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THE UNIVERSITY OF OKLAHOMA

GRADUATE COLLEGE

EVOLUTION OF A CLUSTERED RURAL SETTLEMENT PATTERN: AN EXTENSION OF THEORETICAL SETTLEMENT GEOGRAPHY

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EVOLUTION OF A CLUSTERED RURAL SETTLEMENT PATTERN:

AN EXTENSION OF THEORETICAL SETTLEMENT GEOGRAPHY

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DEDICATION

To an exceptional person,

my loving wife, Caroline

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FOREWARD

The purpose of this research is to extend an existing theory concerning the evolution of rural settlement patterns. Hudson's theory on rural settlement location in an agricultural setting serves as the base of the theoretical development. This research extends Hudson's work to rural non-farm settlement and disaggregates the rural settlement into three components, i.e., newly settled, abandoned, and residual housing.

The principal premise of this work is that dwellings in the contemporary rural settlement are positioned so as to optimize their residents' accessibility to trade-service centers. Here, accessibility is measured by a rural dwelling's location to nucleated settlements and to the principal roads leading to these centers.

Explanation of the pattern of the rural settlement in a southwestern Oklahoma county and its evolution is the special problem addressed in the dissertation. The rural settlement pattern of the study area at any one time is seen as the spatial synthesis of residual housing and the two settlement processes, new settling and abandoning. In analyzing these 3 elements 4 specific questions were posed:

1) To what extent is the pattern of new settling random or non-random,

2) To what extent is the pattern of abandonment random or non-random,

3) To what extent is the pattern of residual dwellings random or non-random, and,

4) How are the patterns of abandonment and new settling combined with the existing settlement to form the settlement morphology at a specific time.

In addition to evaluating the patterns of settlement processes, explanation for changes in pattern were sought.

Settlement Fundamentals

Settlement morphology and process have been and remain fundamental concerns of settlement geography. Relating to rural settlement, Hudson (1969) stated that morphology "...is the spatial realization of transformations on the population produced by settlement process, or settling." (p. 365) Although these fundamentals have persisted in rural settlement geography, their treatment in research has begun to change from being mainly descriptive, as in the past, to being theoretical, as some recent works indicate.

Europeans were the first to describe rural settlement morphologies, but they quickly gained adherents in other parts of the world.[1] Densities, then indices relevant to specific areas and data, and more recently quantitative techniques have been used for measuring settlement

[1] For example: Robert B. Hall, "Rural Settlement Forms of the Monticello Quadrangle of Kentucky," Comptes Rendus du Congres International de Geographie, Paris 1931, Tome III, 257-268; _____, "Some Rural Settlement Forms in Japan," Geographical Review 20 (1931), 93-123; E. Cotton Mather, "A Linear-Distance Map of Farm Population in the United States," Annals of the Association of American Geographers 43 (June 1944), 173-180; Isamu Matui, "Statistical Study of the Distribution of Scattered Villages in Two Regions of the Tonami Plain, Toyama Prefecture," Japanese Journal of Geology and Geography 9 (1932), 251-266; and, Edna Scofield, "The Origin of Settlement Patterns in Rural New England," Geographical Review 28 (Dec. 1938), 652-663.

morphologies.[2] Most of the earlier settlement studies treating morphology were for either descriptive or classificatory purposes and for only certain parts of the world.[3] The first significant theoretical work relating to matrix design in rural settlement was Christaller's (1933) on central place, but this theory and its further development by Lösch (1954) pertained only peripherally to rural dwelling location. Although it focused upon settlement process, Hudson's theory on rural settlement location (1969) had as one of its goals the verification of Lösch's premise of a regular morphology of farm dwellings being situated around trade-service centers.

Stone (1968) has noted the lack of areal considerations given settlement processes in most geographic works in the past.[4] However, settling or colonization, especially in Europe, has lately received not only areal emphasis but also theoretical treatments. One of the more notable European works was Bylund's (1960) which concerned the diffusion of historic settlement. Unfortunately, the models that he developed were

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[2]Examples of each of these measurement categories are found in Kirk H. Stone's "Multiple-Scale Classifications for Rural Settlement Geography," Acta Geographica 20 (1968), 307-328.

[3]Stone (1968) called attention to the lack of both an international classification for and continental map coverage of rural settlement. In his provocative article, "Multiple-Scale Classifications for Rural Settlement," he suggested a standardization of terminologies that are applied to rural settlement, use of 4 scales when distributions are measured for morphology, and the need for defining and analyzing processes in acceptable and informative ways.

[4]According to Stone (1968) settlement process has been construed merely as chronological development in many works. When settlement process was given some areal coverage he remarks that it was subjective or relevant to a very limited area. Finally, he related that while morphology of rural settlement was measured adequately, process was accounted for in the most rudimentary manner (pp. 320-321).

only compared visually to colonization maps of northern Sweden as a means of verification.[5] More recently in the United States, John Hudson's (1969) diffusion processes were related to the spread of settling in an area that affected morphological changes in the settlement distribution. Testing of the theory was done with farm home distribution in the central Midwest.

According to Birch (1970) Hudson's work was important especially since it "...emphasized the need to give further consideration of the process of settling in order to understand form" (p. 610). This need has not been fulfilled in the past and, in fact, as Stone (1968) noted there has been, in general, "...a lack of distinction between rural settlement morphology and rural settling process" (p. 321) in geographical research. Consequently, the incorporation of settlement process and morphology into a workable and meaningful synthesis became a basic prerequisite in the research design for this dissertation.

Although the general purpose of this dissertation is to extend existing theories concerning the evolution of rural settlement patterns, its specific long-range goals are four-fold. These are: (1) to disaggregate the rural settlement into 3 components, new, abandoned, and residual dwellings, and construct periodic matrices for each of these categories; (2) to measure and describe the rural settlement and its component matrices with point pattern analysis, specifically nearest neighbor

---

[5]Gunnar Olsson's (1968) "Complementary Models: A Study of Colonization Maps" presented several analyses suitable for testing the validity of the Bylund models. Olsson used Bylund's colonization data in demonstrating the suitability of certain analyses. The results tended to support several postulates about colonization that had been suggested by Bylund.

analysis and quadrat analysis; (3) to analyze the accessibility of rural dwellings to nucleated settlements and the roads leading to these centers; and (4) to provide a description of rural settlement evolution in southwestern Oklahoma, an area for which no previous investigation has been undertaken.

The remainder of this dissertation consists of five chapters. Chapter I considers rural settlement theory and offers the major hypothesis and supportive hypotheses about clustering in the rural settlement. In Chapter II the methodology used for solving the problem is developed. Chapter III surveys the study area where the empirical testing was focused. Chapter IV treats the macro-level analyses of both the rural settlement matrices and the settlement process matrices for various periods; in this section the major hypothesis and three supportive hypotheses are examined and verified. Thereafter, Chapter IV considers the rural dwelling site factors related to personal accessibility which perfect the two rural settlement processes and residual dwellings. The treatment here is at the micro-level and deals with three supportive hypotheses advanced about the locations of rural dwellings. In Chapter V a summary and conclusion for this work is presented.

CHAPTER I

RURAL SETTLEMENT THEORY

Hudson's theory on rural settlement location requires some extension to insure broad applicability to the contemporary rural settlement scene. These extensions focus upon conceptual and operational aspects of the competition phase of the theory. In this chapter John Hudson's theory is reviewed, and its competition phase analyzed critically. Subsequently a broader approach for disaggregating rural settlement into its components is presented. A theoretical consideration for the evolution of a clustered rural settlement morphology, which is tied to rural inhabitants' retaining or acquiring dwelling sites that optimize their accessibility to trade-service centers, follows.

Hudson's Theory on Rural Settlement Location

Hudson's theory deals with changes in rural farmstead distribution from the time of initial establishment through the present. Two purposes underlie this work, i.e., 1) to verify the Löschian assumption that farms (farmsteads) are uniformiy distributed in the lowest order of the central place lattice; and 2) to link diffusion theory with central place theory where it is applicable (Hudson, 1969, p. 366). The theory uses as analogs ecological models that deal with the relationship between density and patterns. These analogs are used to postulate different morphologies that accompany changes in farmstead

density and size. The entire progression of such changes, according to Hudson, formulates the settlement process.

Three settlement phases are proposed in the Hudson model: colonization, spread, and competition. During colonization settlement is being extended into "....a new territory, or a new environment, or into an unoccupied portion of the old environment" (Hudson, 1969, p. 367). Settlement density decreases with distance from an optimum part of the environment towards the newly settled periphery. According to Hudson, this settlement phase possibly produces a regular spacing between its housing units. Spread occurs when unsettled space within the colonized area is finally occupied. An increase in the settlement density occurs during the second phase, which Hudson believed would evolve a dwelling morphology with a clustering tendency. Competition begins when there "....is a struggle between settlements (farms) to hold their domains intact and to increase their holdings" (Hudson, 1969, p. 371). This competitiveness for land occurs because farms must be at least a minimum size in order to be economically operable. During this phase, settlement density decreases within the settled area as smaller farms gradually become larger, further apart, and more regularly spaced.

Hudson's empirical testing of this theory was in portions of six counties in eastern Iowa. None of the tracts had incorporated communities within their boundaries. Each of these tracts was also selected because there were no notable topographic obstacles that could disrupt settlement. There was no testing of the colonization phase because data were lacking for these counties. The anticipated clustering that was to accompany increases in settlement density during the spread

phase could be tested in only two of the six counties examined by Hudson. Test results for these areas were mixed, and no conclusions were made. For the competition phase, testing verified that as farmstead density decreased the settlement morphology had increased regularity. These data also substantiated the research hypothesis that regularity should increase in an area where the competition phase has been operative for a period of time.

Although Hudson's model provides an important foundation for understanding the evolution of rural settlement, certain concerns must be reexamined. These concerns involve the formulation of the rural settlement, specific questions about competition, and the manner in which the study area was chosen for testing the theory.

First, rural non-farm dwellings were excluded from consideration in this theory. Since the presence of non-farm dwellings surely affected the locations of nearby farm dwellings and, consequently, their resulting settlement morphology, their absence from this model appears to be a serious omission. This shortcoming can be mitigated by extending rural settlement to include both farm and non-farm dwellings.

Three concerns pertaining to the competition phase require discussion. These are:

1. The competition phase focuses upon existing rural settlement, that is the settlement that evolved through either the colonization or spread phases. Once competition becomes operative, decreases in farm housing occur as small farms are eliminated, according to the theory. The implication here, however, is that a residual farm house distribution gradually is reduced through abandonment, and this comprises the rural settlement at a specific time. Unfortunately, this eliminates the possibilities of changes in the distribution from new settling. There is no sound basis for assuming that no new farm housing will be added in a rural area during a period when farm sizes are increasing.

2. One of the assumptions related to the competition phase was that as small farms became economically inoperable their lands were consolidated into larger, adjacent farms. Although such a procedure is obviously desirable, since it allows a larger farm operator to work additional land without much more expenditure in time and labor, there is no means for assuring that the adjacent operator will be able to acquire the land once constituting the smaller farm. Much of the increase in farm sizes in the United States more recently has occurred through renting or purchasing land that was not contiguous to existing farm holdings.

3. Another assumption associated with the competition phase was that as the area of "contiguous farm holdings" increased, the farmstead remained the central locus. Hudson pointed out, relying upon this farm house centrality, that if all farms became the same size that "....the optimum pattern of farmsteads (farm houses) is the hexagonal lattice" (p. 371). This assumption seems unrealistic, since farmstead locations have been closely tied to roads so as to enhance the accessibility of farm residents to off-farm locations; centrally situated house sites are not necessarily related to roads.

The writer believes that the first concern about the competition phase is the most important, since it indicates the need for further investigation into the composition of, and changes in, the rural settlement for a later and/or contemporary period. The approach used in this dissertation provides a mechanism to overcome this problem. The last two concerns are related. Unfortunately, these assumptions lead to a conclusion that the only major influence upon farm house location is an ever enlarging, contiguous landholding within which the dwelling becomes more and more centrally situated. This work presents accessibility factors, which appear to be considerably more realistic as a means for considering rural dwelling location.

Finally, the tracts comprising the study area for this research all avoided nucleated settlements, other than hamlets. Consequently, any orientation that farmstead patterns might have shown towards

larger central places was very likely modified, or perhaps completely obscured. Since one of Hudson's major objectives was discerning farmstead distribution patterns with respect to central places, it is incongruous that rural landscapes surrounding such centers were not considered. It appears that this problem can be easily remedied by selecting a study area where nucleated settlements are included.

The following discussion relates another approach for studying the evolution of rural settlement that is especially applicable to Hudson's competition phase but which could be applied to both the colonization and spread phases as well. Thereafter, the competition phase of Hudson's theory is modified, so that rural dwelling location is explained with factors that relate to accessibility of rural inhabitants.

Rural Settlement: Morphologies of Newly Settled, Abandoned, and Residual Dwellings

A rural settlement pattern is a geometric construct of dwellings distributed across a specific plane. The pattern of settlement at a specific time represents the interactions of two settling processes, new settling and abandonment, upon an existing or residual pattern. Although the two settlement processes collectively influence the settlement pattern, each can be considered as a separate matrix. Patterns associated with new settling and abandonment are the spatial impact of the dynamic aspect of settlement. On the other hand, the dwellings which remained occupied from a prior time period comprise another aspect of the settlement, which is static in its location, and their pattern can also be considered separately.

By disaggregating the rural settlement into its dynamic and

residual components the following mathematical expressions are derived. For the residual matrix

$$RM_{(t+N)} = SM_{(t)} - AM_{(t+N)} \quad (1)$$

where t = a prior time

$t + N$ = a prior time plus additional time in years

RM = the residual matrix, or the total of all dwellings whose locations have been static in a specific area

SM = the settlement matrix, or the total of all occupied dwellings in a specific area

AM = the abandonment matrix, or the total of all vacated dwellings in a specific area

and for the later settlement matrix

$$SM_{(t+N)} = RM_{(t+N)} + NSM_{(t+N)} \quad (2)$$

where NSM = the new settling matrix, or the total of all dwellings placed at new sites in the specific area

This disaggregation of rural settlement is important not only because it depicts quite simplistically the manner of dwelling mixtures, but it also provides a mean through which the components can be expressed as matrices. Once each matrix is constructed, from either historic or contemporary sources, its pattern can be measured and evaluated. This, in effect, combines settlement morphology with both the settlement processes and the residual component.

Considerably more insight about rural settlement is gained when matrices for rural settlement, either of the settlement processes, or the residual dwellings from specific periods are compared, thereby revealing temporal changes. However, this approach becomes particularly effective when the temporal changes are anticipated because of theoretical bases.

Evolution of a Clustered Settlement Pattern

In contrast to Hudson's theory of a regular pattern evolving in the rural settlement during the competition phase, this work theorizes that the rural settlement pattern becomes clustered during such a stage. Clustering occurs in the rural settlement as dwellings are positioned so as to optimize their residents' accessibility to trade-service centers. Accessibility is expressed by a rural dwellings' location to nucleated settlements and to the principal roads leading to these centers.

Changes in the Rural Settlement in the United States

Historically, rural dwelling location in most parts of the United States was tied to land holdings. Farm residences were found on agricultural lands, and non-farm houses ordinarily were situated along roads near nucleated settlements. From the standpoint of the personal accessibility of the farmer the ideal farmstead location was in the center of its contiguous landholding, since this would have minimized his movements. Farmstead sites commonly deviated from this central locus and were found beside the roads that passed along the landholdings' margins. The roadside dwelling site was a good compromise location, since it provided the farmer easy access to the land holding as well as external loci of importance.

The increased dependency of rural dwellers upon commercial trade-service centers is well documented (Bohland, 1973; Brush, 1953; and Clawson, 1966, 1970). This is particularly true for rural farm inhabitants in the last two or three decades. Clawson (1966) noted that "The modern farm family is almost as dependent upon frequent access to the supermarket and drugstore as the suburban family" (p. 286). The same

is true for non-farm families residing in the same setting. The linkage between rural dwellers and rural trade-service centers is directly related to the availability of rapid motor vehicle transportation.

Chisholm (1962), while referring to agricultural regions in developed countries, stated that "It is becoming increasingly possible for the dwelling to be removed from the territory which is cultivated and in many respects such separation is becoming more desirable" (p. 179). This has been true in the United States except for certain areas where agricultural specialties require the presence of farmers at the site, as in dairying or poultry production (Clawson, 1966). The farmer, therefore, is freer than ever before under most circumstances to decide where his residence will be situated. That is, he can remain on the farmstead or, if he desires, locate on a site off the main landholding, or move to a nucleated settlement. Concurrently, non-farm inhabitants still seek rural dwelling locations reasonably close to nucleated settlements because of employment in these nodes or the desire to be near to their sales and services establishments.

If rural inhabitants have been attempting to increase their accessibility over time, the location of their dwellings should indicate such a response. The movement to more accessible locations should be expressed in two ways: 1) the distance of dwellings from the nucleated settlements in the rural landscape, and 2) the dwelling orientation to major roads leading to such centers. Each of these factors is developed further in the sections that follow.

Dwelling Distance from Nucleated Settlements

Accessibility for rural inhabitants is enhanced as the distance or

time of travel between their dwellings and the closest nucleated settlements is minimized. As access to central places becomes more important, rural dwelling sites in their immediate vicinity become more attractive than those further away. Under these conditions the contemporary rural dwelling distribution should show an orientation towards central places if the rural settlement has existed for any reasonable length of time and if rural inhabitants have tended to optimize their dwelling locations so as to achieve better accessibility.

The dimensions of the dwelling distribution, however, are a function of the hierarchial size of the nucleated settlements. Areas proximate to larger, viable commercial centers should retain many long established rural dwellings and attract new dwellings during the recent period. The presence of older and newer dwellings would not only increase the housing density around such places, but also cause a noticeable nucleation to extend into the parts of the countryside. Much of this dwelling concentration appears along both highways and secondary roads that converge at these larger places (Bohland, 1970; Brown, 1966; Clawson, 1966; and Smith, 1965).

Smaller central places, generally with reduced commercial amenities, should prove to be less effective in attracting new rural dwellings to adjacent areas. As in larger nodes, many older dwellings in this same setting will likely remain. The smaller numbers of new dwellings combined with the remaining, older residences produce perhaps moderate dwelling densities closest to the nucleation's borders, but the density diminishes rapidly with increasing distance from the nucleated settlement.

Dwelling Orientation to Principal Roads

The importance of the road network in providing rural inhabitants with access to nucleated settlement is well known (Bohland, 1970, 1973; Brush, 1953; Smith, 1962, and Trewartha, 1943). Assuming that the road network covers the rural landscape uniformly, the most desirable rural dwelling sites are along the roads with the best surface conditions. Surface conditions affect both travel speeds and the possibilities of use in inclement weather. Smith (1947) noted the universal appeal for dwelling sites along paved roads in the United States while Bohland (1970) found large clusters of rural dwellings along hard surface roads in northeastern Georgia.

Highways, farm-to-market roads, and roads to various locales are now frequently paved in rural areas, whereas before such designated routes were usually gravel-base roadways. Highways were paved earlier than other principal roads. It follows that dwellings along and near paved routes, and those designated for paving, would be more likely to remain occupied, since these road conditions enhanced accessibility for the rural occupants. Such routes would also be attractive for new dwelling locations. On the other hand, dwellings situated along unpaved roads and away from the paved routes would be more likely to be vacated because of their relative inaccessibility. These preceding points are developed further in the following model.

The possibilities for retaining or relinquishing four farm dwellings situated along roads with various surface conditions affecting dwellers' accessibility to a trade-service center are illustrated with a descriptive model (Fig. 1). It is assumed that all four farm operators

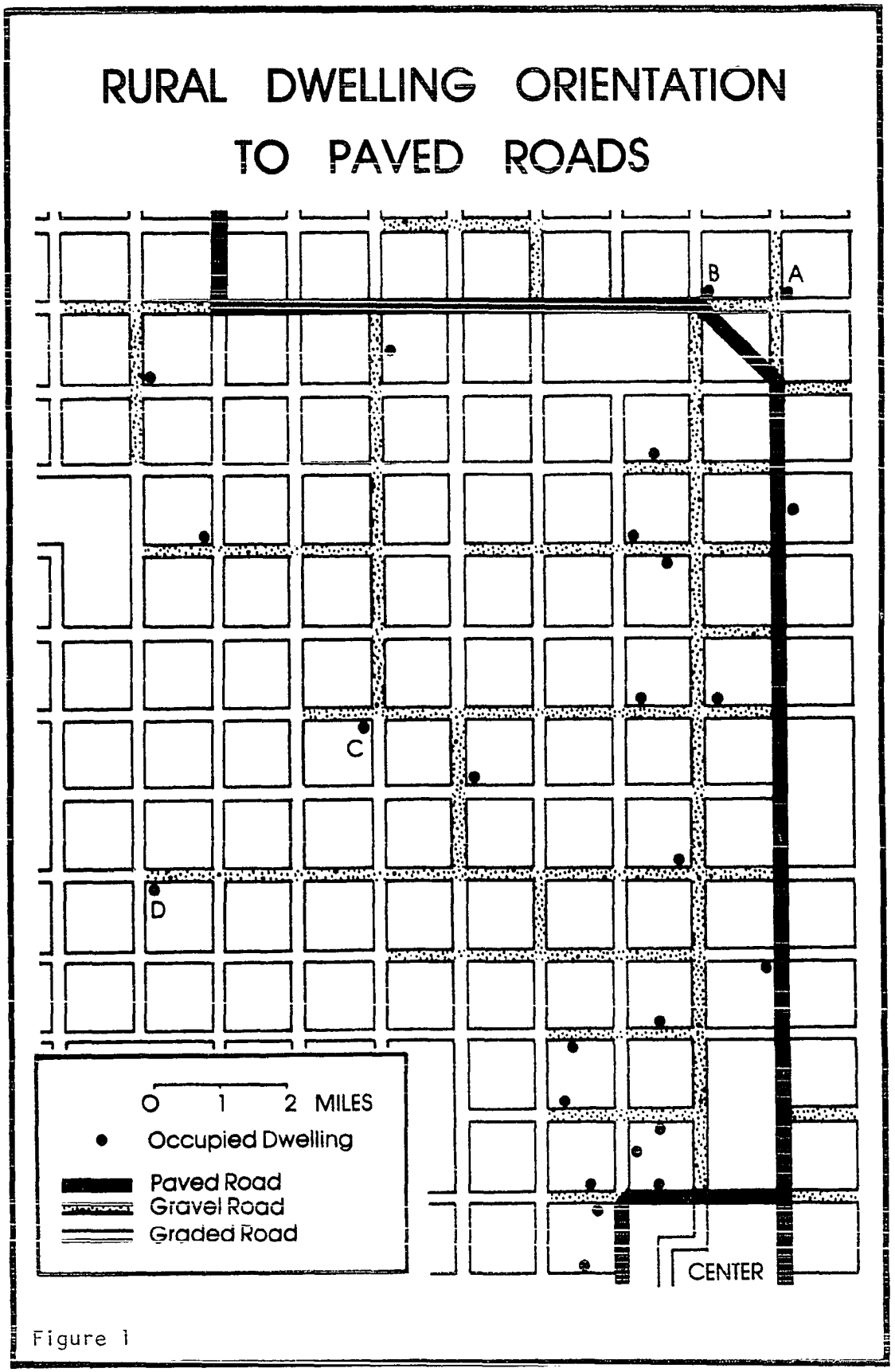
RURAL DWELLING ORIENTATION
TO PAVED ROADS
A
B
C
D
0 1 2 MILES
Occupied Dwelling
Paved Road
Gravel Road
Graded Road
CENTER

Figure 1

use paved roads as much as possible in reaching their dwelling sites, that they could live elsewhere, and that they have equal demands for goods and services from the trade center. Dwelling A is 11 miles from the service center, but 1 mile from a paved secondary road that is normally used for travelling to and from that center. So long as the dwelling is linked to the paved route by an improved road it may be considered quite accessible to the nearby community. The short distance on the improved road would not appear to be that much a deterrent to travel time or to travelling during inclement weather. Ostensibly, its inhabitants could view their location as 11 miles from the nucleated settlement via secondary or good road. This location differs little from another, Dwelling B, found 11 miles away but situated along the paved road. If accessibility is important, one would assume that these dwellings would remain occupied.

Two other dwellings, C and D, are also 11 miles away from the trade center by paved and unpaved roads, but the amount of unpaved road is much greater in these situations. Under normal conditions, travel speeds along the unpaved roads would be lower because of the surface materials. During inclement weather travel could become difficult along this same route. These conditions would offer less inducement to remain at or to move to these dwelling sites.

Both dwelling orientation to principal roads and dwelling distance from nucleated settlements concurrently affect morphologies for new settling, abandonment, and residual dwellings. Expected morphology for each of these dwelling categories can be anticipated assuming that rural inhabitants have retained or chosen residential sites on the

basis of accessibility to trade-service centers.

Anticipated Morphologies for the Settlement Process and Residual Dwelling Distributions

Using the accessibility factors relating to rural dwelling locations, anticipated morphologies were developed for the two settlement processes and the residual dwelling distributions for Hudson's competition phase. In developing each expected morphology the effects of the accessibility factors were maximized.

New Settling

Rural inhabitants express preferences for rural dwelling sites through new settling in these ways:

1. Most new dwellings are constructed by conventional means at these locations, but some residences are definitely prefabricated assemblages (Fig. 2). More recently some residences were mobile homes.

2. Abandoned dwellings are reoccupied. Ordinarily, this dwelling reoccupation is preceded or accompanied by remodeling and other improvements, such as increasing the living space.

3. Dwellings are moved to a site from another location. These dwellings are, in many cases, extensively renovated (Fig. 3).

Foremost among the factors related to accessibility is the size and distribution of central places, for much of the new settling is expected to concentrate around nucleated settlements. These clusters are comprised mainly of non-farm dwellings occupied by families tied economically to the nearby trade-service nodes or by sidewalk farmers. Proximity to the market place allows the sidewalk farmer easy access to both the countryside and the retail-service units in the central place. Although some new farm dwellings still occur within this central place fringe area, most are distributed in more distant locations, but

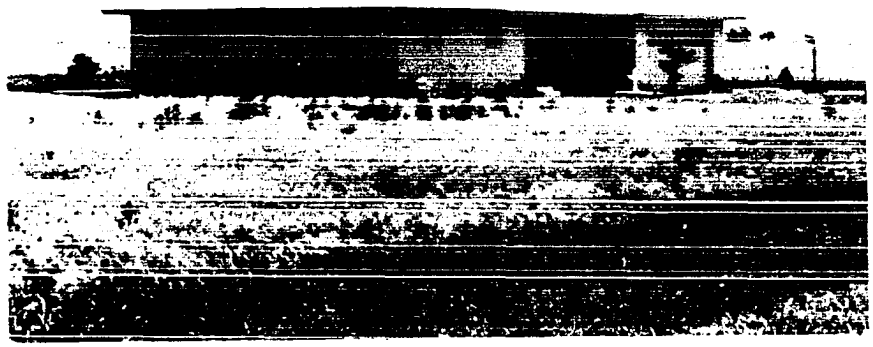

Figure 2: This brick home is representative of some of the new dwellings recently constructed in the study area. Its site is within one mile of a paved highway, six miles east of Lone Wolf.

Figure 3: This frame house exemplifies another form of new settling. It resulted when two residences were moved from elsewhere and joined together at a new site. The dashed line shows where the two buildings were joined.

accessibility in this case is expressed in the orientation of the rural dwelling to the paved road system.

Because of the grouping of new residences in the vicinity of central places in the rural landscape and to a lesser extent along paved roads beyond these places, it is reasonable to assume the morphology for the new settling matrix is one of clustering.

Abandonment

Dwelling abandonment occurs when a resident becomes dissatisfied with his dwelling location or when his occupancy at that site is terminated due to exogenous causes unrelated to site conditions. Both of these situations occur within the rural environment, but each has different distributional patterns.

Two stages of dwelling abandonment ordinarily occur:

1. The early abandonment stage consists of dwellings recently vacated but still in good repair (Fig. 4). Many farmhouses are used during the day, if the farmer is working nearby, for shelter from inclement weather, as a place to eat, or even as a place to clean up before leaving. This is particularly true if the farmer is now in the sidewalk farmer category. Non-farm residences once abandoned are used very little thereafter.

2. The later abandonment stage involves dwellings that have fallen into disrepair after some years of vacancy. Eventually these residences become so dilapidated that their residential function is precluded. Thereafter they are used for other purposes such as farm storage, or they are razed in order to reduce county real estate taxes (Fig. 5).

Abandonment Due to Exogenous Causes. Abandonment resulting from non-site causes is more likely to be dispersed throughout the countryside, showing no geographic concentration, unless the exogenous factor itself has a concentrated location. For example, high rates of dwelling

Figure 4: This vacant house represents the early stage of abandonment. The dwelling is still in relatively good repair, but the same is not true for its pump house and water tank. It is at a farmstead along State Highway No. 54.

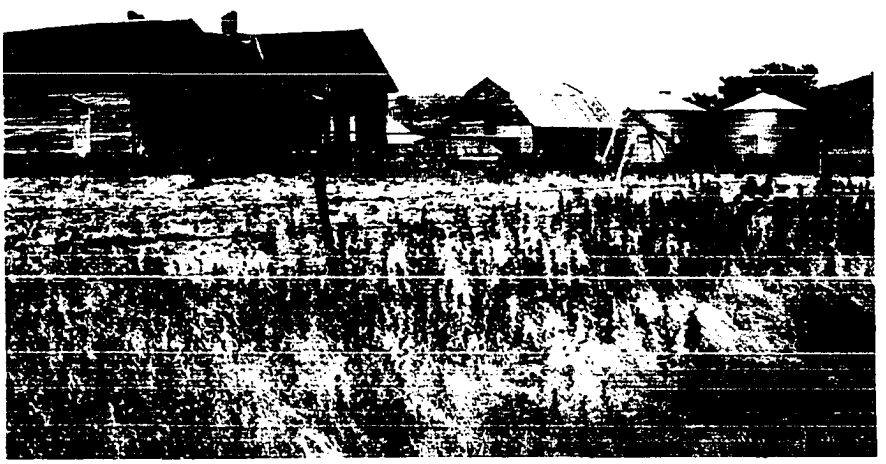

Figure 5: The former residence, at the left, depicts the later stage of abandonment. Most likely, the structure could not be reconditioned as a residence. At this time, its front is removed so that it can be used for storage purposes. Hay is stacked in several of its rooms.

abandonment might be associated with river floodplains, where large tracts of land are set aside for commercial uses such as mining, or where governmental holdings are established. The factor causing most abandonment unrelated to site is the change in farm size. When farms are acquired by larger farming operations the farmhouse of the former owner is usually left abandoned. Changes in farm size are most often a result of the following conditions: 1) economics of scale of farming, 2) decisions of land owners to sell rented agricultural lands, 3) the life cycle of long time farm operators, or 4) farm mechanization.

A smaller number of non-farm homes have been abandoned because of the reduced need for farm laborers due to farm mechanization. And, less frequently, non-farm housing is abandoned in rural neighborhoods when small businesses are closed, teacherages are vacated at consolidated schools, or parsonages at rural churches are left empty.

When exogenous causes affect dwelling abandonment within the rural landscape there is no particular areal focus for its occurrences, unless circumstances causing concentrations prevailed. This pattern of abandonment, therefore, should be random.

Abandonment Due to Site Dissatisfaction. If accessibility is responsible for the occupants' dissatisfaction with rural dwelling sites, abandonment should increase with distance from nucleated settlements. Some modifications in this expectation should occur where principal paved roads cross the rural landscape and reduce abandonment somewhat. Because of its anticipated increase away from nucleated settlements, this process affects mainly farm residences.

Under these conditions the dwelling site abandonment is focused

upon several loci, which are characterized by their distance from central places and their distance from principal paved roads. As a result, abandonment should display a clustered morphology, but with an orientation away from the nucleated settlements.

The combination of clustered and random patterns associated with different types of abandonment should result in a pattern that is clustered but not as clustered as the pattern associated with new settling. The clustering tendency, in addition, should be centrifugal with areas furthest from the nucleated settlements experiencing the greatest abandonment.

Residual Dwellings

A residual dwelling suggests that the site of the structure meets the requirements and functional capabilities of a rural resident and consequently remains continuously occupied. Although these dwellings are remnants from past settlement, their continued occupation reflects their favorable location with respect to accessibility. Therefore, some of the same locational factors responsible for initiating new settling, or site abandonment due to accessibility, are operative in the retention of these dwellings.

The residences comprising this distribution may be older, but many show signs of both exterior and interior improvements (Fig. 6). One of the most frequent improvements is that of increasing the floor space contained in the dwelling. In some instances, an older home has been razed at the site, and a new one has been built in its place. The writer considers the latter situation still represents a residual one, providing the site was continuously occupied (Fig. 7).

Figure 6: This residual dwelling, on a farmstead northeast of Cooperton, was being enlarged with a concrete block addition in 1973. The older part of the structure, a wood frame construction, is typical of the older residences in the county.

