highway, both sides	394	900	2114	987	626	224	149	63
Percent Highway	7.2	16.5	38.7	18.1	11.5	4.1	2.7	1.2
Cumulative Total,	394	1294	3408	4395	5021	5245	5394	5457
Percent	7.2	23.7	62.4	80.5	92.0	96.1	98.8	100.0
Negative* Cumulative Total,	5457	5063	4163	2049	1062	436	212	63
Percent	100.0	92.8	76.3	37.6	19.5	8.0	3.9	1.2

*Negative cumulative total means for each depth the total of that depth and over.

**The category 7 miles includes short stretches of highway with impact at 8 and 9 miles.

In reading this table, it should be noted that depth back from highways by frontage involves each side of the highway, one at a time. Accordingly, the totals for one mile of impact through highway frontage are considerably greater than one mile of impact through highway considered both sides together. This is so because the category is the sum of one mile of impact either side, one mile on both sides, and one mile of impact on one side with any number of miles of impact on the other side. This explains why in Table I, on a frontage basis, one mile of impact accounts for 56.1 percent of total frontage, while on a highway basis (both sides), the corresponding percentage is only 23.7.

Formulating some major findings from Table II, the following important points should be made. The proportion of frontage and highway mileage exhibiting impact of two or more miles in depth is significant because it indicates that impact is more than the initial roadside clutter of houses and highway-oriented businesses. More than one-fourth of all frontage, 2,829 miles of it, has impact two or more miles in depth. In terms of miles of highway (both sides considered together) 2,049 miles, or 37.6 percent, show impact to a depth of three or more miles. Three miles is the category quoted in this latter instance, since on a both-sides-of-the-highway basis, one mile on either side would be counted as two miles of impact. From the negative-cumulative tables, one may state that over 90 percent of the state and federal highway mileage shows an impact of a mile or more. Three-fourths or more exhibit impact of two miles, well over a third yields impact of three miles, while nearly one-fifth has impact of four miles, and so on.

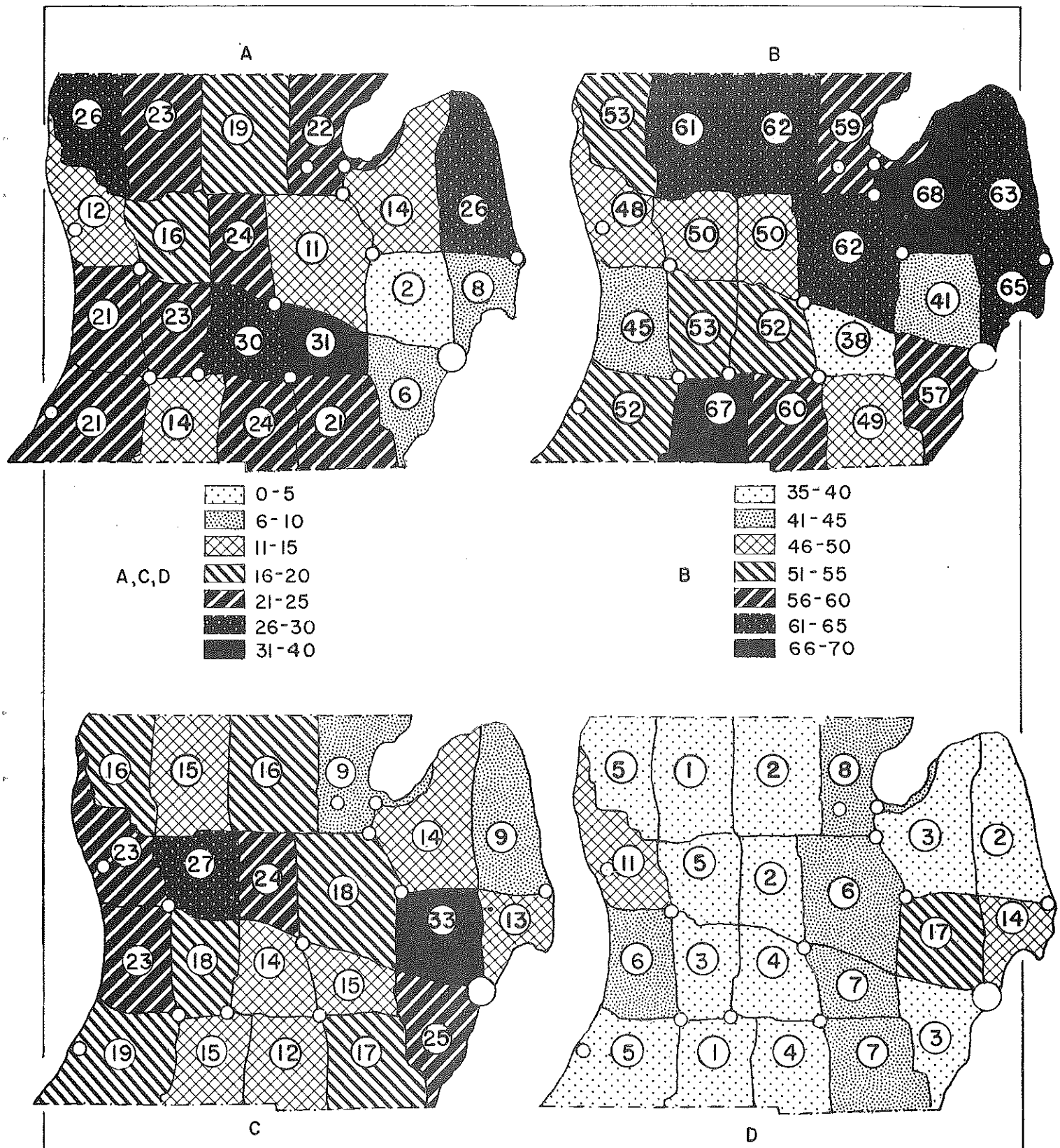
From the map of the web of impact in Figure 9, a number of additional observations should be made. Two major regions of great highway impact absorb the urban dispersal from cities of the urban axis, Detroit to the Tri-Cities of Saginaw-Bay area, and the cities of Western Michigan. These two regions of greater density of the web of impact bracket the Lansing Region in the center of the study area. The center of the state around the capitol-city exhibits less-well developed impact in depth. It might be described as "the hole in the doughnut". A third point, however, might seem to contradict the last one made, since it should be observed how effectively the web of impact covers the portion of the state in the study area. Except for the first two points made, the pattern of the map in Figure 9 may be described as relatively even.

In Figures 10-11 and 12-13 comprising four maps each, the results of regional tabulation of the composit web of impact by frontage and by both sides of the highway are recorded. These maps show

considerable regional variation in the proportion of highway frontage and mileage showing impact of various depths through highways upon the use of land. In Figures 10 and 11 maps A through F show the regional patterns at 0, 1, 2, 3, 4 and 5 or more miles. A word should first be said about the selection of regions. They were designed to divide the study area into sections joining at corners as nearly as possible in the vicinity of the larger cities. In this way combinations of regions in four directions outward from a common corner yields the opportunity to place most of Michigan's larger cities at the center of an area surrounding it on all sides.

Considering the maps of frontage-tabulation first, the zero impact map illustrates three important points. The largest and next to largest regional percentages of highway frontage with no impact are southeast and southwest of the Lansing area. The Detroit to Saginaw-Bay urban axis shows up in a zone of five regions, including the smallest percentage of zero impact, from Detroit to Flint. Other high percentage regions of zero impact are in the Eastern Thumb area and the farthest region away from Detroit in the northwest corner of the study area.

One mile impact map (Figure 10 B) shows a tendency for the very high percentages of one mile depth of impact by frontage in the northern and southern tiers of regions. Percentages there are in the high fifties and sixties. In the center within regions bordering U. S. 16 on the north and south from Detroit to Muskegon percentages are in the forties and low fifties. Depth of impact by frontage for two miles (Figure 10 C) shows just the opposite pattern. Lower percentages in the northern tiers and in the south central tiers with averages in the "teens" while the alignment northwest from Detroit toward Clare, and to Muskegon and the strongest with percentages in the twenties. Map D, showing three miles of frontage impact, reveals a pattern of two urban-regional combinations against a background of minimal highway mileage of that degree of impact. The two exceptions are Detroit and Grand Rapids-Muskegon. Frontage depth-of-impact of four miles is important only in the Detroit regions bordering the St. Clair River and the adjacent Ohio boundary-region near Toledo. Impact through highways to a depth of five or more miles shows a fragmentary scattered pattern associated undoubtedly with major cities. Maps G and H show composites of two or more miles of impact depth and three or more miles of impact depth. Detroit alignment of regions along the St. Clair River, the Lake Michigan Shore and the Route 16 alignment Detroit to Muskegon are strongest. In the case of three or more miles the division of the study area into East and West groups of regions divided by a trough of low percentages occurs for these depths of impact.



PROPORTION OF HIGHWAY FRONTAGE BY REGIONS SHOWING NON-FARM LAND USES TO VARYING DISTANCES BACK FROM HIGHWAYS

Figure 10

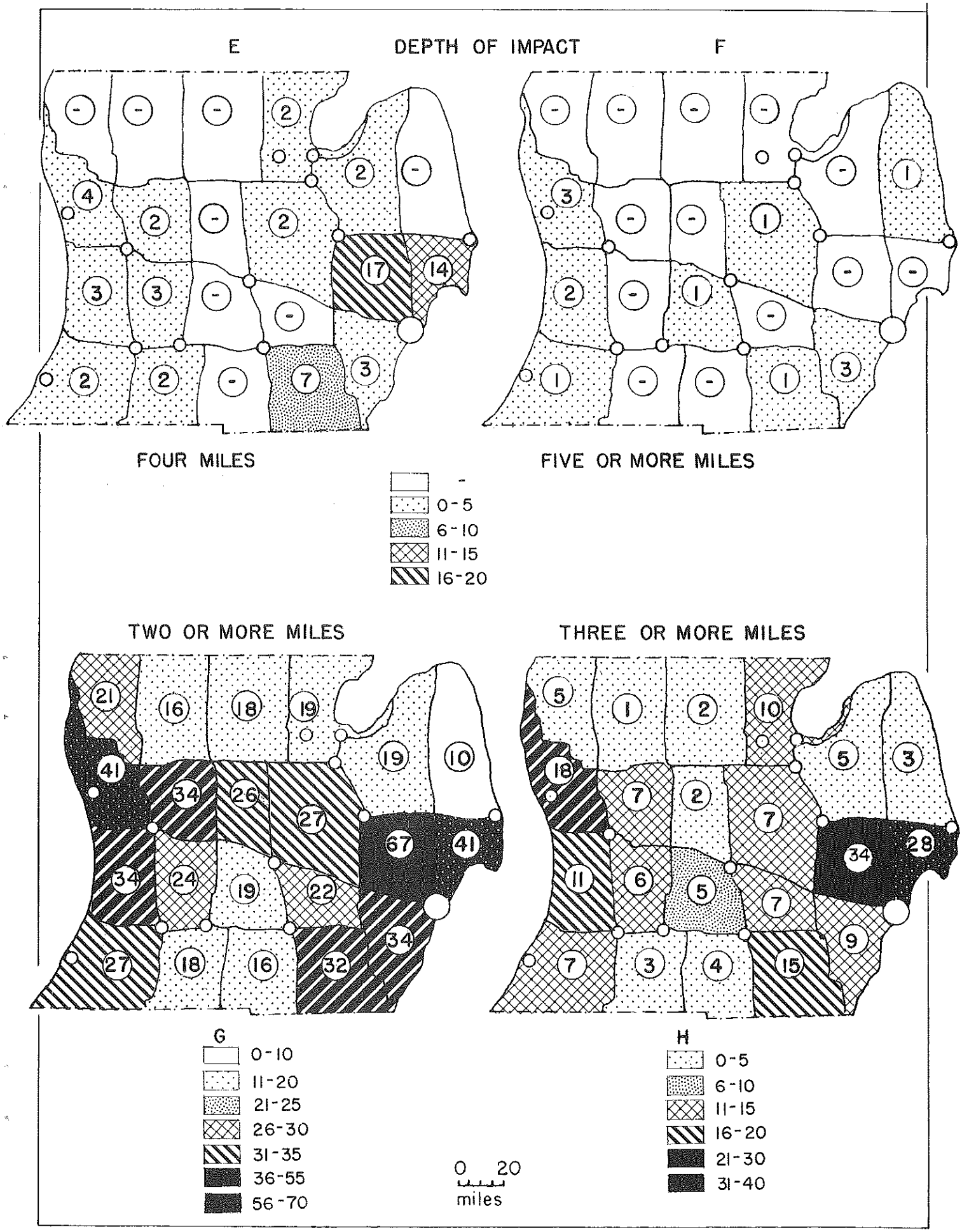
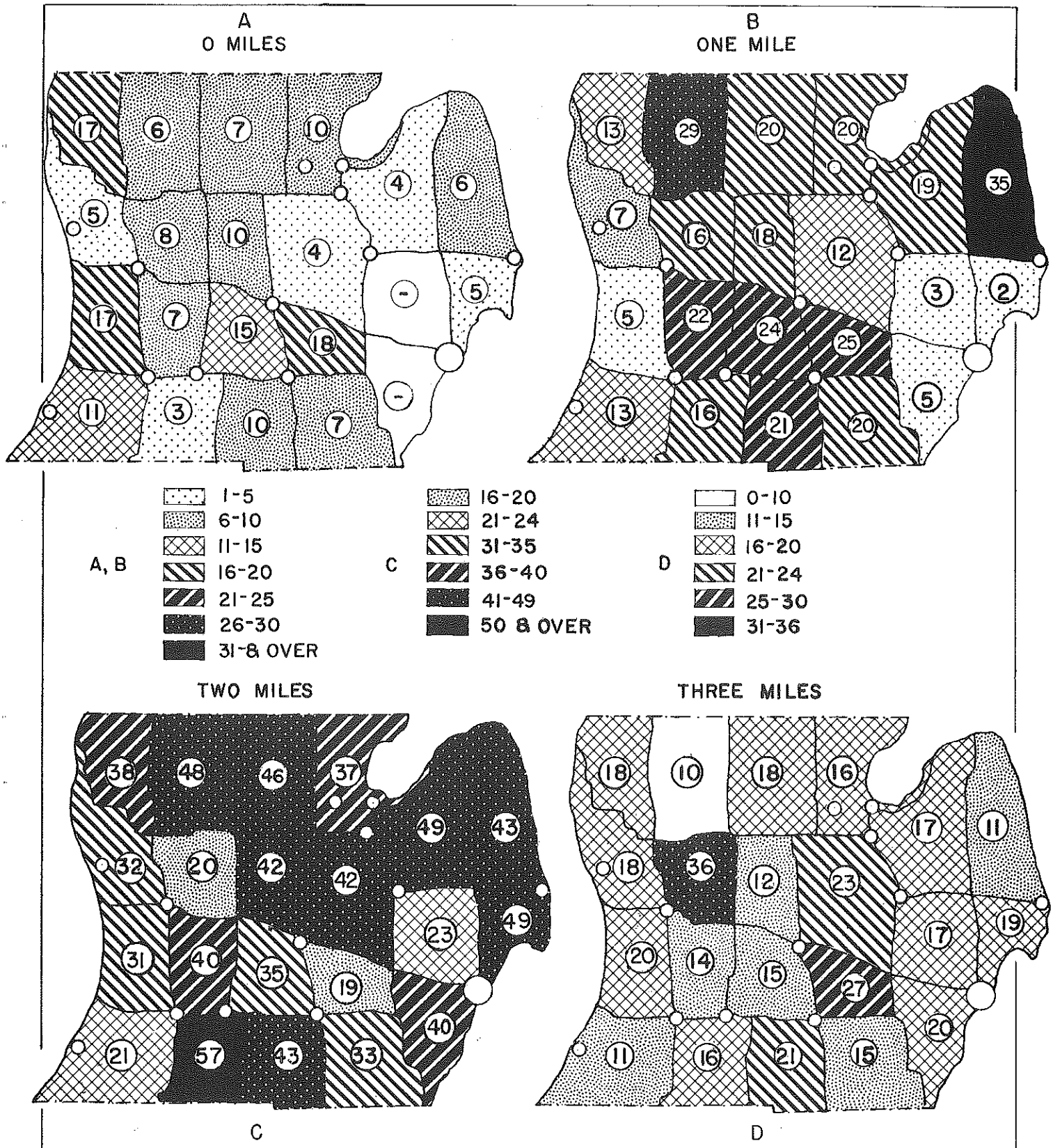