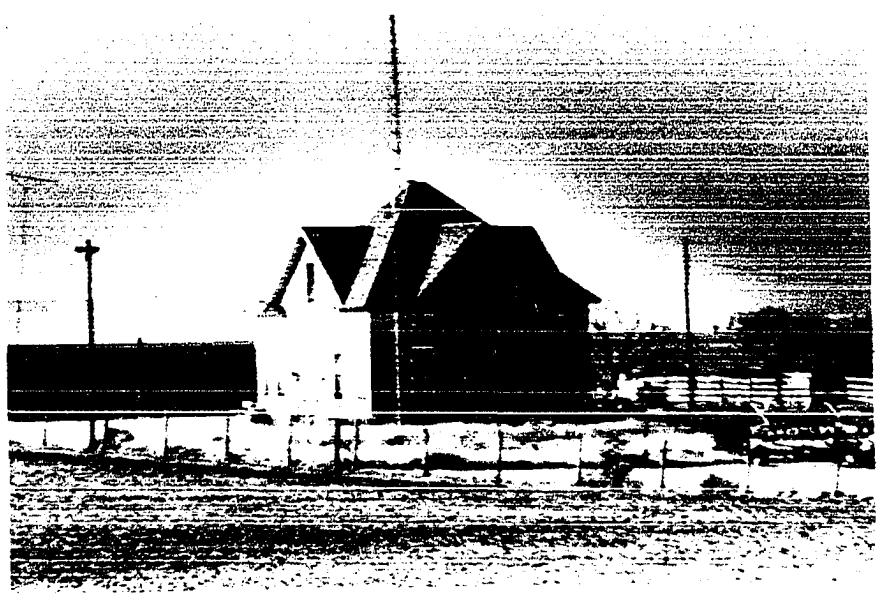

Figure 7: Another way for a residual dwelling to occur is when an older dwelling is replaced by a newer one, as is shown at this farmstead south of Mountain View. The newer building was completed in 1973. Very likely, the older building will be razed or moved elsewhere on the farmstead and turned into a storage building.

The need for residential accessibility argues for rural dwelling sites nearer to nucleated settlements. Such an orientation is anticipated for the greater part of the residual dwelling distribution in the rural environment. In the immediate margins of central places, and especially further away, the farm dwellings in this category should have easy access to the paved road system, with locations either along rights-of-way or at short distances away along feeder roads. Some non-farm dwellings are situated in the fringe areas of nucleated settlements along paved roads. Their occupants are most likely to be people employed in the nearby retail and service establishments, although some sidewalk farmers have resided in these settings for long periods.

Because of the tendency for residual dwellings to become concentrated around nucleated settlements and the major roads that lead into them, it is logical to anticipate that their matrix will tend towards clustering.

Anticipated Morphology for the Rural Settlement Matrix

The synthesizing of the new settling, abandonment, and residual dwelling matrices creates the rural settlement matrix at a specific time. From the three anticipated morphologies just presented it is possible to formulate an expected pattern of the rural settlement for a time period.

A synthesis of the three anticipated matrix morphologies suggests both centripetal and centrifugal distributional characteristics as being operative. Both new settling and residual dwelling distributions were expected to be clustered around only a few loci. Rural dwelling

sites close to nucleated settlements and principal roads are thought to be most suitable, if accessibility is, indeed, a significant locational factor. Abandonment, conversely, is expected to be concentrated around several loci, which are at a distance from nucleated settlements and principal roads.

The rural settlement pattern which results from the union of these three matrices should be clustered. The centripetal influence of both new settling and the residual dwellings accounts for the concentration of residences in the vicinity of nucleated settlements and the principal roads leading to them. Dwelling abandonment should be clustered, but centrifugally oriented from nucleated settlements, thereby reducing the dwelling numbers in their more distant peripheries.

Research Hypotheses

The major hypothesis of this work is that the rural settlement becomes clustered during the competition phase as rural dwelling locations are optimized with respect to trade-service centers and the principal routes leading to these centers. Several supportive hypotheses were tested which pertain to the accessibility factors and the anticipated morphologies for either the settlement process or the residual dwellings presented previously in this chapter.

Hypothesis 1: The morphology of newly settled dwellings will be noticeably clustered during a period when the number of dwellings in the rural settlement and their average density are declining.

Hypothesis 2: The morphology of residual dwellings will be

clustered, but probably less than that for new settling, during a period when the number of dwellings in the rural settlement and their average density are declining.

Hypothesis 3: The morphology for abandonment will be clustered, but probably less than that for new settling, during a period when the number of dwellings in the rural settlement and their average density are declining.

Hypothesis 4: During a period when rural settlement becomes clustered the distance of all occupied dwellings from villages and towns will decrease significantly.

Hypothesis 5: During a period when rural settlement becomes clustered all occupied dwellings will become increasingly oriented to the major transportation routes leading to villages and towns.

Hypothesis 6: During a period when rural settlement becomes clustered the dwelling distribution will show a relationship to the existing hierarchy of villages and towns.

A discussion of the methodology used for testing these hypotheses follows in the next chapter.

CHAPTER II

RESEARCH DESIGN AND METHODOLOGY

In this chapter the components of the rural settlement are clarified, the research design is explained, and the quantitative techniques utilized for measurement are discussed. The research design consists of two parts, one on the measurements of rural settlement morphologies and the other on the variables affecting rural dwelling location.

Rural Settlement Components

There is no consensus about which dwellings constitute the rural settlement matrix. Some researchers limit the matrix to farmsteads only. Others include most or all of the permanently occupied dwellings within a specified rural landscape. Still others rely on governmental definition as found in census materials to define the content of the matrix. For example, fundamental to all these attempts is the differential between the rural and urban portion of the settlement landscape. Again, most investigators have relied on census definition to distinguish between the two groups.

According to the United States Bureau of the Census definition, rural includes the population and area not included in the various urban delimitations.[1] This residual type of definition relies on

[1] According to Census definition the urban population includes those persons living in urbanized areas and in places of 2500 inhabitants or more outside of urbanized areas. The extended city was devised, because certain cities had boundaries extended into district rural settings. An extended city has one or more areas, each with at least

location as the principle factor differentiating between the two. However, the Census subdivides the rural population and dwellings into either rural farm or rural non-farm categories on the basis of function. The former is determined by the fiscal earnings from farm produce in a given year and places certain areal requirements upon the farming unit.[2] All other inhabitants and their respective dwellings are classed as rural non-farm regardless of their economic orientation. A major disadvantage of the rural non-farm category is that it includes persons in either group quarters or recreational areas, neither of which are necessarily permanent residents or distinctly rural in their way of life.

The rural settlement matrix considered here includes all dwellings outside of designated confines of nucleated settlements (hamlets, villages, and towns), distinct recreational nodes, group-living quarters, or governmental holdings in a setting within which primary production predominates.[3] This allows for both farm and non-farm dwellings to be

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five square miles dimension, and with a population density of less than 100 persons per square mile during the 1970 census. This area and/or areas must include at least 25 percent of the land area of the legal city or total 25 square miles or more. (Note that certain portions of the legal city could have rural portions under these circumstances.)

[2]Rural farm population is defined as residents on farms consisting of at least ten acres from which the produce sale was at least fifty dollars in the preceding year. It may also be those persons residing at farm sites of less than ten acres from which the produce sale was at least $250.00 in the previous year.

[3]This conforms to Stone's requirement for a rural landscape. He stated that: "....rural means an areal predominance of agriculture, forestry, mining, fishing, hunting and trapping, or power production directly from local resources." (Stone, 1966, p. 347).

considered as components of the rural settlement matrix.

Settlement Data and Matrix Derivations

Depiction of the rural settlement matrices, the process matrices, and the residual dwelling matrices used in this research required data from current and past periods. Two sources were utilized: county highway maps prepared by the Oklahoma Department of Highways and a map checked in the field. County highway maps were produced for the study area, Kiowa County, in: 1936, 1941, 1949, 1955, 1961, and 1965.[4] Two of these maps, those for 1936 and 1949, were selected for examination and analysis. A third map was obtained by correcting the 1965 county highway map during the summer and fall of 1973. All existing dwellings and dwelling remnants were recorded during this field work. Whenever possible these data were used for correcting dwelling sites on the two previous maps.

The field check of the study area was necessitated because all dwellings, whether occupied or unoccupied, are shown on these maps.[5] This research, however, was concerned with distinguishing between occupied and unoccupied dwellings. The most consistent problem encountered on all three maps was the actual dwelling location with respect to the

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[4] Although these county maps were produced for each of the specified years, their availability was a problem. I was unable to locate a copy of the 1955 county highway map which would have been desirable from a time standpoint in the research. Unfortunately, in the past when a new map was issued the previous one was discarded. Some sets of maps were available at the Oklahoma Historical Association, the Oklahoma Geological Survey, and at some of the libraries at the State's colleges and universities.

[5] After the 1949 series of county highway maps were produced, all dwellings standing on the landscape were shown, although there was no distinction made about their occupancy.

road. Dwellings are shown as squares, which are oversized for the maps. Field checking revealed that most dwellings were, or had been, reasonably close to the roads.

All dwelling sites were coded and identified with cartesian coordinates for the three periods: 1936, 1949, and 1973. Each square mile was subdivided into 10,000 smaller square units, or each side was comprised of 100 equal distance portions. This grid made it possible to locate each site reasonably accurately, with no site being more than 26.4 feet from its actual location in any of the four cardinal compass directions. For this research this degree of accuracy was considered acceptable.

Once the dwelling locations were accurately fixed for the three periodic settlement matrices, it was possible to derive the various settlement process and residual dwelling matrices. From a comparison of the 1936 and 1949 settlement matrices the residual dwelling, new settling, and abandonment matrices were constructed. Similarly, three matrices were fabricated for the same categories for the 1949-1973 interim.

Research Design

The research design consists of two sections. One concentrates upon analysis of the point patterns in the settlement matrices for different periods and in the process and residual dwellings matrices. The other considers two significant variables, which affect dwelling locations--rural roads and distances to service-trade centers.

Analysis of the Settlement Matrices

To test the research hypotheses on settlement morphologies, the rural settlement matrix and both the settlement process matrices and residual dwelling matrices were analyzed at particular intervals during the 37 year period. The major hypothesis is that clustering occurred within the rural settlement matrix during this time interval. Non-random patterns within the settlement process and residual dwelling matrices over the same period is the essence of the supportive hypotheses relating to settlement morphologies.

All matrices here are treated as point patterns for analytical purposes. Point patterns, according to Rogers (1969), possess three spatial properties about which distinctions are important. Any point array may be defined by its shape, a two dimensional characteristic, which is based upon areal enclosure. The description of spacing between each of the points within the array constitutes the pattern, a zero dimensional spatial characteristic; this spacing is referred to as the module (Rogers, 1969, p. 49). Dispersion, a one dimensional spatial characteristic, considers the distribution of points within an area of a specific shape. Rogers views dispersion as "....an attribute of a pattern that is located within a particular shape, at a given density."

For analysis of settlement matrices to be complete all of the point pattern properties must be included. Although shape may be covered relatively easily under the circumstances, both pattern and distribution necessitate more technical treatment. Pattern, as used here, is synonymous with arrangement.[6]

[6]Pattern has been used by several investigators when referring to any morphological characteristic relevant to the settlement matrix. It is important to establish that pattern is a technical term indicating arrangement, which is distinguished from distribution.

Measurement of Arrangement and Distribution

Several methods exist for measuring and expressing rural settlement matrices. From Stone's survey at least eight categories of measures or indices are available (Stone, 1968, pp. 318-320).[7] Most of these measures or indices are applicable to specific areas; that is, their use depends upon special census data or objective field observations. Some of the remainder depend upon predetermined distances or densities for establishing certain measures or indices. Most of the former measures and indices are outmoded, because they are either too general in their pattern description or too limited, which prevents their use elsewhere. Only one category showed potential for meaningful and universal application, i.e., the mathematical representation of pattern.

The mathematical representation of pattern allows for objective interpretation and description of complex distributional data. The most appropriate category of methods for these purposes is referred to as specific mathematical representations by Harvey (1969). Specific mathematical representations utilize the comparison of actual spatial patterns with those generated according to specific theoretical models. Commonly a theoretical random pattern or distribution becomes the basis for comparison. Harvey (1968, 1969) recognizes two methods as especially useful for determining specific mathematical representations--nearest neighbor analysis and quadrat analysis--both of which rely upon a Poisson probability model.

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[7] The categories include: average distance between dwellings, concentration-grouping-agglomeration of the settlement, continuous-discontinuous settlement, density of the settlement, dispersion of the settlement, isolated-scattered-concentrated-condensed indices of settlement, isolation, and pattern departure from randomness (a mathematical representation).

The assumptions of a Poisson probability model, as they apply here, are: that any point has had the same chance of occurring in any location in the point pattern; that any point pattern location has had the same chance of receiving a point; and that the location of any point has been independent from that of any other in the point pattern.

Nearest neighbor analysis measures a point pattern's arrangement, while quadrat analysis measures its distribution. Both measures are used for describing the point patterns found in the different dwelling matrices, because a combined appraisal gives more insight into the nature of the matrix. Computer programs were used for both of these analyses because of the size of the housing data obtained in the study area (Appendices 1 and 2).

Although the combination of nearest neighbor analysis and quadrat analysis have been used to analyze rural settlement matrices, both were not fully explained or evaluated by Birch (1967). Therefore, the application of these analyses needs further attention in rural settings. Because of their intrinsic shortcomings, each measure serves as a check on the other when applied in this combined fashion. Presumably the outcomes from both should be similar, when they are applied to the same settlement data.

Nearest Neighbor Analysis. Clark and Evans (1954) first used nearest neighbor analysis in describing vegetation arrangement. For this analysis a study area is chosen from a similar and considerably larger setting within which a random pattern presumably exists. Pattern is expressed with an index which ranges from 0 to 2.14, where perfect randomness equals one, complete clustering 0, and maximum regularity

equals 2.14 (Fig. 8).

Nearest neighbor analysis was applied to the entire point pattern within the study area.[8] Distances between nearest points are measured for every individual, and an average distance is computed for the population. An average distance expected in a randomly distributed population with a density of the study area is calculated. The average nearest neighbor distance expected under random conditions is compared to that

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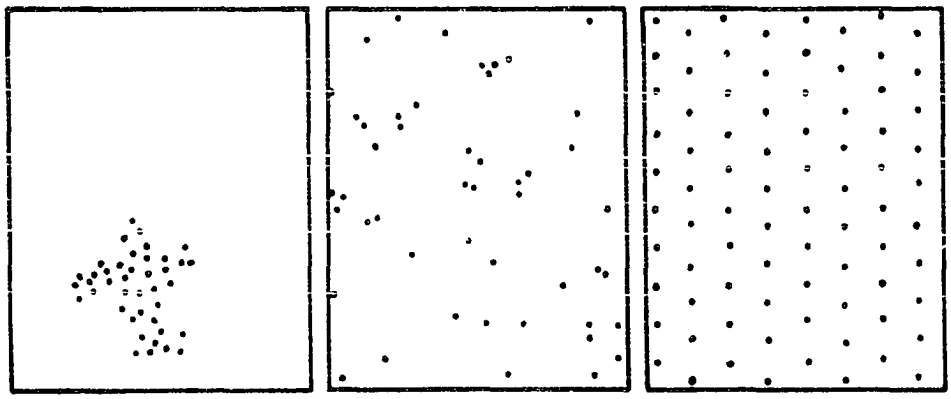
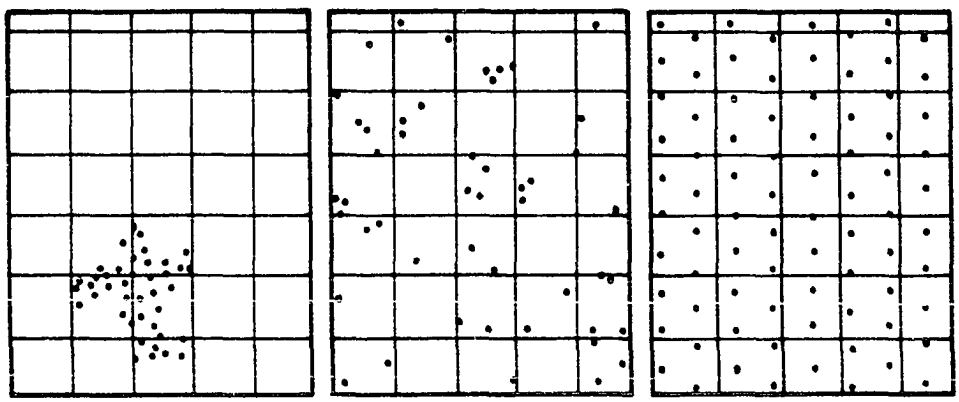
[8] Symbols and formulas used in calculating the nearest neighbor statistic and its significance tests are found below:

Symbols/Formulas	Description
N	The number of points in the study area which serve as centers for measurements.
s	The size of the study area. (The measurement unit used here must agree with that employed for measurements between points--square miles and miles.)
$P = \frac{N}{s}$	Rho is the mean density of points per unit area within the study area.
r	The distance from a point to its nearest neighbor. (The measurement unit must agree with that specified for s, in this case--miles.)
$\bar{r}A = \frac{\sum r}{N}$	Mean distance to nearest neighbors observed in the study area.
$\bar{r}E = \frac{1}{2\sqrt{P}}$	Expected mean of nearest neighbor distances in a large random distribution of points with an average density.
$R = \frac{\bar{r}A}{\bar{r}E}$	Ratio indicating departure of observed nearest neighbor distance in the study area from a random condition.
$\sigma_{\bar{r}E} = \frac{0.26136}{\sqrt{Np}}$	The standard error of the mean distance to nearest neighbor in a randomly distributed population with density.
$c = \frac{\bar{r}A - \bar{r}E}{\sigma_{\bar{r}E}}$	The standard variate of the normal curve.

IDEALIZED CLUSTERED, RANDOM, AND REGULAR POINT PATTERNS



Nearest neighbor analysis necessitates measuring distances between nearest points in the matrix. In the clustered example all distances would be small and $\bar{r}A$ (the mean distance) would therefore be small. In the random example the distances vary and the average distance would be larger. In the regular example the distances are all the same and $\bar{r}A$ would be that same distance.



Quadrat analysis involves counting the number of points in each quadrat. In the clustered example a few quadrats have several points, whereas many quadrats would be empty. In the random example the number of points per quadrat vary, with some empty and the remainder with one, two, three points, and so on. In the regular example all the quadrats have one or more points, but the numbers in each quadrat display little variance.

Figure 8

observed in the population; the resulting ratio becomes the index used for assessing randomness. The reliability of this ratio is tested by evaluating the standard variate of the normal curve.

Three technical problems are linked with the nearest neighbor technique: selection of the study area, boundary measurements, and pattern misinterpretation induced by pairs. The study area consists of a finite population chosen from within a larger infinite population. For measurement purposes this becomes a representative arrangement. Several means have been used for delimiting study areas to which nearest neighbor was used for outlining the investigation areas in an urban setting (Getis, 1964); point pattern changes were suggested for establishing borders in another case (Hsu and Tiedmann, 1968); and, others used several tracks, which possessed certain physical or economic characteristics (Birch, 1967; King, 1962). DeVos (1973) first designated a study area, then established a subarea within it that was measured for nearest neighbors. Another researcher measured nearest neighbors within a specified settled area found in a considerably larger political area (Kariel, 1970). In this work a large representative county was selected for the study area, assuming that this was a valid portion of a considerably larger settlement region.

Measurements to nearest neighbors in the study area's borders are problematic. In the Clark and Evans procedure measurements are made to closest neighbors, even when they are outside of the delimited area. Such interareal measures increase the observed distance measure, $\bar{r}A$, by the proportion of its distance outside the boundary. Thus, when the R statistic is derived from $\bar{r}A/\bar{r}E$ it is inaccurate, since it assumes that

both distance measurements are for the same area. Several methods have been suggested for omitting this bias (DeVos, 1973; Hsu and Tiedmann, 1968; and Getis, 1964). The refinement followed in this work entails not crossing the boundary. This keeps all measurements within the study area. Such a technique eliminates any exaggeration in the observed distance measure, $\bar{r}A$.

The last problem that can be encountered in nearest neighbor analysis involves the occurrence of pairs throughout much of the population. Clustering of the point pattern is expected whenever extremely small observed distances exist within the point array. Ordinarily this occurs when all of the points are clustered in a relatively small area within a considerably larger space. However, short distances can also be found where an entire population is comprised of pairs of individuals. Under these conditions, measured distances are relatively small, thereby indicating clustering with the R statistic. These pairs may be arranged in either random or regular patterns and not be correctly identified with the nearest neighbor technique. Although such unique distribution could be encountered in either natural, economic, or other cultural circumstances, this in no way negates the value of the nearest neighbor measure. Therefore, unless the pairs' arrangement is suspected, the nearest neighbor measurement may be applied to a particular point pattern. This assumption was followed here, since no planned pairing of dwellings occurred previously on a large scale within the study area.

Quadrat Analysis. Quadrat analysis, like nearest neighbor analysis, was developed for measuring distributional characteristics by plant ecologists. Its application consists of counting points within quadrats

after a quadrat grid is superimposed over a particular distribution (Fig. 8).[9] These observed data are placed in a frequency distribution. A random frequency distribution is generated for the same population with the Poisson series. The observed and random frequency distribution are compared with a variance-mean ratio.

The variance-mean ratio is an index indicating randomness. In the Poisson the mean is equal to the variance. Thus, a perfect random distribution is depicted by a ratio of one. A ratio of less than one indicates regularity, whereas a ratio greater than one identifies clustering. In order to assess the statistical significance of this ratio the chi-square goodness of fit test is normally used.

The major disadvantage with quadrat analysis is its sensitivity to quadrat size. If a population is distributed with perfect randomness, then the quadrat size should not matter (Greig-Smith, 1964). However, when non-random distributions are analyzed, quadrat size can bias the results. Normally, the larger the quadrat the more likely a distribution is to appear regular or uniform regardless of the actual pattern. This results as each quadrat has some points within it. Conversely, extremely small quadrats can erroneously indicate clustering, since many are apt to be free of any points. Thus, the use of one quadrat size for measuring a point pattern is to be avoided if meaningful results are desired. Valid results, on the other hand, can be achieved by using different quadrat sizes to analyze the same distribution.

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[9] It is important to recognize that as the quadrat grid sizes are changed that various portions of the study area will be excluded from the measurement.

Six different quadrat sizes, ranging from 0.31 square miles to 4 square miles, were chosen for observing the point pattern in the study area. An initial quadrat size was selected for each periodic rural settlement matrix by determining the cell dimensions for an appropriate average density of one dwelling per cell. These initial quadrat sizes were: for 1936 an average of one dwelling per 0.31 square miles, in 1949 an average of one dwelling per 0.42 square miles, and for 1973 an average of one dwelling for 1 square mile. Larger cell sizes were added which allowed for a consistent check on randomness, since it should have been found at one or more cell sizes if it existed. In addition, the use of increasing cell sizes served as a means for picking out regularity in the distribution, if it existed.

Another problem encountered in the use of quadrat analysis is its density dependency. This measure necessitates a relatively low population density reaching all portions of its delineated area; when densities are maximized, Poisson probability no longer is operative. Both of these prerequisites were fulfilled at all times by the settlement matrix being considered here.

Finally, the placement of the quadrat grid over the point pattern can present some bias. This problem can be easily averted by starting at a central, initial point in laying out each of the grids. Some peripheral omissions will occur but this procedure allows for them to be achieved as fairly as possible. Regardless of how these various sized quadrats are placed over the point patterns some points will be split. Each such point has to be counted in only one of the quadrats which very slightly biases the cell counts.

Analysis of Rural Dwelling Relationships With Rural Roads and Nucleated Settlements

Three supportive hypotheses were offered for dwelling locations which were related to the anticipated clustering for the rural settlement over time. To test these hypotheses, dwelling locations were analyzed regarding their relationship to rural roads and their distances to nucleated settlements.

Rural dwelling locational data were taken from the rural settlement matrices for 1936, 1949, and 1973. Locational data were supplemented by using the 1961 and 1965 editions of the General Highway Map for Kiowa County. Road surface conditions were obtained from these same maps. Additional information about surface conditions was obtained from records of the Oklahoma Department of Highways.

To verify the significance of major transportation routes to rural dwelling location in the study area the following procedures were used. The development of the county's road network was discussed in order to show the systematic nature of the road paving program. Then the effects of paved roads upon the location of newly settled, residual, and abandoned dwellings were analyzed through a series of comparisons using the Student "t" Test or the Chi Square Test. Specifically, the characteristic about dwelling locations were sought along paved roads, along side roads in adjacent areas, and along all side roads in the vicinity of principal routes. From these analyses it was possible to derive generalizations about the sites of various dwelling categories and rural roads.

The other factor affecting the location of rural dwellings concerned their distance from trade-service centers. However, it was recognized

that at the same time that distance was affecting dwelling location, there was also very likely a dwelling orientation towards the larger nucleated settlements. Supportive hypotheses had been proffered for both of these locational influences.

To categorize the hierarchial structure of the county's nucleated settlements, Brush's (1953) and Trewartha's (1943) classifications were used. All nucleated settlements peripheral to the study area were also classified to determine where their trade areas or hinterlands were with respect to the study area. These classifications were used because of their suitability to nucleated settlements found here.

In order to establish the relationship between rural dwelling location and the county's nucleated settlements, the following approach was used. Measurements were made along the shortest all-weather road distances from all rural dwellings to the closest village or town in the county or in peripheral counties. Shortest road distances were used to establish boundaries for trade areas for each of the nucleated settlements in Kiowa County. This procedure made it possible to eliminate any portions of the study area that were oriented to nucleated settlements in surrounding counties, according to shortest road distances. Median shortest road distances were calculated for dwelling locations in 1936, 1949, and 1973.[10] The median shortest road distances for the 3 periods were compared in order to determine whether dwelling locations by the end of the study period were significantly closer to the nucleated

[10]The median, rather than the arithmetic average, was used here since it was recognized that the dwelling distributions throughout the study period were skewed towards the nucleated settlements. The arithmetic average is a valid measure of centrality, only when it can be assumed that a normal distribution exists.

settlements. These comparisons were made with Analysis of Variance.

It was recognized that dwelling locations could be affected by the hierarchial size of its closest nucleated settlement. In comparison to smaller trade-service centers, larger commercial centers were considered to be more effective in attracting new dwellings as well as in retaining longer established residences in their proximity.

To measure variations in housing distributions surrounding the various nucleated settlements in the county, an occupancy ratio was formulated

$$\text{Occupancy Ratio} = \frac{\dfrac{\text{Number of dwellings in the commuting area}}{\text{Total dwellings in the county}}}{\dfrac{\text{Area (in square miles) for the commuting area}}{\text{Total area for all commuting areas}}}$$

The use of this measure eliminated the bias of area in assessing differences in dwelling distributions. This ratio provided a means where the actual number of rural dwellings in a particular commuting area were compared on a county basis to those in all other commuting areas.

An occupancy ratio of 1.0 designated a rural dwelling distribution proportional to the delimited commuting area. A ratio of greater than 1.0 showed a positive disproportion of rural dwellings in such a setting. And, a ratio of less than 1.0 depicted a negative disparity in the rural dwellings situated in a commuting area.

The shortest all-weather road distances were used for determining the closest trade-service center for all housing outside of nucleated settlements in Kiowa County. Boundaries were subsequently established for areas for the shortest commuting distance to each of the nucleated settlements. The area was measured and the housing numbers taken for each of these designated areas. Once these data were obtained they were

used for working an occupancy ratio for each community. These ratios were then used for describing differences between the housing in the areas around the larger and smaller communities.

The analytical procedures that have been presented provide the means for testing both the major hypothesis and the supportive hypotheses for this work. Before applying them to the rural settlement data, however, it will be helpful to familiarize the reader with the study area which was selected.

CHAPTER III

THE STUDY AREA

The study area displayed the basic prerequisites of Hudson's competition phase from 1936 through 1973 with farm numbers decreasing, while average farm sizes were increasing. Its selection, in addition, was important for other reasons. First, it provided a representative rural landscape in a geographical region of the United States different from those previously studied for rural settlement. Second, it fulfilled a research need of studying a large contiguous rural setting where both nucleated and non-nucleated settlement were represented. Finally, it lacked major interruptions in the rural settlement matrix from interstate highway rights of way, large landholdings by various governmental departments, or diverse physical features.

Kiowa County, in southwestern Oklahoma, is one of the largest counties in the western part of the state with an area of approximately 1,030 square miles (Fig. 9). Agricultural activities are carried out everywhere in this county, and mining operations are found at specific locations. The topography is flat to gently rolling plains with minor outcrops, which cause little interruption to the rural settlement, of either granite or limestone near the southeastern and central western borders.

Two areas within the county were excluded from the analysis, and another required special treatment. The Altus - Lugert Public Hunting

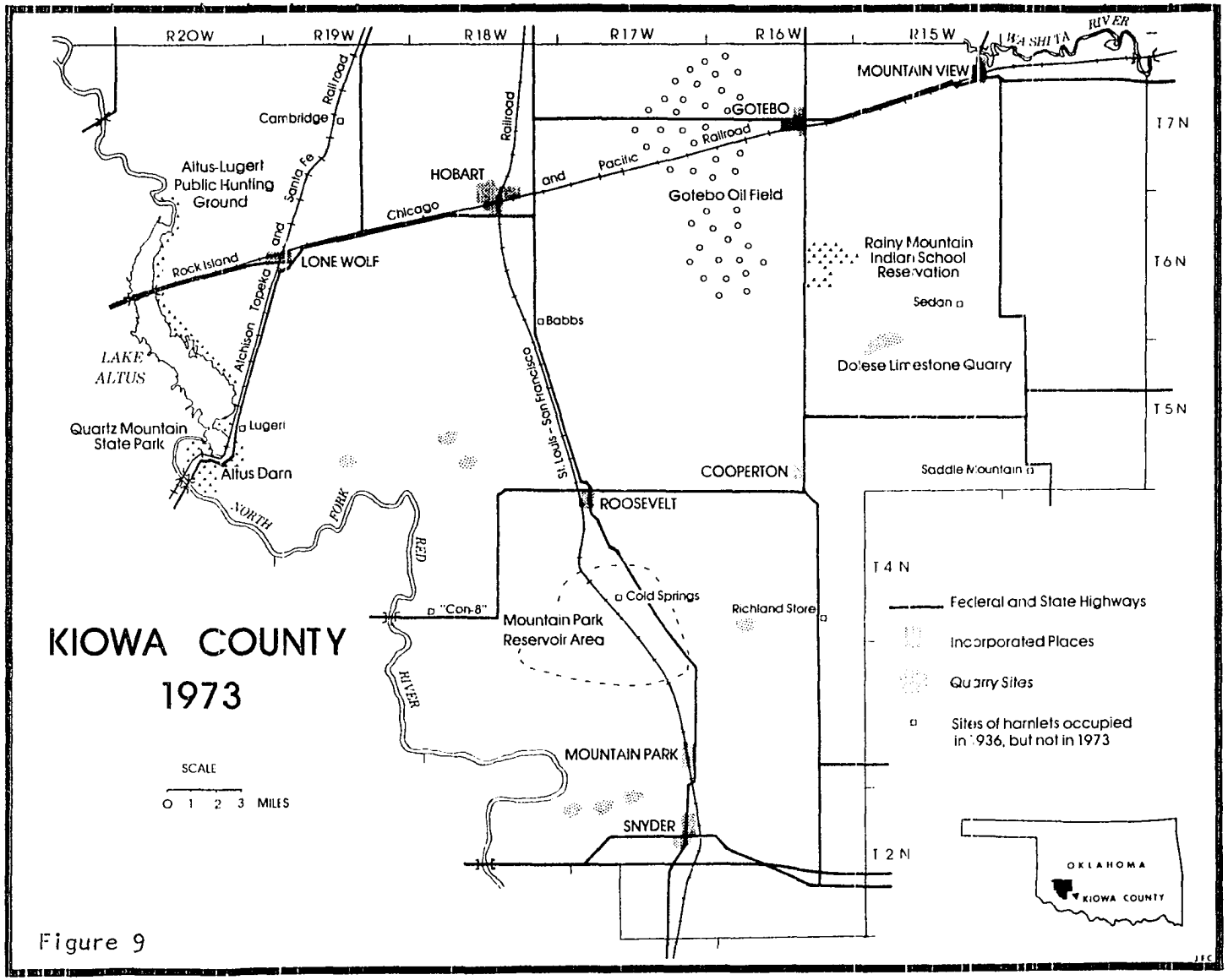
R20W
R19W
R18W
R17W
R16W
R15W
WASHITA RIVER
MOUNTAIN VIEW
GOTEBO
Railroad
Cambridge
Santa Fe
Railroad
HOBART
Chicago
and
Pacific
Railroad
Gotebo Oil Field
Altus-Lugert
Public Hunting
Ground
Rock Island
and
Texas
LONE WOLF
Rainy Mountain
Indian School
Reservation
Sedan
Babbs
Atchison
Topeka
and
Santa Fe
LAKE
ALTUS
Dolese Limestone Quarry
T7N
T6N
T5N
Quartz Mountain
State Park
Lugert
Altus Dam
St. Louis - San Francisco
COOPERTON
Saddle Mountain
NORTH FORK
RED
RIVER
ROOSEVELT
T4N
Cold Springs
"Con-8"
Mountain Park
Reservoir Area
Richland Store
Federal and State Highways
Incorporated Places
Quarry Sites
Sites of hamlets occupied
in 1936, but not in 1973
KIOWA COUNTY
1973
SCALE
0 1 2 3 MILES
MOUNTAIN PARK
SNYDER
T2N
OKLAHOMA
KIOWA COUNTY

Figure 9

Area is on the eastern and southern margins of Lake Altus. Seasonal homes are found within this designated area near the lake and some group campgrounds are somewhat further away. Quartz Mountain State Park, with a lodge, campgrounds, and several outdoor attractions is on the extreme southwest end of Lake Altus. In the northeastern part of the county is the Rainy Mountain Reservation, comprised of three sections where an Indian School once operated.

Mountain Park Reservoir, in the southern portion of the county, provides the City of Snyder with a water supply. This water body resulted after the Bureau of Reclamation increased the size of a former reservoir, Lake Snyder, in 1973 - 1975. The expanded size of the reservoir caused the razing of the small community of Cold Springs. When the new lake is filled, this site will be submerged. This project also necessitated rerouting the railroad and the Federal Highway No. 183. Prior to the initiation of construction, the Federal Government, through the Bureau of Reclamation, purchased all the land within the area planned for the project. Houses still occupied in this area during the summer of 1973 were included in the settlement matrix, which was analyzed.

Nucleated settlements are located along the three railroad lines crisscrossing the county. Primary roads, closely paralleling the railroads, connect these same centers. A more lengthy system of secondary roads provides access to all portions of the county. Hobart, the county seat, is the largest of these nucleated settlements. Five other service centers of some consequence include Gotebo, Lone Wolf, Mountain View, Roosevelt, and Snyder. Earlier, some other minimal service centers functioned. These remain today mainly as clusters of rural dwellings.

These clusters are Cooperton, Mountain Park, "Con - 8" (Consolidated School District No. 8), Saddle Mountain, and Lugert.

Non-nucleated settlement in Kiowa County has undergone considerable change in the last four decades. During the summer of 1973 there were 1,018 dwellings comprising its settlement fabric, whereas there were 2,357 dwellings in 1949 and 3,261 dwellings in 1936. A general understanding of the causes for these changes can be ascertained from a consideration of patterns of population and economic activities in the study area.

Population Distribution and Changes

Kiowa County has experienced a distinct population decline in the last four decades, a common occurrence in nearly all rural settings in western Oklahoma. Between 1930 and 1970 the county's total population decreased 17,098, or 57.7 percent (Table 1). The depopulation rate steadily increased during each decennial census period, representing a 23 percent change by 1940, approximately 36 percent by 1950, and nearly 50 percent in 1960. These changes differ, however, for various portions of the rural population.

Only one community, Hobart, has been classed as urban according to U. S. Bureau of the Census requirements. After 1930 this service-trade center experienced some growth until after 1950. During this interim, it increased by 398 inhabitants or about eight percent. Thereafter, decline occurred, with the 1970 Census indicating about a seven percent drop below the 1930 population. In 1970, the county's administrative center had 4,638 inhabitants (Table 1).

Other nucleated populations are found in seven incorporated service-trade centers and certain unincorporated centers. Collectively, this

TABLE 1

TOTAL POPULATION, NUCLEATED AND NONNUCLEATED POPULATIONS FOR KIOWA COUNTY

Year	Total Population		Nucleated Population				Nonnucleated Population	
			Urban		Others[b]			
	Absolute	Percentage Change[a]	Absolute	Percentage Change[a]	Absolute[c]	Percentage Change[a]	Absolute	Percentage Change[a]
1930	29,630	-----	4,982	-----	5,747	-----	18,901	-----
1940	22,817	-22.85	5,177	+ 3.91	5,414	- 5.79	12,226	-35.32
1950	18,926	-36.13	5,380	+ 7.99	5,273	- 8.25	8,273	-56.62
1960	14,825	-49.97	5,132	+ 3.01	4,802	-16.44	4,891	-74.12
1970	12,532	-57.70	4,638	- 6.90	4,702	-18.18	3,192	-83.11

SOURCE: U. S. Department of Commerce, Bureau of the Census, Census of Population: 1930, 1940, 1950, 1960, and 1970 (Washington, D. C.: U. S. Government Printing Office), various tables.

[a]Percentages of change are all based upon population figures for 1930.

[b]Others, included in the nucleated population, are those inhabitants found in hamlets, villages, and towns for the particular census year.

[c]Absolute figures include approximated populations for unincorporated settlements, since they are not included in the Census of Population for specific years.

population had declined 1,045 inhabitants, or slightly more than 18 percent, since 1930 (Table 1). Only two incorporated centers, Snyder and Mountain View, have grown since 1930 (Table 2); these were the second and third largest communities in the county, respectively, during the 40 year interval. The remaining communities, on the other hand, lost population at rates between 42.9 and 63.6 percent in the same period, except for one center. Mountain Park had a 1970 population which was one less than that for the 1930 Census.[1] Unincorporated places experienced considerable change during the same period (Table 3). In 1930 eight such centers existed, all of which provided minimal functions for the surrounding population. Coincident with the rural depopulation was the decline of all of these small centers. By 1970 only two places, Cold Springs and Lugert, remained although their hamlet function no longer existed.[2] The remainder of those which existed in 1930 were no longer recognizable centers. One location, Richland Store, disappeared prior to 1950, whereas the other five locations remain but in limited capacities. Some contain only a single old grain elevator or a few residences.

The greatest population decline in the county occurred in the non-nucleated rural population. Between 1930 and 1970 this number declined 83 percent, from 18,901 to 3,192 (Table 1). This non-nucleated rural

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[1] This particular community has recently manipulated its population numbers through its recruiting of teachers for its elementary school. No teacher is hired without consenting to move into the immediate confines of the incorporated place permanently. Moreover, any teacher must have children entered in the school.

[2] Functional classifications of hamlets, villages, and towns are possible using either the definitions of Trewartha (1943) and Brush (1957); these are considered in Chapter V.

TABLE 2
OTHER NUCLEATED POPULATIONS: INCORPORATED PLACES

Place	Populations and Percentages of Change Since 1930								
	1930	1940		1950		1960		1970	
	Absolute	Absolute	% Change	Absolute	% Change	Absolute	% Change	Absolute	% Change
Coopertown	151	187	+23.84	129	-14.56	106	-29.80	55	-63.57
Gotebo	827	607	-26.60	574	-30.59	538	-34.95	376	-54.53
Lone Wolf	1,023	783	-23.46	660	-35.48	617	-39.69	584	-42.91
Mountain Park	459	441	- 3.92	418	- 8.93	403	-12.20	458	- 0.21
Mountain View	1,025	1,075	+ 4.88	1,009	- 1.56	864	-15.70	1,110	+ 8.29
Roosevelt	721	744	+ 3.19	679	- 5.83	495	-31.35	353	-51.04
Snyder	1,195	1,278	+ 6.95	1,646	+37.74	1,663	+39.16	1,671	+39.83
Totals or Average Percentages	5,401	5,115	- 2.16	5,115	- 8.46	4,686	-17.79	4,607	-23.45

SOURCE: U. S. Department of Commerce, Bureau of the Census, Census of Population: 1930, 1940, 1950, 1960, 1970 (Washington, D. C.: U. S. Government Printing Office), various tables.

TABLE 3
OTHER NUCLEATED POPULATIONS: UNINCORPORATED PLACES

	Populations and Percentages of Change Since 1930[a]								
	1930	1940		1950		1960		1970	
Place	Absolute	Absolute	% Change	Absolute	% Change	Absolute	% Change	Absolute	% Change
Babbs	17	15	-11.76	---[c]		---[c]		---[c]	
Cambridge	17	15	-11.76	---[c]		---[c]		---[c]	
Cold Springs	103	86	-16.50	61	-40.78	52	-49.51	37	-64.08
"Con - 8"[b]	30	26	-13.33	26	-13.33	---[c]		---[c]	
Lugert	103	86	-16.50	26	-74.75	17	-83.50	11	-89.32
Saddle Mountain	26	22	-15.38	19	-26.92	14	-46.15	---[c]	
Sedan	34	30	-11.76	26	-23.53	17	-50.00	---[c]	
Richland Store	17	15	-11.76	---[d]		---[d]		---[d]	
Averages % Changes	347	295	-13.59	158	-35.86	100	-57.29	48	-76.70

SOURCE: Writer's notes, several editions of the General Highway Map of Kiowa County, and rural population averages from the U. S. Census of Population: 1930, 1940, 1950, 1960, and 1970, various tables.

[a]All populations have been computed from dwelling counts obtained from County Maps which are multiplied by the average number of inhabitants per household for each period.

[b]"Con - 8" is named for Consolidated School District No. 8.

[c]Too small to any longer be considered a nucleated place.

[d]Settlement completely missing on the landscape.

population is comprised of rural farm and rural non-farm inhabitants; the former reside at functional units, which qualify as farms or farmsteads, whereas the latter category of people includes all those residing at non-farm dwellings.[3] Rural non-farm population increased proportionately after 1930, with its current and highest amount being 39 percent (Table 4). Concurrently, the proportion of rural farm population declined from 96 percent to the present figure of about 61 percent. Much of this change can be attributed to three factors, i.e.: (1) the absolute number of farmers and their families decreased, (2) the number of non-farm residences of many farmers and their families increased,[4] and (3)

TABLE 4

RURAL NONNUCLEATED POPULATIONS FOR KIOWA COUNTY, 1930-1970, IN ABSOLUTE AMOUNTS AND PERCENTAGES

	Rural Farm Population		Rural Non-Farm Population[a]	
Census Year	Absolute Population	Percentage of Rural Population	Absolute Population	Percentage of Rural Population
1930	18,208	96.34	692	3.66
1940	11,871	97.06	359	2.93
1950	7,421	89.40	879	10.59
1960	3,679	74.97	1,228	25.03
1970	1,947	60.99	1,245	39.01

SOURCE: U. S. Department of Commerce, Bureau of the Census, Census of Population: 1930, 1940, 1950, 1960, and 1970 (Washington, D. C.: U. S. Government Printing Office), various tables.

[a]Calculated for rural non-farm population residing outside of any nucleated settlements

[3]Both rural farm and rural non-farm definitions are discussed in Chapter II.

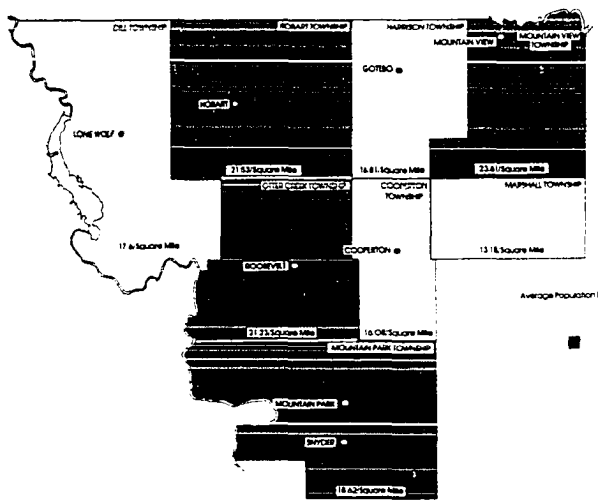
[4]Included in this number are all of the farm families living off the farm site, either in a nucleated settlement or elsewhere in the non-nucleated settlement matrix.

the presence of an agricultural support population, retired inhabitants, and individuals employed in nearby nucleated centers added to the non-farm component.

Population densities for the eight political townships in Kiowa County reveal much about the population losses. Average densities for the county have dropped from 18.58 inhabitants per square mile in 1930, to 8.02 inhabitants per square mile in 1950, and finally to 3.19 inhabitants per square mile during 1973 (Figs. 10a-c). Densities for the political townships vary during the time periods, but the pattern of variation was constant through time. At all times those townships with the largest nucleated settlements within their boundaries have had higher densities, e.g., Hobart, Mountain Park, and Mountain View Townships. Otter Creek Township consistently has had higher than average densities, although its one service-trade center, Roosevelt, was considerably smaller. Conversely, Dill Township showed lower than average densities consistently, while its service-trade center, Lone Wolf, registered ample population. This node's current population is markedly lower. The remaining townships with smaller communities reveal lower than average densities for each of the respective periods.

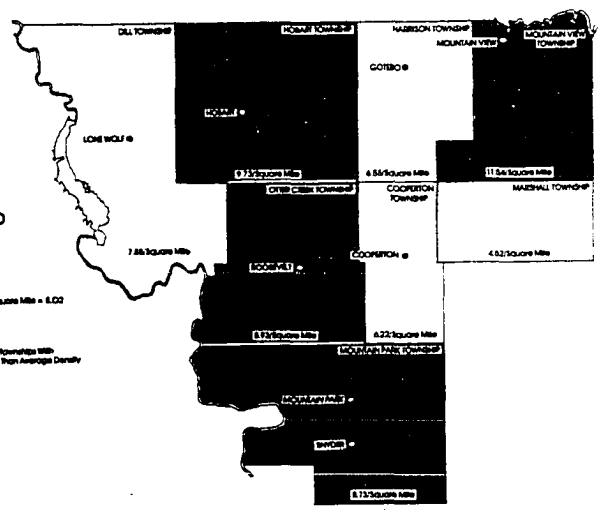
Economic Activities

Agricultural activities predominate throughout Kiowa County. The area occupied by farming activities has been proportionately high. According to the Census of Agriculture, since the 1930s more than 90 percent of the land use within the county has been for agrarian activities (Table 5). The land area in farms declined after 1935 until 1949, but thereafter it increased. However, some recent data indicate that



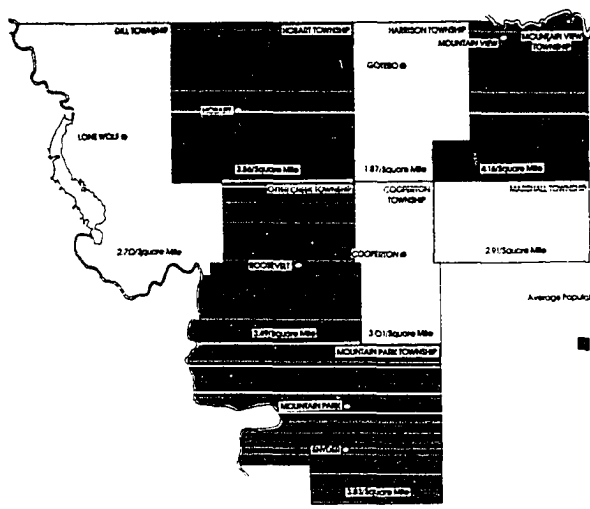
POPULATION DENSITIES FOR POLITICAL TOWNSHIPS IN KIOWA COUNTY: 1930

Figure 10a



POPULATION DENSITIES FOR POLITICAL TOWNSHIPS IN KIOWA COUNTY: 1950

Figure 10b



POPULATION DENSITIES FOR POLITICAL TOWNSHIPS IN KIOWA COUNTY: 1970

Figure 10c

certain farms in the county are utilizing land elsewhere, thereby inflating the total acreages above 100 percent.[5]

TABLE 5
LAND IN FARMS AND THE PERCENTAGES OF TOTAL COUNTY AREA FOUND IN FARMS

Year	Land in Farms (in acres)	Percentage of Total County Area in Farms
1930		
1935	634,804	94.7
1940	621,715	94.1
1945	621,344	94.1
1949	601,328	91.0
1954	614,259	93.0
1959	618,374	93.6
1964	617,342	93.5
1969	665,296	101.2
1974	635,696	96.7

SOURCE: U. S. Department of Commerce, Bureau of the Census, Census of Agriculture: 1930, 1935, 1940, 1945, 1950, 1954, 1959, 1964, 1969, and 1974 (Washington, D. C.: U. S. Government Printing Office), various tables.

Farm numbers steadily decreased after 1930, while the average farm size increased, for as individual farming operations were liquidated their lands were incorporated into the remaining farms (Table 6). Small farms became uneconomical to operate following the large-scale mechanization of farming operations; because certain levels of investment were required for machinery, smaller farms were squeezed out slowly.

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5 The Census of Agriculture reports data pertaining to farming operations headquartered in a particular county which can include acreages or farm production in another county in the reported statistics. Consequently, these statistics are at best extremely good indicators or the agricultural occurrences in any county or the changes these activities show over time.

Mechanized farming operations could easily and profitably increase the land area used for crop and livestock production. Vehicular transportation made another modification possible in the countryside. As both automobiles and trucks became readily available the farmer and his family were less attached to the farmstead. Many moved to residences in either nucleated settlements or elsewhere in the rural setting. This trend is depicted by the changes over a 29 year period. In 1945 about 91 percent of the farm operator families lived at the farmstead, thereafter this number declined, so that in 1974 only 40 percent of the operator families were found in residence (Table 7).

TABLE 6
TOTAL FARM NUMBERS AND AVERAGE FARM SIZES
IN KIOWA COUNTY, 1930 - 1974

Year	Number of Farms in the County	Average Size of Farms in the county acres
1930	3,532	171.2
1940	2,602	238.9
1950	1,870	321.6
1959	1,308	472.8
1969	1,225	543.0
1974	1,010	629.0

SOURCE: U. S. Department of Commerce, Bureau of the Census, Census of Agriculture: 1930, 1940, 1950, 1959, 1969, and 1974 (Washington, D. C.: U. S. Government Printing Office), various tables.

The area occupied by various farm operators underwent considerable change after 1930. This is most apparent in tenant farmer operations. In 1930 these farms occupied about 53 percent of the area, whereas in 1974 only 13 percent was so occupied. Their numbers declined from 2,183 to 195 in the same interim, a reduction of about 91 percent (Table 8). Concurrently, partially owned farms increased. Acreage

TABLE 7

RESIDENCES OF FARM OPERATORS AND THEIR FAMILIES IN KIOWA COUNTY, 1945-1974
(Percentages)

Year	Operators and Families Residing at Farmsteads	Operators and Families Not Residing at Farmsteads
1945	91.1	8.9
1950	86.6	13.4
1954	79.1	20.9
1959	76.6	23.4
1964	66.9	33.1
1969	58.6	41.4
1974	40.5	59.5

SOURCE: U. S. Department of Commerce, Bureau of the Census, Census of Agriculture: 1945, 1950, 1954, 1959, 1964, 1969, and 1974 (Washington, D. C.: U. S. Government Printing Office), various tables.

TABLE 8

TYPES OF FARM OPERATORS AND PERCENTAGES OF TOTAL AREA OCCUPIED BY THEIR OPERATIONS 1930-1974, FOR KIOWA COUNTY

Year	Number of Full Owners	Percentage Total Area Occupied	Number Partial Owners	Percentage Total Area Occupied	Number of Tenants	Percentage Total Area Occupied	Number of Managed Farms	Percentage Total Area Occupied
1930	984	25.69	359	20.96	2,183	53.09	6	0.27
1940	757	(NA)	429	(NA)	1,408	(NA)	8	(NA)
1949	604	21.71	588	50.89	676	27.13	2	0.27
1959	388	19.30	508	61.23	387	19.47	0	
1969	486	20.45	525	67.05	214	12.50	0	
1974	379	22.42	436	64.63	195	12.94	0	

SOURCE: U. S. Department of Commerce, Bureau of the Census, Census of Agriculture: 1930, 1940, 1950, 1959, 1969, and 1974 (Washington, D. C.: U. S. Government Printing Office), various tables.

(NA) = Not Available

increased from about 21 percent to 65 percent of the total for the county in 1974. Many farm operations were conducted on both owned and rented lands. Much of the rented land was previously share-cropped by tenants. Fully owned farms decreased in number after 1930, with the 1974 total representing about 61 percent of those found earlier. The total area for these farms decreased slightly.

Within the study area roughly two-thirds of the land has consistently been used for crops and one-third as pasture since 1930. Of the most significant crops produced in Kiowa County two dominate, wheat and cotton (Table 9). After 1930 harvested cotton acreages steadily lost in importance, while harvested acreages in wheat gained. Wheat now occupies about 76 percent of the harvested acreages in significant crops and cotton about 19 percent. Forage crops are the next in importance. Other small grains comprise the remaining harvested acreages of significant crops found in the county.

Beef cattle production dominates agricultural livestock activities. Numbers of beef cattle have steadily increased. The 1974 population was over three times that of 1930 (Table 9). Undoubtedly the increased wheat acreages, mainly in winter wheat, provides a significant seasonal pasture for these additional animals. Horses, mules, and dairy cattle diminished in importance in the period since 1930, primarily because of technological or marketing changes.

Mineral extraction also occurs in the county. Oil and natural gas are extracted in the county's north central sector, west and southwest of Gotebo and east and northeast of Hobart. Development commenced in the north in the late 1940's, then proceeded southward. Granite and limestone

TABLE 9

CROPLANDS HARVESTED, SIGNIFICANT CROPS, PASTURAGE AND SELECTED LIVESTOCK DATA FOR KIOWA COUNTY BY AGRICULTURAL CENSUS YEAR

Year	Harvested Croplands in Kiowa County	Significant Crops Harvested in Kiowa County Indicated in Acreage Percentages by Agricultural Census Year				Pasturage Area Used and Selected Livestock for Kiowa County by Agricultural Census Year			
	(in acres)	Cotton	Wheat	Forage Crops[a]	Other Small Grain Crops[b]	Total Pasturage Used (in acres)	Cattle, Excepting Dairy Stock	Horses and Mules	Dairy Cattle
1930	379,417	71.2	22.5	13.7	7.4	189,427	15,641	14,822	10,784
1934	273,698	37.9	43.6	7.:	11.3	210,518	27,701	11,044	12,715
1940	289,661	24.6	45.9	7.7	21.8	N.A.	21,801	4,418	11,730
1945	355,214	21.2	45.9	7.1	25.7	226,782	45,049	2,931	9,558
1950	335,968	12.9	63.9	8.6	6.7	215,738	30,480	1,119	6,109
1954	308,982	19.5	52.4	14.6	13.6	243,697	35,492	495	3,014
1960	237,861	17.8	59.5	7.2	14.9	228,071	39,692	N.A.	1,241
1964	248,676	17.2	66.6	6.8	9.4	242,027	49,563	N.A.	696
1969	266,166	15.9	72.1	5.9	6.1	205,381	60,924	N.A.	350
1974	311,083	18.3	76.3	3.1	2.0	208,464	53,134	N.A.	330

SOURCE: U. S. Department of Commerce, Bureau of the Census, Census of Agriculture: 1930, 1935, 1940, 1945, 1950, 1954, 1959, 1964, 1969, and 1974 (Washington, D. C.: U. S. Government Printing Office), various tables.

[a]Forage crops include several categories, which are: sweet and grain sorghums for silage and hay, alfalfa, small grains for hay, and other tame and wild grasses used for hay.

[b]Other grain crops are: oats, corn, sorghums, and barley.

N.A. = Not available.

quarrying occurs at several sites. The largest operating quarry is that of the Dolese Company from which limestone is taken. This quarry is situated east of State Road No. 54, just southwest of Sedan. It was opened in the late 1950's. Several small granite quarries are operated in the southern part of the county. All of these are operated in conjunction with monument manufacture found in the vicinity of Roosevelt, Mountain Park and Snyder.

This analysis of the competition phase in the study area since the mid 1930s provides the lens to focus on the measurements of the rural settlement morphologies that evolved. These observed patterns will then be compared to the hypothesized accessibility lattice.

CHAPTER IV

PATTERN MEASUREMENTS AND INTERPRETATIONS

Rural settlement patterns for 1936 through 1973 in Kiowa County are examined in order to determine whether their changes reflect an increased dwelling orientation to nucleated settlements with time. This examination is divided into three sections. First, a general background of the study area's rural settlement is provided through an examination of dwelling densities for 1936, 1949, and 1973. Second, measurements and interpretations of periodic settlement process and residual dwelling matrices are made. New settling, abandonment, and residual dwelling matrices are considered for two periods: 1936-1949 and 1949-1973. Hypotheses were proffered earlier that these three matrices would evolve clustered patterns. The last section considers the primary research hypothesis about clustering within the rural settlement with time. Dwelling patterns for 1936, 1949, and 1973 are analyzed and interpreted. Salient findings about the settlement processes and the residual dwelling occurrences supplement the discussion related to the evolution of the rural settlement.

Dwelling Densities for Kiowa County: 1936, 1949, and 1973

Rural settlement has been consistently dispersed throughout Kiowa County despite the fact that its dwelling density has steadily decreased during the nearly 40 years involved in this study (Table 10). Dwelling density patterns for the 3 years selected for detailed study

TABLE 10

RURAL DWELLING CHARACTERISTICS FOR KIOWA COUNTY
FOR 1936, 1949, and 1973

Year	Number of Rural Dwellings	Area Available to Settlement[a] (in square miles)	Average Dwelling Density Per Square Mile
1936	3,261	1007.97	3.24
1949	2,357	1000.78	2.36
1973	1,018	1001.43	1.02

SOURCE: Counts and calculations from General Highway Maps - Kiowa County, Oklahoma: 1936 and 1949, and from the field map of 1973.

[a]Changes in the area available for settlement occurred because of increases in the boundaries of the Altus-Lugert Public Hunting Area, modifications in the areas occupied by nucleated settlements, and land included in the Rainy Mountain Indian School Reservation.

are described in order to provide background relevant to the modification of rural settlement in the study area.

In 1936 the average rural dwelling density for the county was 3.24 dwellings per square mile. At that time the settlement was dispersed over the entire study area, although certain sectors showed low densities or vacancies (Fig. 11). Lower than average densities occurred in the extreme southern section and the north central portion of the county. The existence of oil fields in the north central areas may have accounted for its lower densities. Although sections (square miles) lacking dwellings were scattered over the county, most were located near the periphery, where either river floodplain conditions or severe slopes were influential in limiting dwelling placement. High densities were often contiguous and scattered over the county. These nodes were

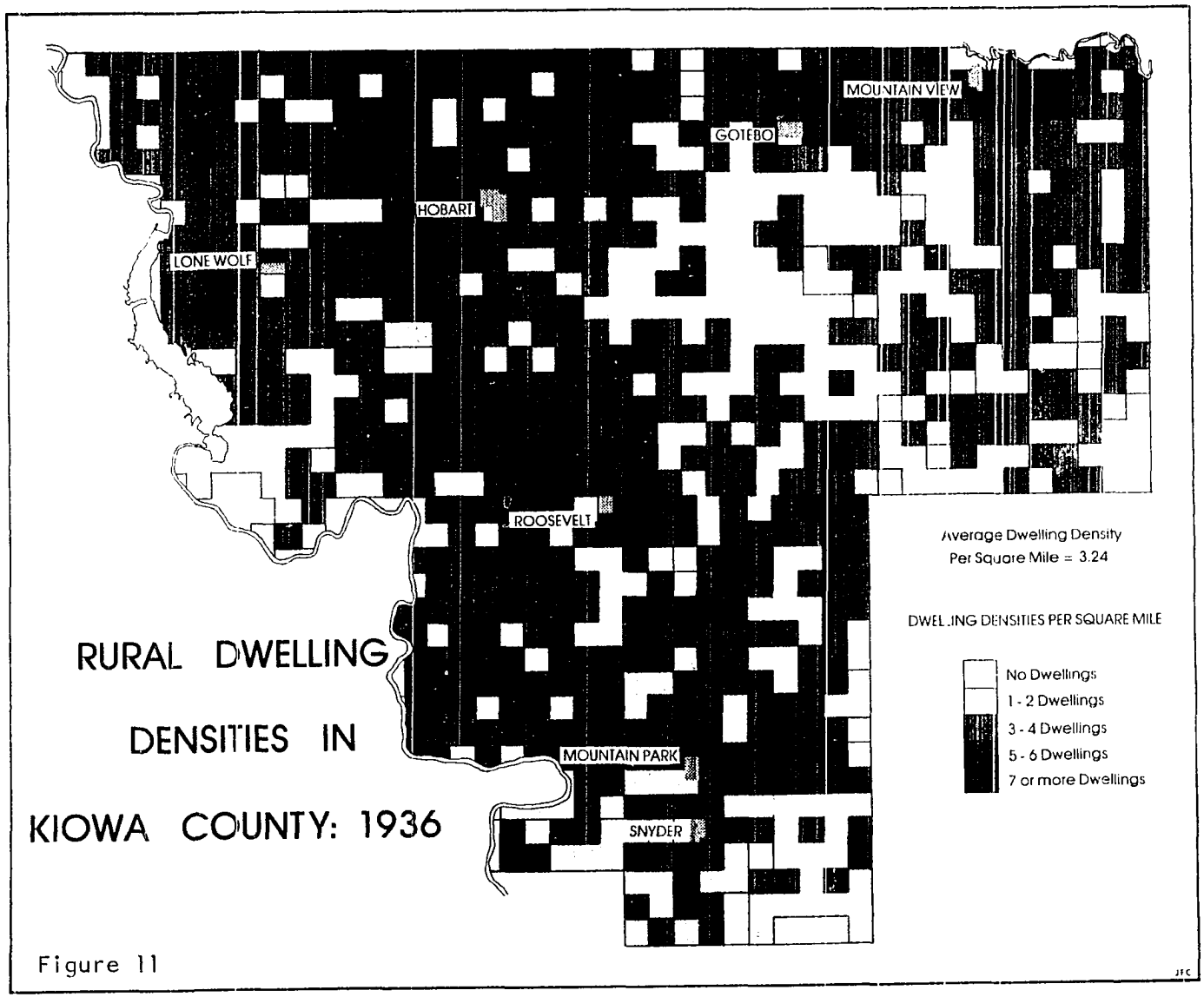
MOUNTAIN VIEW
GOTEBO
HOBART
LONE WOLF
ROOSEVELT
MOUNTAIN PARK
SNYDER
RURAL DWELLING
DENSITIES IN
KIOWA COUNTY: 1936
Average Dwelling Density
Per Square Mile = 3.24
DWELLING DENSITIES PER SQUARE MILE
No Dwellings
1 - 2 Dwellings
3 - 4 Dwellings
5 - 6 Dwellings
7 or more Dwellings

Figure 11

associated with clusters of houses, which were mainly occupied by small farmers or sharecroppers. Highest densities occurred at the edges of nucleated settlements.

In 1949 the average rural dwelling density for Kiowa County was 2.36 dwellings per square mile. The highest densities, as in the earlier period, were concentrated around or in the vicinity of nucleated settlements (Fig. 12). Higher densities, 5 to 6 dwellings per square mile, were found in several parts of the county's western sector, often contiguous as in 1936. Moderate densities, 3 to 4 dwellings per section were found mainly in the northwest, west central, southern, and northeastern parts of the study area. Sections with one and two dwellings were located predominantly in north central Kiowa County, in the area where oil extraction occurred. Previously principal production was in the southern part of this field. Low densities were also encountered in the eastern, southern, and western sectors. More sections in the county lacked dwellings in 1949. As in the prior period, more of these sections occurred in the peripheral areas of the county. Others were scattered throughout the county, where farms were abandoned.