E
DEPTH OF IMPACT
F
FOUR MILES
FIVE OR MORE MILES
-
0-5
6-10
11-15
16-20
TWO OR MORE MILES
THREE OR MORE MILES
G
0-10
11-20
21-25
26-30
31-35
36-55
56-70
0 20
miles
H
0-5
6-10
11-15
16-20
21-30
31-40

Figure II

The maps in Figures 12 and 13, showing the proportion of both sides of the highway of varying widths of impact, record substantially the same picture; but are deemed worthy of record because they show the relative length of highways in terms of width of impact when both sides are taken together as they actually occur. Map A shows zero impact. Relatively very small amounts of highways in the Detroit to Saginaw Bay Corridor are of this category. The largest amounts of zero-impact highway occur around the Lansing area, and in the regions along the Lake Michigan shore. One mile depth of highway impact, shown in Map B, when both sides are taken together means impact on one side of one mile and zero impact on the other. The mileage of this sort is smallest in the regions of the Detroit Corridor and the western regions extending from Kalamazoo to Muskegon and is largest in the eastern Thumb region. Map C, showing two miles of impact depth, shows a tendency for high proportions of mileage in the high thirties and low forties in the north and extreme south central regions of the study area. Along the central alignment from Detroit to Muskegon proportion of two miles of highway impact are in the twenties and thirties for the most part. This is a reflection of the fact that the picture is reversed for three or more miles of highway impact. The regional pattern for any single category of higher impact width is perhaps best generalized by the four mile width. This includes two miles on each side of the highway, three and one, and four and zero as the possible combinations of four mile width. Regions from the St. Clair River border of southeastern Michigan narrowing to a belt of east-west regions north of Lansing toward Muskegon join the north-south band of Lake Michigan coastal regions in having substantially more than 10 percent of all highways in this category of impact width. The high is 31 percent in the region diagonally from Detroit to Flint, followed by 22 percent in the region northwest from Grand Rapids which includes Muskegon. Another figure worth noting is the 17 percent of four mile width of impact in the region northwest of Lansing. Maps F and G record widths of five and six miles. In them the scattered and fragmented pattern of the two largest cities emerges in regions around Detroit and Grand Rapids. Perhaps the best summary of this entire regional discussion is afforded by the composite map of impact width of three or more miles shown in map H. In this map the north-south alignment from Detroit to Saginaw Bay emerges strongly, as does also the east-west alignment from Detroit to Muskegon. The latter has a low point, just barely high enough to make a "ridge" in the region northwest of Lansing where the proportion dips to 29 percent. Everywhere in the "H" shaped region of higher proportionality of highways with more than 3 miles of impact width the figure is 30 percent



PROPORTION OF HIGHWAY IMPACT BY REGIONS TO VARYING DEPTHS BACK FROM THE HIGHWAYS ON BOTH SIDES

Figure 12

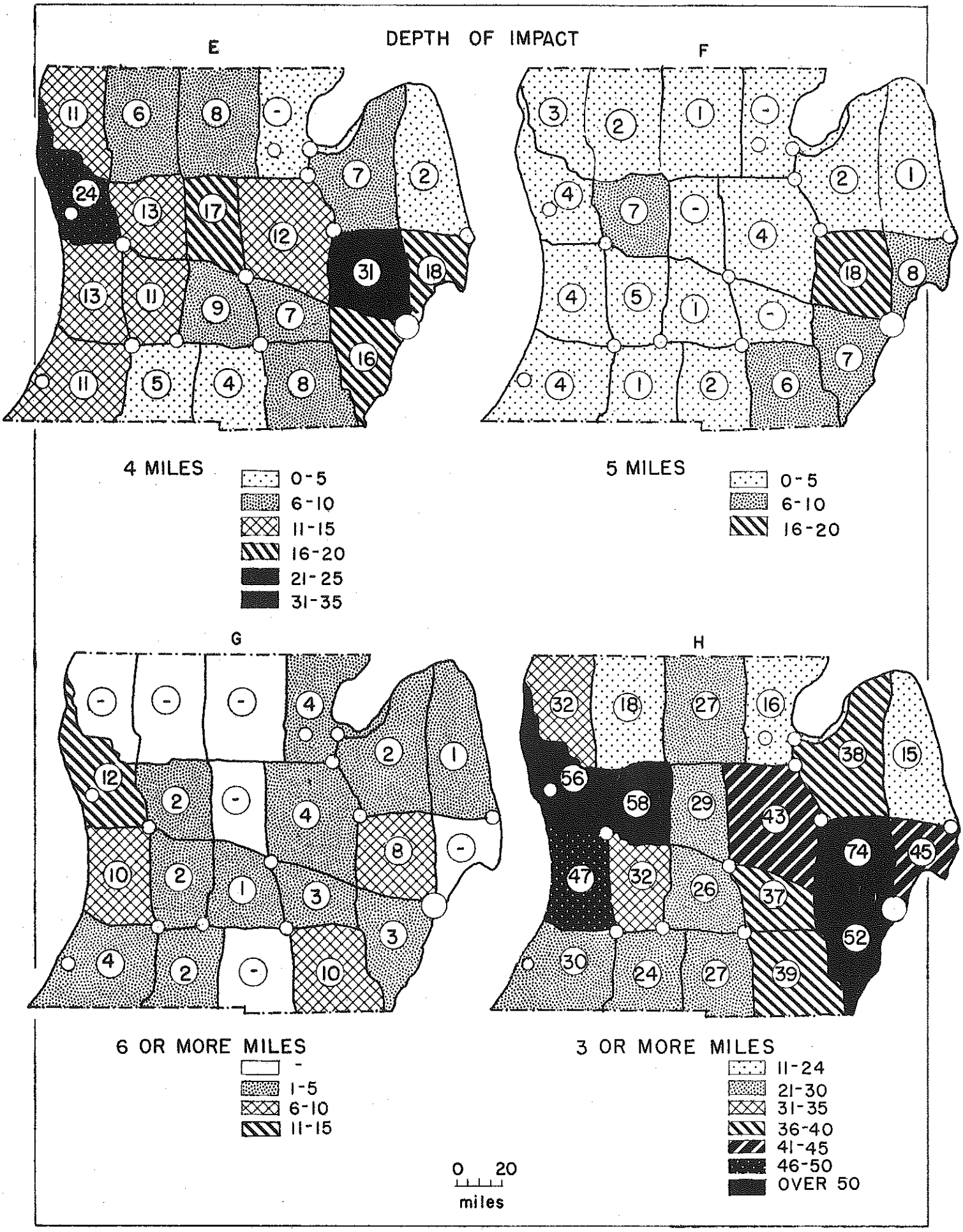

DEPTH OF IMPACT
E
F
4 MILES
0-5
6-10
11-15
16-20
21-25
31-35
5 MILES
0-5
6-10
16-20
G
H
6 OR MORE MILES
-
1-5
6-10
11-15
3 OR MORE MILES
11-24
21-30
31-35
36-40
41-45
46-50
OVER 50
0 20
miles

Figure 13

or more. Two regions in the Detroit complex have more than 50 percent in this category, as have two in the Grand Rapids complex.

Relation of the Web of Impact to the Dispersed City Concept

What is the relationship between the pattern of the web of impact and the concept of the dispersed city? An answer to this question may be found in the proportion of the quarter sections having non-farm land uses shown on the map in Figure 1 which are accounted for in the highway-oriented territories of the web of impact. This relationship was analyzed. If one were to superimpose the web of impact over Figure 1, nearly three-fourths of all of the black squares, 73.7 percent, would fall within it.

That relationship gives rise to the question, just how much of the total area of the 47 counties is devoted to the zone or web of impact? For the significance of having nearly three-fourths of the dispersal of urban-type land uses within the web of impact depends in part upon the probability of their coinciding by chance alone.

The improbability of this occurrence is shown by the fact, as calculation shows, that only 42.9 percent of the total area of the 47 counties within the study area is within the web of impact, whereas nearly three-fourths of the dispersed urban-type land uses are concentrated within the web of highway impact. The regional variations within the study area are shown in maps X and Y of Figure 14 for two separate ratios used to establish these facts. Map X shows the percent of the total area occupied by the web of impact. Map Y shows the regional variations of the percentage of quarter sections having some non-farm land uses within the web of impact.

Examination of these maps in Figure 14 shows that they have quite similar patterns but separated for the patterns as a whole by from 25-35 percentage points. The difference between 73.7 and 43.2 is 30.5. This represents the average difference in percentage points between Maps A and B.

It may be concluded, therefore, that the composite web of highway impact is a reasonable measure, both of the geographical distribution of the DISPERSED CITY and of the role of state and federal highways as arteries making its development possible.

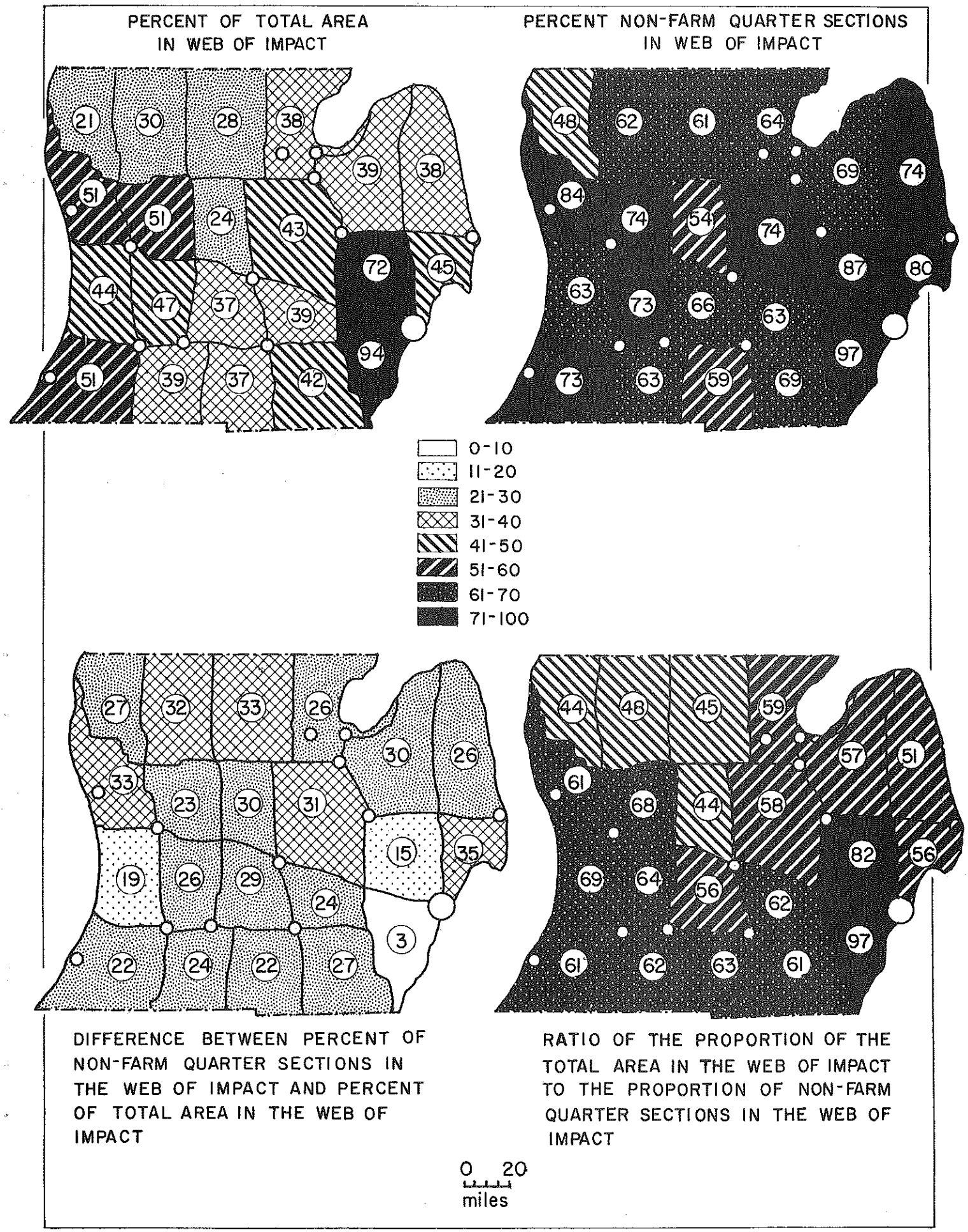

PERCENT OF TOTAL AREA IN WEB OF IMPACT
PERCENT NON-FARM QUARTER SECTIONS IN WEB OF IMPACT
0-10
11-20
21-30
31-40
41-50
51-60
61-70
71-100
DIFFERENCE BETWEEN PERCENT OF NON-FARM QUARTER SECTIONS IN THE WEB OF IMPACT AND PERCENT OF TOTAL AREA IN THE WEB OF IMPACT
RATIO OF THE PROPORTION OF THE TOTAL AREA IN THE WEB OF IMPACT TO THE PROPORTION OF NON-FARM QUARTER SECTIONS IN THE WEB OF IMPACT
0 20
miles

Figure 14

Ten Dispersed-City Regions

If the reader will refer back to the map in Figure 1, it is apparent that each of the major as well as minor cities of the study area exhibits a marked scattering of quarter sections with some urban or at least non-farm type land uses within them outward from their formal borders. Analysis has already been made by strip-areas revealing the regular manner in which this pattern diminishes numerically along or parallel to and also perpendicularly with respect to highways. The visual pattern of decreasing numbers of quarter sections outward from major cities can be used to define the outlines of outer boundaries for the territories primarily focusing upon each as far as commuting and general movement into and out from central cities is concerned. The ten maps in Figures 15 to 24 show for ten major urban regions an hypothesis of the extent of each as a DISPERSED-CITY REGION based upon visual analysis of the original gross land use map.

Definition of Dispersed-City Regions

This visual analysis is based upon two criteria. These are contiguity, or substantial coverage of whole townships. Contiguity is simply the visual appraisal of the fact that the individual quarter sections touch one another at the scale of unit areas a quarter square mile in size, in succession back to the continuously built-up city. Substantial coverage of whole townships indicates, as is obvious by examining the maps, that the regions are defined in terms of combinations of whole townships. This was done in order to facilitate relation of these dispersed-city regions to minor civil division statistics of the U. S. Census and to administrative units of the political area organization within our society. The outlines of dispersed-city regions in the maps, accordingly, are those parts of the pattern of the original land use map shown in Figure 1, around major Michigan cities in the study area which substantially covered whole townships with quarter sections exhibiting dispersed non-agricultural or urbanized land uses. In the majority of the townships in such a case, the dispersed non-agricultural or urbanized quarter sections are largely though not entirely contiguous through one another back to the areas of the central cities shown in white.

Maps were made for each of the following Dispersed-City Regions: Detroit, Grand Rapids, Flint, The Tri-Cities (Bay City, Saginaw, and Midland), Kalamazoo-Battle Creek, Lansing, Muskegon, Jackson, Benton Harbor-St. Joseph, and Port Huron.