The most striking characteristic of the rural dwelling density in 1973 was the number of sections lacking dwellings. More than 40 percent of Kiowa County's area had no dwellings (Fig. 13). The areas of low density, i.e. one to two dwellings per square mile, predominated and were well scattered throughout the county. The average dwelling density was only 1.02 dwellings per square mile in 1973. High density areas were in the vicinity of nucleated settlements, although a few sections with densities of 3 to 4 dwellings were scattered over the

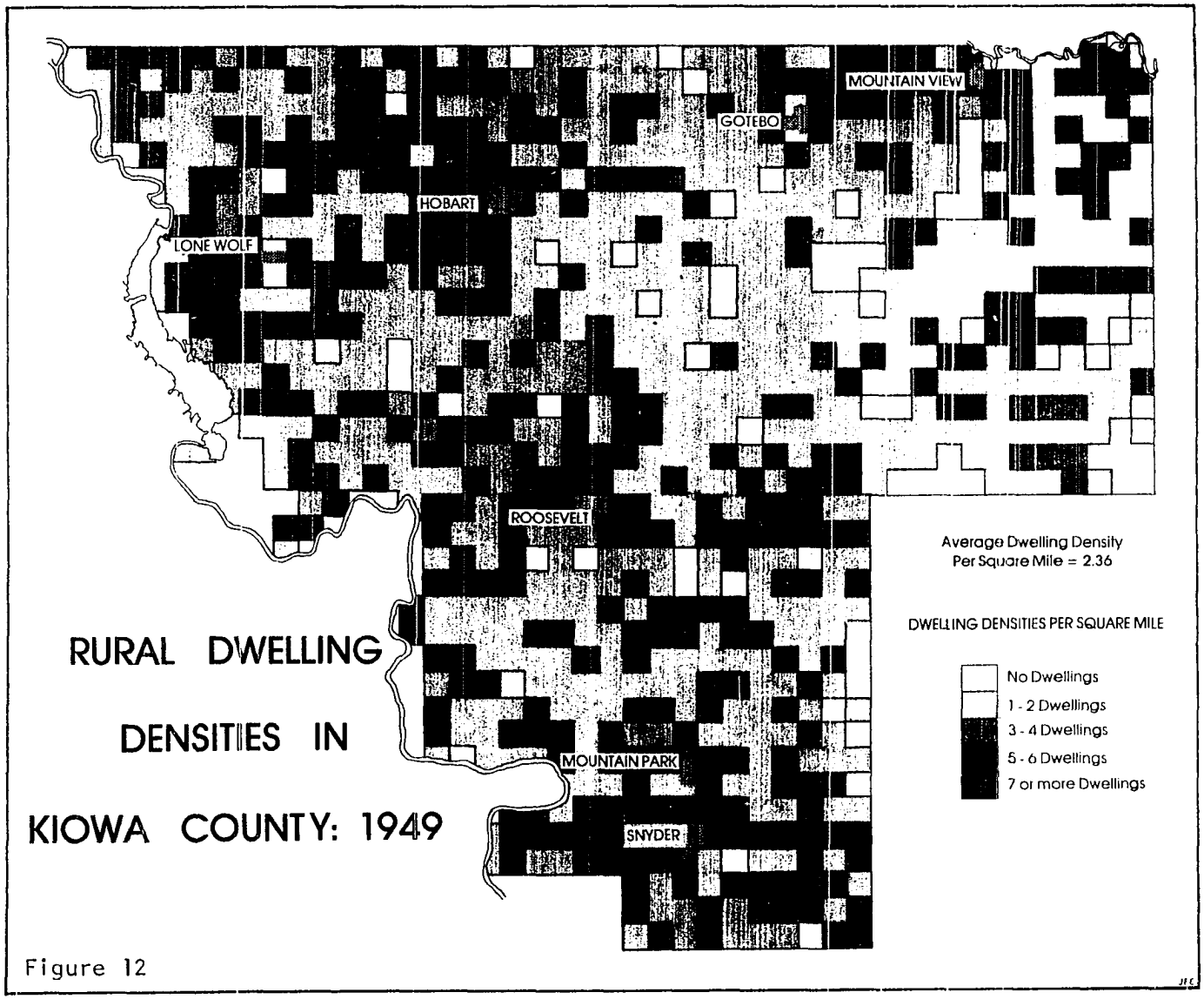
MOUNTAIN VIEW
GOTEBO
HOBART
LONE WOLF
ROOSEVELT
MOUNTAIN PARK
SNYDER
RURAL DWELLING
DENSITIES IN
KIOWA COUNTY: 1949
Average Dwelling Density
Per Square Mile = 2.36
DWELLING DENSITIES PER SQUARE MILE
No Dwellings
1 - 2 Dwellings
3 - 4 Dwellings
5 - 6 Dwellings
7 or more Dwellings

Figure 12

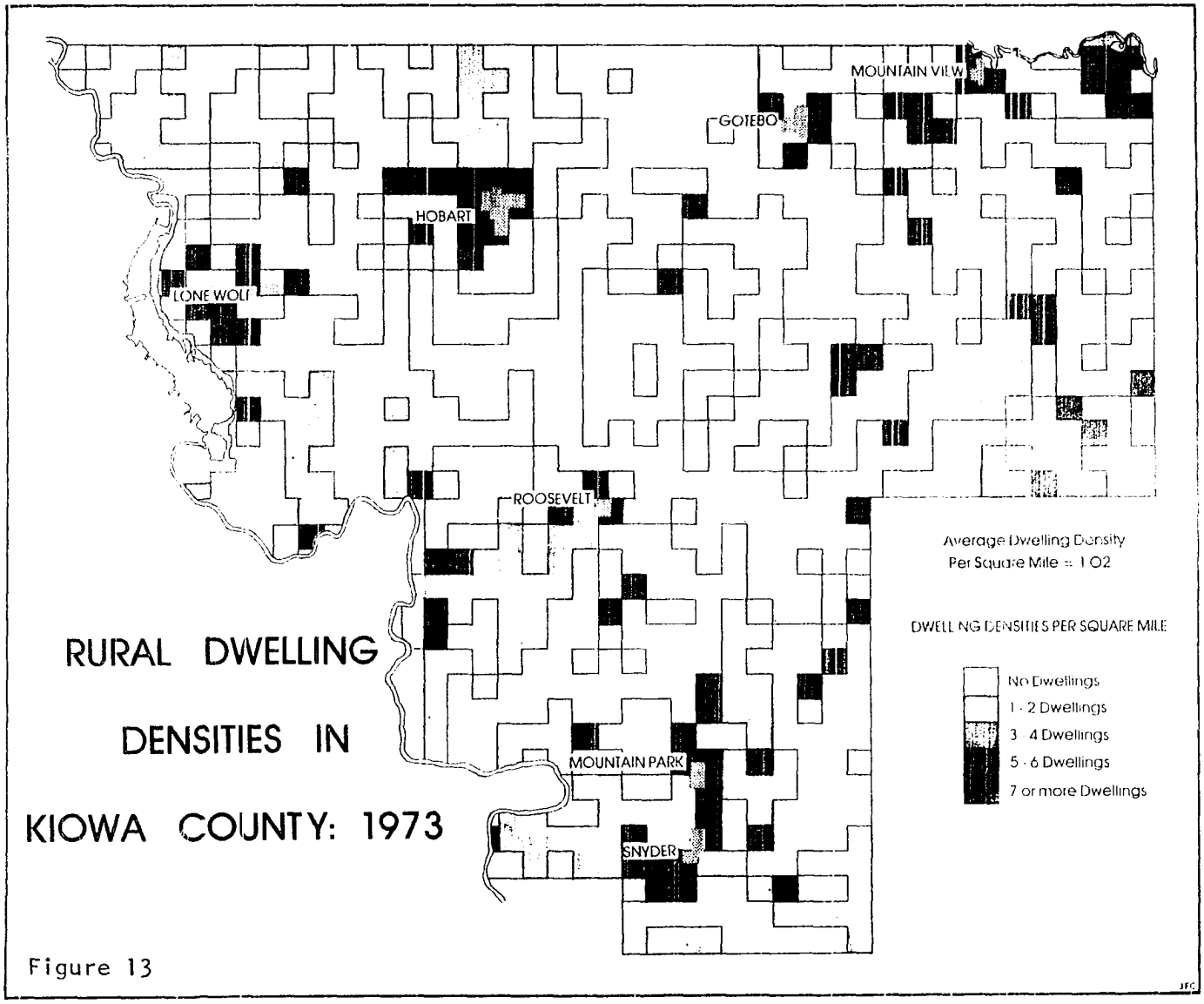
MOUNTAIN VIEW
GOTEBO
HOBART
LONE WOLF
ROOSEVELT
MOUNTAIN PARK
SNYDER
RURAL DWELLING
DENSITIES IN
KIOWA COUNTY: 1973
Average Dwelling Density
Per Square Mile = 1 02
DWELLING DENSITIES PER SQUARE MILE
No Dwellings
1 - 2 Dwellings
3 - 4 Dwellings
5 - 6 Dwellings
7 or more Dwellings

Figure 13

area. These dwellings were mainly remnants from prior higher density nodes. The most notable single concentration of dwellings occurred in the Hobart vicinity.

In about 40 years, the average dwelling density in Kiowa County declined from over 3 residences per square mile to approximately 1 residence per square mile. Concurrently, dwelling densities increased in the vicinities of the villages and towns. The largest increase occurred around the county's largest nucleated settlement. In the countryside, which constitutes most of the study area, the dwelling densities declined, and the lack of housing was common throughout rural areas at the end of the study period. Rural settlement became oriented towards the nucleated settlements in the study area during the time span that was considered. The analyses which follow explain this orientation.

Analyses of the Settlement Process and Residual Dwelling Matrices

Since the morphological characteristics of the settlement processes and the residual dwellings were useful in describing the development of the rural settlement morphology in Kiowa County, their analyses and descriptions were undertaken first. Hypotheses suggested that the two settlement processes and the residual distribution would evolve clustered morphologies with time, if rural dwelling sites progressively reflected accessibility to nucleated settlements and the routes leading to them.

Two dwelling matrices were formulated for each process and residual distribution, one for the 1936-1949 period and another for the time

between 1949 and 1973. These matrices were analyzed with both nearest neighbor analysis and quadrat analysis. The same six quadrat sizes used in the analysis of the rural settlement matrices were used here.

Other descriptive measurements were applied to the matrices to clarify certain features germane to the settlement patterns. Designations and either characteristics about, or the composition of, the dwelling distributions as being near to, or more distant from, the nucleated settlements in this county are meaningful. A systematic analysis employed a 6 mile radius, since maps and field work indicated that such a distance was appropriate in this setting. Non-farm housing was the main criterion used for determining this break, since it was important to the rural settlement composition around the nucleated settlements.

New Settling

New settling became increasingly important in "shaping" the rural settlement in Kiowa County during the time period covered in this study. Its morphology became more clustered with time. These morphological characteristics were, in the writer's opinion, the best indicators for the changes that eventually transpired in the rural settlement format.

The absolute number of new dwellings added to the rural settlement from 1949-1973 was less than the total increase from 1936-1949, but the total for the latter time represented more than 26 percent of the settlement matrix in 1973, while that for the earlier interval was only 15 percent. The proportional representation of new settling in the

rural settlement increased 73 percent from the end of the early period to the end of the late period.

Pattern Analysis of New Settling

Both nearest neighbor analysis and quadrat analysis showed that new settling became more clustered from the earlier to the later interval. Nearest neighbor measures were 0.746 for the 1936-1949 interval and 0.696 for 1949-1973, both of which were significant (Table 11). These results, incidentally, constituted the strongest clustering measures found with the nearest neighbor measurement for all of the dwelling matrices.

TABLE 11

NEAREST NEIGHBOR STATISTICS FOR NEW SETTLING MATRICES IN KIOWA COUNTY FOR THE PERIODS: 1936-1949 AND 1949-1973

Periods	Total Number	Percentage of Total Matrix	R Statistic	Standard Variate of Normal Curve
1936-1949	359	15.23	0.746	- 26.2846[a]
1949-1973	267	26.22	0.696	- 35.6335[a]

SOURCE: Counts and calculations from General Highway Maps - Kiowa County, Oklahoma: 1936 and 1949 and the field map of 1973.

[a]Level of statistical significance < .01.

Quadrat analysis showed the distributions to exhibit an increase in clustering through the latter period (Appendix I). For the 1936-1949 period there was an overall increase in magnitude of the variance-mean ratios, although the increase was unsteady (Table 12). With the exception of the 4 square mile quadrat, the measurements for the remaining quadrats were significant. A considerably stronger case was

TABLE 12

QUADRAT ANALYSIS STATISTICS FOR NEW SETTLING MATRICES
IN KIOWA COUNTY FOR THE PERIODS: 1936-1949 AND 1949-1973

Periods Quadrats (in square miles)	Variance-Mean Ratios	Chi-Squared Test Results	Degrees of Freedom	Statistical Significance
1936-1949				
0.31	1.4453	18.7968	1	.001
0.43	1.5704	14.1257	2	.001
1.00	1.7796	43.8349	2	.001
2.00	1.5608	29.5350	2	.001
3.00	1.4364	24.9971	3	.001
4.00	1.6867	11.7416	4	.02-.01
1949-1973				
0.31	1.5448	129.041	1	.001
0.43	1.7649	94.287	1	.001
1.00	2.1684	164.461	2	.001
2.00	2.4683	90.738	2	.001
3.00	2.5224	69.554	3	.001
4.00	3.6491	59.399	3	.001

SOURCE: Data derived from the General Highway Maps - Kiowa County, Oklahoma: 1936 and 1949 and from the field map of 1973.

made for clustered new settling distributions with the analysis for the 1949-1973 interval. Variance-mean ratios for this interval increased monotonically with quadrat size, and all of these were statistically significant.

Other Measurements of the New Settling

To facilitate the interpretation of the pattern analysis for new settling, two measurements and one classification of new residences were made for 6 mile radii of the larger nucleated settlements and areas associated with these centers lying beyond the 6 mile boundary.

The rationale for considering these two areas has been discussed previously. A new settling ratio, i.e. newly settled dwellings during the period / total dwellings at the end of the period, was derived for each mile zone. This provided a suitable means for describing the degree of new settling that actually transpired relative to the existing rural settlement. New residences were counted in mileage zones, which radiated outwards from commercial centers. These data were placed in frequency distributions and described. Finally, the types of dwellings were also determined for these settlings to assist in describing why housing locations change.

New Settling Around Nucleated Settlements. For the 1936-1949 period, 61 percent of the new settling was within the 6 mile radius for villages and towns, in an area occupying about 54 percent of Kiowa County. New settling was slightly oriented toward the nucleated settlements by the end of the sequence. Its rate of increase from 1936-1949 was 15.16 percent, comparable to that for the entire study area. New settling here occurred at a rate nearly identical to that for Kiowa County, indicating that the existing rural settlement was similarly oriented toward the nucleated settlements. The new settling ratios and the distribution profile that follow, however, clarify the degree of orientation to the central places of new housing.

The trend of new settling ratios for the area within 6 miles of nucleated settlements indicated that new residences occurred at a moderately low level within 1 to 2 miles of the commercial nodes and became steadily lower through the 6 mile borders (Fig. 14). Although the average new settling ratios for the various sized communities in

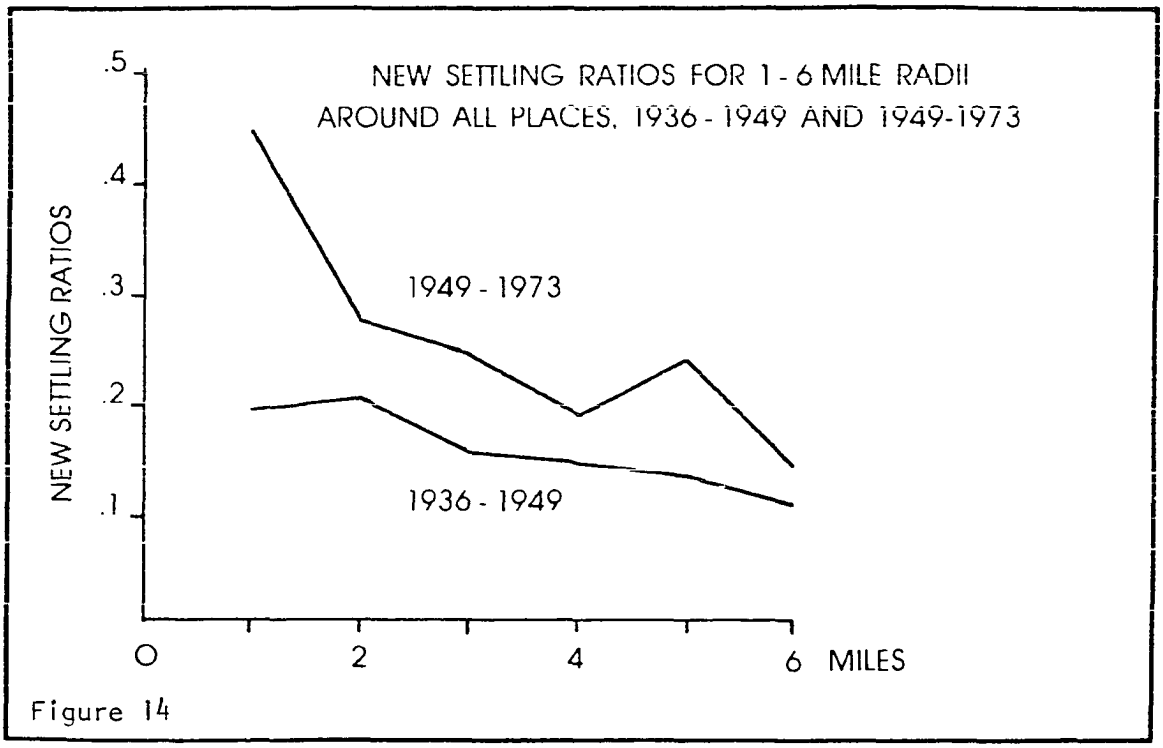

Figure 14

Kiowa County each showed some divergencies from the general trend, the most noticeable deviation was the difference between the new settling within 3 miles of the larger and smaller communities (Fig. 15). New dwellings were concentrated on the outskirts of the larger commercial centers indicating an attraction to such nodes, whereas small places had little attraction around their boundaries for such residences. It can be inferred from the new settling for the 6 mile settings around small places that nearly all of the dwellings were farmsteads, because of their dispersion away from the commercial centers into the countryside. Only after 3 miles were the ratios for three sizes of communities comparable. This indicates similar degrees of attractiveness for new settling.

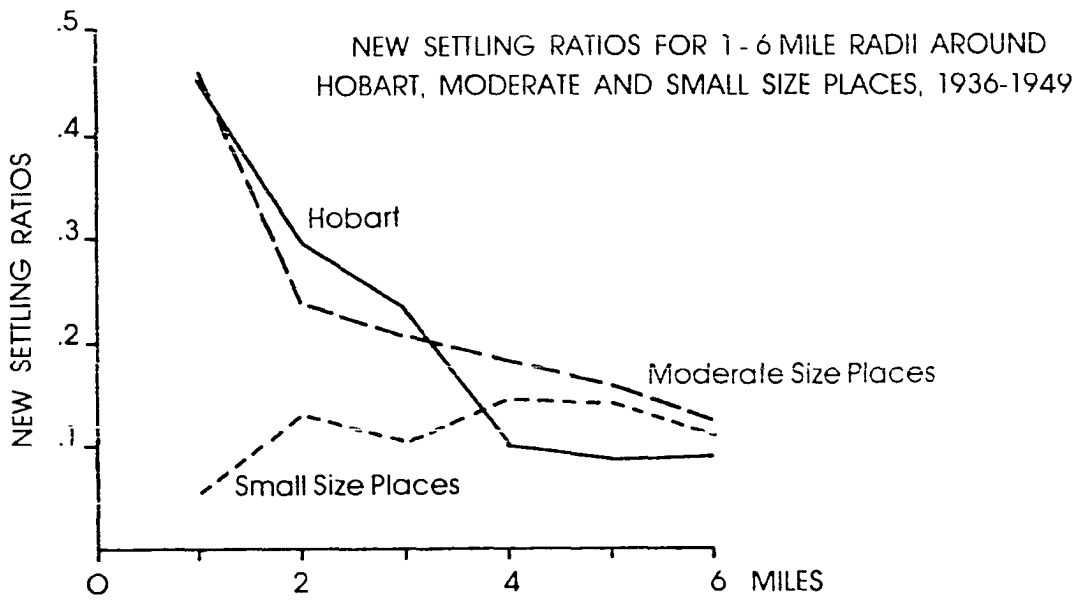

Figure 15

At the end of this period the distribution for new settling was fairly consistently dispersed throughout the 6 mile zones (Fig. 16). Using the percentage of new settling increase for the interval as a comparison, the consequence of this dispersion was that disproportionate numbers of new dwellings were near the central places. Dwellings in the first 2 miles exceeded parity, those in the next 3 miles were near parity, and only the dwelling numbers in the last mile were less than parity.

Nearly 72 percent of the new homes within 1 mile of the villages and towns in this county were of the non-farm category. Most of these, however, were occupied by agricultural laborers. The non-farm residences situated within the other mileage zones ordinarily were associated with service, trade, or processing sites and never exceeded more than a few at any location. Farm residences comprised the majority of

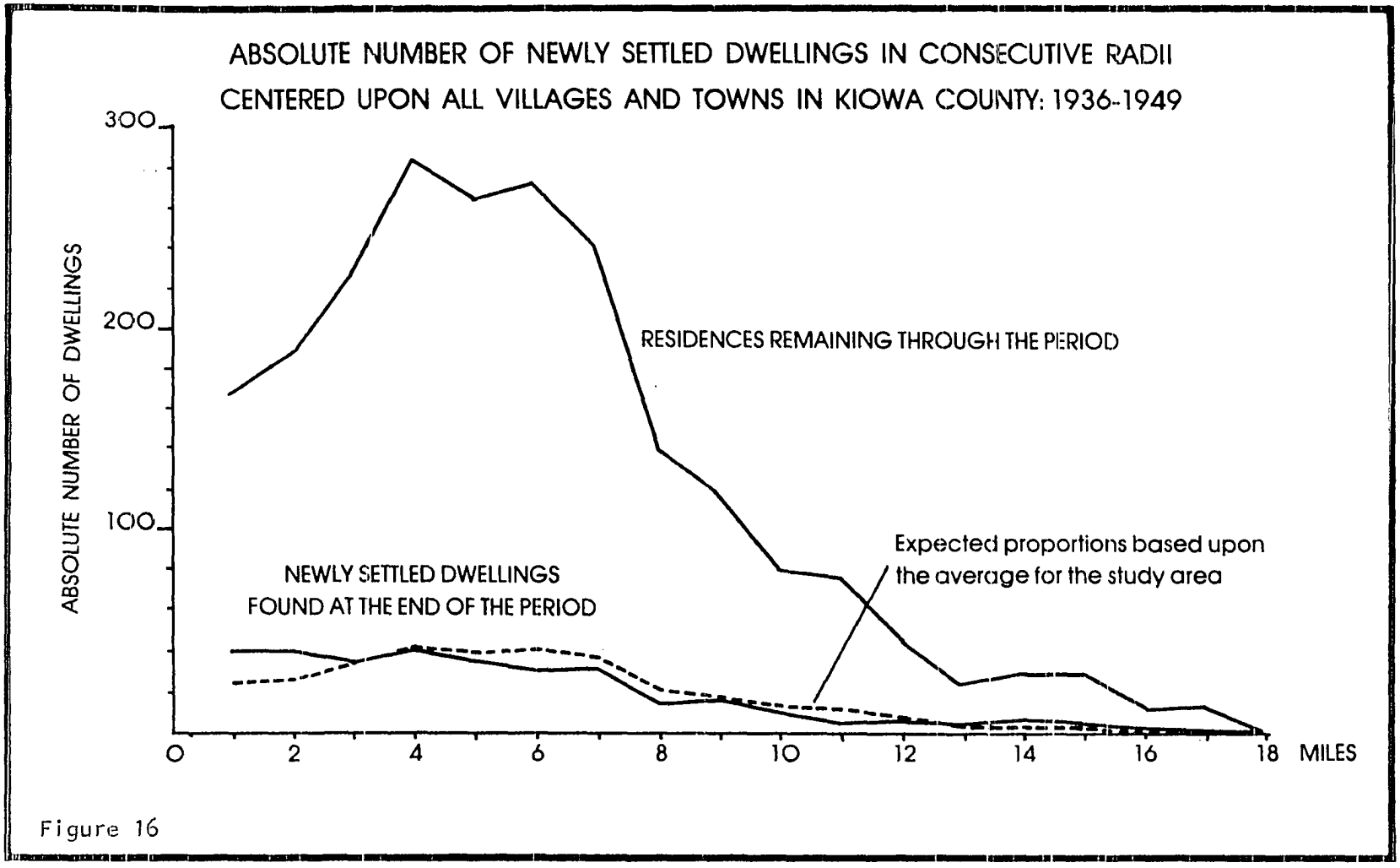
ABSOLUTE NUMBER OF NEWLY SETTLED DWELLINGS IN CONSECUTIVE RADII
CENTERED UPON ALL VILLAGES AND TOWNS IN KIOWA COUNTY: 1936-1949
ABSOLUTE NUMBER OF DWELLINGS
300
200
100
RESIDENCES REMAINING THROUGH THE PERIOD
Expected proportions based upon
the average for the study area
NEWLY SETTLED DWELLINGS
FOUND AT THE END OF THE PERIOD
0
2
4
6
8
10
12
14
16
18
MILES

Figure 16

new dwellings, as would be expected in this study area, and these became the dominant dwelling type outside the first mile (Table 13). Non-farm homes were often situated along the main roads leading into the nucleated settlements, but farm houses were considerably more dispersed throughout the countryside.

TABLE 13

TOTAL NEW DWELLINGS AND THEIR PERCENTAGES FOUND IN THE 6 MILE RADII SURROUNDING ALL VILLAGES AND TOWNS, ALONG WITH THEIR FARM AND NON-FARM COMPOSITION, FOR KIOWA COUNTY: 1936-1949 AND 1949-1973

Periods / Radial Mileage Zones	New Dwellings		Composition by Mileage Zones			
	Total By Miles	Percentages for County	Farms		Non-Farm	
			Number	Percent	Number	Percent
1936-1949						
1 Mile	39	10.86	11	28.20	28	71.80
2 Miles	39	10.86	32	82.05	7	17.95
3 Miles	35	9.74	30	85.71	5	14.29
4 Miles	41	11.42	40	97.56	1	2.44
5 Miles	35	9.74	35	100.00	0	0.00
6 Miles	30	8.35	30	100.00	0	0.00
1949-1973						
1 Mile	63	23.59	13	20.63	50	79.36
2 Miles	26	9.73	17	65.38	9	34.61
3 Miles	25	9.36	21	84.00	4	16.00
4 Miles	18	6.74	15	83.33	3	16.66
5 Miles	21	7.86	18	85.71	3	14.28
6 Miles	13	4.86	10	76.92	3	23.07

SOURCE: Data derived from the General Highway Maps - Kiowa County, Oklahoma: 1936 and 1949 and from the field map of 1973.

At the end of the 1949-1973 sequence, 62 percent of the new dwellings for Kiowa County were situated within 6 miles of villages and towns, an area constituting 54 percent of this political unit. New settling here was 1 percent higher than during the 1936-1949 sequence. This, of course, represented only a subtle increase in the orientation

of new settling towards the nucleated settlements. The rate of the new settling increase was 26.86 percent in this setting, almost the same as that for the county, which had a 26.22 percent increase. As indicated, for the earlier sequence, the close agreement of the new settling rates for this and the county also indicates some orientation of the rural settlement to the central places.

The representation of new dwellings in the areas surrounding all of the villages and towns was higher than in the preceding period (Fig. 14). The new settling ratios for all of these communities indicated that new housing occurred at a high moderate level at 1 mile, decreased to a moderately low level by 4 miles, rose slightly, and then decreased slightly in the 6th mile. The new settling ratios for the three sizes of nucleated settlements, on the other hand, revealed divergences from the generalized format. Large and moderate sized places had nearly identical tendencies for new settling that were, overall, higher than the average for the county (Fig. 17). The ratios for the smaller places showed that new settling was lower overall, but the profile was oriented towards the central places, a reversal from the earlier sequence.

The distribution of newly settled dwellings within 6 miles of the nucleated settlements that evolved from 1949 through 1973 was decidedly oriented towards these centers (Fig. 18). For the first mile this distribution exceeded the percentage line that represented proportions based upon the new settling increase for the period. After slightly exceeding the proportional percentage line in the second mile, the percentages decreased and were less than parity through the sixth mile.

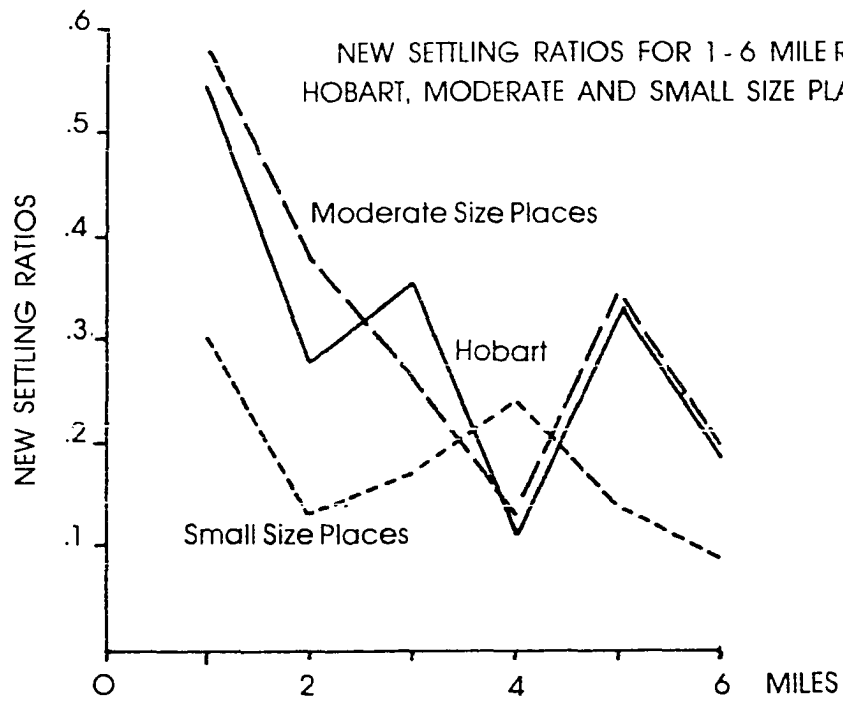

Figure 17

Nucleated settlements at the end of this period had just one quarter of the new homes for the county within 1 mile and more than one third of the county's new residences inside their 2 mile radii (Table 13). This represented a notable increase over new housing in the same zones at the end of the 1936-1949 interval.

Non-farm dwellings were more important in the new dwelling composition around these centers than previously (Table 13). Although the percentages of non-farm residences in the first mile increased over the former period as might be expected, the percentages for these dwellings through the sixth mile indicates an increasingly important impact in the rural matrix. The dwellers in most of these homes were either sidewalk farmers or persons engaged in economic activities in the nearby trade-service centers. The percentages of newly settled farm residences

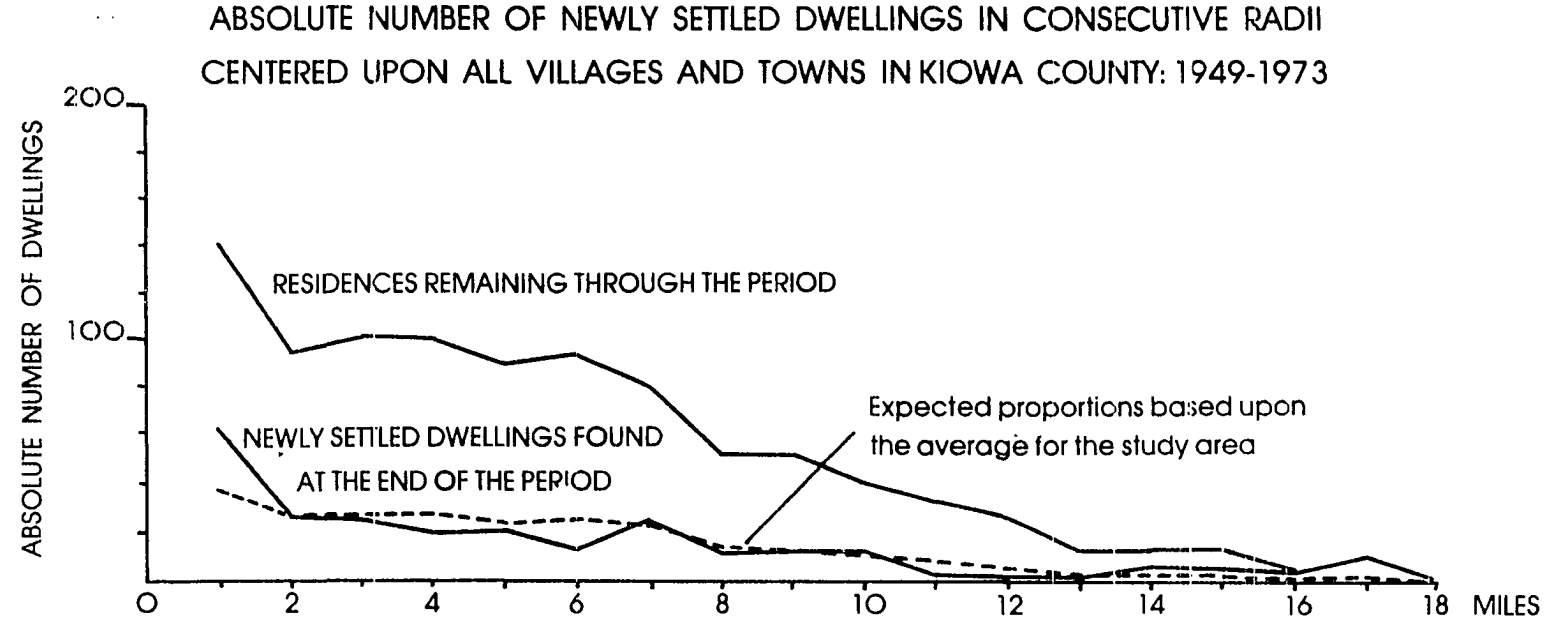
ABSOLUTE NUMBER OF NEWLY SETTLED DWELLINGS IN CONSECUTIVE RADII
CENTERED UPON ALL VILLAGES AND TOWNS IN KIOWA COUNTY: 1949-1973
ABSOLUTE NUMBER OF DWELLINGS
200
100
RESIDENCES REMAINING THROUGH THE PERIOD
NEWLY SETTLED DWELLINGS FOUND
AT THE END OF THE PERIOD
Expected proportions based upon
the average for the study area
0
2
4
6
8
10
12
14
16
18
MILES

Figure 18

in each mileage zone increased with distance from the central places. Non-farm and farm houses alike showed a strong tendency for sites along main roads.

New Settling Beyond the Six Mile Radii. Those portions of the study area outside of the 6 mile radii surrounding nucleated settlements received noticeable input from new residences during both of the sequences, i.e. 38 percent of the new settling in the county in the period ending in 1973 as compared to 39 percent at the end of the earlier time period. About 46 percent of the county's area was occupied by essentially the same proportions of new settling at both times. The rate of new settling increased from 15.33 percent for the 1936-1949 period to 25.25 percent for the 1949-1973 period. Although this percentage increase was significant when the impact of new settling upon the rural settlement was considered, its occurrence was not due to notable increases in the absolute number of new residences but to the noticeable decrease in the number of long occupied homes.