THE DETROIT DISPERSED-CITY REGION

Figure 15

THE GRAND RAPIDS DISPERSED-CITY REGION

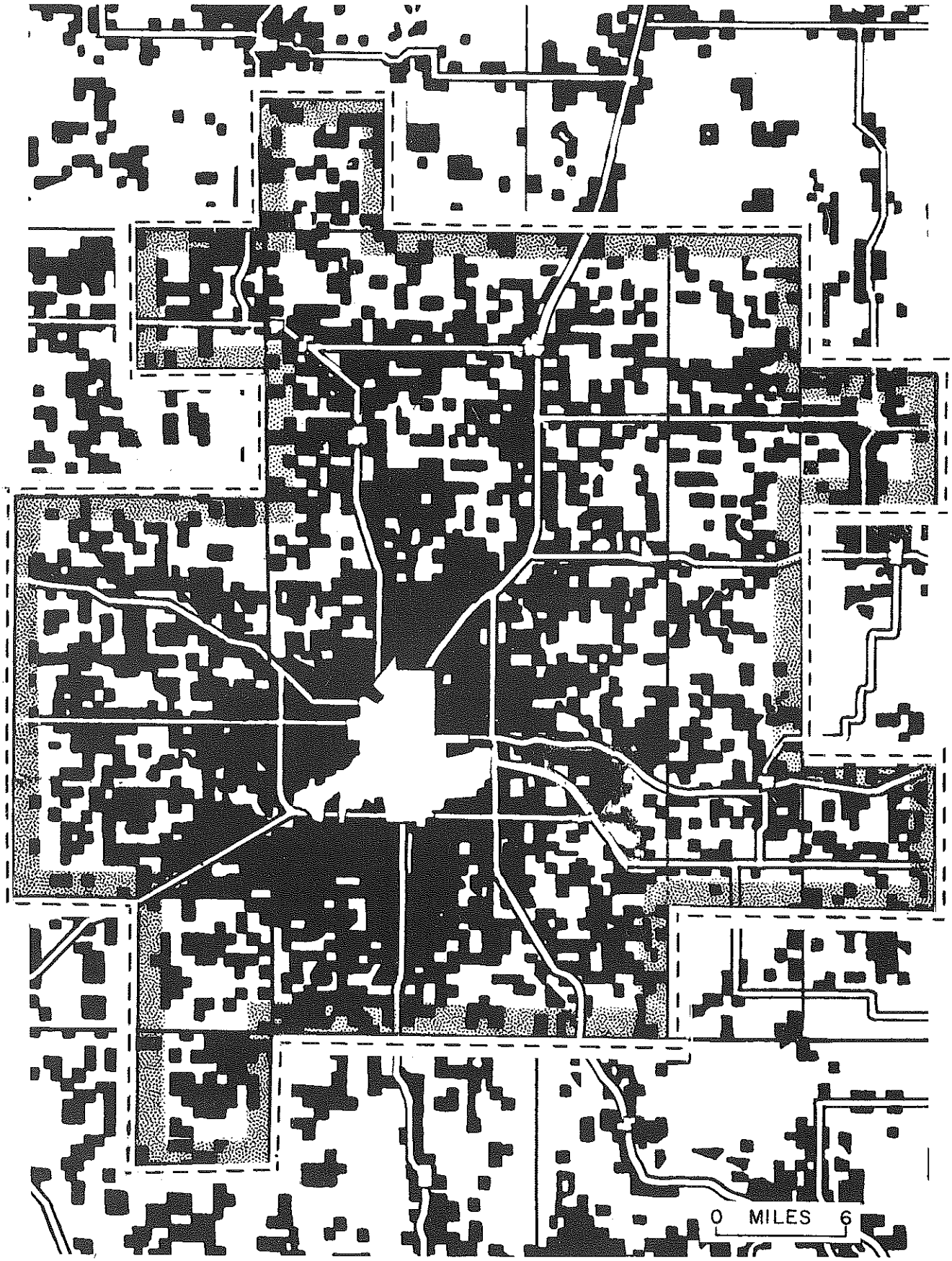


Figure 16

THE FLINT DISPERSED-CITY REGION

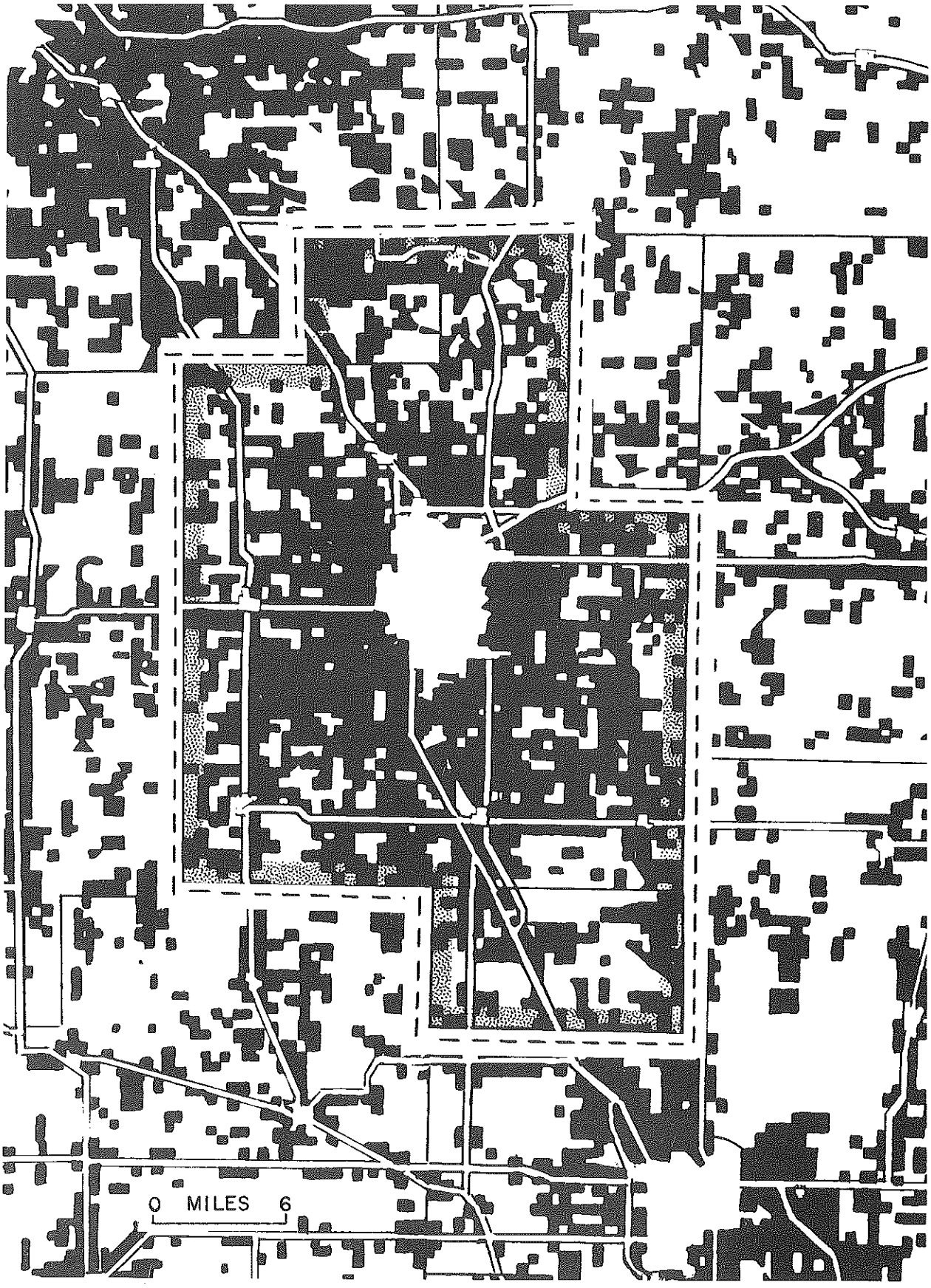


Figure 17

THE TRI-CITY DISPERSED-CITY REGION

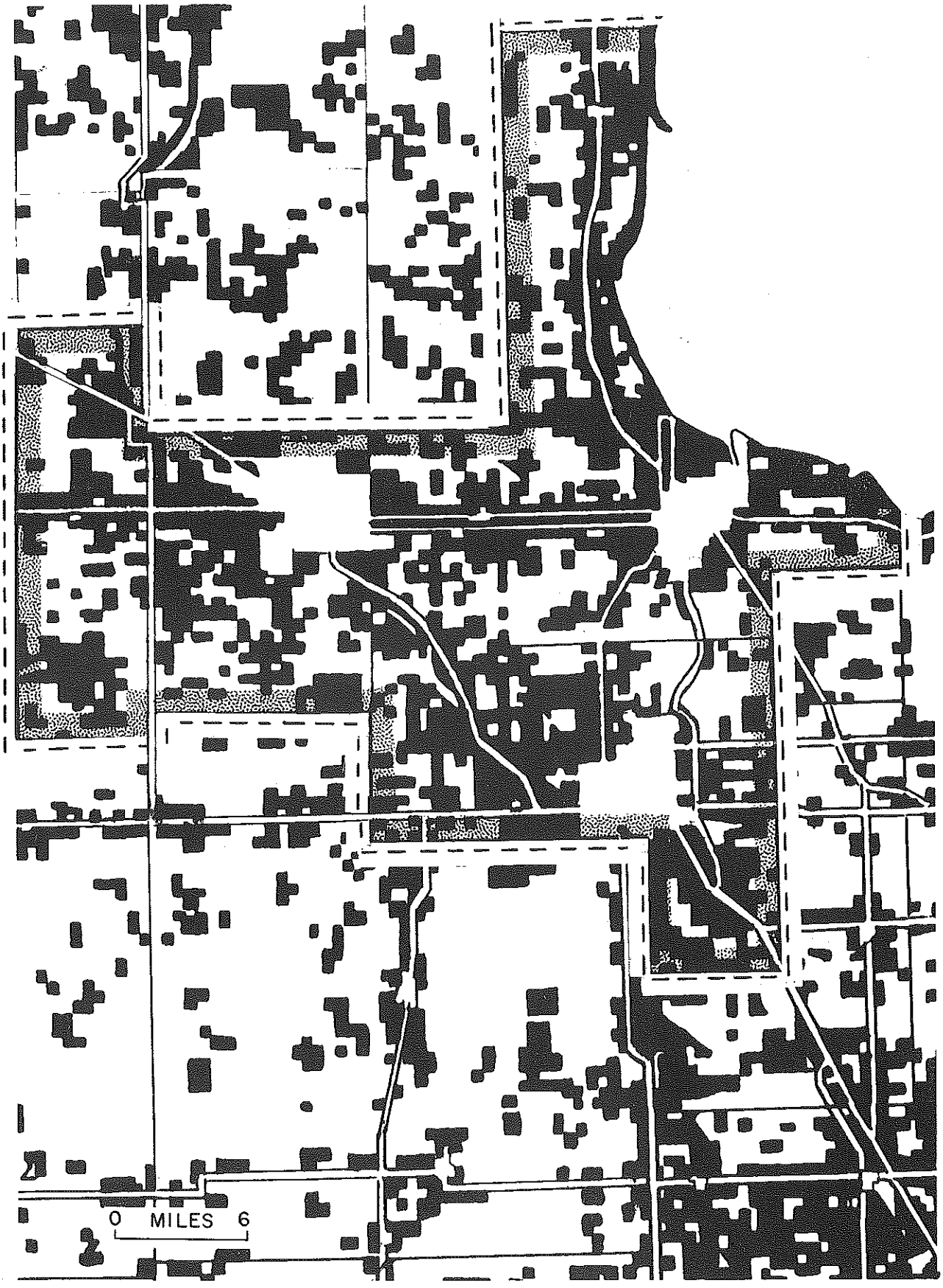


Figure 18

THE KALAMAZOO-BATTLE CREEK DISPERSED-CITY REGION

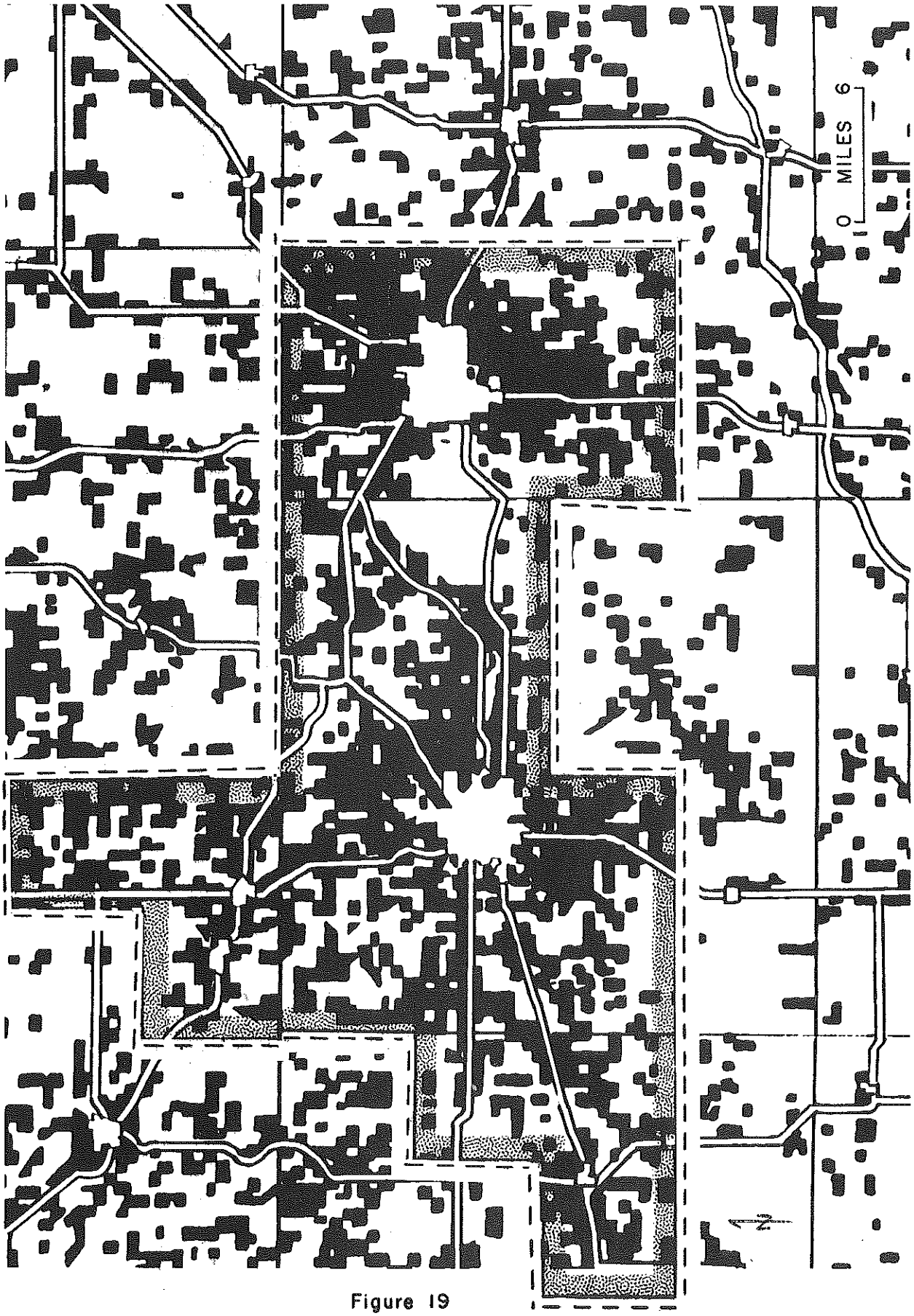


Figure 19

THE LANSING DISPERSED-CITY REGION

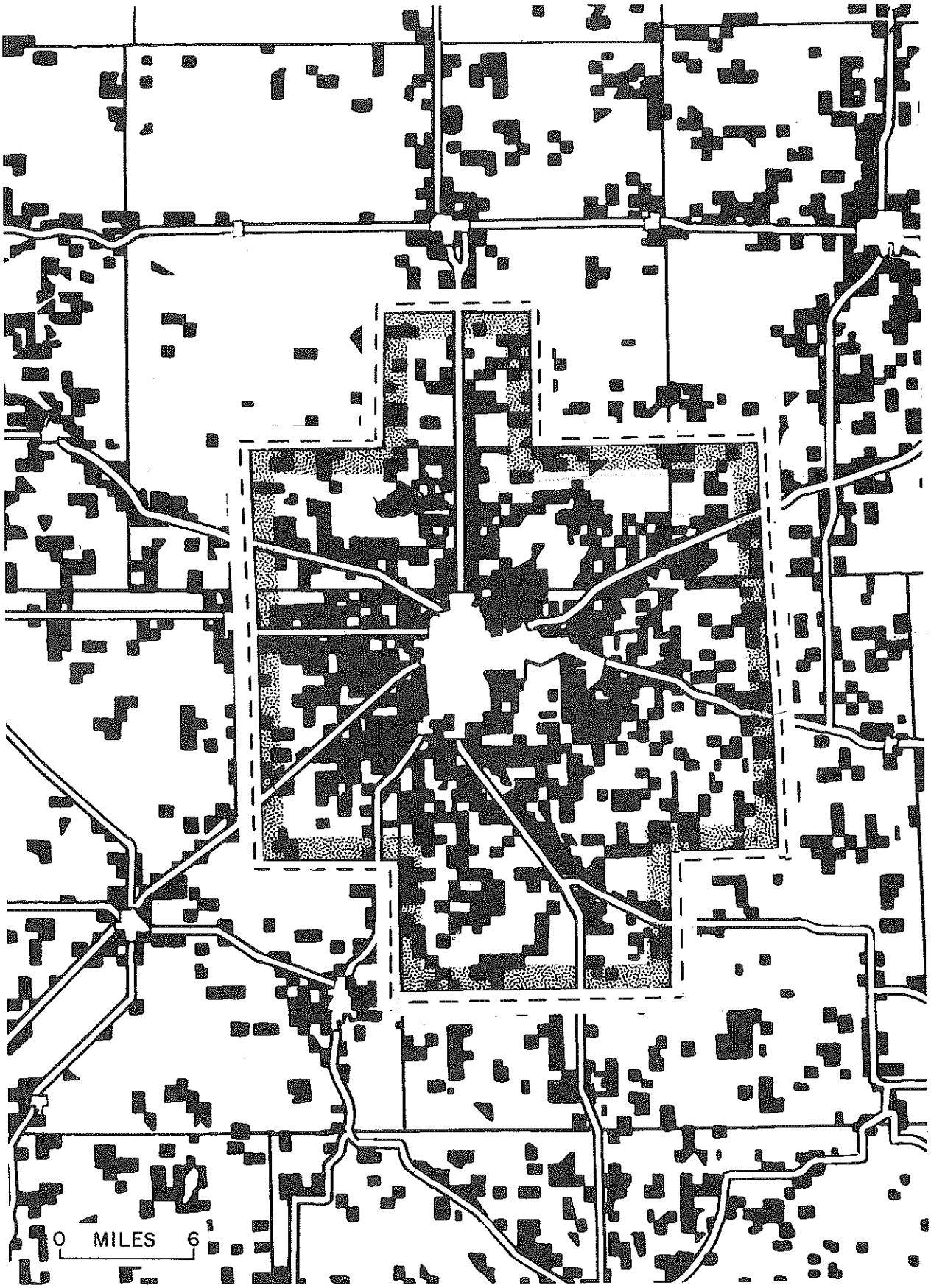


Figure 20

THE MUSKEGON DISPERSED-CITY REGION

Figure 21

THE JACKSON DISPERSED-CITY REGION

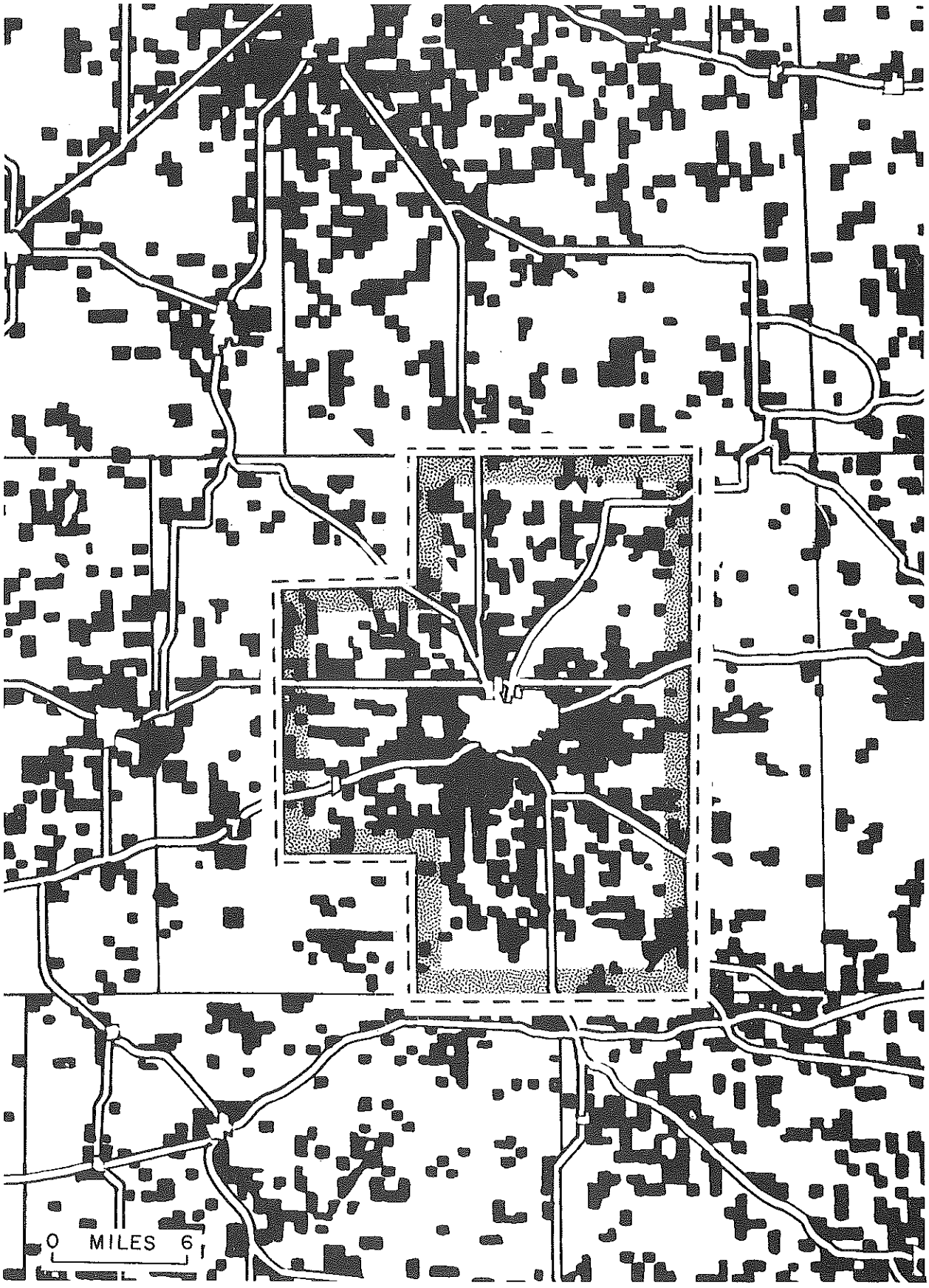


Figure 22

THE BENTON HARBOR - ST. JOESEPH DISPERSED-CITY REGION

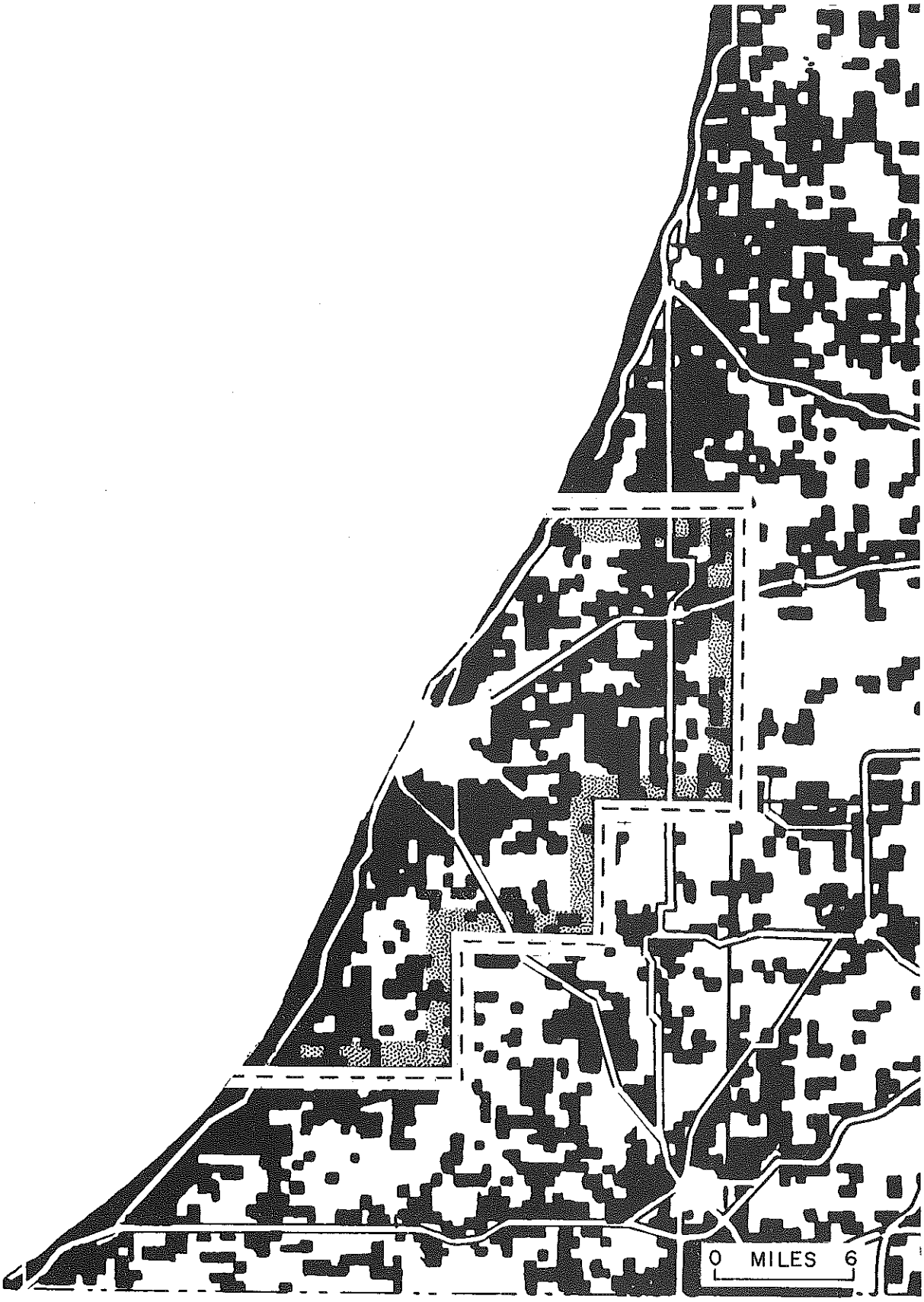


Figure 23

THE PORT HURON DISPERSED-CITY REGION

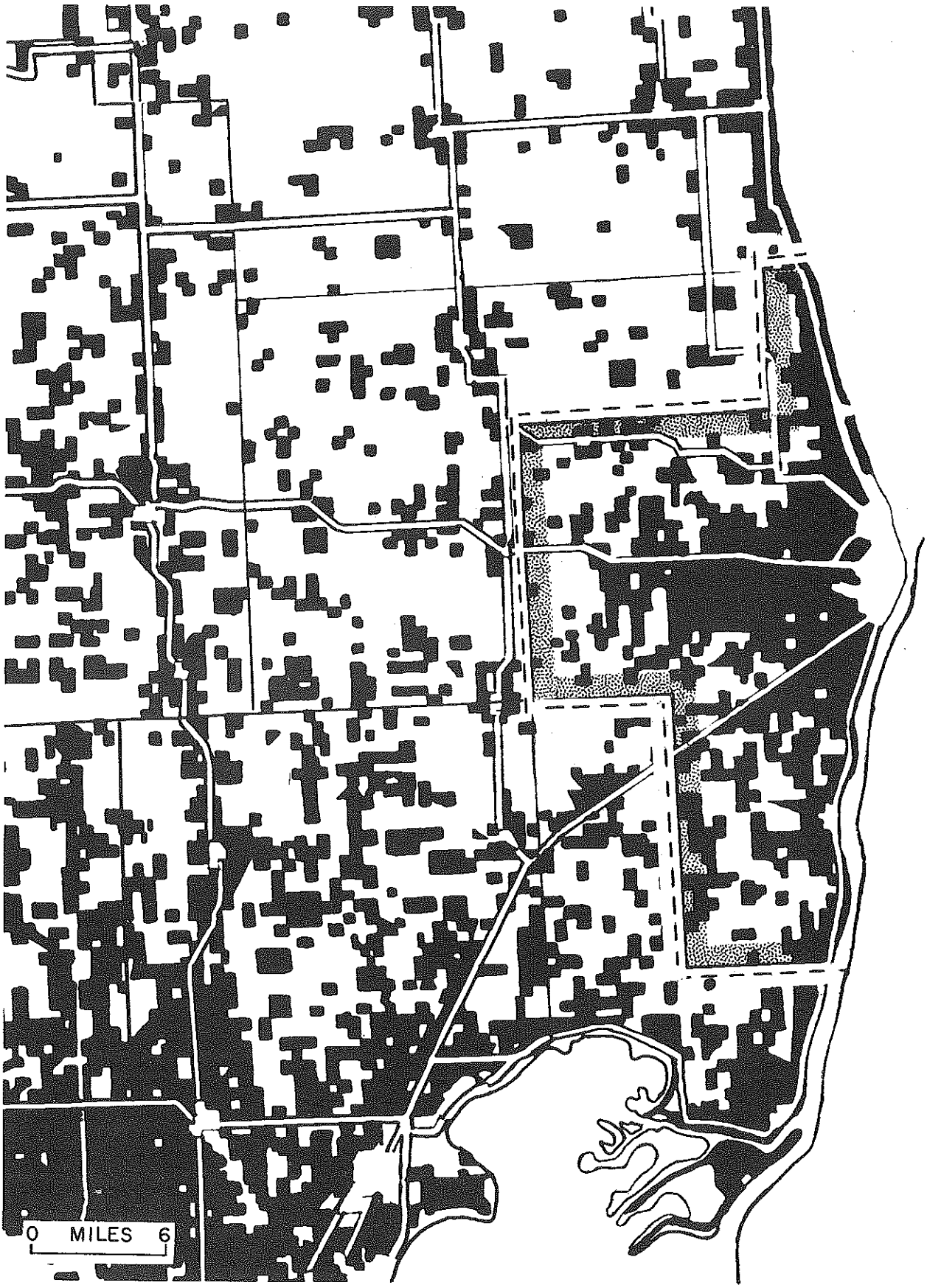


Figure 24

Data for each of these regions, for 1940 and 1950, for comparison purposes, are presented in Table III. Not all of the preliminary figures necessary are available for the same type of information to be included for 1960. In the cases of those dispersed-city regions where the information was available, these data have been provided in Table V. The map in Figure 25 shows the territories of the study area included in the dispersed-city regions.

Population of Dispersed-City Regions

According to Table III, there were, in 1950, 4,762,544 people living in the 10 dispersed-city regions out of a total population of the study area of 5,836,236. This shows the concentration of 81.6 percent of the people of the area in these dispersed city regions. From the standpoint of the localization of population generating the traffic on the state's highways from within the study area, the fact that this percentage is as high as it is seems quite significant. The corresponding percentage for 1940 was 79.8 percent.

The table separates the population of each dispersed-city region into two components, those living within nucleated settlements and those living in dispersed settlement. The percentage of dispersed settlement to total dispersed-city region population varies from 22.3 percent for the Detroit Complex to 52.9 percent in the case of the Benton Harbor-St. Joseph Complex. Nucleated settlement in these instances means all incorporated places and all unincorporated places listed in the censuses of 1940 and 1950. In cases where new places were listed in the 1950 census which had not been listed in the 1940 census, the 1940 census was followed in order to make the totals comparable. The total population in dispersed settlement within the territory of the dispersed-city regions as defined on the map but outside city or village limits in Figure 25 was well under one million (835,441) in 1940. In 1950 it was more than a million and a quarter (1,293,114). This sizeable portion of the state's population lives within what may be defined as an urban-peripheral environment and focuses its activities within major urbanized areas. It is more than one-fourth of the population of the study area (27.2 percent). This portion of the population was only slightly more than one-fifth of the corresponding study area population in 1940 (22.2 percent). It is probably approaching one-third of the population in 1960.

According to the total shown in Table III, the population of all 10 dispersed-city regions combined grew from 3,764,349 in 1940 by almost one million persons (998,195). During the same period

TABLE III
POPULATION OF DISPERSED-CITY REGIONS 1940 - 1950

Region Nucleated Dispersed	Area in Sq. Mi. (Den.Sq. Mile)	1950 Population	% Dispersed	1940 Population	% Dispersed	Change	% Dispersed	% Change over '40
Detroit	2453.3	3,172,570		2,468,260		704,310		28.5
Nucleated	(1302.7)	2,466,560	22.3	2,045,236	17.1	421,324	40.2	20.6
Dispersed		706,010		423,024		282,986		66.9
Gr.Rapids	1262.9	319,104		271,668		47,436		17.5
	(252.7)	204,629		187,171		17,458		9.3
		114,475	35.9	84,497	31.1	29,978	63.2	35.5
Flint	683.9	275,566		232,034		43,532		18.8
	(402.9)	182,316		167,417		14,899		8.9
		93,250	33.8	64,617	27.8	28,633	65.8	44.3
Tri-City	719.3	233,835		192,887		40,948		21.2
	(325.1)	164,116		144,496		19,620		13.6
		69,719	29.8	48,391	25.1	21,328	52.1	45.1
Kal.-B.C.	790.9	223,312		174,087		49,225		28.3
	(282.4)	119,281		108,747		10,534		9.7
		104,031	46.6	65,340	37.5	38,691	78.6	59.2
Lansing	521.9	179,088		134,599		44,489		33.1
	(343.1)	119,617		90,418		29,199		32.3
		59,471	33.2	44,181	32.8	15,290	34.3	34.6
Muskegon	429.6	130,098		101,742		28,356		27.8
	(302.8)	86,049		68,402		17,647		25.8
		44,049	33.9	33,340	32.8	10,709	37.8	32.1
Jackson	372.8	96,256		82,890		13,366		16.1
	(258.2)	52,280		50,740		1,540		3.0
		43,976	45.7	32,150	38.8	11,826	88.5	36.8
B.Hbr.-St.J.	237.4	68,457		54,023		14,434		26.7
	(288.4)	32,225		28,274		3,951		14.0
		36,232	52.9	25,749	47.7	10,483	72.6	40.7
P.Huron	259.7	64,258		52,159		12,099		23.2
	(247.4)	42,357		38,007		4,350		11.4
		21,901	34.1	14,152	27.1	7,749	64.0	54.8
Total	7,713.7	4,762,544		3,764,349		998,195		26.5
Nucleated	(617.4)	3,469,430	(72.8)	2,928,908	(77.8)	540,522	(54.1)	18.4
Dispersed		1,293,114	27.2	835,441	22.2	457,673	45.9	54.8
State Pop.	57,022	6,371,766		5,256,106		1,115,660		21.2
	(111.7)							
Balance Outside D-C Reg.	49,308	1,073,692		950,136		123,556		13.0
	(21.7)							

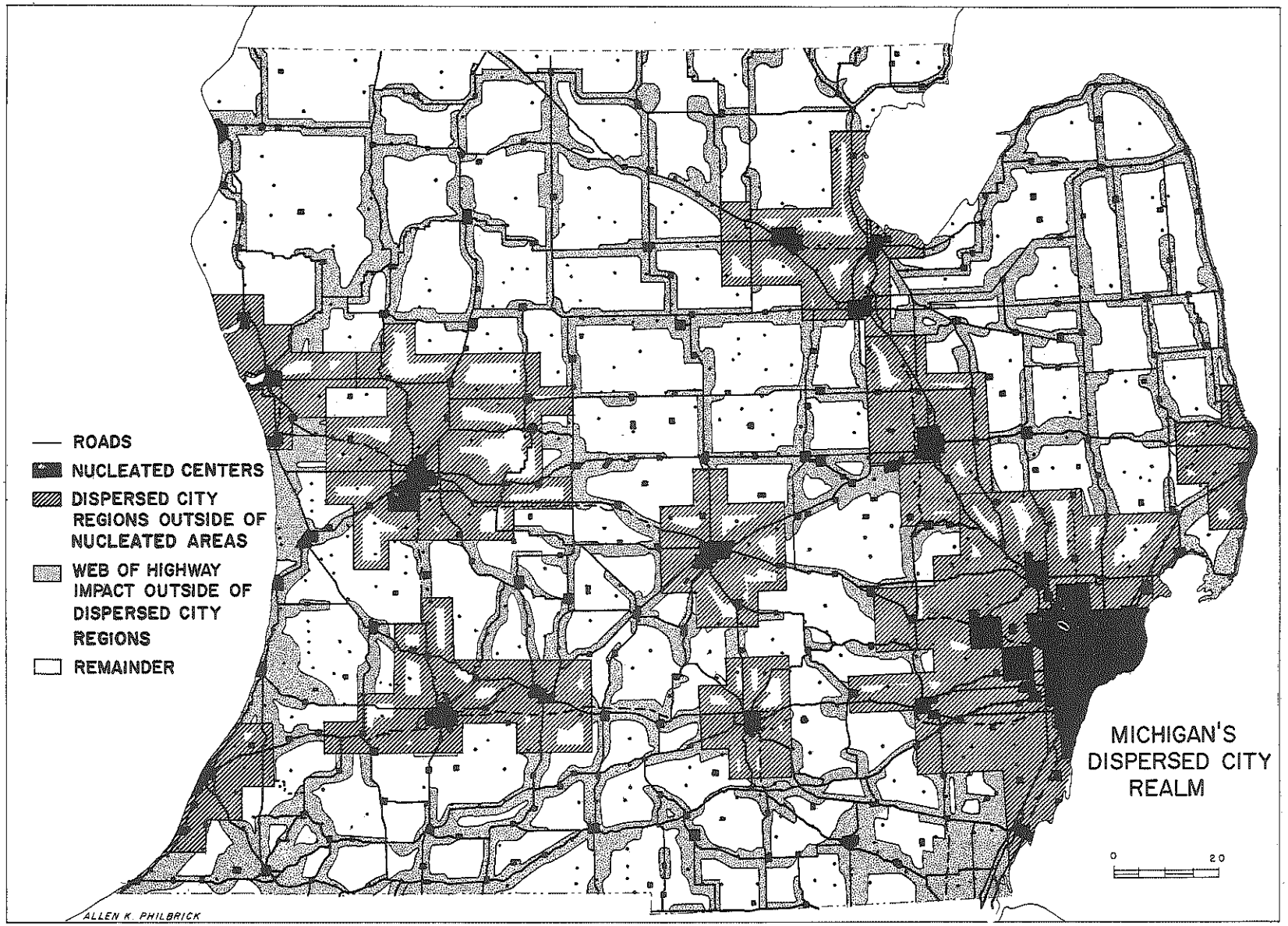

ROADS
NUCLEATED CENTERS
DISPERSED CITY REGIONS OUTSIDE OF NUCLEATED AREAS
WEB OF HIGHWAY IMPACT OUTSIDE OF DISPERSED CITY REGIONS
REMAINDER
MICHIGAN'S DISPERSED CITY REALM
0
20
ALLEN K. PHILBRICK

Figure 25

the population of the entire study area grew only by 1,121,751. This means that the change in population within the dispersed-city regions from 1940 to 1950 was 89 percent of the total population increase in the study area. Since the net population change in the entire state was less than that in the study area, only 1,115,660 persons, it may be said that the change in the dispersed-city regions enumerated accounted for 90 percent of the net population growth during the 1940s in the entire state. These findings show to what extent these major concentrations of population and hence traffic generation dominate the state numerically.

Area of the Dispersed-City Regions

The regions as shown on the map in Figure 25 comprise a total of 7,713.7 square miles out of 29,364 in the study area. This means that the dispersed-city regions occupy more than one-fourth (26.3 percent) of the total area, not counting those parts of the dispersed pattern of non-farm land uses outside of the dispersed-city regions as defined. If the reader refers to the map in Figure 25 once again, showing the territory occupied by the 10 dispersed-city regions as defined, it will become evident that they are grouped in three major complexes. These are the Detroit-Saginaw Bay Axis, including Port Huron, the Western Michigan Complex including Grand Rapids, Kalamazoo-Battle Creek, Muskegon and Benton Harbor-St. Joseph, and the Capitol Complex comprising Lansing and Jackson. These regions have been referred to in the tabulation of highway mileage with varying depths of impact back from the highways by regions in preceding sections. It will be recalled that the regions corresponding generally to the Lansing-Jackson capitol complex show up on the map recording the percent of the web of impact to total area in map X of Figure 14, and on map H of Figure 13, recording the depth of impact of three or more miles of both sides of the highway, and on map A of Figure 10 showing the highest proportion of highways with zero impact by regions within the entire study area. These facts were reflected in the "hole in the doughnut" characterization for the area just outward from the pattern of non-farm land uses and urban dispersion around Lansing, in particular, with respect to the even greater dispersion evidenced from cities in the east and western regions of the state. In the same vein, the greater urbanization in the eastern and western thirds of the study area, it will be recalled, was similarly reflected in more miles of highway-impact within those same regions.

Measures of the Dispersed-City Concept in the Study Area

Taking all of the previous discussion into account, it may be said that all of the phenomena of urban dispersal within the study area of Michigan justifies the observation that the lower half of the Lower Peninsula of Michigan encloses in reality one great dispersed-city realm comprising 10 or more major dispersed-city regions and a composite web of highway impact interconnecting them. Data measuring and reflecting the spatial concentricity of this pattern of affairs are presented in Table IV.

Table IV and the map in Figure 25 both show a regular progression of diminishing concentrations of population within the study area. These are the patterns of population which express the patterns of land use in Figure 1. The different categories on the map and in the table measure the number of people involved, the size of the territory they collectively occupy as a category, and the average density of population per square mile within each area. The categories quantify the land use map indirectly; and at the same time make more specific the description of the dispersed-city.

The population of the study area is treated as a spatial continuum. Starting in the nucleated centers, the most concentrated population in the cities and unincorporated villages accounts for roughly 60 percent of the total with an average density of more than 5,500 per square mile. Dispersed settlement within the territories defined as dispersed-city regions brings the total to more than four-fifths in a little more than one-fourth of the area, as already indicated. The next larger concentration as shown on the map in Figure 25 is that part of web of impact not already accounted for within the dispersed-city regions. This raises the cumulative area of the dispersed-city to 42.9 percent. No estimate of the division of population between the balance of the web of impact and the rest of the study area is readily obtainable. The remaining 18 percent of the population averages 50 persons per square mile. The patterns on the map in Figure 25 and the outer edges of dispersed non-farm land uses on the map in Figure 1, however, give an idea of how this remainder of the population is distributed.

The partial evidence available at this time for 1960 population recorded in Table V shows that the process of growth of the pattern of urban dispersal has been continuing since the 1950 census. In another decade the Grand Rapids dispersed-city region if it keeps up the present rate of growth will have passed the half million mark. It has passed 400,000 in 1960. In 1960 the

TABLE IV

THE MICHIGAN DISPERSED-CITY REALM

Category	1950 Population	Per-cent	Cumulative Population	Per-cent	Area in sq. miles	Per-cent	Cumulative Area	Per-cent	Pop.per sq.mile
Study Area	5,836,236	100	5,836,236	100	29,364	100	29,364	100	199
Nucleated settlement areas in Dispersed-City Regions	3,469,430	59.4	3,469,236	59.4	610	2.1	610	2.1	5,688
Dispersed settlement areas in Dispersed-City Regions including some farmers	1,293,114	22.2	4,762,544	81.6	7,104	24.2	7,714	26.3	182
Areas outside Dispersed-City Regions	1,073,692	18.4	5,836,236	100					50
Part of which is occupied by dispersed settlement within the web of impact, including farmers					4,891	16.6	12,605	42.9	
The remainder of which is occupied partly by people developing non-farm land use; and partly by farmers					16,759	57.1	29,364	100	
Subtotal	1,073,692	18.4	5,836,236	100	21,650	73.7	29,364	100	50

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TABLE V

Population of Selected Dispersed-City Regions
1950-1960

City Regions	Area	1950 Population	Density Per Sq. Mile	1960 Population	Density Per Sq. Mile	% Change in Density 40-50	50-60
Grand Rapids	1262.9	319,104	252.7	402,040	318.3	17.4	25.9
Flint	683.9	275,566	402.9	377,009	551.3	18.7	36.8
Lansing	521.9	179,088	343.1	225,112	431.3	33.0	25.6
Port Huron	259.7	64,258	247.4	72,524	279.3	23.1	12.8
Total of Four	2728.4	838,016	307.1	1,076,685	395.6	21.4	28.5

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Lansing area passed the 200,000 mark, as defined by the land use map in Figure 1. It is probable that the 10 dispersed-city regions described in this report approach six million in total population. The 1960 population of the study area is 7,237,535, based upon preliminary figures. This is 92.8 percent of the state total. In 1950 it was 91.6 percent, indicating a continuation of the trend of population to become increasingly concentrated in the lower half of the Lower Peninsula. If the proportion of the population in the 10 dispersed-city regions were to have remained the same, and not increased at all, 81.6 percent of the study area population would be 5,905,828 persons.

PART III

CHANGES IN NUMBER OF STRUCTURES IN RELATION TO HIGHWAYS, 1930s TO 1950s

Still another means of quantifying the growth and geographical dispersal of our cities with regard to highways is through the data made available by the second phase of the project. It will be recalled that this phase of the study dealt with the enumeration of change in the number of structures shown by culture symbols upon the general highway maps for each county. These maps occur in two series, one dated 1940 which reflects conditions in the late 1930s, the other variously dated from 1951-1958, reflecting conditions in the early fifties.

Interpretation is shown for the tabulated results of 28 of the counties within the study area. These cover, as the map in Figure 26 shows, all the counties except Lenawee, south of a line generally extending from Muskegon north of Grand Rapids, north of Flint, to Port Huron. The territory encompassed includes all of the dispersed-city regions except the Tri-City complex at the head of Saginaw Bay.

The Pattern of Non-Farm Dwelling Construction

The pattern of non-farm dwelling construction by strip areas within this 28 county territory between the late 1930s and early 1950s is shown on the map in Figure 26. Comparison of this map with those in Figures 1 and 3 shows that the patterns are substantially similar in outline. The value of the map inventory lies in the quantification possibilities it affords with respect to the numbers of structures involved. Before proceeding with a discussion of the number of non-farm dwellings involved, however, the following observations should be made.