The new settling ratios, distribution profiles, and the dwelling type considerations that follow depict characteristics for new settlement in the outlying area for the two periods. The measures apply only to radial zones associated with nucleated settlements within the study area. Such measures appear to be representative of conditions obtaining in the outlying parts of Kiowa County at both times.[1]

---

[1]Two parts of the study area were clearly associated with two nucleated settlements situated outside of Kiowa County. These included an area on the county's north central border that was very close to Sentinel in Washita County and a setting along its northeastern border which was very close to Carnegie in Caddo County. New dwellings in these settings were not included in measurements for either the new settling ratios or for the percentages used in compiling the distribution profiles. Because of these exclusions, 36 dwellings, or 10 percent of

The new settling ratios for the outlying radial areas of all the villages and towns showed that two changes occurred from the early to the later periods. The impact from new settling increased in all of the mileage zones during the time period, although the increases represented changes from low to low-moderate levels or from low-moderate to moderate levels (Fig. 19). The trend of new settling changed from one that gradually increased with distance during the early sequence to one that decreased through 11 miles, then increased to a peak at 14 to 15 miles.

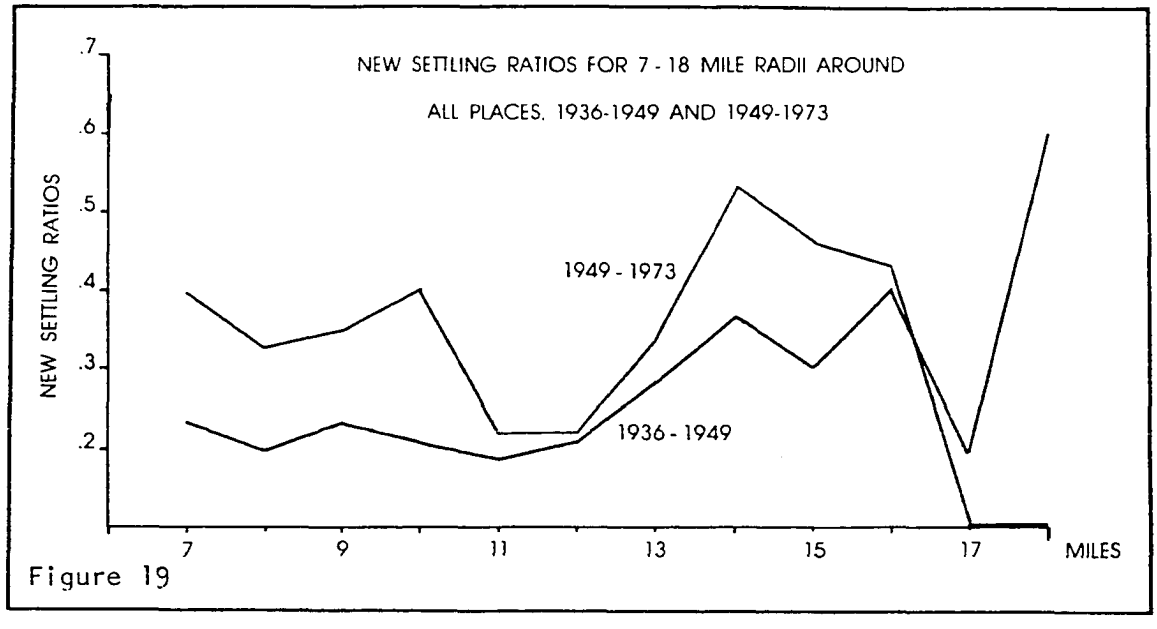

Figure 19

New settling ratios for outlying areas of different sized commercial centers in the county showed certain deviations from the general trends for each sequence. For the largest community, Hobart, the

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those found in 1949, were omitted and 18 dwellings, or 6.7 percent of those which existed in 1973, were excluded.

impact of new settling upon the existing settlement was relatively steady for 1936-1949, but its impact varied considerably during 1949-1973 (Figs. 20 and 21). The ratio profiles for moderate sized places followed the trends for the area closely, except for the increase between 8 to 10 miles during the latter time frame. New settling ratios for smaller places matched the trends for the area during both times, although the magnitude of new settling at the greater distances was reduced by the end of the second sequence.

The distributions for new settling in the mileage zones associated with the nucleated settlements showed that the percentages of new dwellings were roughly proportional to the mean new settling rate at the ends of both periods, except for the increases in the most distant parts of the county (Figs. 16 and 18). Nearly all of the new dwellings added in the distant parts of the county were in the Saddle Mountain vicinity. New settling never reached the proportional percentages at either 8 miles or in the 11 to 12 miles zones. The paucity of new residences at 11 to 12 miles both times represented the lowest percentages that occurred from 7 miles out.

New residences were scattered throughout the area in the 1936-1949 period. Most of these dwellings were farm houses on quarter section land divisions. Non-farm housing in 1949 included four residences associated with small stores in various neighborhoods and three teacherages at two schools. From 1949-1973 new settling was widely scattered as in the earlier period, but there was a recognizable orientation of these dwellings to improved roads. Farm residences comprised about 90 percent of the dwellings in this category. The remaining 10 percent

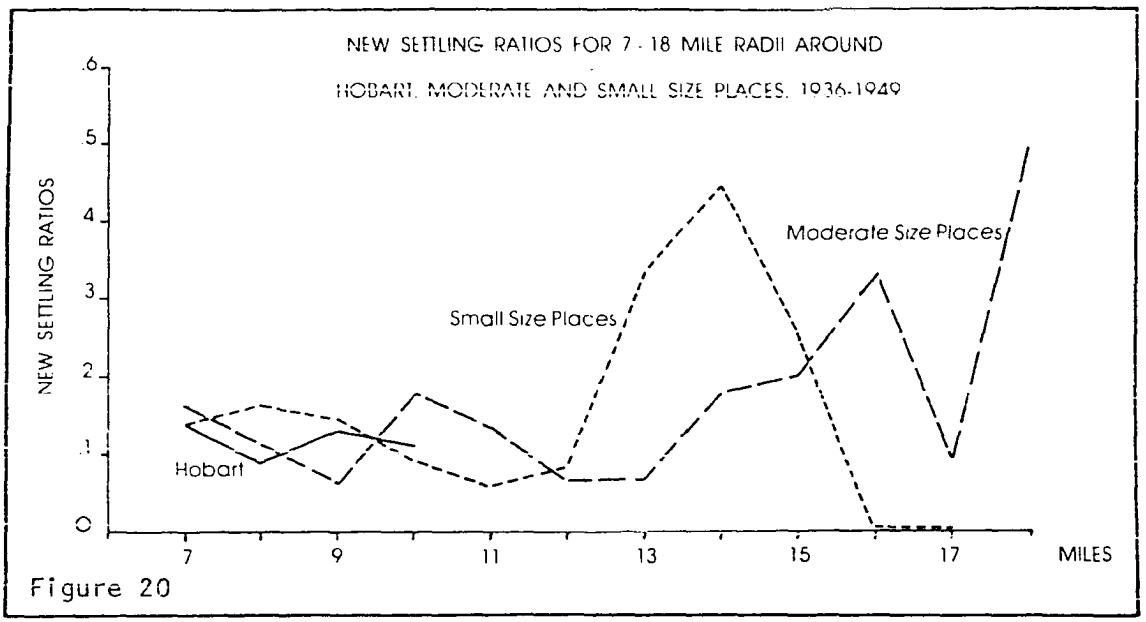

Figure 20

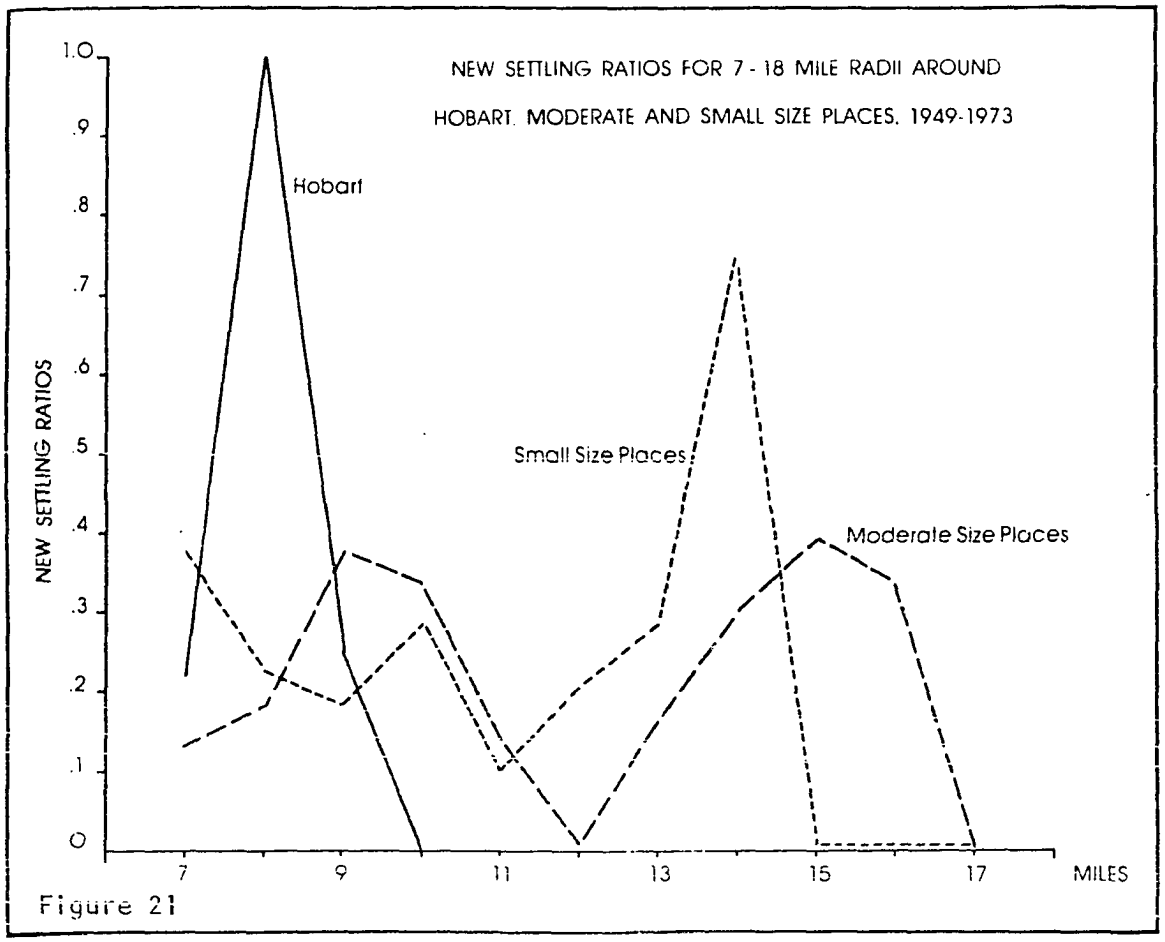

Figure 21

of the dwelling types, which comprised the non-farm component, were homes occupied by Indian families. These dwellings were parts of two Indian enclaves in the northeastern part of Kiowa County. All of these dwellings were constructed after 1970 upon individually owned Indian land with Federal monies under the auspices of the Bureau of Indian Affairs.[2] New houses were sited either along, or relatively close to, primary and secondary roads by the end of the second period, while only a limited number of new homes during the first sequence were adjacent to these routes.

Interpretation of New Settling

Between the early and latter periods studied new settling became more clustered within Kiowa County, a situation which supports the research hypothesis. Principal causes for this pattern becoming more clustered with time were that new settling gained proportionately in its composition of the rural settlement; a distinct concentration of new residences occurred in the vicinities of the nucleated settlements, and new settling in the countryside became oriented to major roads.

Although the number of new residences added in the 1949-1973 period was 26 percent smaller than the figure for 1936-1949, the proportion of these new dwellings in the rural settlement increased from 15 percent at the end of the early period to 26 percent at the end of the later period, which represents a 73 percent increase for new settling in the rural settlement composition in the later period.

[2]The Bureau of Indian Affairs developed its Turnkey III, Mutual Help for Indians, program so that low-income Indian families could purchase their homes. Funding comes from the Department of Housing and Urban Development. Low interest loans are made through housing agencies which are set up by the Indian tribes. Mutual help is provided by the family contributing some of the labor for the dwelling's construction, contributions of cash, contributing the homesite.

During both intervals the new settling within 6 miles of the villages and towns was slightly disproportional to the area it occupied, i.e. 61 to 62 percent of the new residences were in 54 percent of the county.

More important, however, was the increase in new dwellings near central places. Thirty-one percent of the new homes in the county between 1936 and 1949 were within 3 miles of these places, while 43 percent of the new residences in the study area were here from 1949 through 1973. These changes were pronounced around the large and moderate sized places as compared to the smaller nucleated settlements. Non-farm dwellings became increasingly significant in comprising the new settling closest to these trade-service centers. These dwellings housed mainly farm laborers during the earlier period. Thereafter they were occupied by both sidewalk farmers and individuals with economic ties to the nearby centers. As would be expected, houses situated on farms constituted the majority of new dwellings in the agricultural setting. New housing became oriented to the major roads during the course of the two periods.

The new settling for the outlying portions of Kiowa County composed 39 percent of the total new residences at the end of the late period and 38 percent of those by the end of the early period. This consistency of percentages indicated that new settling here remained important in formulating part of the rural settlement through the end of the second period. However, it should be emphasized that the absolute number of new dwellings declined 26 percent after the first period and that the constancy in the new settling percentages occurred in part because of a large decline in the homes present in the succeeding

interval ending in 1949. Newly settled homes tended to decline with distance through the outlying settings, and their numbers within mileage zones generally were proportional to the number of existing homes. One exception occurred in the most distant parts of the county where new settling increased. However, this was only in an area associated with a moderate sized nucleated settlement. Nearly all of the new residences in this setting at both times were associated with a few businesses or at processing and industrial sites, whereas those found during the late period consisted of housing for Indian families on their land in one part of the county. New homes after 1949 were oriented to the primary and secondary roads. Previously there was less evidence of such an orientation.

The criteria requisite for clustering in the new settling matrices existed during both periods that were studied. Nearest neighbor measures proved to be sensitive to these changes in the distributions of new settling. It appears that the slight increase in clustering, which occurred by 1973, resulted from the distinct increases in the grouping of new homes around trade-service centers. Similarly, shorter distances between new nearest neighbor homes in the countryside, largely sited along major roads had an impact. Quadrat analysis, with its pattern assessment at several cell sizes, produced results similar to those in the nearest neighbor analysis. However, this was because dwelling counts in quadrats nearest nucleated settlements were high, while there was a low number of quadrats with dwelling counts beyond these loci.

Abandonment

Abandonment became the most extensive settlement process in terms of absolute numbers, affecting the rural settlement during the course of this study. The settlement pattern for abandonment was nearly random for 1936-1949 and random by the end of 1949-1973. This morphology implied that exogenous causes were responsible for the greater part of the dwelling abandonment, rather than dwelling site dissatisfaction related to accessibility.

The abandonment process reduced the 1936 rural settlement by 1,262 dwellings, or approximately 39 percent, by 1949. Between 1949 and 1973, 1,612 dwellings, or nearly 70 percent of the total residences present in 1949, were abandoned. The number of abandoned homes for the second period was 28 percent higher than for the earlier time.

Pattern Analysis for Abandonment

Random, or nearly random patterns, were measured for abandonment during both periods by nearest neighbor analysis and quadrat analysis. Nearest neighbor analysis of the 1936-1949 abandonment matrix indicated a pattern close to random with R = 0.949 that was statistically significant (Table 14). The near neighbor measure for the following period revealed a distinctly random pattern. Its R statistic, 0.976, had a 0.26 level of statistical significance.

The results from quadrat analysis showed nearly random and random patterns, respectively, for the abandonment matrices during the early and later periods studied, although there were certain inconsistencies in these results (Appendix II and Table 15). The analysis of the

TABLE 14

NEAREST NEIGHBOR STATISTICS FOR ABANDONMENT MATRICES
IN KIOWA COUNTY FOR THE PERIODS: 1936-1949 AND 1949-1973

Periods	Total Numbers	Percentages of Settlement Matrix	R Statistics	Standard Variate of Normal Curve
1936-1949	1,262	38.70	0.949	- 2.7660[a]
1949-1973	1,612	68.39	0.976	- 1.1290[b]

SOURCE: Counts and calculations from General Highway Maps - Kiowa County, Oklahoma: 1936 and 1949 and the field map of 1973.

[a]Level of statistical significance < .01.
[b]Level of statistical significance .26.

TABLE 15

QUADRAT ANALYSIS STATISTICS FOR ABANDONMENT MATRICES
IN KIOWA COUNTY FOR THE PERIODS: 1936-1949 AND 1949-1973

Periods Quadrats (in square miles)	Variance-Mean Ratios	Chi-Square Test Results	Degrees of Freedom	Statistical Significance
1936-1949				
0.31	1.224	84.813	3	.001
0.43	1.095	12.050	3	.01-.001
1.00	0.967	10.072	5	.10-.05
2.00	1.181	19.147	7	.01-.001
3.00	1.449	32.244	8	.001
4.00	1.226	10.501	10	.30-.50
1949-1973				
0.31	1.102	12.144	3	.01-.001
0.43	1.061	5.918	4	.02-.01
1.00	0.960	9.004	6	.20-.10
2.00	1.221	16.816	8	.05-.02
3.00	1.307	23.668	10	.01-.001
4.00	1.287	24.173	12	.02-.01

SOURCE: Data derived from the General Highway Maps - Kiowa County, Oklahoma: 1936 and 1949 and from the field map of 1973.

1936-1949 abandonment matrix showed patterns that were close to, or actually random, for 5 of the 6 distributions analyzed. Only the distribution for the 3 square mile quadrat showed a slightly clustered pattern. Analysis of the 1949-1973 abandonment matrix showed similarities to those found earlier, except that variance-mean ratios for distributions from the 2 largest quadrats hinted at slightly clustered patterns. The distributions for the 4 smaller quadrats had random, or nearly random, patterns. Four of these distributions had significance levels of < 0.02, while two exceeded this limit.

Other Measurements of Abandonment

Dwelling abandonment data from both of the sequences were measured and classified in order to describe the impact of this process in the vicinity of villages and towns throughout the county, as well as to assess its effects upon the resulting settlement patterns. The measurements and classifications of abandoned dwellings were applied to 6 mile radii for the commercial centers and then to radial mileage zones from 7 miles to the county's periphery. An abandonment ratio, i.e. abandoned dwellings during the period / total dwellings at the beginning of the period, was computed for all the mileage zones. Thus, relative change within each mile was ascertained. The total number of abandoned dwellings per mile was plotted on frequency polygons and then described. Deviations from expected abandonment values were easily identified using proportions based upon the former rural settlement. Abandoned dwellings were also classified according to dwelling types.

Abandonment Around Nucleated Settlements. During the early period,

1936-1949, 61 percent of the dwelling abandonment in the study area occurred within 6 miles of villages and towns. The abandonment rate for this setting was close to the county's average. The 39.45 percent rate exceeded that for the study area by only 0.7 percent. Dwelling abandonment was roughly proportional to the number of dwellings at the sequence's beginning. The disproportionate share of the county's abandonment in this setting, reflected the total area of the parcel, rather than an excessive rate of abandonment.

Abandonment ratios in the 6 mile radii for all nucleated settlements showed that the tendency for abandonment increased gradually with distance. A low level of abandonment occurred in the first mile, abandonment rose to a low-moderate level in the second mile, and this level continued through the sixth mile (Fig. 22). Abandonment around Hobart, the largest community, deviated the most from the generalized trend. There was an overall steady increase in abandonment towards the 6 mile radius (Fig. 23). In the settings surrounding the two moderate sized places, a low-moderate rate of abandonment occurred in the first 3 miles, then it increased to a moderate level by the fifth mile, but dropped slightly in the last mile. The abandonment that occurred around the smaller places matched that of the trend for all central places.

The frequency polygon for abandonment in the 6 mile radii about the commercial centers showed that abandonment increased with distance, and, in general, the dwellings were proportional to those present in each mile at the beginning of the sequence. (Fig. 24) Certain deviations from a proportional dispersion were found. Using a value based

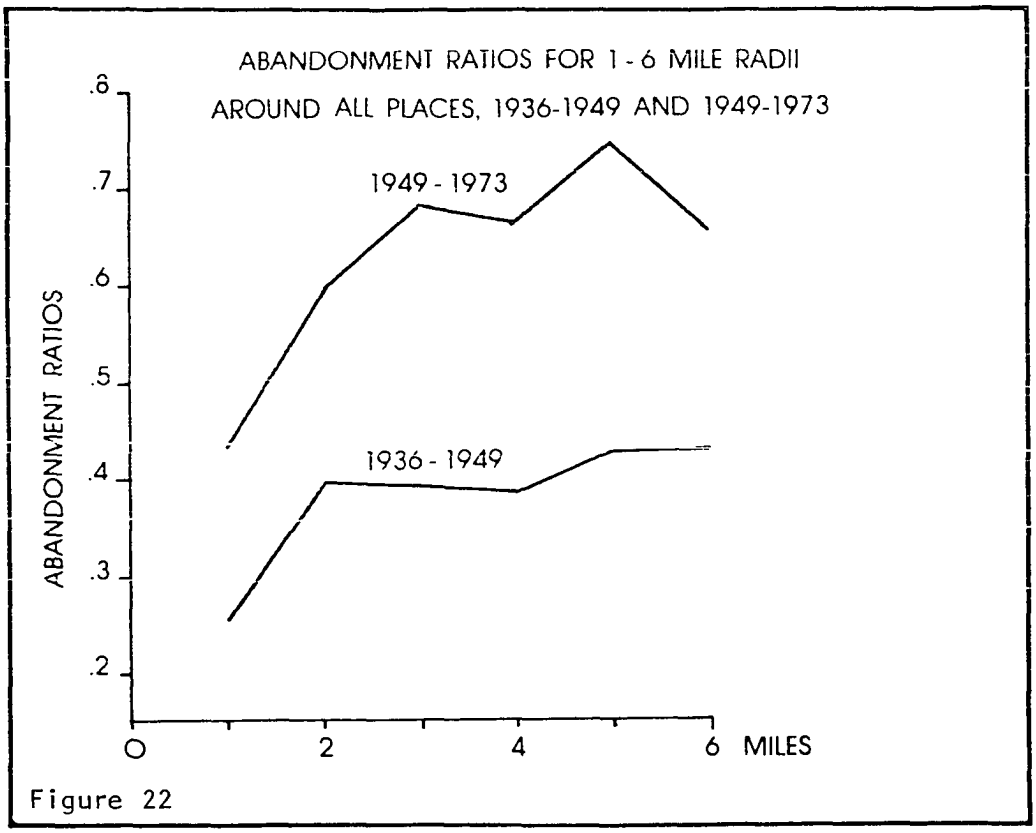

Figure 22

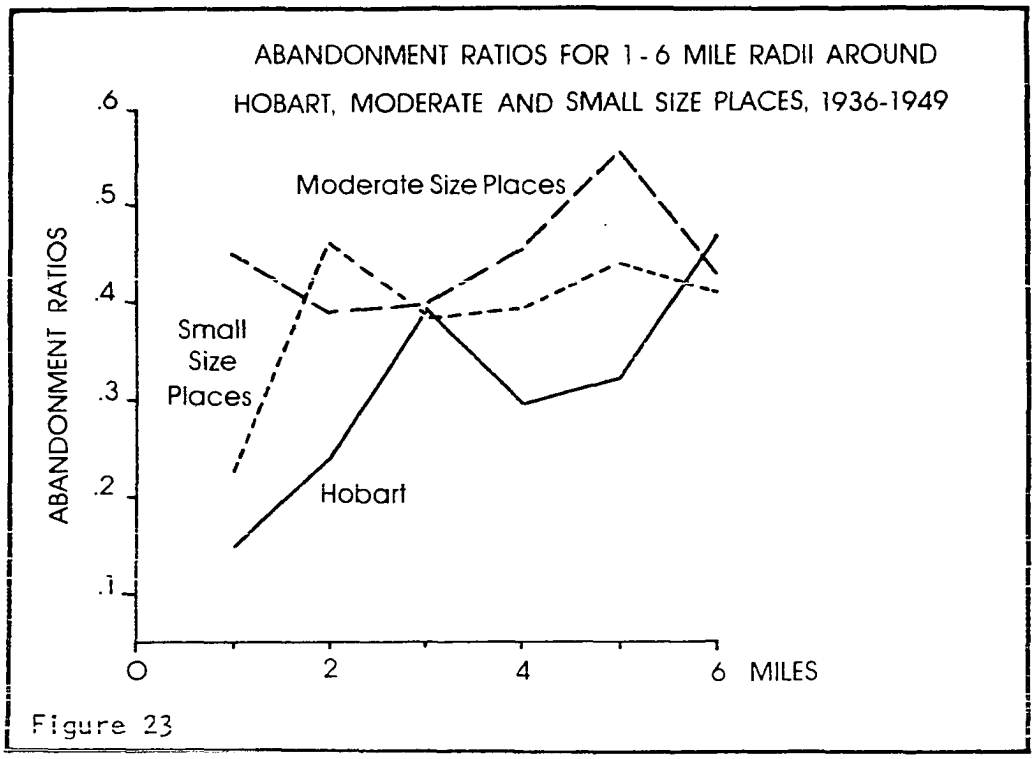

Figure 23

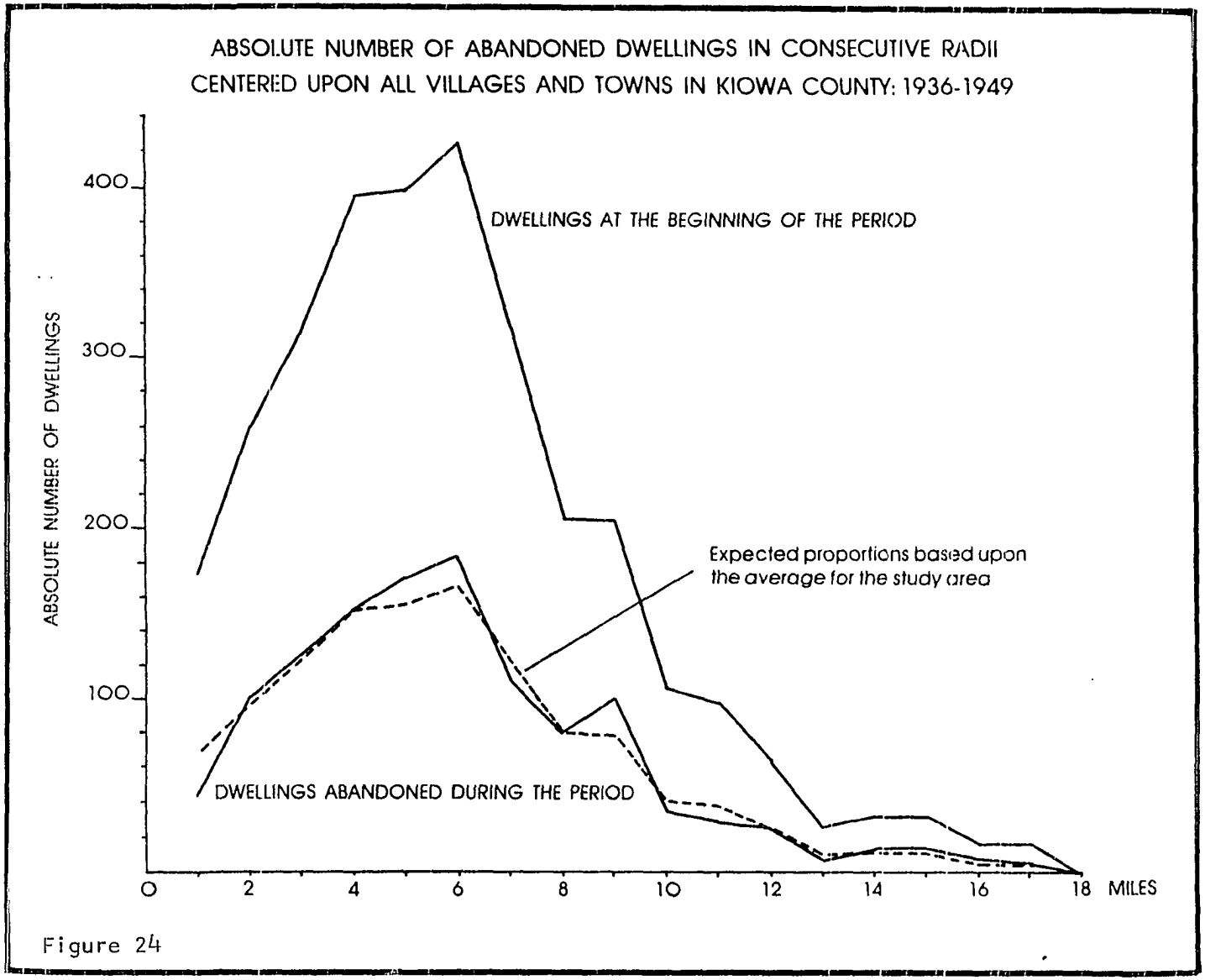
ABSOLUTE NUMBER OF ABANDONED DWELLINGS IN CONSECUTIVE RADII
CENTERED UPON ALL VILLAGES AND TOWNS IN KIOWA COUNTY: 1936-1949
ABSOLUTE NUMBER OF DWELLINGS
400
300
200
100
DWELLINGS AT THE BEGINNING OF THE PERIOD
Expected proportions based upon
the average for the study area
DWELLINGS ABANDONED DURING THE PERIOD
0
2
4
6
8
10
12
14
16
18
MILES

Figure 24

upon the mean abandonment rate as a guide, excessive abandonment was encountered at 5 to 6 miles during the period. A moderate abandonment deficiency characterized the area within 1 mile of the trade-service centers, although this reduction applied principally to Hobart.

Over 96 percent of the dwellings abandoned within 6 miles of the central places were farm houses (Table 16). Abandoned non-farm residences, less than 4 percent of those in the 6 mile settings, were found primarily within 1 mile of nucleated settlements. Most of their former occupants were farm laborers, who lived on the outskirts of the various commercial centers. Limited numbers of abandoned non-farm homes were in each of the remaining mileage zones. These residences, ordinarily, occurred singly and were formerly associated with either crossroad stores, post offices, processing sites, churches, or public schools.

Between 1949 and 1973, 57 percent of the dwelling abandonment for the county occurred in this setting. The abandonment rate, 67 percent, only 1 percent below the county's, was comparable to that throughout the study area. Consequently, there was a slight disproportion in abandonment here, as before. However, this was a smaller disparity than at the end of the first period.

Abandonment ratios for the settings around all nucleated settlements indicated, in general, that abandoning tendencies increased with distance (Fig. 22). Ratio profiles for the areas surrounding the 3 different sized communities in Kiowa County, however, all deviated to some extent from the general tendency. Around Hobart, abandonment occurred at moderate levels for the first 2 miles, rose to a high-moderate level at 3 miles, and then its rates were the highest for the

TABLE 16

TOTAL ABANDONED DWELLINGS, THEIR PERCENTAGES, AND THEIR FARM AND NON-FARM COMPOSITION FOUND IN THE 6 MILE RADII SURROUNDING ALL TOWNS AND VILLAGES IN KIOWA COUNTY DURING: 1936-1949 AND 1949-1973

Periods	Abandoned Dwellings		Composition by Mileage Zones			
Radial Mileage Zones	Total By Miles	Percentage of Total	Farms Number	Farms Percent	Non-Farm Number	Non-Farm Percent
1936-1949						
1 Mile	44	3.96	34	77.27	10	22.72
2 Miles	99	8.31	97	97.97	2	2.02
3 Miles	124	10.41	123	99.20	1	0.80
4 Miles	153	12.84	147	96.08	6	3.92
5 Miles	170	14.27	166	97.64	4	2.35
6 Miles	183	15.36	177	96.72	6	3.27
1949-1973						
1 Mile	60	4.19	40	66.66	20	33.33
2 Miles	101	7.06	97	96.03	4	3.96
3 Miles	162	11.33	141	87.03	21	12.96
4 Miles	221	15.46	214	96.83	7	3.16
5 Miles	199	13.92	199	100.00	0	0.00
6 Miles	176	12.31	176	100.00	0	0.00

SOURCE: Data derived from the General Highway Maps - Kiowa County, Oklahoma: 1936 and 1949, and from the field map of 1973.

3 community categories (Fig. 25). The ratios for moderate sized places were similar to those in the earlier sequence, but they were slightly higher. Abandonment around smaller places occurred at a low-moderate level in the first mile and rose to the high-moderate level in the second through the sixth mile.