The white areas on the maps, except for Lenawee County which was not inventoried, are the congested or most built-up areas where no culture symbols were provided in the 1950 map series. These include not only the city and village territories of nucleated settlement, but also considerable territory immediately surrounding the city or village limits usually thought of as the "urban fringe". No exact count, therefore, of the non-farm dwellings constructed within the dispersed-city regions is possible from the data gathered. Relative comparison, however, of the numbers of structures involved and their locations with respect to highways can be analyzed. Examination of the map showing diminution of

INCREASE IN NUMBER OF NON-FARM DWELLINGS BY STRIP AREAS

FROM THE LATE 1930'S TO THE LATE 1950'S

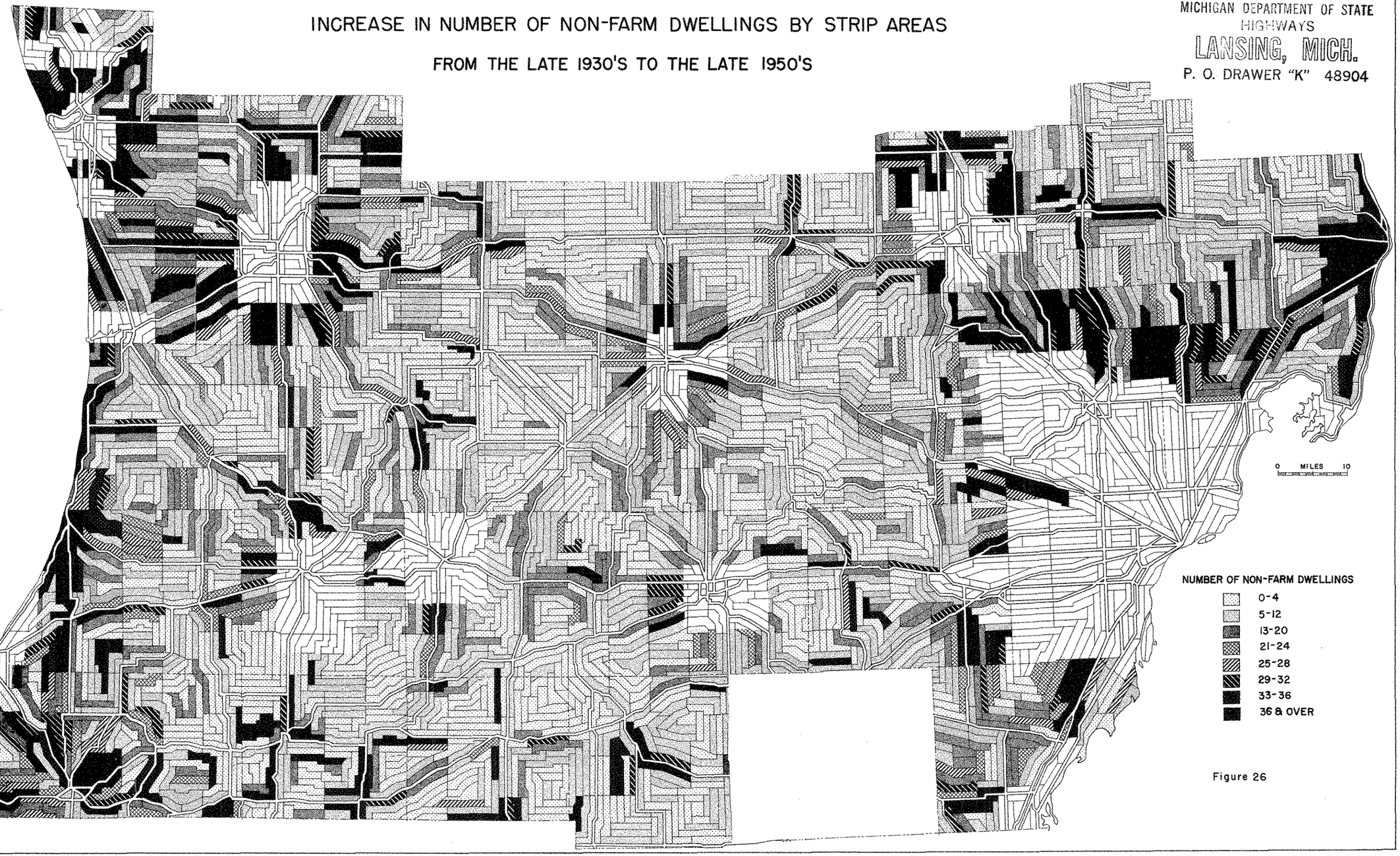

Figure 26

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urban type land uses with distance from both cities and highways in Figure 3 in comparison with the map of changes in number of structures in Figure 26 indicates that these white areas on the latter map correspond to the larger areas of black on the former map. The congested areas were left white on the map in Figure 26, however, in order to show the limits of the territories for which no data were available.

The pattern of black strips indicating the areas of greatest building activity again confirm the existence of an eastern and a western urban concentration in the study area. The evidence of greater building activity than average within the southern two tiers of counties in the state is also worthy of note. The pattern of non-farm dwelling construction during this period again emphasizes the relatively less dense pattern of such structures in the central part of the study area, surrounding the dispersed pattern of construction around the Lansing area.

The Change in Number of Farm Structures between the Two Map Series

The change alone in number of non-farm dwellings in the 28 counties analyzed total 39,211 houses. If one assumes an average of 3.5 persons per family, these non-farm dwellings were occupied by roughly 140,000 persons, (137,237).

There were within the 28 counties of study area number two in 1950 5,172,803 people. If the 4,008,735 persons listed as living in urban areas are subtracted, the remaining 1,164,068 persons account approximately for the rural population of the counties in study area number two. This figure excludes the congested areas for which no culture symbols were available in the 1950 map series, although it cannot do so with statistical precision.

The corresponding figure for 1940 cannot be calculated, however, since the 1940 urban definition did not include urban fringe population as did the 1950 urban definition. Since the 1950 rural population of 1,164,068 may be assumed to have increased at the same rate as the total rural population of the state, 26.2 percent, however, the corresponding figure for 1940 can be estimated to be in the neighborhood of 922,399 persons.

The inventory of 1940 county-highway maps enumerated 9,529 non-farm dwellings within the rural areas of the 28 counties in study area number two. At the same ratio of 3.5 persons per family, this means 33,352 persons. This population figure is 3.6 percent of the estimated rural total. The number of houses counted for

the 1950s map series was 48,740, accounting for a total of 170,590 people. This population figure is 14.6 percent of the 1950 rural population of study area number two.

What is most striking of all, however, is the comparison of the change in total rural population at 26.2 percent with the change in non-farm dwellings enumerated on the county highway maps. The latter increase from 9,529 to 48,740 is over 400 percent (411.5 percent).

It may be concluded, therefore, that the unusually high proportionate increase of non-farm dwellings, which is very substantially highway-oriented, dramatically underscores the dispersion of urban land uses and urban population since World War II.

It must be remembered, of course, that the above comparisons can not be statistically accurate in absolute terms. The urban population does not necessarily correspond with the population of the areas for which no culture symbols were included on the maps. Furthermore, the maps are of various dates, ranging from 1951 to 1958, and the period of change in the numbers of structures does not correspond to the period of the census population. There is also the strong probability that the category of non-farm dwellings includes migratory farm labor temporary-housing which further introduces inaccuracy to precise comparisons. Lastly, as already mentioned, the urban definitions for the two census periods vary considerably.

Nevertheless, the number of new persons involved in non-farm occupancy represents the dispersal, within the countryside in these 28 counties, of a fair-sized metropolitan area, which can be expected to continue to increase rapidly.

Comparison of the Change in Structures Within and Outside of the Web of Highway Impact

If the comparison of the change in number of structures with the change in population is very dramatic, the comparison of geographical pattern of the change with respect to highway orientation is equally revealing.

The number of non-farm dwellings constructed within the web of impact and outside of that territory was calculated. The results of the count showed that 28,943 were within the web of impact as measured by the criteria discussed previously. This number represents practically the identical percentage, 73.8 as the proportion, 73.7 between the number of quarter sections with urban or non-farm

land uses within them in the web of impact out of the total number of quarter sections in the study area. This apparent agreement between the patterns of non-farm dwellings and non-farm land uses by quarter sections must be tempered somewhat, however, by the fact that the study area in one case is 28 counties, while that of the gross land use analysis is 48 counties.

In order to visualize this comparison better, the map in Figure 27 should be examined. It shows the percentage of houses constructed in the period between the two series of highway maps as recorded by the inventory of culture symbols in the web of impact by regions within the second study area. If this map is compared with map Y in Figure 14 showing the percent of quarter sections with non-farm land uses in the web of impact by regions for the first study area, the two patterns are strikingly similar. The region least comparable is the second from the right on the bottom row. This region contains Lenawee County. If the data from Lenawee County were in the ratio of new houses constructed since the 1940 map series, the percentage figures in all probability would be comparable. Such visual confirmation simply underscores the fact that the gross land use map and the inventory of non-farm dwellings between the two map series represent common geographical measures in different terms of the same statistical population.

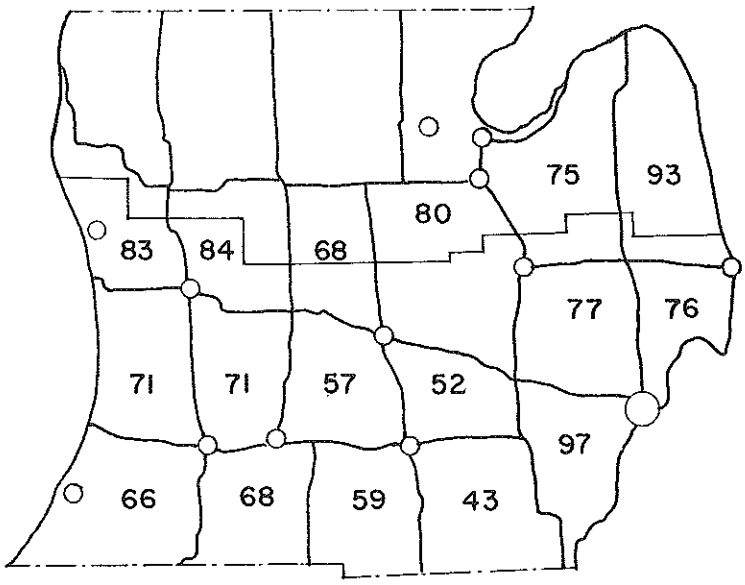
Change in Number of Non-Farm Dwellings per Square Mile Within and Outside of the Web of Impact

The sizes of the territories within the web of impact and outside of the web of impact are very different for the 179 cells or partial cells involved in the inventory for study area number two. Accordingly, the significance of the much higher percentage of non-farm dwellings constructed in the web of highway impact is partly lost when the contrast is presented by percentage figures alone. Therefore the area was measured for each of the highway bounded cells and the figure thus obtained was used to calculate the number of houses constructed per square mile within the web of impact and outside of the web of impact for each cell.

These data are presented in graphical form on the map in Figure 28. In each case the pattern for the web of impact should be compared with the companion pattern for the area outside of the web of impact. In nearly every cell there is a considerably higher density per square mile noted for non-farm dwellings constructed in the web of impact over the corresponding figure for the area outside of the web of impact. In the few cases

(A) PERCENT OF NON-FARM DWELLINGS CONSTRUCTED BETWEEN THE 1930'S AND MID-1950'S BY REGIONS

AVERAGE FOR STUDY AREA NUMBER 2 - 73.8



(B) PERCENT OF NON-FARM QUARTER SECTIONS IN WEB OF IMPACT BY REGIONS

AVERAGE FOR STUDY AREA NUMBER 1 - 73.7

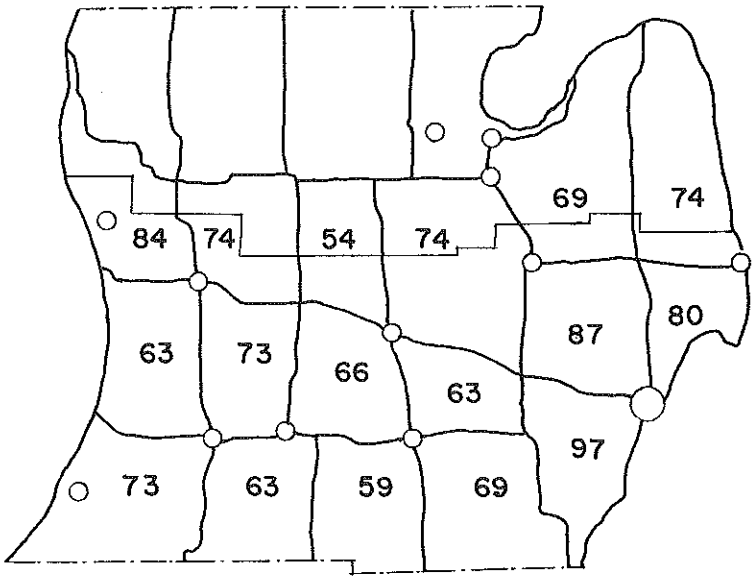


Figure 27

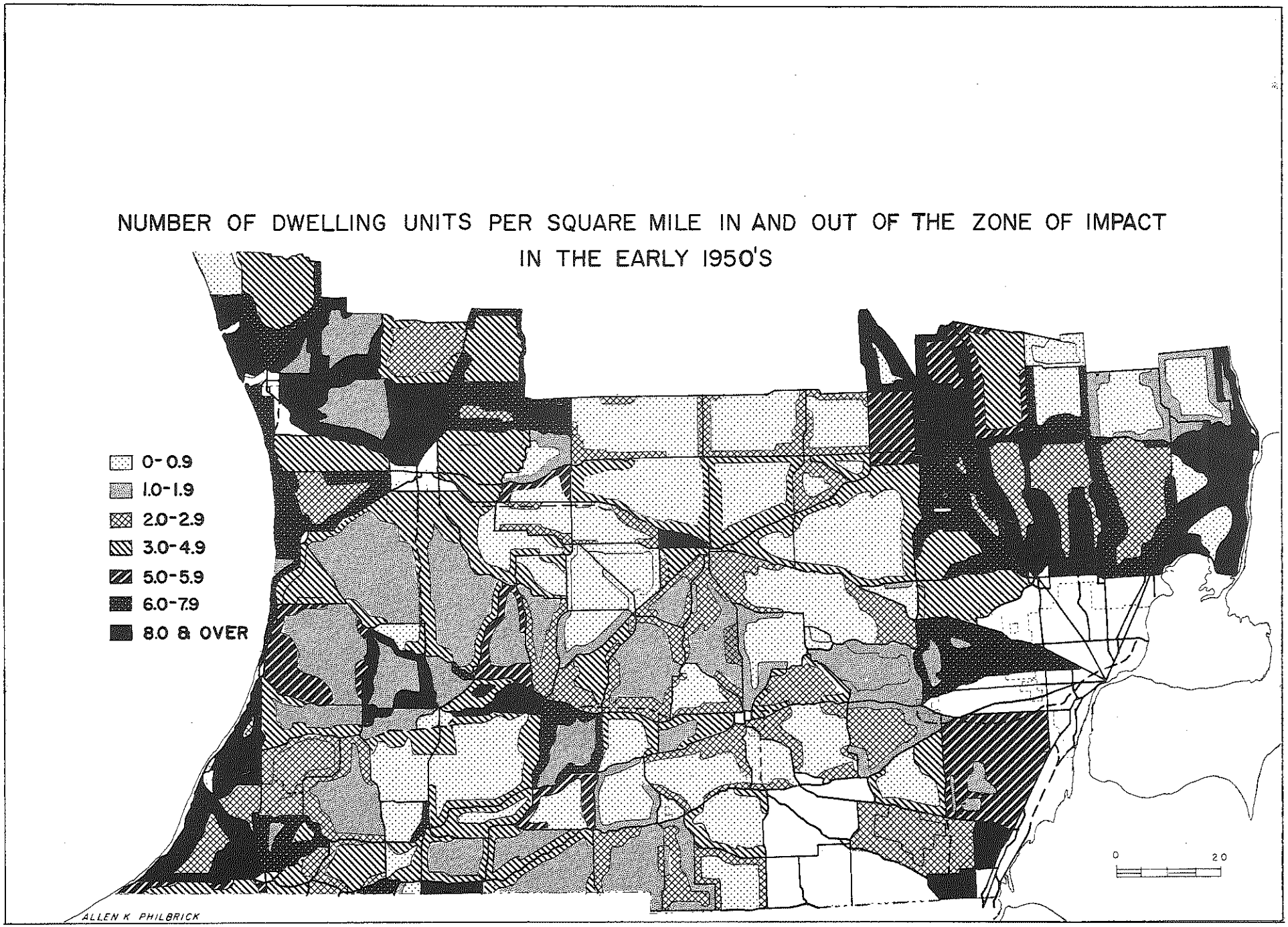

NUMBER OF DWELLING UNITS PER SQUARE MILE IN AND OUT OF THE ZONE OF IMPACT
IN THE EARLY 1950'S
0-0.9
1.0-1.9
2.0-2.9
3.0-4.9
5.0-5.9
6.0-7.9
8.0 & OVER
0
20
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Figure 28

where the relationship is the reverse, this situation is due to a resort or other housing development within a small cell toward the center of it where the size of the area produces a larger average number of houses per square mile than closer to the highways within the web of impact. These anomalous or exceptional circumstances are surprisingly few in number. This may be explained by the fact that the areas of the web of impact have a sufficiently large enough superiority in numbers of houses constructed to mask or offset the anomalies within the interior of most cells.