Abandonment within 6 mile radii for villages and towns had a proportionate resemblance to the rural settlement at the sequence's beginning, but certain deficiencies from a true proportion occurred. An abandonment deficiency approaching 33 percent occurred at 1 mile, when the observed value was compared to an expected one based upon the

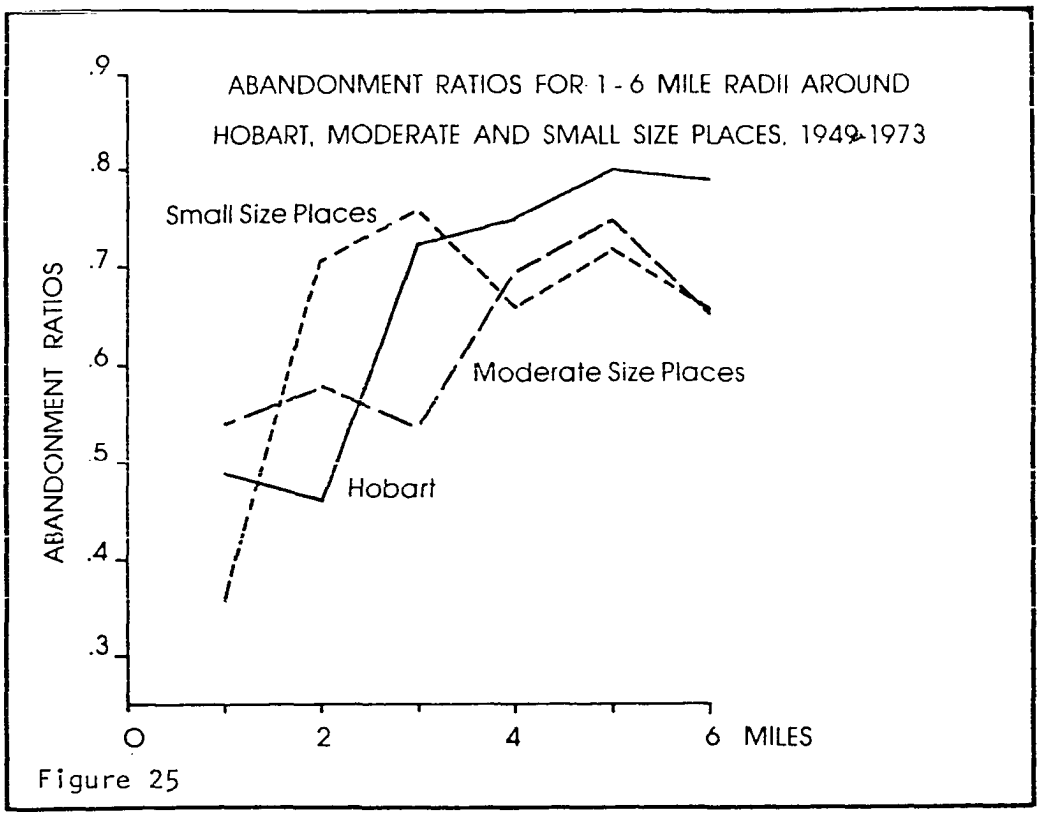

Figure 25

average abandonment rate. This deficiency continued into the second mile as a much lower percentage. Notable abandonment excesses of 10 to 11 percent were measured at 4 and 5 miles. This excessive rate of abandonment continued through the sixth mile, although at a reduced rate (Fig. 26).

Farm residences were 94 percent of those abandoned in this setting during the period. Their composition in each mile increased from 66 percent nearest the nucleated settlements to 100 percent at 5 to 6 miles (Table 16). Non-farm dwellings were a third of those abandoned at 1 mile. Percentages of abandoned non-farm houses were low at 2 and 4 miles, but reached 13 percent in the third mile. As in the earlier period, the former occupants of most of these residences nearest the communities were farm laborers. Non-farm residences abandoned from 2 to

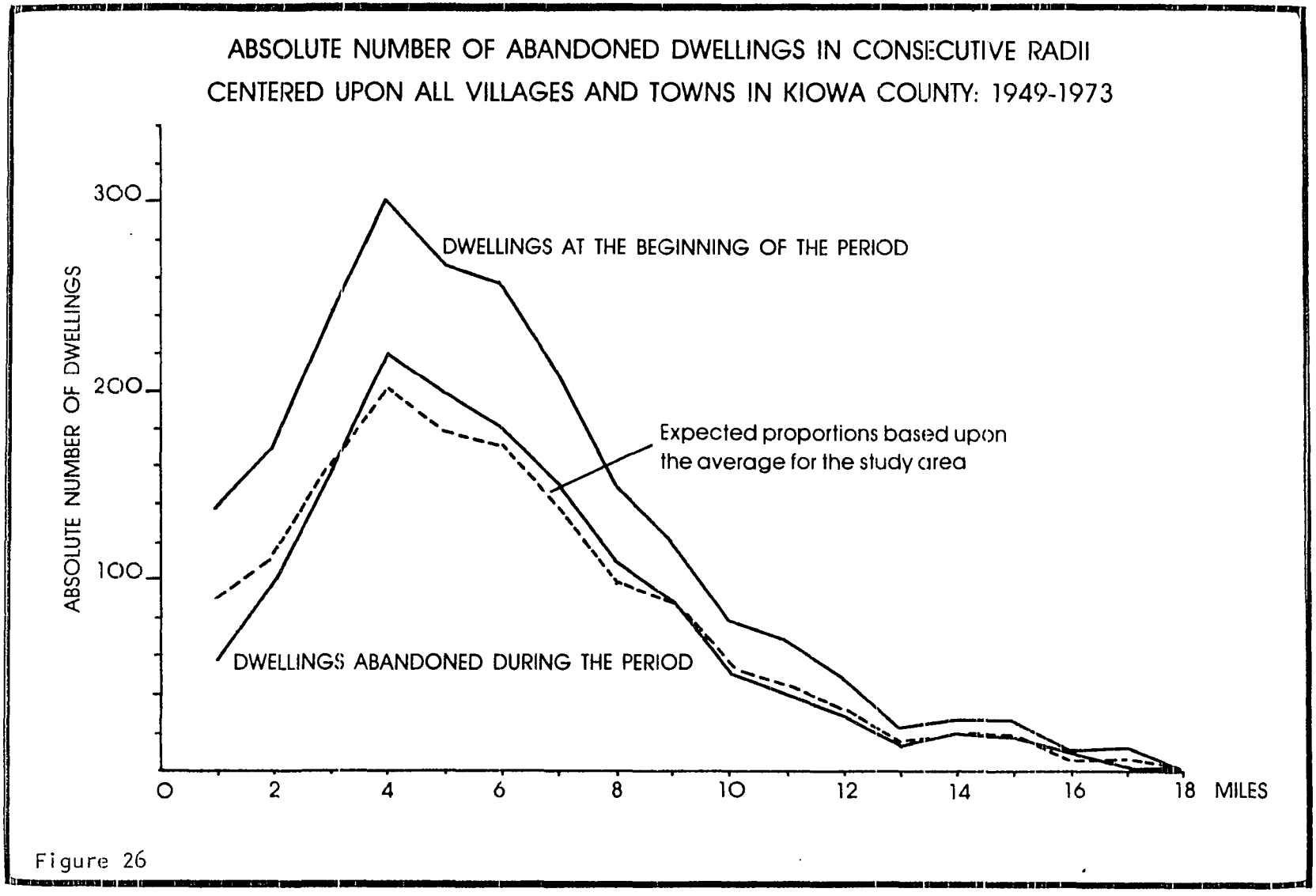
ABSOLUTE NUMBER OF ABANDONED DWELLINGS IN CONSECUTIVE RADII
CENTERED UPON ALL VILLAGES AND TOWNS IN KIOWA COUNTY: 1949-1973
ABSOLUTE NUMBER OF DWELLINGS
300
200
100
DWELLINGS AT THE BEGINNING OF THE PERIOD
Expected proportions based upon
the average for the study area
DWELLINGS ABANDONED DURING THE PERIOD
0
2
4
6
8
10
12
14
16
18
MILES

Figure 26

4 miles had previously housed persons at a few remaining businesses, school complexes, or processing sites. Although some dwelling abandonment occurred along the major roads in the settings surrounding these central places, most of the abandoned residences were situated along the less developed section line roads.

Abandonment Beyond the Six Mile Radii. Thirty-nine percent of the abandonment in the county occurred in the settings beyond the 6 mile radii associated with central places for the 1936-1949 period and 43 percent of that during the 1949-1973 span. Both percentages were close to the percentages of dwellings in these outlying areas at the beginning of the sequences, i.e. 40 percent for 1936 and 42 percent for 1949. The 1936 rural settlement was reduced by an abandonment rate of 38 percent, which was 1 percent lower than the county's average. A 70 percent abandonment rate obtained during the 1949 rural settlement period, a rate 2 percent higher than that for the county during this period.

The procedure used for considering abandonment ratios, frequency distributions, and dwelling types was similar to that utilized for new settling. The outlying areas for the nearest nucleated settlements in Kiowa County were treated, but two areas, which were tied to commercial centers outside of the study area, were excluded. Measurements employed were sufficient to represent conditions for abandonment.[3]

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[3] These two areas included a setting along the northcentral border of the county which was closest to Sentinel, in Washita County, and another setting in the northeastern part of the county that was closer to Carnegie, in Caddo County. During the 1936-1949 period, 78 dwellings or 6.18 percent of the total were here and in the 1949-1973 period 181 dwellings or 11.23 percent of the total were there.

Abandonment tendencies for areas outside of the 6 mile radii for nucleated settlements in the county were similar during the two periods (Fig. 27). Beginning at 7 miles, abandoning declined through the 13 mile zone, after which it increased toward the periphery. Separate abandonment ratio profiles showed differences for areas tied to the three sizes of communities. Most apparent was the difference in abandonment levels at extreme distances for moderate and smaller sized places during both periods (Figs. 28 and 29). Abandoning was modified in outlying areas of moderate sized nucleated settlements, while for similar areas of smaller places it was extremely high or almost complete. In the Hobart area abandoning was under the average for the early period, but above it during the later sequence.

Abandoned dwelling distributions for this setting were generally proportional to the dwellings present in the mileage zones in 1936 and in 1949. This illustrates that the mean abandonment rate was commonly effective throughout this portion of Kiowa County for both periods. Both distributions from 7 miles to the county's peripheries showed deviations from the mean abandonment rate (Figs. 24 and 26). During the early years excesses in abandonment of from 25 to 33 percent were found at 9 and 16 miles, and deficiencies of 10 to 25 percent occurred at 7, 10, and 11 miles. At the end of the later sequence, abandonment excesses of 7 to 9 percent were found at 7 and 8 miles, while deficiencies of 13 to 33 percent were encountered at 11 to 13 miles and at 68 percent at 17 miles.

Farm residences comprised nearly the total of houses abandoned during both periods. During the 1936-1949 sequence, many of the abandoned farm homes were those formerly occupied by sharecroppers. By the end of

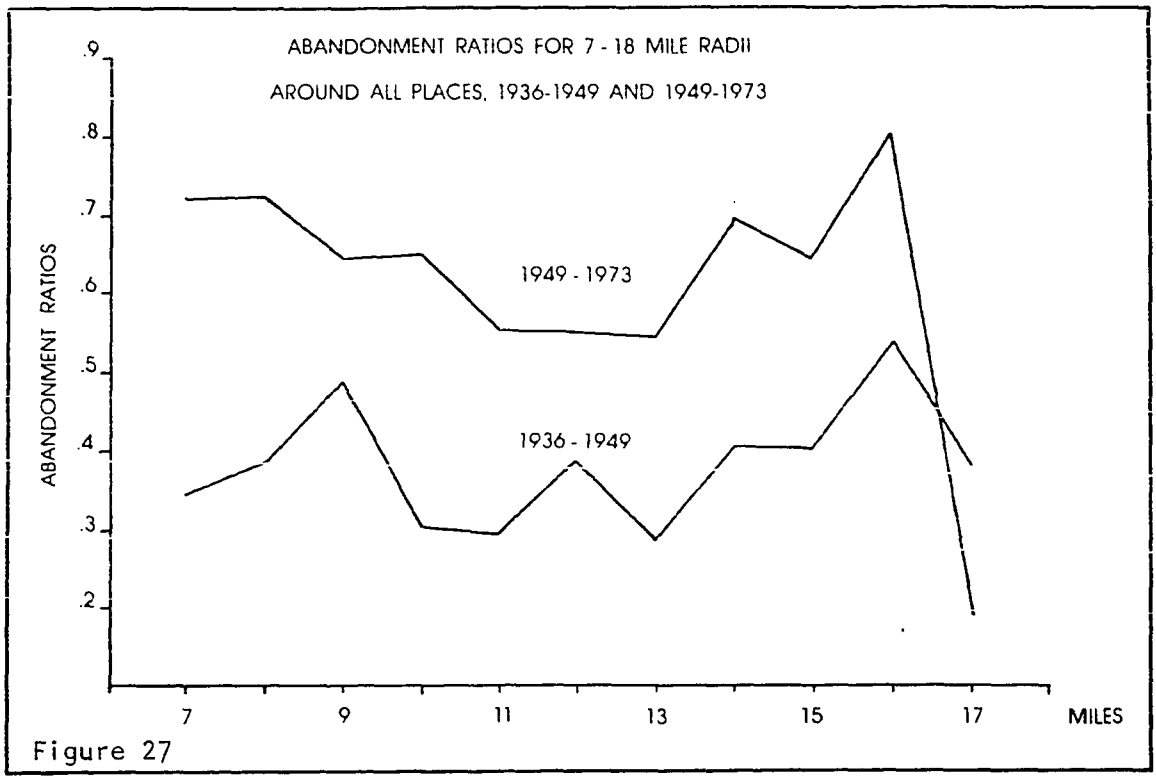

Figure 27

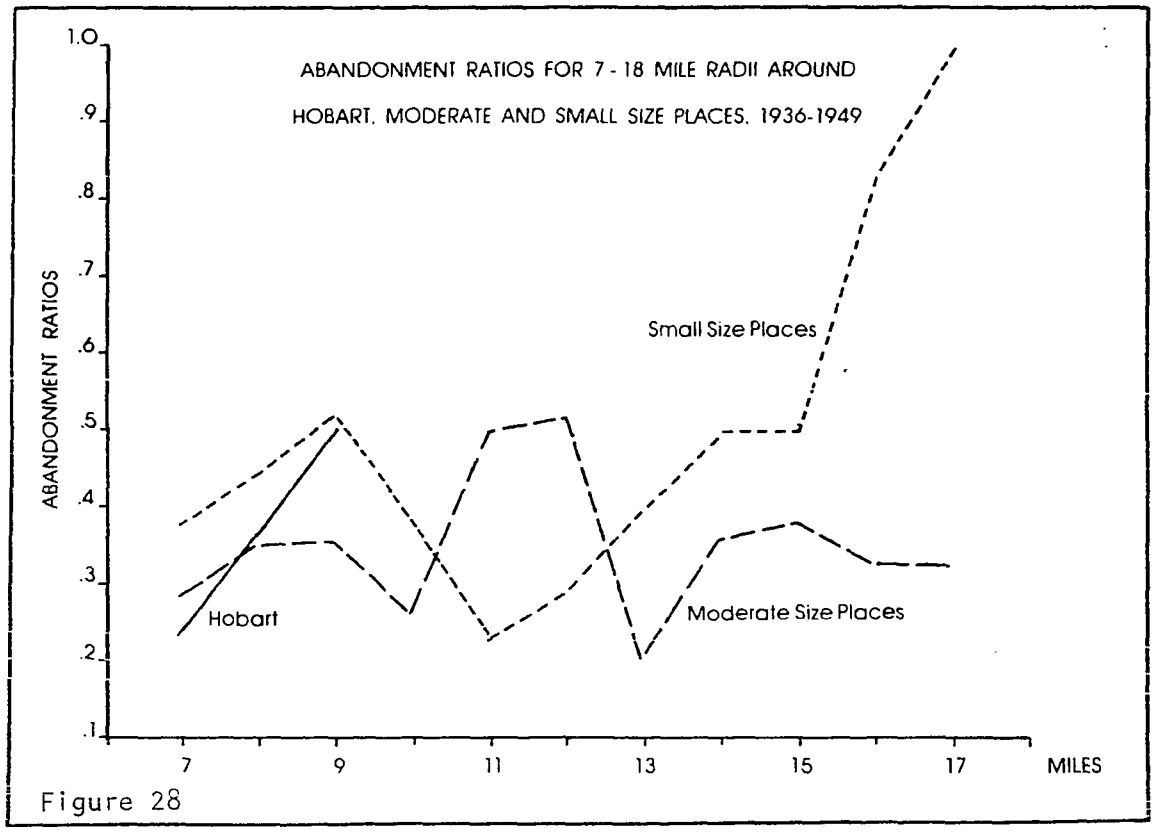

Figure 28

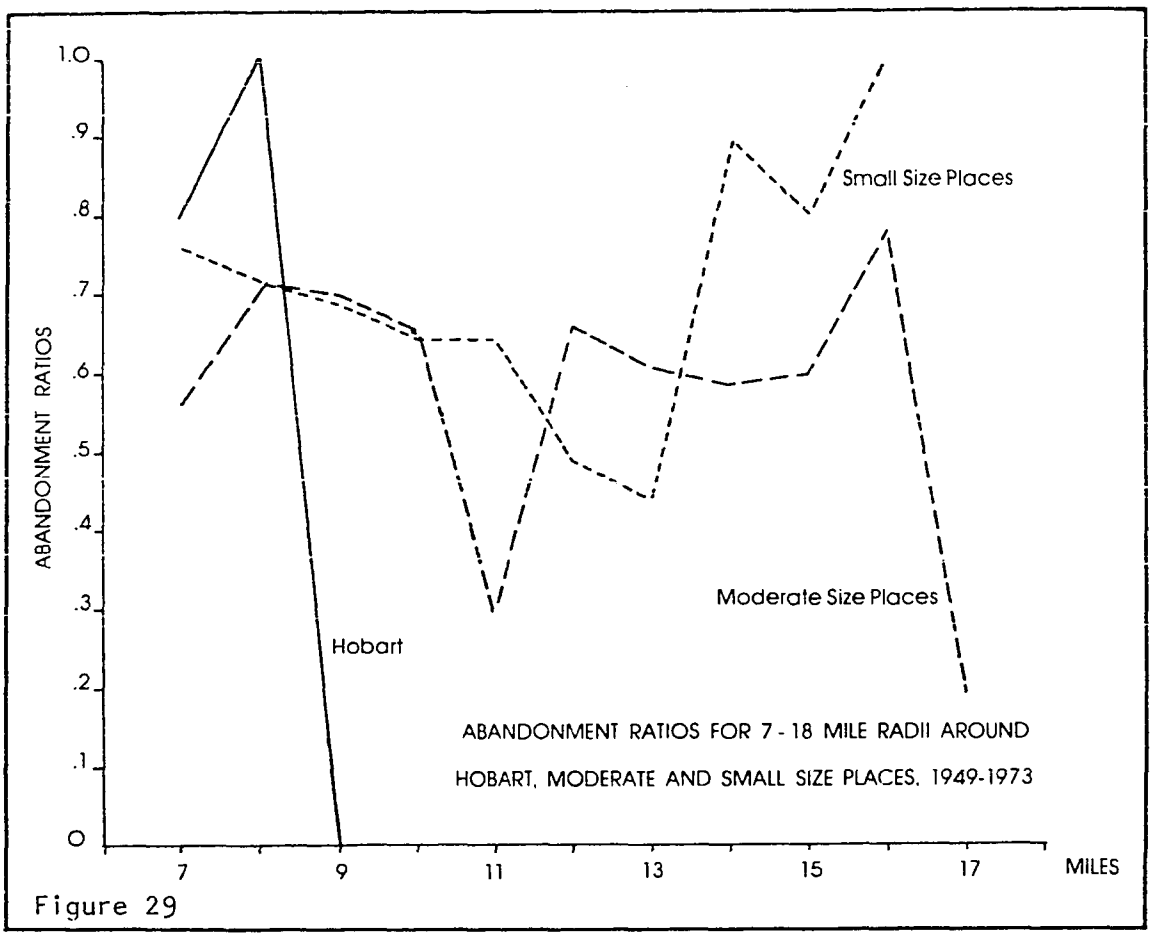

Figure 29

the second period, however, the abandoned houses included the former dwellings of many resident farm owners. The non-farm homes that were abandoned included those that had housed farm laborers, those located near two remaining rural school complexes, and those situated at one of the granite quarries northwest of Snyder.

Interpretation of the Abandonment Process

Abandonment in Kiowa County was nearly random and then random during the first and later sequences. These measurements did not support the research hypothesis of a clustered morphology evolving as dwelling abandonment became highly concentrated towards the county's periphery. These findings suggested that dwelling abandonment was primarily the result of exogenous causes that were widely spread throughout the study

area. The dwelling abandonment that occurred due to site dissatisfaction was obscured by the dominant, random morphologies. Major reasons for the evolution of this random pattern were that abandonment was a settlement process affecting large numbers of dwellings throughout the study area; a distinct lack of focus for abandonment occurred; and that the abandonment occurrences varied considerably in their magnitudes around nucleated settlements.

Dwelling abandonment in the study area increased during the two periods that were studied. From 1936-1949 this process, affecting 1,262 dwellings, reduced the 1936 rural settlement matrix by 39 percent. In the 24 years that followed, dwelling abandonment became considerably more effective in modifying rural settlement. During this time 68 percent of the residences comprising the rural settlement in 1949 were abandoned. The 1,612 residences which were abandoned after 1949 constituted a 28 percent increase over the former period.

During the course of the two sequences 61 and 57 percent respectively of the abandonment in Kiowa County occurred within 6 miles of the nucleated settlements. The abandonment rate here was 39.45 percent for the early period and 67 percent during the latter time, and both were within 1 percent of the county's rate. The higher incidences of abandonment developed as most rural settlement was located here initially. The area did not experience excessively high rates of abandonment. Abandonment around the nucleated settlements was generally proportional to the settlement existing at the beginning of the sequences. Using the average abandonment rate for comparison, abandonment deficiencies occurred 1 to 2 miles from the commercial centers, whereas abandoning

excesses developed at 5 to 6 miles.

Abandonment increased slightly in those parts of the study area lying outside the 6 mile radii for nucleated settlements during the two periods. These areas comprised 39 and 43 percent, respectively, of the abandoning for the county. The abandonment rate for the early period, 38 percent, was 1 percent less than the county's rate, but the abandonment rate during the latter period was 70 percent, two percentage points higher than that for the county. Dwelling abandonment excesses occurred from 7 to 9 miles during these sequences, while abandoning deficiencies were found from 10 to 13 miles at the same time. Beyond 13 miles abandoning was influenced by the size of the nearest nucleated settlement. Abandoning was considerably higher, or complete, in areas closest to smaller communities, but it was distinctly modified when the closest nucleated settlement was larger. The near random, and random, settlement patterns that evolved for abandonment from 1936 to 1973 were foreseen as an alternative to the hypothesized morphology of clustering. As asserted earlier, random patterns resulted because the abandonment lacked a distinct focus, because it was spread throughout the study area; and because the magnitude varied. Results from the nearest neighbor analysis and quadrat analysis were very similar during the two sequences. Both measures were, in addition, sensitive to the slight increases in randomness that occurred between 1949 and 1973.

Residual Dwellings

Residual dwellings representing the remnants of earlier settlement, gradually became oriented to the nucleated settlements in Kiowa County during the course of this study. The residual dwellings' pattern

changed from being close to random in 1936-1949 to slightly clustered in 1949-1973.

The 1,998 dwellings that remained at the end of the 1936-1949 period formed 85 percent of the rural settlement in 1949. The residual rate for this period was 61.26 percent. At the end of the 1949-1973 period, the 751 dwellings in this category amounted to 74 percent of the rural settlement matrix. Residual dwellings in the rural settlement decreased 11 percent from the earlier period, but they constituted the majority of the dwellings comprising the 1973 rural settlement. Because of the loss of 1,247 homes from the 1949 rural settlement matrix, the residual rate was 37.58 percent in 1973.

Pattern Analysis of Residual Dwellings

Nearest neighbor analysis and quadrat analysis indicated that the distribution of residual dwellings became slightly clustered with time. For this distribution from 1936 until 1949 the nearest neighbor measure indicated a pattern close to randomness with R = 0.925 at the 0.01 level of statistical significance (Table 17). The nearest neighbor statistic was slightly lower during the 1949-1973 interval, indicating that the stability became slightly clustered during this interim. The R statistic, 0.8610, was also significant.

The dwelling distributions measured with quadrat analysis for the 1936-1949 period indicated slight clustering, but inconsistencies were revealed in the variance-mean ratios for these quadrats as evidenced by the decline in the ratios from the 0.31 to the 1.0 square mile cells (Table 18). A similar ratio drop occurred within the later distributions. Variance-mean ratios were significant at the 0.001 level, except

TABLE 17

NEAREST NEIGHBOR STATISTICS FOR THE RESIDUAL DWELLING MATRICES IN KIOWA COUNTY FOR THE PERIODS: 1936-1949 AND 1949-1973

Periods	Total Number	Percentage of Settlement Matrix	R Statistic	Standard Variate of Normal Curve
1936-1949	1,998	84.77	0.921	- 3.3851[a]
1949-1973	751	73.78	0.861	- 9.7135[a]

SOURCE: Counts and calculations from General Highway Maps - Kiowa County, Oklahoma: 1936 and 1949 and the field map of 1973.

[a]Level of statistical significance < 0.01.

TABLE 18

QUADRAT ANALYSIS STATISTICS FOR RESIDUAL DWELLING MATRICES IN KIOWA COUNTY FOR THE PERIODS: 1936-1949 AND 1949-1973

Periods Quadrats (in square miles)	Variance-Mean Ratios	Chi-Squared Test Results	Degrees of Freedom	Statistical Significance
1936-1949				
0.31	1.4424	39.4046	4	.001
0.43	1.3390	18.6493	4	.001
1.00	1.1500	57.0059	6	.001
2.00	1.6689	17.3567	9	.05-.02
3.00	1.5692	48.4289	12	.001
4.00	1.3516	96.3282	13	.001
1949-1973				
0.31	2.0673	156.0470	2	.001
0.43	2.3559	82.9140	2	.001
1.00	2.3330	19.8188	3	.001
2.00	2.9468	91.5558	5	.001
3.00	2.7587	88.6600	6	.001
4.00	2.0139	46.7304	7	.001

SOURCE: Data derived from the General Highway Maps - Kiowa County, Oklahoma: 1936 and 1949 and from the field map of 1973.

for the 2 square mile quadrat during 1936-1949. More consistency was displayed in the measurement of the 1949-1973 residual dwellings. The variance-mean ratios increased from 2.0673 for the 0.31 square mile cell to 2.9468 for the 2 square mile cell distributions, then declined to 2.0139 for the 4 square mile quadrat distribution. All of the latter measurements registered higher degrees of clustering than those for the previous period. Levels of statistical significance for all of the distributions for the 6 cell sizes were at the 0.001 level.

Other Measurements of Residual Dwellings

Two measurements and a classification were applied to the residual dwelling data from the sequences to interpret the pattern analysis results more effectively. The study area was divided into two segments using a 6 mile radius from nucleated settlements as the division. A residual ratio, i.e. the number of dwellings remaining from the beginning to the end of the period / the number of dwellings at the beginning of the period, was computed for each mileage zone. Such a measure was useful in recognizing tendencies for housing residuals within each mile for the different sized commercial centers. Dwelling data were charted on a frequency polygon, and their distribution was described and compared to an average residual proportion. Dwelling types, farm and non-farm, were classified and identified for respective mileage zones.

Residual Dwellings Around Nucleated Settlements. In 1949 residual dwellings, which remained for 13 years in the 6 mile radii for the nucleated settlements, constituted 59 percent of that for Kiowa County. This distribution was slightly skewed towards the nucleated settlements,

since it occupied 54 percent of the county's area. The residual rate here was 60.54 percent, slightly lower than the county's rate of 61.26 percent. Since this rate was nearly comparable to the county's, the disproportion in the number of remaining dwellings reflected a similar condition in the earlier rural settlement.

The residual ratios for all of the nucleated settlements' radial areas showed that there was a tendency for the remaining housing to decline slightly with distance. For all centers these dwellings were moderately high in the first mile, then declined slightly to a moderate level, and remained relatively constant through the sixth mile (Fig. 30). The dwellings around Hobart deviated the most from the county's generalizations, when tendencies for the various sized communities were considered separately. Its ratio indicated that these homes were higher overall and that they decreased generally with distance from the node (Fig. 31). Both the moderate and small sized places had hinterlands where the general tendency of constancy for dwelling stability applied.

With two exceptions the distribution for residual dwellings was smaller but proportional comparable to the 1936 rural settlement through the 6 miles. Consequently, the number of dwellings per mile increased from 1 mile through the fourth and then leveled off (Fig. 32). The average residual dwelling rate was used for computing expected residual amounts for each mile, and then the observed amount of remaining dwellings was compared to it to identify deviations. In the first mile a 25 percent excess in the remaining dwellings occurred which suggested the importance of dwelling sites near nucleated settlements. Deficiencies in the dwelling distribution of 5 to 6 percent were found between

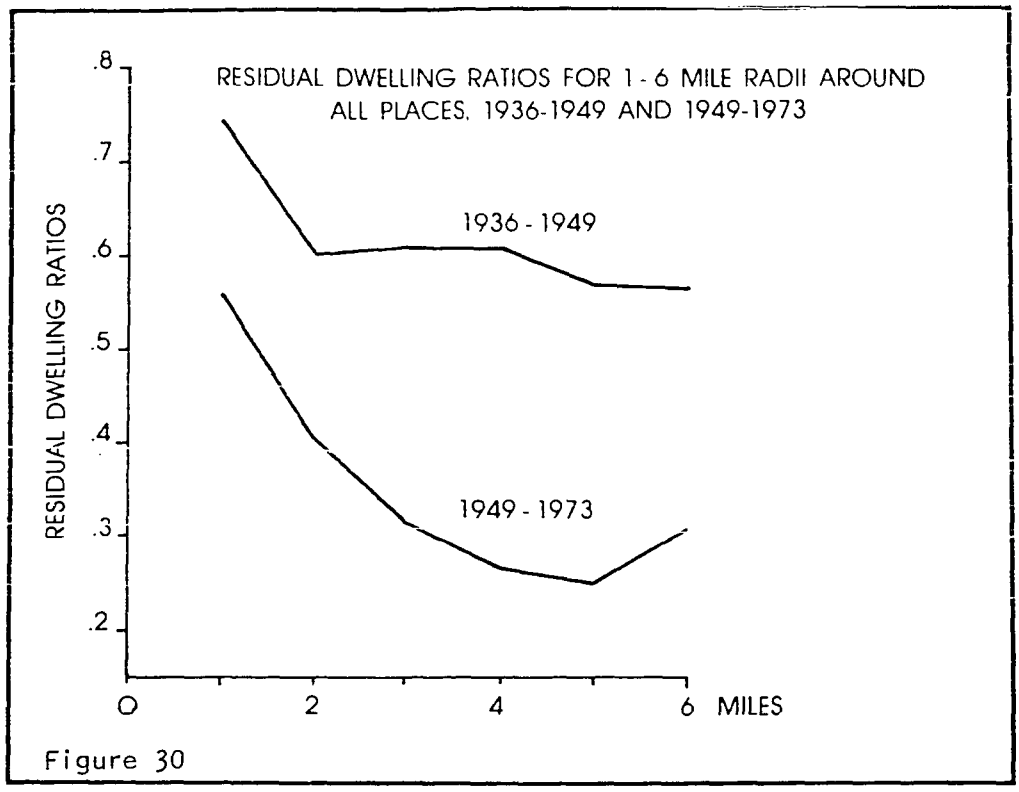

Figure 30

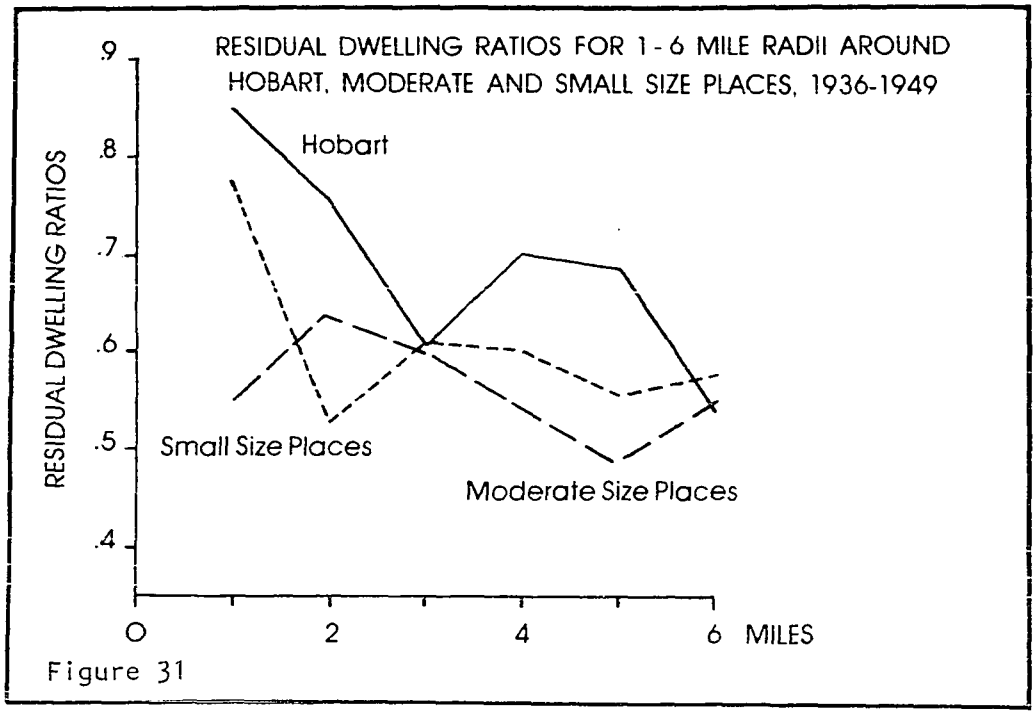

Figure 31

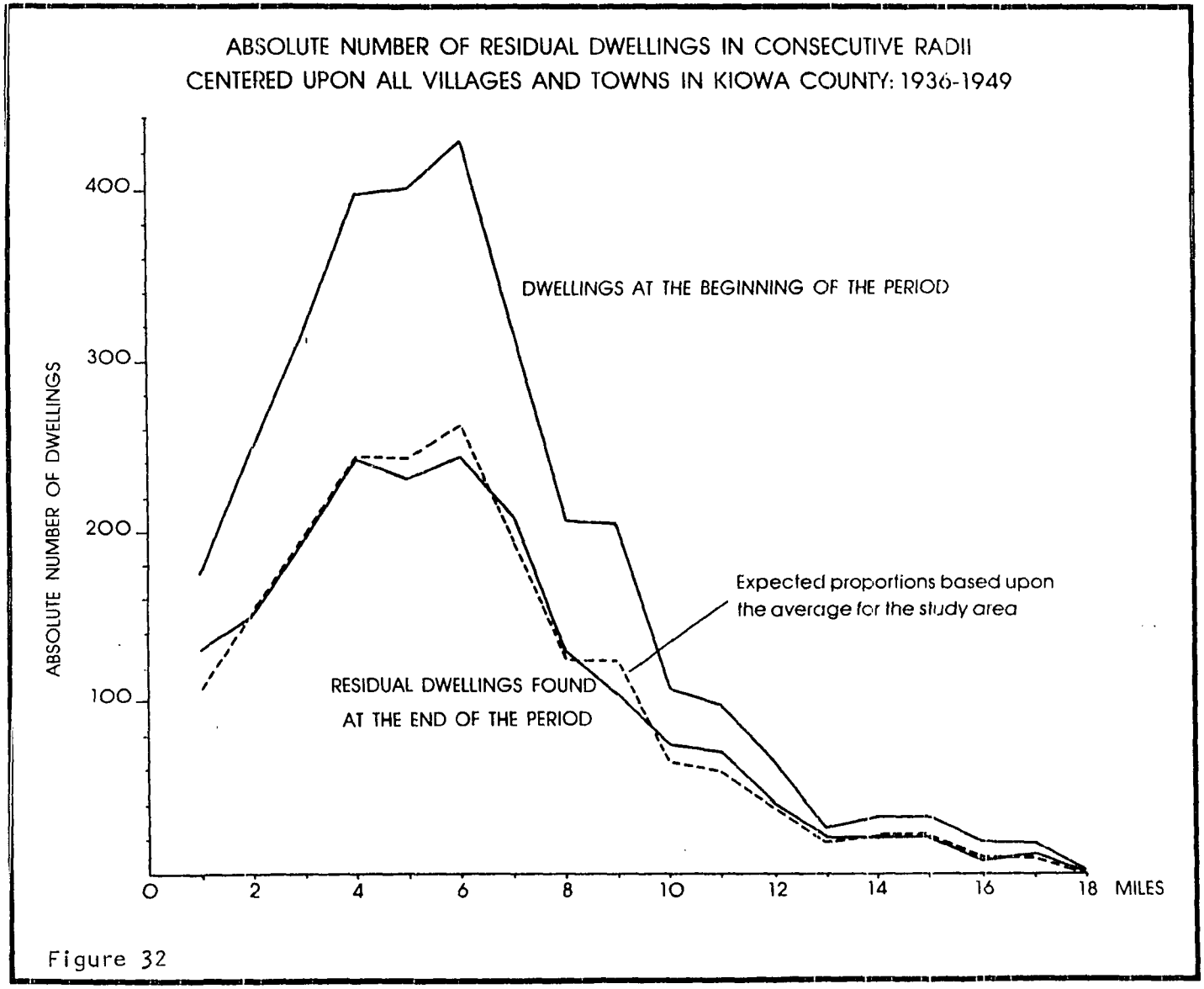
ABSOLUTE NUMBER OF RESIDUAL DWELLINGS IN CONSECUTIVE RADII
CENTERED UPON ALL VILLAGES AND TOWNS IN KIOWA COUNTY: 1936-1949
ABSOLUTE NUMBER OF DWELLINGS
400
300
200
100
DWELLINGS AT THE BEGINNING OF THE PERIOD
Expected proportions based upon
the average for the study area
RESIDUAL DWELLINGS FOUND
AT THE END OF THE PERIOD
0
2
4
6
8
10
12
14
16
18
MILES

Figure 32

5 and 6 miles, and although these were small deficiencies, their occurrences were indicative of a decrease in the residual dwelling numbers as distance from the commercial centers increased. The decreased dwelling numbers here, as measured by the residual ratios, operated especially around the smaller and moderate sized places.

Farm dwellings composed over 92 percent of the residual housing, and represented at least 94 percent of the dwellings in each mile, except for the first (Table 19). Non-farm dwellings were over 7 percent of this distribution, however their greatest impact on the rural settlement was in the first mile. These homes represented 53 percent of those found in 1949. Farm laborers were the major occupants of these residences. The non-farm residences situated in the other 5 mile zones were associated with either a few school complexes, some single business establishments at crossroads, and a few processing or industrial sites. A low percentage of the homes were situated along or near the main roads, since most of the housing was still closely tied to quarter-section farms.

The percentages of residual dwelling for the study area that occurred within 6 miles of villages and towns by the end of the second sequence was only 1 percent higher than for the prior period. Sixty percent of the dwellings forming this distribution occupied 54 percent of the county's area. As in the previous instance this represented a disproportionate share of the dwellings in the county. This setting's dwelling residual rate was 32.96 percent, which exceeded the county rate, 31.86 percent, by just over 1 percent. Comparability of the two residual rates reflect a similar disparity in the rural settlement in 1949.

TABLE 19

TOTAL RESIDUAL DWELLINGS AND THEIR PERCENTAGES FOUND IN THE 6 MILE RADII SURROUNDING ALL VILLAGES AND TOWNS, ALONG WITH THEIR FARM AND NON-FARM COMPOSITION, FOR KIOWA COUNTY: 1936-1949 AND 1949-1973

Periods	Residual Dwellings		Composition by Mileage Zones			
Radial Mileage Zones	Totals By Miles	Percentages For the County	Farms Number	Farms Percents	Non-Farms Number	Non-Farms Percents
1936-1949						
1 Mile	130	6.50	61	46.92	69	53.07
2 Miles	149	7.45	141	94.63	8	5.36
3 Miles	194	9.70	192	98.96	2	1.03
4 Miles	242	12.11	239	98.76	3	1.24
5 Miles	228	11.41	227	99.56	1	0.44
6 Miles	245	12.16	239	97.55	6	2.44
1949-1973						
1 Mile	77	10.25	20	25.97	57	74.02
2 Miles	69	9.18	56	81.15	13	18.84
3 Miles	77	10.25	73	94.80	4	5.19
4 Miles	81	10.78	80	98.76	1	1.23
5 Miles	67	8.92	64	95.52	3	4.47
6 Miles	81	10.78	79	97.53	2	2.46

SOURCE: Data derived from the General Highway Maps - Kiowa County, Oklahoma: 1936 and 1949 and from the field map of 1973.

Dwelling residual ratios for the area around all of the villages and towns declined from a high-moderate level in the first mile to a low-moderate level at 5 miles and rose slightly in the sixth mile (Fig. 30). The ratio profile for this latter period was lower than its predecessor. The area surrounding Hobart changed from the former sequence where the remaining dwellings ratio was moderate in the first 2 miles as was expected. Subsequently, however, it was low and remained at a low level through the sixth mile (Fig. 33). For moderate sized places the profile was similar to its earlier counterpart, although somewhat lower through three miles. Beyond three miles there was a decline to low-moderate levels. Dwelling residuals around smaller

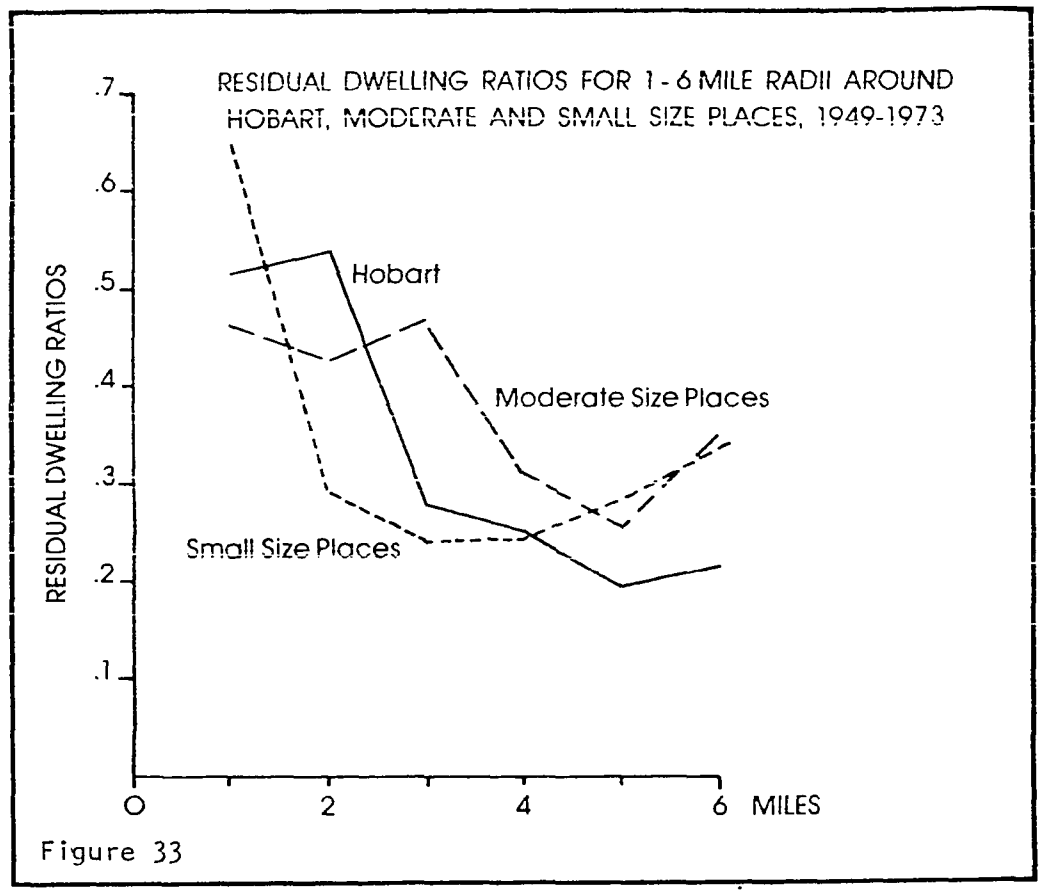

Figure 33

places came closest to matching the general tendencies for the study area.

The distribution of residual dwellings by the mile in the radial zones was more oriented towards the nodes than during the previous period (Fig. 34). Although this distribution resembled the 1949 rural settlement somewhat, its increased orientation to nucleated settlements was apparent near these nodes as well as at 4 to 6 miles. Using the percentage for the mean residual rate as a comparison in each mile, excesses in dwelling residuals occurred through the second mile from the centers. Dwellings in the first mile were 71 percent higher than would occur using this rate, and the count in the second mile was 23 percent higher. For the 4 to 6 mile zones, residual deficiencies

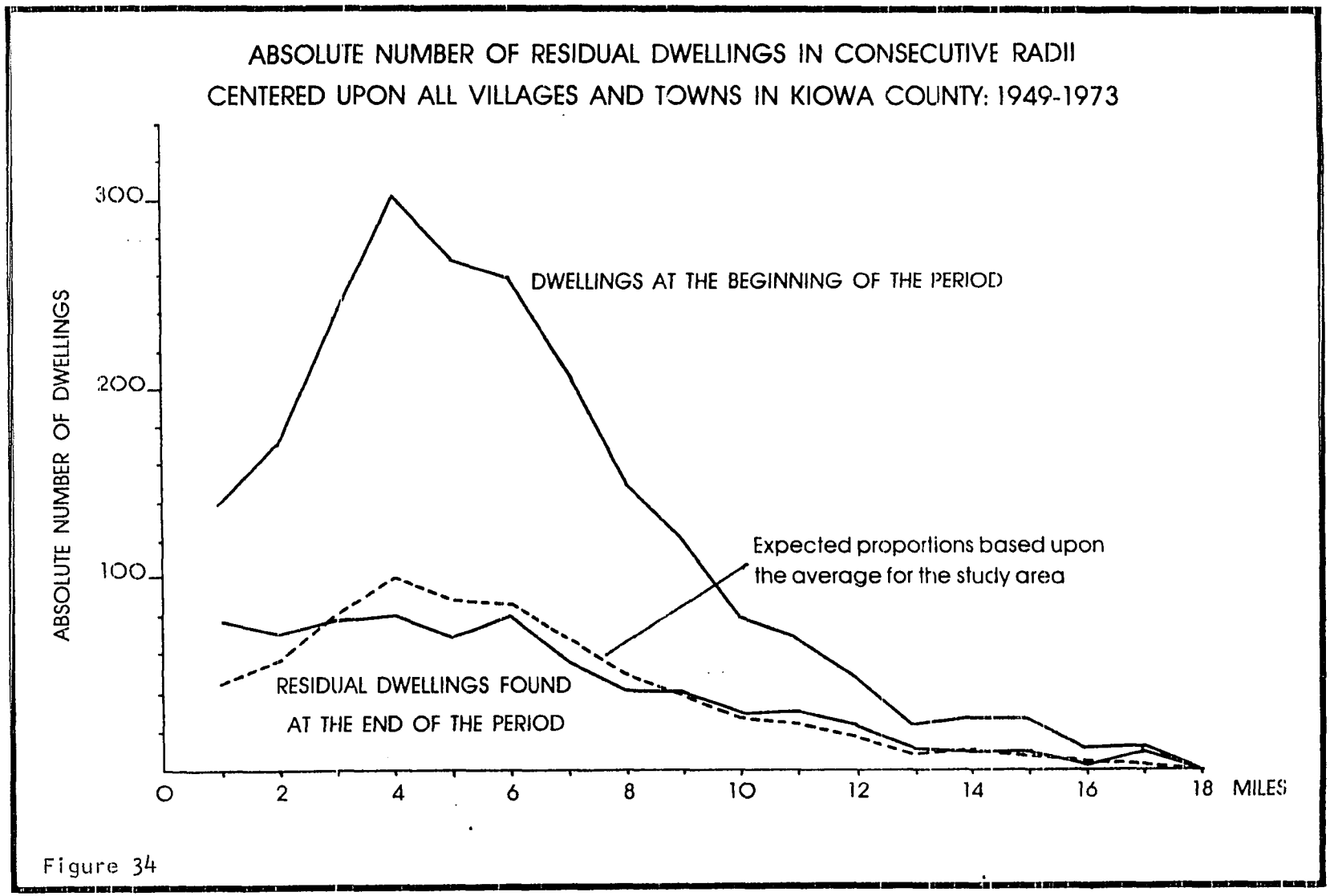
ABSOLUTE NUMBER OF RESIDUAL DWELLINGS IN CONSECUTIVE RADII
CENTERED UPON ALL VILLAGES AND TOWNS IN KIOWA COUNTY: 1949-1973
ABSOLUTE NUMBER OF DWELLINGS
300
200
100
DWELLINGS AT THE BEGINNING OF THE PERIOD
Expected proportions based upon
the average for the study area
RESIDUAL DWELLINGS FOUND
AT THE END OF THE PERIOD
0
2
4
6
8
10
12
14
16
18
MILES

Figure 34

amounting to 25, 29, and 6 percent, respectively, were observed. These deviations accentuated conditions that existed in the first sequence.

Although 82 percent of the dwellings in the distribution were farm houses, the orientation of this distribution to nucleated settlements resulted primarily from the non-farm homes which formed the remaining 18 percent. Non-farm housing not only gained proportionately in the first 3 miles from nucleated settlements after the first period, but the numbers also significantly exceeded those predicted by studying the average residual rates. In addition, the number of farms remaining in the second and third miles slightly exceeded their anticipated numbers (Table 19). There was comparatively little change in the farm - non-farm composition in each mile in the outer three miles of these radial areas during the two periods. Consequently, the percentage of homes situated within 3 miles of nucleated settlements increased from 24 to 30 percent of all those in the residual category from the first to the second period. Sidewalk farmers occupied the majority of the non-farm houses in these settings, but, as in the former period, some of the occupants worked in, or owned, businesses in the commercial centers. Housing in this category showed a distinctive orientation to major roads in this six mile setting by the end of this time.

Residual Dwellings Beyond the Six Mile Radii. The residual dwelling matrix lying outside of the 6 mile radii of nucleated settlements was 41 percent of that for the county at the end of the 1936-1949 period and 40 percent in 1973. During both periods these portions of the dwelling residuals occupied 46 percent of the county. These distributions were less than parity. This condition existed at the end of both

periods, since the dwelling residual rates that occurred were similar to those for the county. These rates were 62 percent for the early sequence and 30 percent for the later period. The rates for the county were 61 and 32 percent, respectively.

Two of the measurements that follow were computed from data observed in these outlying areas within concentric circles which were centered in the nearest village or town in Kiowa County. Since two segments of this outlying part of the county were closest to commercial centers in contiguous counties, the observed data from these areas were not included in either the residual dwelling ratios or in the distributions' frequency polygons.[4] These data and ratios were considered to be representative for the county.

The residual dwelling ratio profiles for the outlying areas to nucleated settlements in the county during the two periods were similar, but that for the latter period was lower (Fig. 35). The ratios were or became lower in the first 3 miles, then increased through 13 miles, decreased steadily until 16 miles, and then increased in the distant margins. Two differences in the later profile, however, were sufficient to affect a subtle change in its trend as compared to that from the earlier sequence. Residual ratios at 7 to 8 miles were lower than earlier, and those in the most distant settings were higher. Consequently, although the trend for dwelling residuals was constant for

[4]These two settings were comprised by an area close to Sentinel in Washita County and another area along Kiowa County's northeastern boundary which was nearest to Caddo County. For the 1936-1949 period, 116 residual dwellings or 5.80 percent of the total in this category were in these settings. At the end of the latter period, 39 residual dwellings, 5.19 percent of the total for this category, were in these two locations.

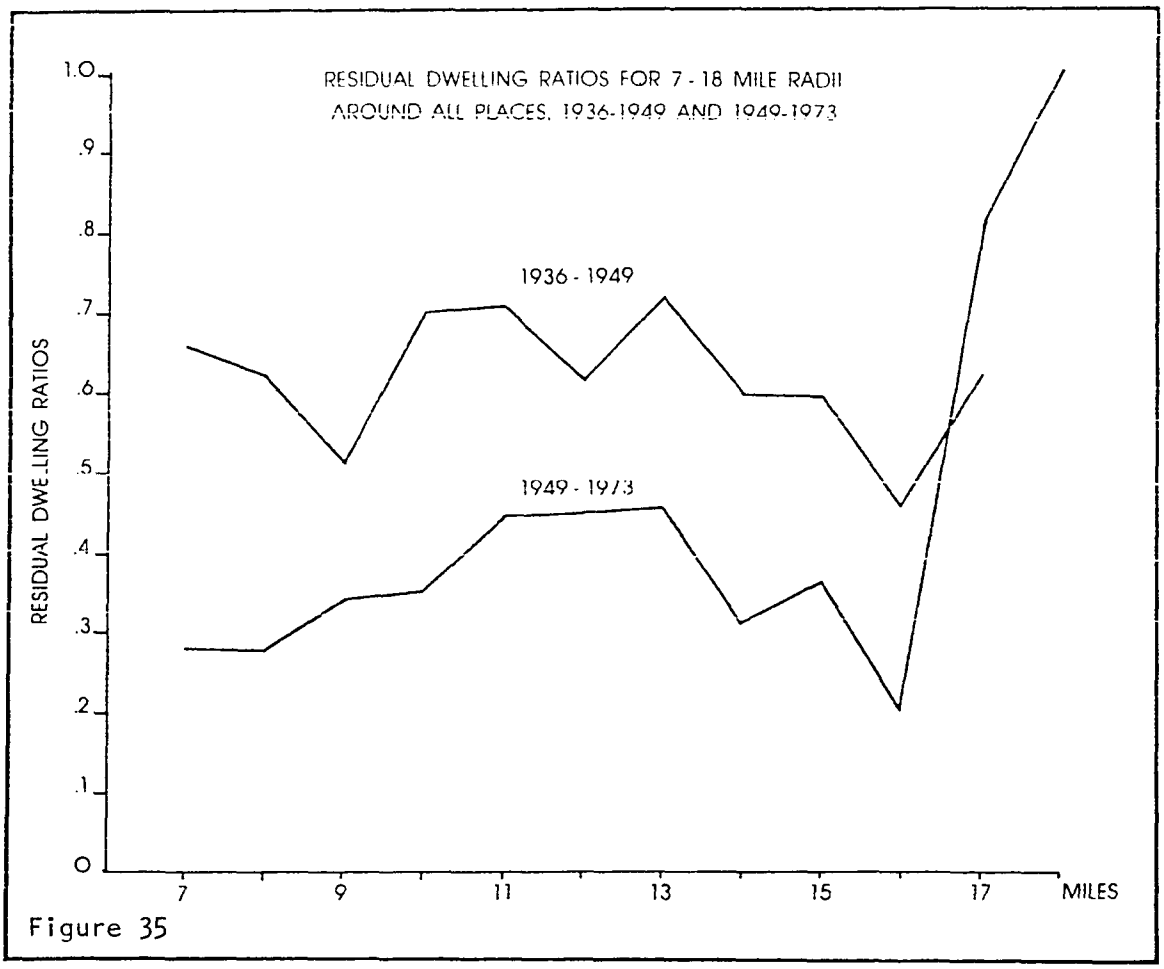

Figure 35

the early period, that for the latter period increased gradually with distance.

The residual dwelling ratio profiles for the various sized communities differed from the general trends during both sequences. Hobart, the county's largest center, had a declining profile comparable to the general trend during 1936-1949, but during the latter period the profile was erratic (Figs.36 and 37). Moderate sized places had a profile which declined unsteadily from high-moderate to low-moderate levels in the early period, but their profiles closely matched the general profile by the late period. For the areas closest to small places,

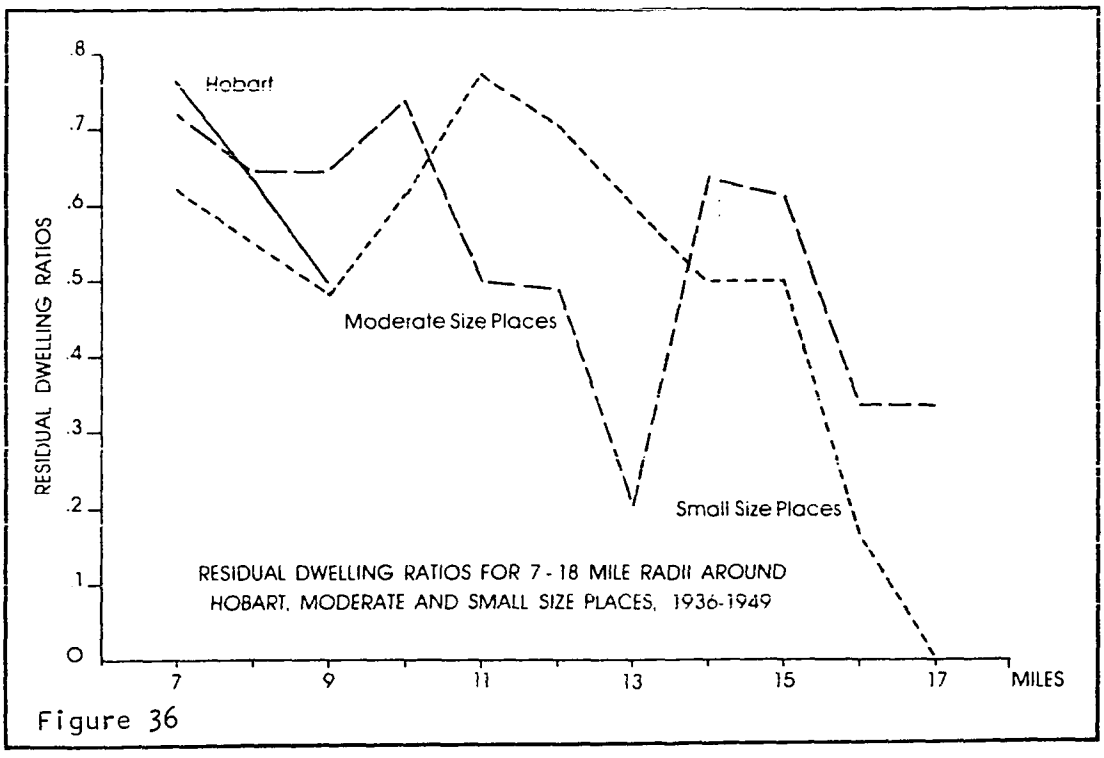

Figure 36

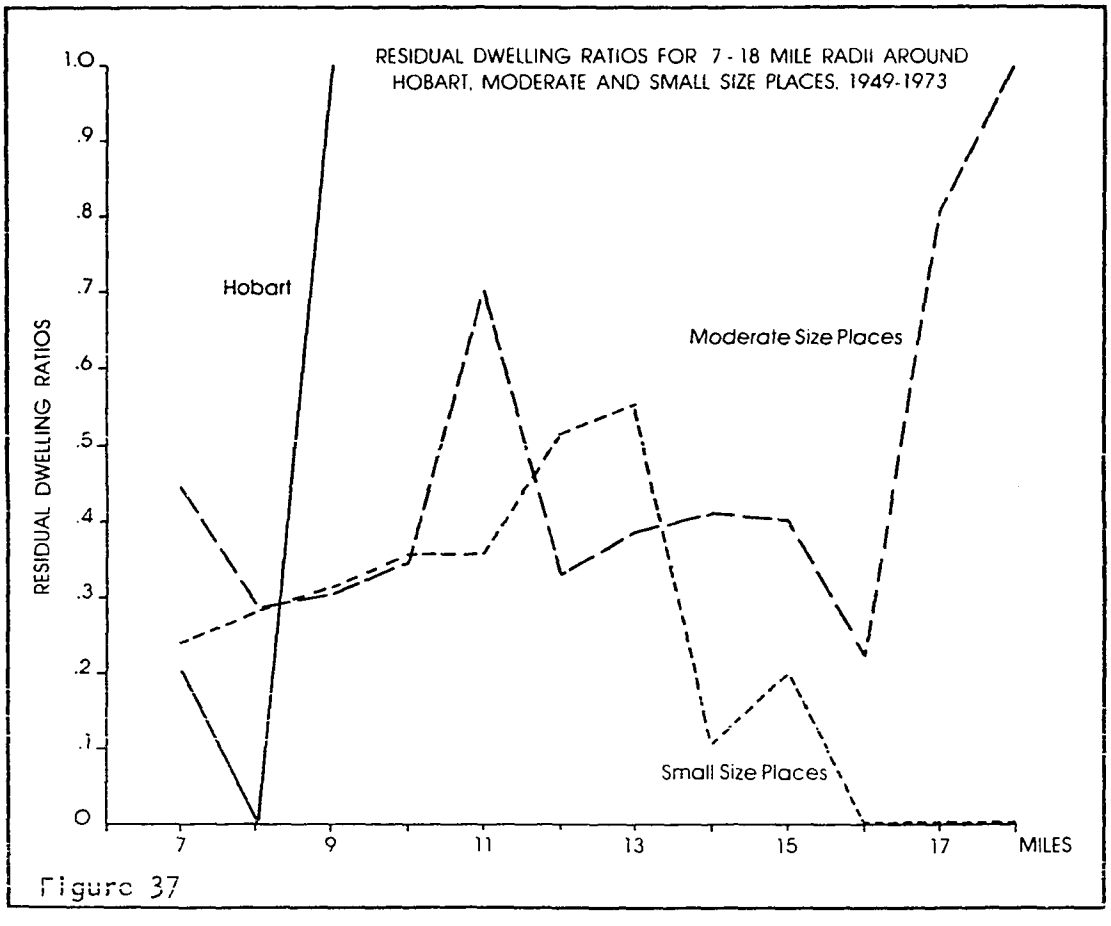

Figure 37

both ratio profiles were similar to the general trends through 17 and 15 miles, respectively, during the early and late sequences, but then each profile dropped quickly to the baseline.

Residual dwelling distributions were, in general, proportional to the rural settlement in this area at the beginning of each period (Figs. 32 and 34). Deviations from a truly proportional dispersion of dwellings occurred, just as within the area 6 miles of commercial centers. None of the excesses or deficiencies that occurred earlier deviated more than 18 percent from the expected values. Many of these deviations were accentuated by the second sequence. One notable deficiency occurred in the latter distribution at 7 to 8 miles, where deficits of from 16 to 20 percent existed. Previously these 2 miles had values slightly above parity. Marked residual dwelling occurrence existed at 10 to 13 miles, as in the previous period, where it ranged from 16 to 47 percent. At 17 miles residual numbers above parity occurred during both sequences, but the disparity in the second sequence was 200 percent, compared to only 11 percent earlier. However, this latter excess represented a minimum number of dwellings.

Nearly all of these dwellings were at farmsteads. Most dwellings tended to be in the vicinity of major roads. This tendency became more pronounced in the 1949-1973 residual dwelling matrix and focused specifically upon paved roads. Only 234 dwellings remained in this portion of the county by 1973, compared to the 816 residences at the end of the first period.

Interpretation of Residual Dwelling Occurrences

The residual dwelling matrix changed from being close to random

during 1936-1949 to a slightly clustered pattern for 1949-1973. These results supported the research hypothesis. The major causes for this pattern becoming slightly clustered were that many of the dwellings in the vicinity of nucleated settlements and along or near major roads throughout the study area were continuously occupied.

Absolute and proportional declines in the residual dwelling component of rural settlement during the two sequences provided potential for occupying dwellings with the most accessibility to nucleated settlements. Residual dwelling rates of 61 and 32 percent occurred in Kiowa County for these consecutive periods. From these sequential residual rates, losses were discerned that amounted to 39 percent for 1936-1949 and 68 percent for 1949-1973. These reductions, in turn, caused these residuals in the rural settlement to decrease 11 percent, from 85 percent in 1949 to 74 percent by 1973.

Residual dwellings within the 6 mile areas encircling nucleated settlements gained only 1 percent of the county's total from the first to the second period, changing from 59 to 60 percent. At the same time, within the 6 mile areas there was change. A 6 percent gain occurred in the dwellings that remained for 1949-1973 as compared to the earlier period in the first 3 miles from these commercial centers. Consequently, a similar percentage of dwellings was lost from 4 to 6 miles. Most of this gain was in the non-farm dwelling category which included sidewalk farmers and families tied economically to the trade-service centers.

Forty one and 40 percent of the county's residual dwellings were outside of the 6 mile radii of nucleated settlements during both sequences. The distributions that evolved through each sequence were,

in general, proportional to the rural settlement at the beginning of each sequence.

One distribution characteristic that occurred during both sequences may be revealing about the evolution of the residual dwelling matrix. Based upon the average residual dwelling rate for the county, from 9 miles to the periphery residuals exceeded or equalled parity on a mileage basis; whereas, between 7 and 9 miles there was a deficiency during 1936-1949 and another deficiency for 7 to 8 miles during 1949-1973. The latter deficiency was contiguous to a similar condition from 4 to 6 miles. By the end of the second period the locations of the residual dwelling deficiencies suggested that rural inhabitants were more reluctant to vacate a dwelling site from 9 miles towards the county's periphery, as compared to dwelling locations between 3 and 8 miles. However, dwelling occupancy in the most distant parts of the county was more probable when the closest trade-service center was at least moderate in size, i.e. a large village. An inference can be made from these findings that the locations between 3 to 8 miles were those where most of the farms that are not occupied by their operators are found, a characteristic that has gradually increased in Kiowa County.

Analysis of the Rural Settlement Matrices

It was hypothesized that the pattern of rural settlement would become clustered with time in the study area if rural dwelling sites progressively reflected accessibility to nucleated settlements and the routes leading to them. The analyses that follow test the validity of the research hypothesis, however, because of their usefulness in explain-

ing changes in the rural settlement, data from the preceding section dealing with the settlement processes and residual dwellings were utilized. The focus of the discussion is upon the dwellings comprising the rural settlement in the study area, consequently new settling and residual dwellings are emphasized considerably more than abandonment.

Rural settlement matrices for 1936, 1949, and 1973 were analyzed with both nearest neighbor analysis and quadrat analysis. Six different quadrat sizes, ranging from 0.31 square miles to 4 square miles, were chosen for observing point patterns in the study area. The first three quadrat sizes represented minimum cell sizes for each rural settlement matrix, whereas the three larger sizes were included to check further for randomness.[5] Quadrat analysis was applied to the three minimum quadrats for the 3 years and then to the sets of six quadrats for each of these times.

To supplement the interpretation of the rural settlement other descriptive measurements were made for the study area. Dwellings were counted in consecutive radii from all nucleated settlements to the county's borders. The areas of these radii were also measured. Dwelling counts and the area measurements of radii were converted into percentages. These data were used for describing dwelling distribution with respect to the nucleated settlements and the area contained in the measured radii. Changes in the rural settlement composition were described with new settling and residual dwelling data from the preceding

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[5]This approach is covered succinctly in Chapter II with the discussion pertaining to quadrat analysis.

section. Rural settlement was discussed within and beyond 6 mile radii of nucleated settlements, as was done for the process matrices and the residual dwelling distributions. The rationale for the division was based upon the prevalence of non-farm housing within the 6 mile radius.

Rural Settlement

The rural settlement in Kiowa County became oriented to the nucleated settlements in the period that was examined. Concurrently, its morphology changed from slightly clustered - nearly random to a distinctly clustered tendency.