The contrast between highway-oriented non-farm dwellings and internally-located ones makes the composite reveal sharply the significance of the pattern of the web of highway impact.

Geographical variations in the contrasts between the interiors of cells outside of the web and exterior of cells fronting upon highways within the web of impact are to be noted. These contrasts emphasize position close to or at a distance from the larger cities. Also these contrasts emphasize once again the existence of the relative weakness of urban dispersion in the central region and the strength thereof in the east, south, and west of the study area.

PART IV

METHODOLOGY AND CONCLUSIONS

In this section of the report the division of subject matter is between methods and overall summary and conclusions of the report.

Methodology and Techniques

One of the principal findings of importance in research concerns how to go about doing it. For, without methods and particular techniques to implement them, research would be like manufacturing without machine tools, a dream without substance.

Methods and Techniques of Gross Land Use Mapping

The author of this report has now had considerable experience implementing a method of land-use analysis defined under the general heading of Gross Land-Use Mapping. It is altogether probable that this particular method may have many applications to research of this and other kinds involving the collection of information in its spatial or geographic distribution. Accordingly, it is believed worthwhile to include a section dealing with the concept and techniques of the method.

The concept of the method is basically geographic, i.e., it proceeds on the assumption that there are relationships between phenomena which can be revealed best by visualizing them in their spatial or area distribution. In following this procedure, in general, it may be said that the following steps are essential to what may be called the geographic method of research. These steps are classification, mapping, map analysis, and interpretation. The bulk of this report has dealt with map analysis and visual interpretation of the gross land use map from which the map in Figure 1 was constructed. This section of the report will discuss the classification and mapping techniques upon which this map is based.

Classification of Land Use Associations Suitable for A Unit Area Method of Observation

It should be stressed at the outset that the observation and recording of the raw data for geographic research of this complex nature presents a major task. The nature of this problem may be appreciated in terms of the selectivity required in order to reduce the man-hours of labor and the expense of acquiring the necessary information to a level where the research becomes feasible.

The author is often asked if aerial photography was not the most suitable technique for providing appropriate data. The answer must be that it depends upon the kind of information sought, and the relative difference in time involved between photo interpretation and direct observation. If direct observation can be accomplished effectively, it is always preferable to indirect approaches. In rough or heavily wooded terrain, changes in land use which are hidden from view can be checked by supplementary use of aerial photography. The author, when in doubt, found it convenient to use access roads leading off the highways to see "behind" in areas obscured from view from the road. Direct observation employing a classification of phenomena observed appropriate to a unit area system of recording has the great advantage of incorporating generalization and a degree of interpretation on the spot when the observer is in direct contact with the items being observed. The unit area method of observation and recording has several advantages. Each unit area is a separate case. Mistakes in one unit are not carried over into the next one. Classification of information by unit areas produces data which are ready-made for enumeration and arrangement for either visual or statistical analysis. Development of a classification appropriate to a unit area basis of observation and record requires advance preparation and analysis so that the items observed will reveal rather than obscure the relationships which it is desired to visualize spatially. In this instance it was desired to visualize the dispersion of urban-type establishments outward from nucleated settlements into the open countryside. Convenient unit areas of a standardized size already existed into which the regional pattern of settlement was divided -- sections and quarter sections of the township and range survey; or city blocks within nucleated settlement.

The classification utilized is based upon recognizing four major land uses, divided between the two kinds of unit areas, the quarter section and the city block.

The four land uses are, of course, subdivisible into many subtypes; but it is beyond the purpose of this kind of land use mapping to subdivide. On the contrary, the significance of the method lies in correctly generalizing diversity within these four major headings and their combinations. The four major land uses are:

1. Agricultural
2. Forest
3. Non-Farm Residential
4. All Other Livelihood Uses

In the city-block-type unit areas, only two of the above uses are commonly involved. A block may either be wholly devoted to residences, to livelihood establishments not involving agriculture, or to a mixture of both types of land use. In using color to record this pattern of land use associations within the city blocks of towns, villages, and cities, the following color scheme is

recommended: a very dark green for urban residence, very dark wine red for blocks entirely occupied by livelihood establishments, and bright scarlet for blocks having a mixture of the two kinds of land use. In short, therefore, the two variables have three possible combinations: each by itself and the two combined.

In the case of the pattern of quarter sections, which will from now on be referred to as "open" pattern, there are four variables, each of the four major land uses. If all combinations are found, this would mean 15 separate land use associations. These 15, one additional in the case of unit areas which are unused, and the three previous combinations under block-type, would require a total of 19 colors. The number of combinations is reduced, as shown by the diagram in Figure 29, by treating the two extensive uses of land, (agriculture and forests), as "parallel" background, so to speak, to the more particularly localized uses of land (non-farm residence and non-farm livelihood). Mixtures of non-farm residential and non-farm livelihood uses of land with either agricultural or forest land uses were recognized and recorded in the field mapping; but combinations of forest with agricultural land use in the same associations were ignored. The effect of this arbitrary decision was to treat as part of the farm association all forested land in quarter sections having any cleared land-in-farms within its borders. The effect was further to recognize and record as part of the forest association only those quarter sections which had no farm land at all within them. Other land uses mixed with forest land use are recorded as shown in Figure 29. One exception was allowed to this procedure. In cases where a quarter section was almost entirely forested but there was a small quantity of cleared land and no other combination of land uses, a dark green was used to indicate a mixture of forest with some agricultural land use. This compromise was used sparingly.

As shown by the diagram in Figure 29, there are within "open" pattern areas three sets of combinations. The first comprises the three possibilities when land is occupied with either non-farm residences, or non-agricultural livelihood, or the two combined. The second set involves the mixture of non-farm residential land and non-farm livelihood land with farm land in varying combinations within quarter sections. There are four possibilities. These are the mixture, in turn, of non-farm residential with farmland, or of non-farm livelihood with farmland, or of all three combined, and lastly, agriculture by itself. The mixture, in turn, of non-farm residential and non-farm livelihood uses of land with forest produces four analagous associations paralleling the four possibilities in the case of agriculture. The latter two sets of associations are shown in parallel columns

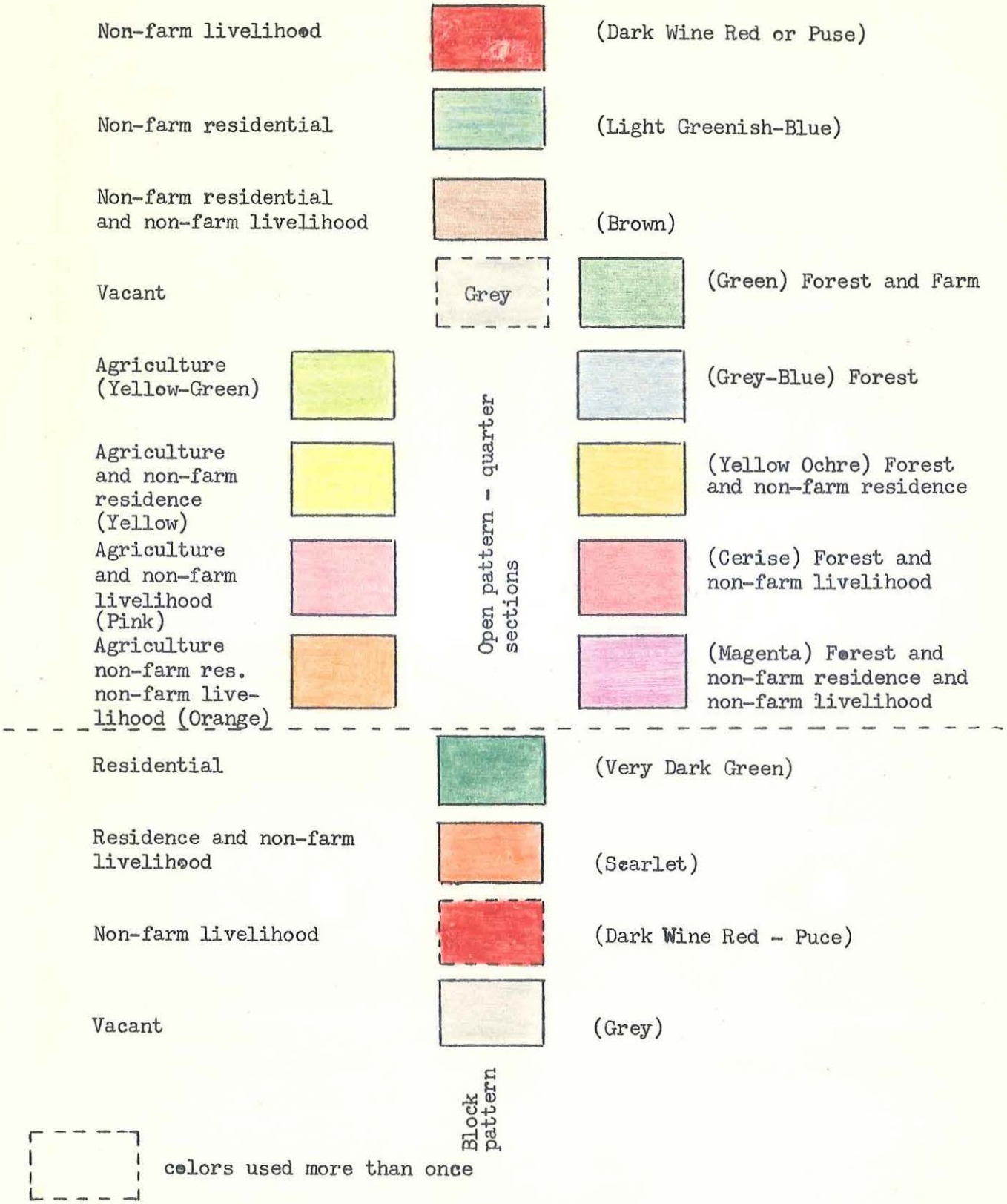

Fig. 29 Recommended color scheme for field notation in Gross Land Use Mapping

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in the diagram in Figure 29. The recommended color scheme for use in recording open-patterned land use associations is shown in the same diagram.

Since dark wine red (puce) and grey are used twice, there is a total of 15 colors employed. Since work is usually either in block pattern or open pattern, and within open pattern is usually either in agricultural or forested areas, there are in most cases no less than three or more than seven or eight colors to be used at one time.

It will be noted that a color parallel exists corresponding to the classification parallel between the associations listed under agricultural and forest headings. The yellow-green and grey blue of agriculture and forest, respectively, are intended to be about the same degree of lightness or darkness. The yellow of non-farm residential land use mixed with agriculture resembles the yellow ochre of non-farm residential land use mixed with forest. An analagous parallel obtains between pink and cerise red, and between orange and magenta. On the whole, however, in order to avoid confusion, the color analogy used in the forest and forest combinations should be made somewhat darker than those of the farm combinations.

It was found with regret that it was not possible to adapt the standard color system for land use mapping recommended by the American Institute of Planners to this problem. It was not possible because the idea of mapping land-use associations rather than individual land use identities is an entirely different approach to land use mapping. To have attempted an adaptation of the color scheme of the new system to that of the former would have led only to confusion. A second reason is that the gross land-use association system applied in this research is much wider in scope than the color system devised for urban land use mapping. The new system ranges over total land use, both urban and rural, in an overall gross-pattern covering total land area within a region.

A full discussion of the color theory and reasoning behind the system recommended is not appropriate to this report. It is difficult without color reproduction of the original land use maps to appreciate the logic of the color selection. The possible usefulness of this information to others who might wish to make gross land use maps over extensive areas warrants this brief discussion of field methods, and the cartographic planning or design upon which the recording system is based.

Suffice it to say that darker or bright lighter colors were selected to "bring out" particularly located types of land uses by contrast against medium dark background colors used for extensively distributed forest and farm lands. Where pattern of land use consistently alternates, alternating dark and light bright colors produces by contrast a striking visualization of the pattern. This idea is used in the city block land use areas. They are relatively small, almost punctiform in character except for the very largest cities. Use of dark green, dark wine red, and scarlet make the resulting patterns of villages and cities stand out vividly against the lighter colors of the open-pattern associations. Within open pattern light bright colors such as yellow, pink, and orange stand out against a background of medium dark green of agriculture. Yellow ochre, cerise, and magenta stand out similarly against a background of medium dark blue-grey for forest land. The whole color system is designed for one purpose, to show the spatial continuity of the "reach" of cities outward from their centers.

Practical Suggestions for Using the Classification and Recording System in the Field

There are two basic requirements for successful field mapping with this classification and recording method by automobile traverse. One must develop the ability to maintain constant map to land contact as one drives along the frontages of the unit areas. In addition one must develop the habit of mind of classifying what one observes almost instantaneously. With a little practice as one proceeds around the last corner of a given unit area, the land use combination classified on the basis of the moments of observation is uppermost in mind as a color -- green, orange, yellow, etc. This color can be indicated within the proper space on the map with the barest minimum of effort, provided one is in precise map contact with one's actual location. By this time the mind is already classifying the developing combination of land uses within the next unit area. It is well to begin with classification and observation and recording of one unit area at a time. As the necessary mental habits are formed it will become routine to keep both sides of the road under observation and possible to proceed with the classification of several unit areas simultaneously. This process is made difficult by the fact that as one drives down a given road one can observe and classify only one frontage of each of the two unit areas. Then at the corner, if one turns to go around the unit area on the right hand side, the left-hand frontage now belongs to yet a third unit area. One way to facilitate memory is to mark the frontages that are left behind with a line parallel to the road of the appropriate color for the land use classification observed for that frontage only.

This can be changed for the unit area as a whole if necessary after one has seen the other frontages.

It is obviously impossible to examine all frontages of unit areas without backtracking. There are two basic driving patterns which may be followed. One is to keep turning and finish unit areas one at a time. The other is to keep going and map frontages only along several miles of road. Then, after repeating this along successive roads in the same direction parallel to the first, do the same in the direction perpendicularly to the first frontages. When a sizeable area has been traversed in this criss-cross manner, the whole can be colored in at once at some convenient stopping place. Alternation of these driving patterns is recommended to relieve monotony and reduce fatigue.

It is, of course, absolutely necessary to understand the uses of land which are being observed. In order to become familiar with the types of land use being classified it is necessary at first to stop and ask questions when the meaning of what one sees is unclear. After this procedure has been followed for a time, stopping to test the accuracy of observation and classification will become less necessary; but care should be taken as mapping proceeds into new territory to make sure that one interprets correctly what one sees.

The one-half-inch-to-the-mile county highway maps of the Michigan State Highway Department were the base maps upon which colors were plotted. Without so accurate and excellent a series of base maps to provide the pattern of unit areas, the mapping would have been much slower and more difficult.

In the cases of the major cities and the counties within the Detroit Standard Metropolitan Area secondary source materials were available which could be "translated" into the color terms of the gross land-use mapping system. The financial assistance of the All University Research agency of Michigan State University supported some of the field research, particularly within the city-block-pattern areas described.

The steps involved in the analysis and interpretation of the resulting land use map have been described accompanying the report of findings.

Methods and Techniques of County Highway Map Inventory

The technique of inventory adopted is basically simple. It was an adaptation of the "fractional code" technique used quite generally in inventorying land use and other features on the land.

This technique, originally developed by Professor V. C. Finch of the Geography Department of the University of Wisconsin in the 1920s, was enlarged upon and used successfully in the 1930s in geographic analysis conducted by the Tennessee Valley Authority. It has also been utilized extensively in the Northwestern University Geography Department's land use study in Puerto Rico. The general feature of the technique is use of numerator and denominator for different items of inventory, as well as the position of digits in each portion of the fraction. The form of the fraction in the present instance was as follows:

$$\frac{\text{Structures on the Land 1940}}{\text{Structures on the Land 1950}}$$

The structures in each case were divided into three categories: (1) farm residences; (2) non-farm dwellings; and (3) stores or small business establishments. These are identifiable on master maps which serve as the basis of record by position in the fraction. Farm residences were recorded in the first position, followed by non-farm dwellings, and then stores or small business establishments. Thus, if a given area had two farm residences, three non-farm dwellings, and one store in 1940, the fraction would have a numerator consisting of

$$\underline{2\ 3\ 1}$$

If by 1950 the same area showed an increase of two non-farm dwellings, for example, and the other types of structures remained unchanged, the denominator of the fraction would appear as

$$\overline{2\ 5\ 1}$$

and the entire fraction would be

$$\frac{2\ 3\ 1}{2\ 5\ 1}$$

In using this fractionally coded enumeration of the maps to be inventoried, it was decided to make the inventory on the same unit-area basis, insofar as feasible, as the gross land use map. This meant using the quarter section unit areas in the open country. Since there were no data available in block-patterned settlement areas, there could be no corresponding map inventory in that case.

The purpose of having the unit areas as small as a quarter section was to render the inventoried information both comparable to the land use map, and in as flexible a form for combination in various ways as possible. This decision turned out to be a wise one, since in the beginning the idea of creating strip-area units

for comparison of data with distance from highways had not occurred. Had the data been collected in terms of larger units, none of the subsequent analysis and interpretation in this report would have been possible. There is no particular significance to the absolute numbers of structures involved. The significance lies in being able to compare their occurrences geographically in terms of distance from highways and from concentrated urban population centers.

Conclusions and Recommendations

This report summarizes the finding from two phases of a single project of research. The objective has been to examine the impact which people have exerted through use of Michigan state and federal highways upon the uses of land and the changes in number of structures built upon the land within a stated interval of time.

Conclusions

Findings are principally summarized in terms of a number of maps. The text records results of analysis and interpretation. With reference to the impact of people through highways upon land uses, the gross land use map of 47 counties of the Lower Peninsula of Michigan is presented in Figure 1. Analysis of that map proceeded principally by use of strip areas. Percentages of quarter sections having non-farm land uses were calculated for highway-oriented strips and recorded on the map in Figure 5. The resulting patterns and analyses show clearly a simultaneous variation of land uses proportionately by strip areas in terms of two variables. These variables are distances which measure the diminution of the force of cities outward from their centers and perpendicularly from radially arranged pattern of highways. Taken together the resultants of these two different directions demonstrates conclusively that highways are the major means through which the processes of dispersal of urban population and forms of settlement have exerted their impact upon the land uses of the study area.

Analysis of the pattern of strip areas giving evidence of the impact of urban forces upon the countryside took the form of the definition of the web of highway impact in Figure 3. Measurements of the number of miles of highway exhibiting different depths or widths of impact back from highway frontages were made. These showed that a very large proportion of the frontage and miles of state and national highways has afforded access to the dispersal of Michigan's urban phenomena. Over 92 percent of the highway mileage, 5,068 miles of road, has at least one mile of impact on one side. Nearly 9,000 miles of highway frontage (8,956) has at least one mile of impact.

The web of impact encompasses 73.7 percent of the quarter sections with non-farm land uses within them, but itself occupies less than half, 42.9 percent of the total territory of the study area.

These evidences of the expansion of urban phenomena throughout the economy in turn lead to the conclusion that Michigan in its

most populated districts south of Township line sixteen is rapidly becoming dominated geographically by the diffusion and dispersion of its cities. Findings with respect to the definition of 10 distinct dispersed city regions are presented by maps in Figures 15 to 24. Together these dispersed city regions and the web of impact through highways which interconnect them and most of the smaller cities and nucleated settlements of the study area represent one united Dispersed-City Realm. The map in Figure 25, in conjunction with the data in Table IV, shows that nucleated settlement within dispersed-city regions accounts for 60 percent (59.4 percent); the sum of both nucleated and dispersed settlement within the dispersed-city regions exceeds 80 percent, (81.6 percent). Some idea of the initial concentration of urban population and then the dispersal of relative concentration of population can be gained by referral in summary to the areas of the study area involved in the two categories of dispersed-city regional population above. The nucleated population (59.4 percent) occupies 2.1 percent of the study area, while the dispersed population of the regions raises the total to just below a quarter of the study area.

Repeating a measure already noted, but within this context, the web of impact which encompasses nearly three-fourths of the entire dispersed pattern of non-farm land uses occupies well over one-third, or 42.9 percent, of the total area.

It is within this outer web of impact territory that the final measure of the dispersal of urban phenomena analyzed in this report becomes important. This item refers to the analysis of change in numbers of non-farm dwellings within 28 of the 47 counties from the late 1930s to the mid-1950s. In this final category, the measure has almost an identical percentage of its cases located within the web of impact as did the non-farm quarter sections in relation to the total quarter sections of the larger 47 county gross land use map; that is, 73.8 percent and 73.7 percent, respectively.

In 1940, some 3.6 percent of the rural population of study area number two were distributed in the pattern of non-farm dwellings recorded on the 1940-series of county highway maps. These were the 9,529 non-farm dwellings enumerated by the inventory. By the 1950s, while the rural population as a whole had increased by slightly more than one-fourth in number, the non-farm dwellings enumerated by the inventory of the 1950 map series had increased 411.5 percent. The total in the mid-1950s was nearly 50,000 non-farm dwellings (48,740), housing approximately the equivalent of a metropolitan area of 170,590 persons. These data record, in "social motion" so to speak, the automobile-induced replacement

or dispersal of the mid-twentieth century "population explosion" typical of the United States today. It is introducing an entirely new form of settlement -- that of the dispersed city.

Interpretation and Recommendations

The author is of the opinion, on the basis of the preceding summary of the findings, that this report places the study area in a somewhat different perspective. The general recommendations appropriate to such findings will be placed in the form of the questions which this perspective raises.

We are wont in the absence of geographical perspective to think of our cities by rank in their importance to our economy in terms of their population. The growth in numbers and in importance of activities in Detroit, for example, cannot be ignored, certainly. Yet, the people of the study area, the most populous and urbanized region of the State of Michigan, have created and are apparently going to continue to develop a pattern of location and dispersal of their activities in which not one but a dozen or more cities are important. They have done this in response to the existing possibilities inherent in the use of the automobile and truck for movement, within a generally radial and grid pattern of major highways. The resulting pattern of urban facilities has two major characteristics. First, there is the dispersal of urban people outward from many urban centers into dispersed-city regions much larger in area than most people are generally aware. Second, there is the emergence of an interconnected pattern of these dispersed-city regions into what has been called in this report Michigan's dispersed-city realm. Thought of diagrammatically, the urban pattern of the study area is mainly an integrated and interconnected circle of urbanized regions. The circuit runs from Battle Creek-Kalamazoo in a clockwise direction to Grand Rapids, the Tri-Cities, to Flint, Pontiac, Detroit, and Jackson back to the starting point.

The diagram in Figure 30 shows the urban ring, the "hole in the doughnut" within it, and the Capitol City Region within the hole in the doughnut. A recommendation in the form of a question comes to mind. To what extent have we planned our new alignments of limited access highways, which are the new boulevards replacing the former functions of highways which have become the "streets of the dispersed city", so that all parts of the urban realm within the State have as nearly as possible the same access to one another?

There are in general three types of access important to this discussion, local regional access, intra-urban realm access, and interstate access. Local regional access gets people and goods

DIAGRAM OF MICHIGAN'S DISPERSED-CITY REALM

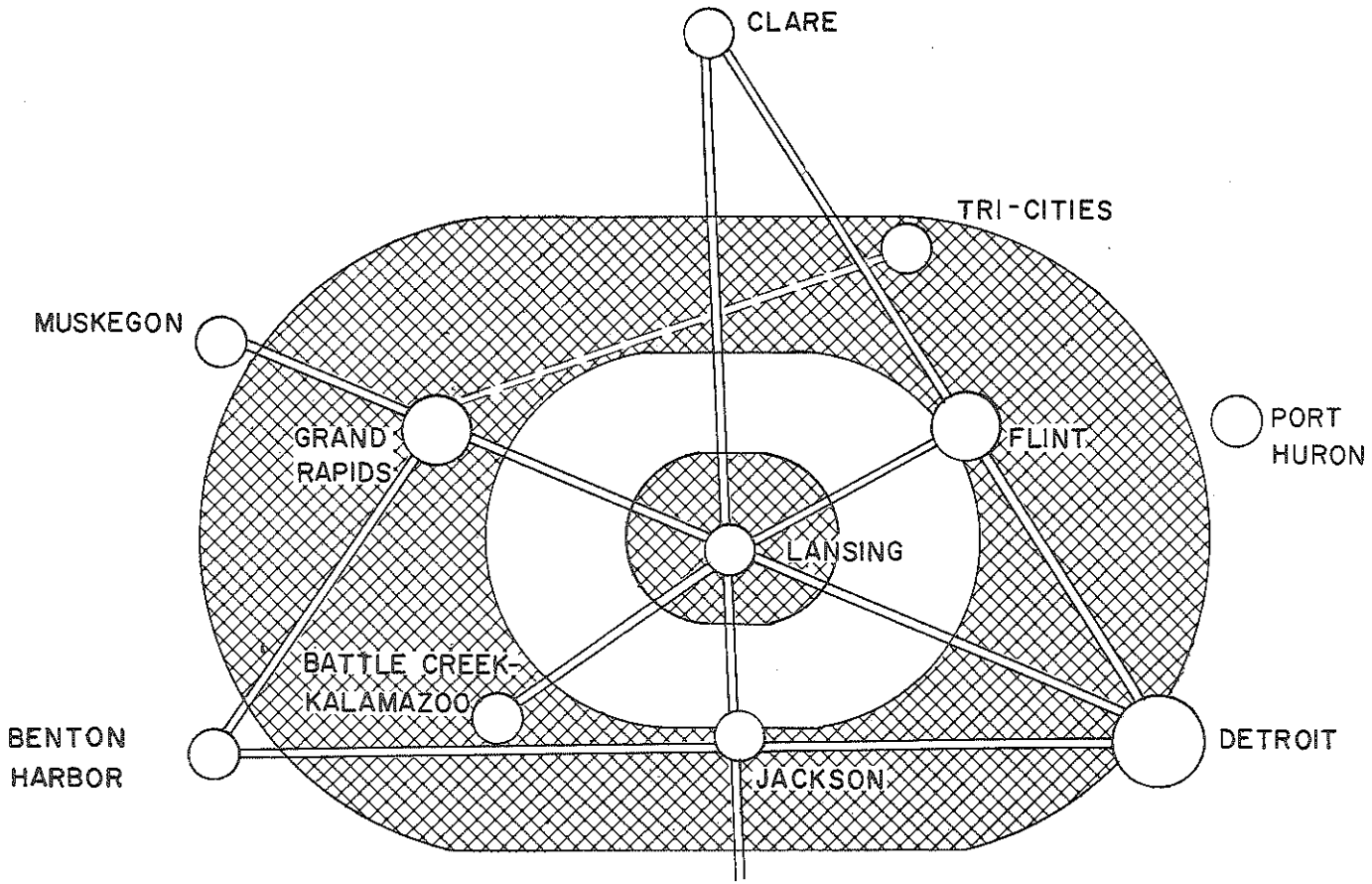

Figure 30

in and out within each dispersed-city region. Interstate access, takes care of those internal alignments which carry beyond the limits of the state. Since Michigan is a peninsula, certain of these through routes are attracted to specific points of ingress to and egress from the Lower Peninsula of Michigan. Four points are of primary importance geographically in this connection. These are the southeast and southwest corners of the state, the Port Huron-Sarnia area, and the Straits of Mackinac. The radial pattern of the routes of the Interstate Highway system from Detroit utilize all of these points to pass into and out of the state.

From the standpoint of intra-urban realm access, however, should not all of the major secondary dispersed-city regions as well as Detroit have equal access to each other? It is the perspective of looking at the pattern of cities as a whole which suggest this possibility. The least possible number of major lines of movement capable of approximating the interconnection of all points on a circle is a triangle. Such a triangle is indicated by continuous and dashed lines on the diagram in Figure 30. Only one alignment --that shown by the dashed line -- is not already in existence.

In terms of manufacturing and wholesale distribution of products in commerce as well as in the transhipment of goods and people by transportation media, the cities of the urban ring within the study area are all in competition with one another as well as complementary to one another. In such a situation, would it not seem logical that the functional interconnection of the <u>whole</u> region would require equal opportunity for interchange between not only east and west, and east and north, but also west and north? No single city is the center of our economy to which all roads must lead. The findings of this report concerning the impact through highways upon land use and the construction of non-farm dwellings indicate a pattern in which each city in turn reaches out beyond its borders to every other one of its kind. The development of the region as a whole is best served by understanding and perspective which can give each part of the region the maximum opportunity to have access to every other part.

As indicated at the beginning of this report and documented by observations and analysis in its findings, highways are more than bridges across the intervening spaces between places of concentrated population, although they serve that function well. They are also not, in the opposite sense, only means of interconnecting the city and the country, although they also serve that function well. But in addition the people have thrust upon the highways a third function. They have used and give every indication of continuing to use the highways as if they were the

streets and boulevards of one great dispersed city.

In the process of urban dispersion, highways have proved to be one of if not the major agency of the growth and expansion of urban activities. Such dispersion has undoubtedly taken away much of the internal pressure of growth and change from within the central cities. In doing this, highways have provided avenues of escape, so to speak, for the temporary alleviation of urban pressures.

This kind of escape valve and the consequent dispersed pattern of urban settlement which is evolving creates a host of additional short and long range problems. This report cannot be expected to solve or even enumerate such problems. But the perspective provided by the accurate visualization, quantification, and analysis of existing conditions is prerequisite to their recognition and eventual solution.

The patterns shown by the maps in Figures 1, 3, 9, 19 and 20 show a vast intermittent web of urban type establishments. This web-like pattern follows faithfully the alignments and inter-connections provided by highways. <u>This is the pattern of a future Michigan</u> much more widely urbanized than at present. What is significant about the gross pattern of land uses in Figure 1? The importance of that map lies in the fact that it <u>predicts the trend of the future pattern of settlement within our state</u>.

Urban population will become more dispersed even as, on a statewide basis, it becomes more concentrated within the areas of the present dispersed-city realm, both within the dispersed-city regions and within the composite web of highway impact. The territories now occupied by these categories of settlement will be extended outward and further back into the agricultural and forested areas at even greater distances from highways as the major agency of population dispersion.

ADDENDUM

The following minor errors were discovered too late to correct in certain figures as follows:

Figure 8a - Tenth line of title should read "US 16" instead of "US 27".

Figure 8b - Figure for second zone should read "22" instead of "23".

Figure 14 - Sub-figures are as follows:

Upper Left - X	Upper Right - Y
Lower Left - A	Lower Right - B