The number of dwellings contained in the rural settlement in Kiowa County declined 69 percent between 1936 and 1973. Rural settlement consisted of 3,261 dwellings in 1936. There were 2,357 residences constituting the 1949 rural settlement, 72 percent of the number which formulated the earlier matrix. By 1973 1,018 homes were contained in the rural settlement, and their number was only 31 percent of that for 1936. However, the emphasis in the following discussion is upon the dwellings morphology during these years and the composition resulting from residual dwellings and new settling.

Pattern Analysis of the Rural Settlement

Nearest neighbor measurement indicated that the rural settlement became more clustered during the time period studied (Table 20). This pattern, however, did not develop progressively. In 1936 the nearest neighbor statistic was 0.8671, indicating slight clustering. The following rural settlement matrix, that for 1949, had a higher nearest neighbor statistic, 0.9499. This suggested a tendency toward randomness,

TABLE 20

NEAREST NEIGHBOR STATISTICS FOR RURAL SETTLEMENT MATRICES IN KIOWA COUNTY FOR THE YEARS: 1936, 1949, AND 1973

Year	Total Dwellings	R Statistic	Standard Variate of the Normal Curve
1936	3,261	0.8671	- 4.7021[a]
1949	2,357	0.9499	- 1.9761[b]
1973	1,018	0.7834	-13.0069[a]

SOURCE: Matrices were formed from the General Highway Map of Kiowa County, Oklahoma for 1936 and 1949 and from the field map of 1973.

[a]Level of statistical significance < .01.

[b]Level of statistical significance between .05 and .01.

although the R statistic differed significantly from unity or 1.0. Some clustering was evident in the pattern for the 1973 rural settlement, with a nearest neighbor measure of 0.7834.

The results obtained through quadrat analysis showed that the rural settlement matrices became more clustered from 1936 through 1973. Quadrat analysis was first applied to minimal quadrats and then to a set of quadrats for each period. The results from these analyses can be summarized as follows. First, the distributions for the minimum quadrats from the three rural settlement matrices became more clustered between 1936 and 1973. Variance-mean ratios for these minimal cell distributions increased from 1.266 for the 0.31 square mile quadrat in 1936, to 1.412 for the 0.43 square mile quadrat in 1949, then to 2.745 for the 1 square mile quadrat in 1973 (Table 21). Although the ratio increases revealed a distinct development of clustering in the

TABLE 21

QUADRAT ANALYSIS STATISTICS FOR RURAL SETTLEMENT MATRICES IN KIOWA COUNTY FOR THE YEARS: 1936, 1949, and 1973

Year Quadrat Sizes (in square miles)	Variance-Mean Ratios	Chi-Squared Test Results	Degrees of Freedom	Significant Statistically
1936				
0.31*	1.266	101.900	5	.001
0.43	1.190	62.712	6	.001
1.00	0.949	88.126	9	.001
2.00	1.449	24.893	13	.001
3.00	1.527	502.395	15	.001
4.00	1.495	1448.090	18	.001
1949				
0.31	1.248	11.776	4	.02-.01
0.43*	1.412	49.597	5	.001
1.00	1.368	57.484	7	.001
2.00	1.903	59.919	11	.001
3.00	1.855	86.896	13	.001
4.00	1.788	72.685	15	.001
1973				
0.31	2.052	167.394	2	.001
0.43	2.468	420.449	3	.001
1.00*	2.745	80.933	4	.001
2.00	4.306	198.341	6	.001
3.00	3.922	242.280	7	.001
4.00	3.867	88.303	8	.001

SOURCE: Data derived from the General Highway Map - Kiowa County, Oklahoma for 1936 and 1949 and from the field map of 1973.

*Minimal quadrat sizes for each respective year.

three rural settlement matrices that were studied, it was imperative that some distributions for other quadrat sizes during each period be measured before accepting these results as representative.

The second and more encompassing result included sets of variance-mean ratios for the three periods. These sets of variance-mean ratios

also showed that the patterns for the rural settlement became more clustered during the 37 year period (Table 21). Results obtained from the quadrat analysis of the set of variance-mean ratios for 1936 were inconsistent. The first three ratios were close to random, while the latter three were only slightly higher. Therefore, it was interpreted that this set of ratios illustrated patterns, in general, close to random. The 1949 set of variance-mean ratios deviated more from unity than its predecessor. This was considered to be indicative of slightly clustered patterns. A distinct clustering tendency was represented by the set of variance-mean ratios for 1973.

The results obtained from nearest neighbor analysis and quadrat analysis showed that these matrices had a distinct clustering tendency by the end of the 37 year period that was examined. Measurements from the analyses for the 1936 and 1949 rural settlement matrices differed only slightly. Although this had not occurred in the measurements for the various process and residual dwelling matrices, it appeared that by combining the residual dwelling and new settling matrices slight differences in their measurements could have occurred easily.[6] Since

[6]Two points are pertinent with reference to the slight differences in these measurements. First, the description of pattern assigned the 1936 rural settlement for quadrat analysis was derived through compromise because of some inconsistency in the results of the set of variance-mean ratios. It is possible that too much of a bias towards randomness was reported for its overall pattern by the writer. Second, by 1949 the rural settlement had begun to become concentrated in the vicinity of nucleated settlements, while the remainder of its dwellings were still widely dispersed. For the nearest neighbor measure this would consist of many near neighbors at very short distances and many at longer distances. The result could easily be one of each group cancelling out the other in the calculations, producing an R statistic very near unity.

the descriptive nomenclature from 1936 and 1949 measurements from both analyses were obtained, they were combined for describing the overall characteristic of the pattern for each year. The morphology for rural settlement in both 1936 and 1949 was slightly clustered to nearly random, whereas that for 1973 had a distinct clustering tendency.

Other Measurements of Rural Settlement

The rural settlement was examined in more detail in the following sections. Dwelling characteristics within a 6 mile radius of villages and towns in the study area were treated first. Beyond the 6 mile radius consecutive radii from the nucleated settlements were continued to the borders, but they were omitted in two settings where the rural settlement is closer to villages outside of the study area.[7] Dwellings within these outlying radial zones were examined and their characteristics considered as representative for this part of the study area.

Rural Settlement Around Nucleated Settlements. Rural settlement within 6 miles of nucleated settlements in Kiowa County changed noticeably during the course of this study. In 1936, 1949, and 1973 about 60 percent of the rural settlement was within these radii, which occupied 54 percent of the county's area. Although some orientation to nucleated settlements in the county's rural settlement was suggested by these percentages, the actual orientation of rural dwellings to these centers

[7]These are the same settings that were excluded for the process and residual dwelling matrices. They are along Kiowa County's northcentral and northeastern borders. By the end of the 1936-1949 period 152 dwellings or 7.61 percent of the rural settlement was in these two settings and at the end of the 1949-1973 period 57 dwellings or 5.60 percent of the rural settlement was here.

exhibited a considerable increase through the 37 years of the study period.

The orientation of rural settlement within 6 miles of nucleated settlements changed from one that increased proportionally with increasing area to one that displayed distinct assymetrical positioning towards the commercial centers (Fig. 38). Percentages for rural housing from 1 to 6 miles roughly paralleled the percentages representing the area contained in consecutive mileage zones away from these zones in 1936. Even at this time, however, some housing concentrations were around the trade-service centers. The 1949 percentages for housing showed some assymetry in housing placement since the percentages increased around the nucleated settlements as compared to 1936, and percentages decreased at 5 to 6 miles from these centers. By 1973 the

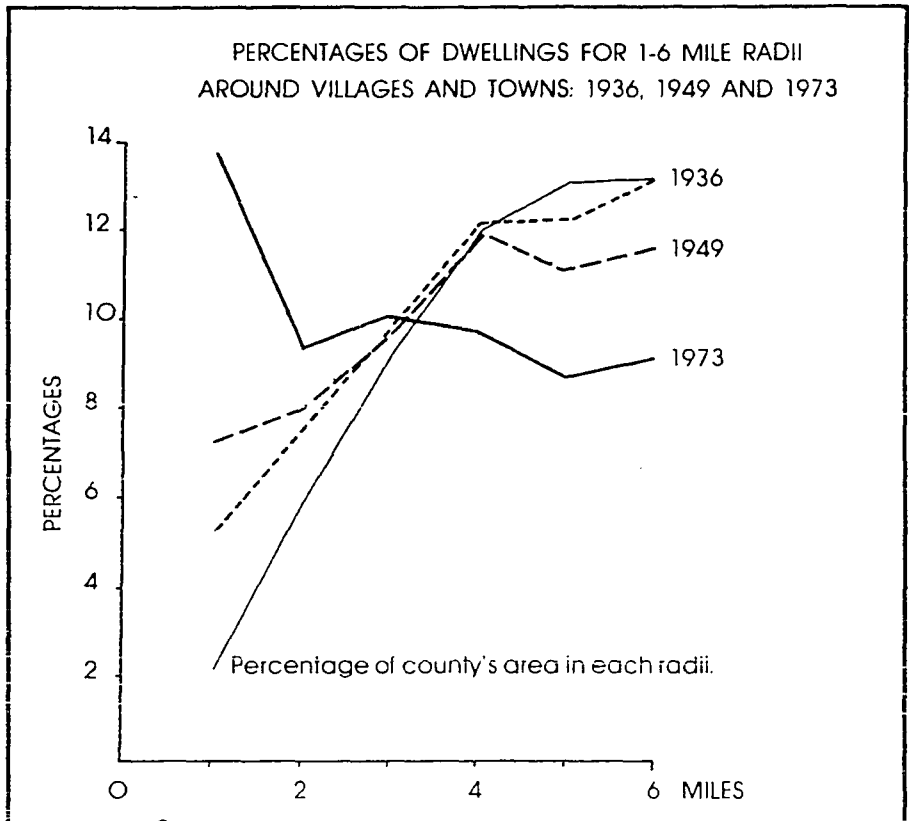

Figure 38

percentage changes in housing were considerably more accentuated compared to those in 1949, particularly within 1 mile of the communities where the percentage nearly doubled. Just as important to this assymetry, on the other hand, was the decline of at least 2 percent in housing in each mileage zone from 4 to 6 miles.

The changes that occurred within the 6 mile radii from nucleated settlements were effected by both new and residual dwellings. The distribution of dwellings increased from 5.3 percent of the county's total at 1 mile to just over 13 percent in the sixth mile in 1936 (Fig. 39). In 1949, rural dwellings increased from over 7 percent of the county's total in the first mile to nearly 12 percent in the sixth mile. New dwellings comprised nearly one-quarter of the residences in the first mile, but their percentages declined thereafter and just exceeded one-tenth of the residences in the sixth mile. Dwellings in the residual category constituted nearly 75 percent of those in the first mile and increased to 90 percent of those in the sixth mile (Fig. 40).

The distribution of rural dwellings for 1973, reflecting a definite orientation to the nucleated settlements, had nearly 14 percent of those for the study area in the first mile from the center, over 9 percent in the second mile, and approximately constant percentages for each mile out to 6 mile distances (Fig. 41). Although dwellings from the new settling and residual categories together produced this distribution, the influence of new settling in effecting much of the change in orientation was unmistakable. New dwellings included nearly half those within 1 mile of the commercial centers, a quarter of the homes in the next 2 miles, and from a fifth to a seventh of the residences in the latter 3 miles. Residual dwellings were just over half those in the first mile

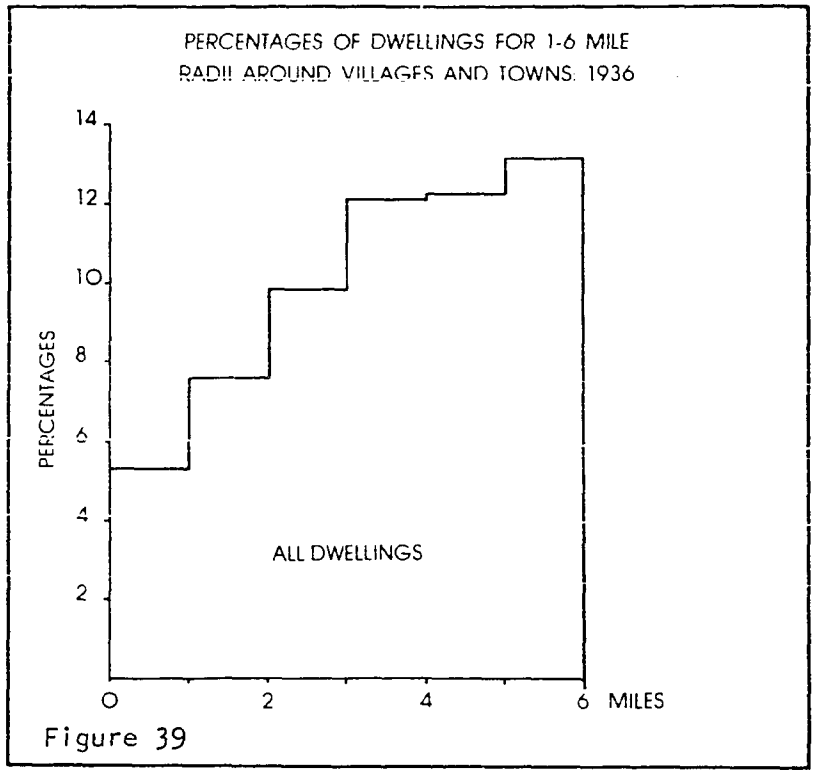

Figure 39

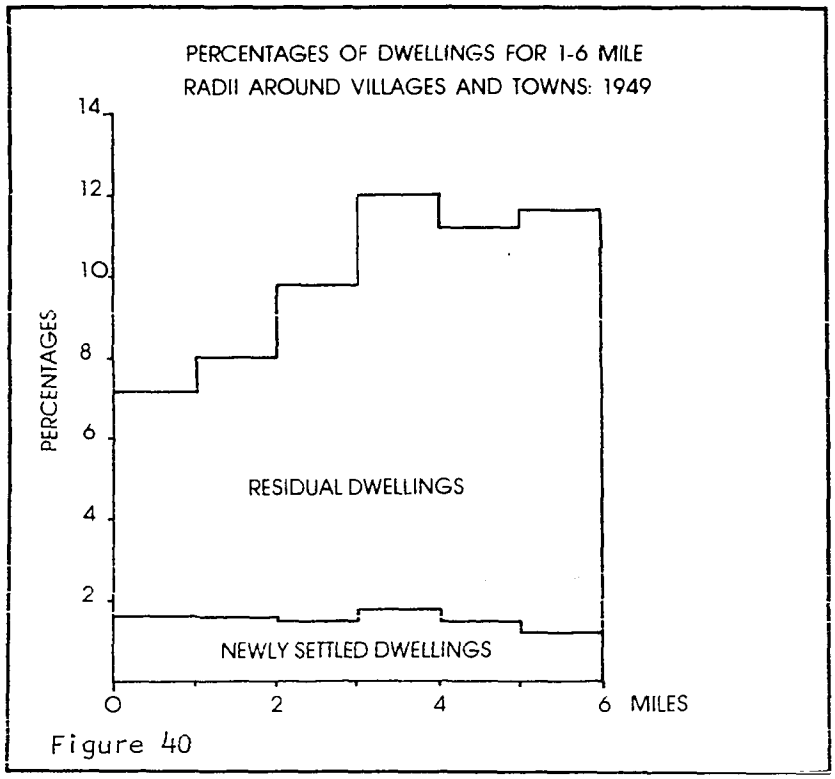

Figure 40

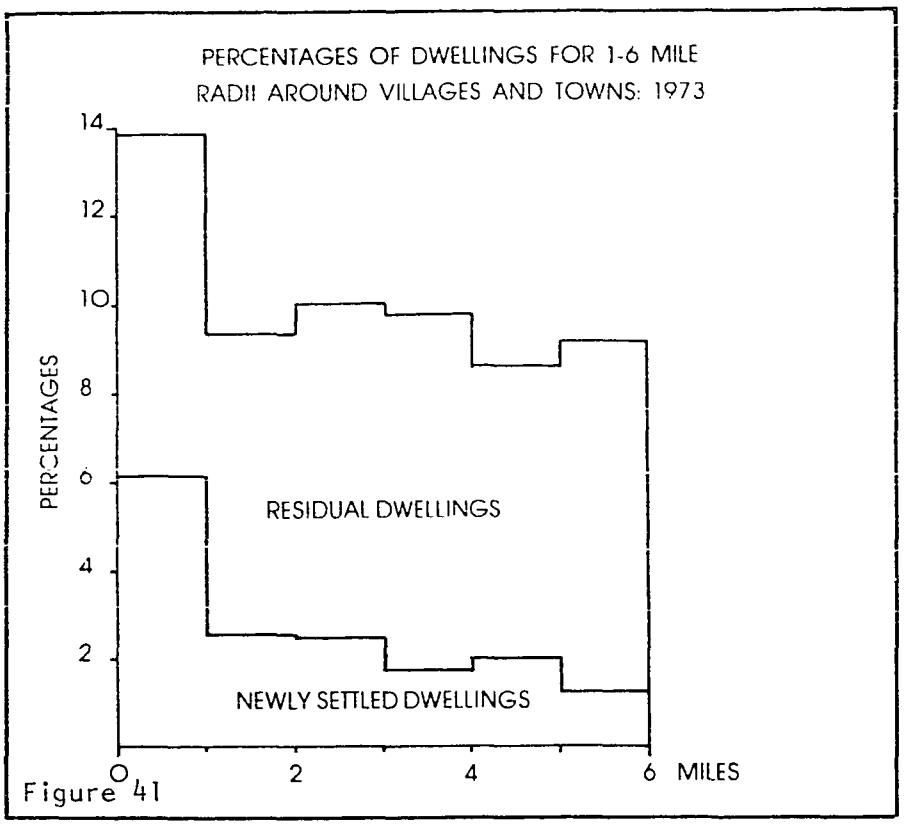

Figure 41

and increased to six-sevenths of the composition at 6 miles.

Dwelling types contributed significantly to the changes in orientation of rural housing after 1936. Non-farm dwellings comprised only 9 percent of the housing within 6 miles of all nucleated settlements in 1949, however 57 percent of its placement was within 1 mile of these centers, and nearly 12 percent were found in the second mile, while small percentages existed in the remaining 4 miles. Most of the inhabitants nearest to the centers were farm laborers, although sidewalk farmers and people with economic ties to the communities occupied some of these dwellings. Farm residences, of course, constituted the remainder of the dwellings. In 1973, non-farm dwellings were 25 percent of all the residences in the setting. Seventy percent of their total, however, were in the first mile of central places, with 14 percent in

the next mile, and 15 percent in the last 4 miles. In the first 2 miles the inhabitants were mainly sidewalk farmers, but families with employment in the communities were also found here, and they were likely to be located in the next 4 miles as well. All of the remaining residences were in the farm category.

Rural Settlement Beyond the Six Mile Radii. The rural settlement beyond the 6 mile radii of nucleated settlements composed 40 percent of that in Kiowa County in 1936, 1949, and 1973. These distributions occupied 46 percent of the study area, indicating that rural settlement percentages were lower here throughout the course of this study. The portion of the outlying distribution that experienced the most change was between 7 and 9 miles, which represented merely a continuation of an occurrence that began at 4 or 5 miles during these periods. This change consisted of housing losses, especially after 1949, which accentuated the orientation of rural settlement towards the nucleated settlements.

Rural settlement for both 1936 and 1949 from 7 miles of nucleated settlements to the county's boundaries reflected distributions closely related to existing area. Both housing distributions were similar and their percentages, in general, were less than those for the area represented in each consecutive mile (Fig. 42). Nearly ten percent of Kiowa County's rural housing was in the seventh mile. Dwellings declined to under one percent by 18 miles from nucleated settlements at both times. Because of the consistency of housing distribution compared to area, it appeared that dwellings were sited on large agricultural tracts.

Compared to the former rural settlement, the 1973 pattern deviated in two ways. First, between 7 and 9 miles of nucleated settlements housing percentages declined from a fifth to a tenth of their respective

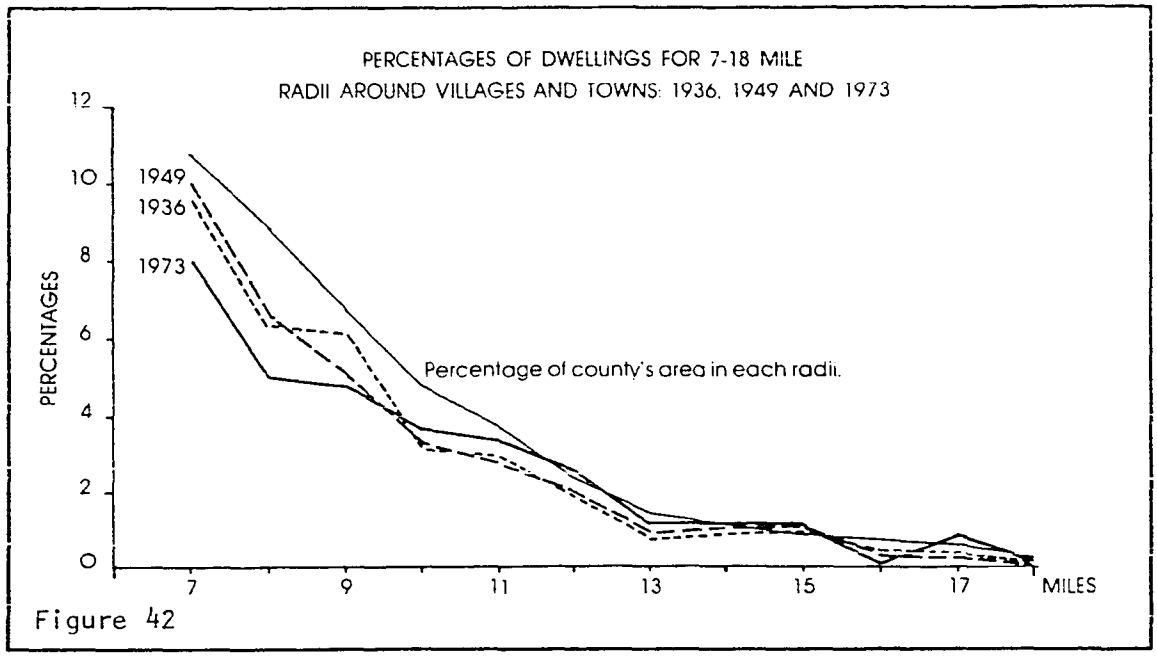

Figure 42

1936 and 1949 levels (Fig. 42). This decline appeared to be a continuation of one existing between 4 to 6 miles of these centers. In addition, this decline became more accentuated at the same time that housing proportions increased around nucleated settlements. Second, between 10 miles and the county's borders there were, in general, slight gains in housing percentages per mile over those found earlier. However, the 3 period distributions were quite similar.

Rural settlement for this part of the study area was comprised of both newly settled and residual dwellings in both 1949 and 1973, but the impact from new settling was more significant in 1973. Rural dwellings were nearly 10 percent of the county's total at 7 miles, and then these percentages declined finally reaching 1 percent at 17 miles in 1936 (Fig. 43). The percentages for the rural settlement in 1949 were similar to those for 1936 due to additions from new housing (Fig. 44). New dwellings were one seventh of those at 7 miles, and their propor-

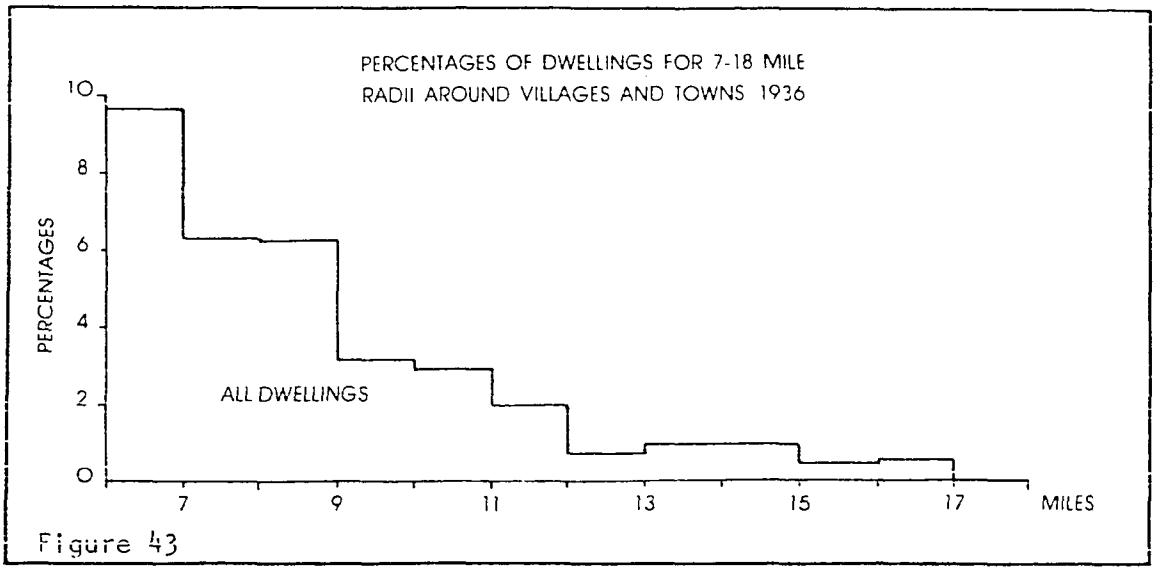

Figure 43

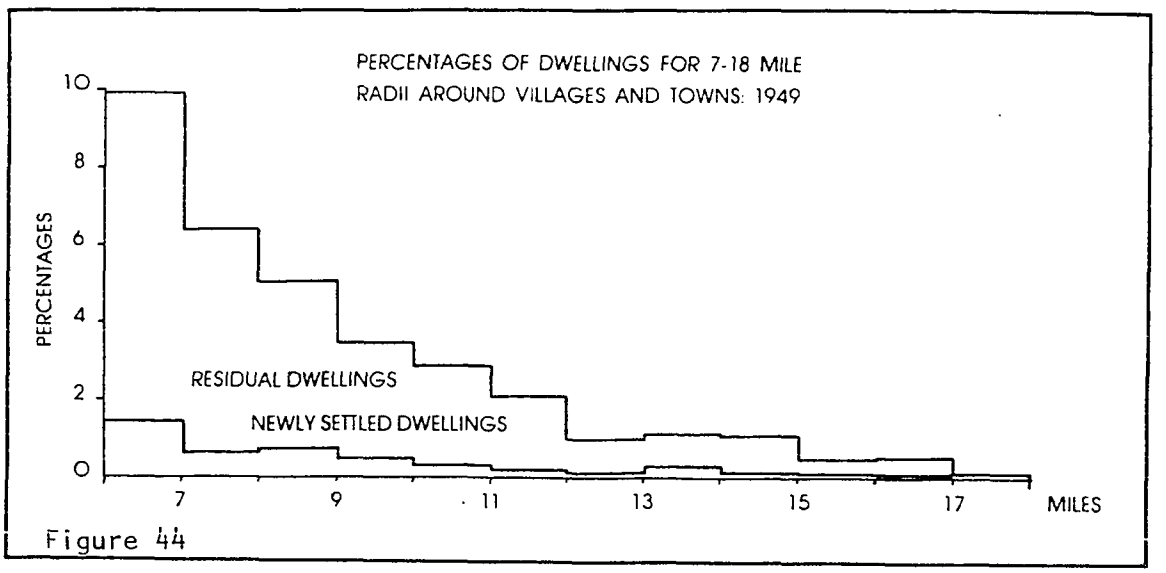

Figure 44

tions gradually declined to the periphery, where they were one-third of the very low percentages of homes at 18 miles. Dwellings in the residual category were 86 percent of those in the seventh mile, and then declined towards the periphery where they comprised two-thirds of the residences found at 18 miles.

By 1973, rural dwelling percentages decreased from 8 percent in the 7 mile zone to under 1 percent at 18 miles, but new housing was more important to this composition than before (Fig. 45). Nearly one-third of the residences were new at 7 miles. At 11 miles this number declined to 10 percent of the total. At 16 miles this proportion had increased back to a third of the total. Residual dwelling percentages complemented those for new settling in each mile, but these percentages were all smaller than previously.

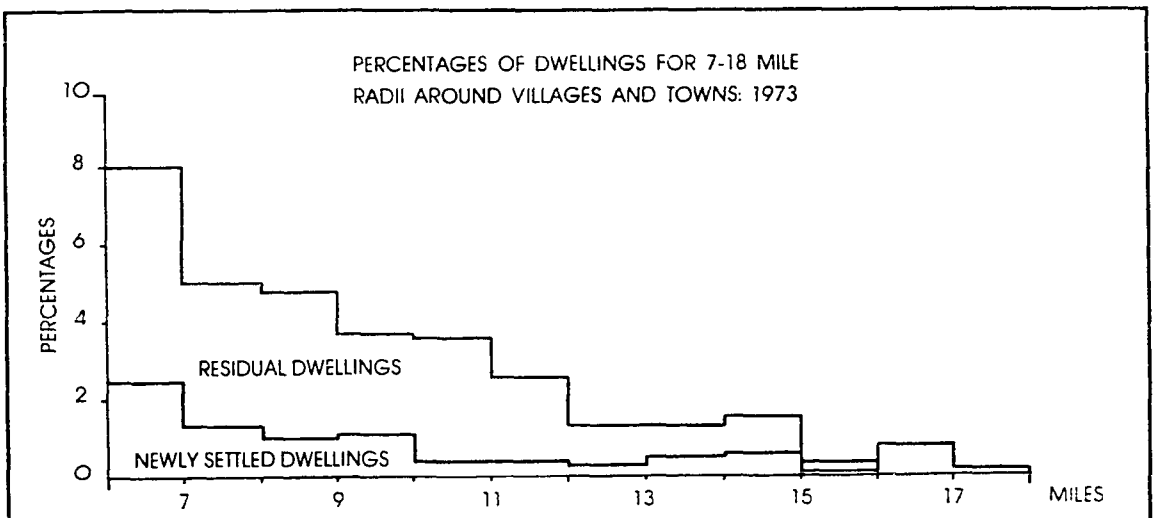

Figure 45

Dwelling types proved to be important in effecting changes in the rural settlement around nucleated settlements, especially when non-farm categories were considered. In the outlying part of the county, however, non-farm housing was always very small in number and applied mainly to business and service establishments, such as schools and churches. In 1973 the only non-farm dwellings in this setting were those occupied by Indian families in two small enclaves in the northeastern part of the study area. Consequently, nearly all of the dwel-

lings comprising the rural settlement at the three times that were examined were farm residences. One characteristic of these dwellings that has become increasingly universal has been their orientation to the paved road systems, which traverse the countryside.

Interpretation of the Rural Settlement

The rural settlement changed from slightly clustered - nearly random in 1936 and 1949 to a pattern with a distinct clustering tendency by 1973. This supported the research hypothesis. By the end of the period examined in this study the rural settlement showed a distinct orientation to the nucleated settlements in the study area. This orientation evolved as rural dwellings became more concentrated in the vicinity of nucleated settlements and were positioned along the principal routes leading to these centers.

The number of rural dwellings decreased by over two-thirds from 1936 through 1973. Abandonment was the cause of the decrease, but its total effect was offset by 1949 and 1973 with new settling. The number of new dwellings after 1949 was 26 percent smaller, however, than prior to that date. The number of dwellings in the residual category consequently declined during this period, and their composition in the rural settlement decreased from 85 percent in 1949 to 74 percent by 1973. The 3,261 dwellings in 1936 diminished to 2,357 dwellings in 1949 and finally to 1,018 dwellings by 1973.

Rural settlement within 6 miles of nucleated settlements in the study area constituted 60 percent of the total during the three different years, but the orientation of this rural settlement here changed notably. Percentages of dwellings in each consecutive mile from these commercial centers to their 6 mile radii increased in both 1936 and

1949, which indicated that the settlement was related to increased area. However, this relationship was less accentuated in 1949 than in 1936, since some housing increases nearest to the central places occurred, and housing decreased at 5 to 6 miles. Most of the housing increase was due to new settling and over half of these dwellings in the 1 mile radii were occupied by non-farm inhabitants.

By 1973 dwelling percentages had increased within 3 miles of the nucleated settlements and decreased between 4 to 6 miles. New settling caused a significant part of the increase nearest the central places, whereas residual dwellings were minimally influential. On the other hand, reductions in housing percentages in the latter 3 miles was related primarily to decreases in residual dwellings. At this time non-farm dwellings composed a quarter of all the residences in this setting, and nearly 90 percent of them were within 2 miles of these commercial centers. Sidewalk farmers were the majority of these non-farm dwellers nearest the communities, while people with economic ties to the central places were scattered through the 6 mile areas. Rural dwellings in 1973, particularly, showed a distinct association with paved roads.

In 1936, 1949, and 1973 the rural settlement beyond the 6 mile radii was 40 percent of the total for Kiowa County. This housing was contained in 46 percent of the county's area, but this was associated with dwellings being sited upon large tracts related to agriculture. There was no evidence of rural settlement repeatedly avoiding extremely large portions of this outlying area.

Representative measurements showed that during 1936 and 1949 the rural settlement outside of the 6 mile radii was distributed on an

areal basis, although abandonment had reduced the numbers of dwellings by the later time. By 1973 the rural settlement was markedly reduced from 7 to 9 miles compared to the prior distribution. Similar occurrences had been observed between 4 and 6 miles. Near the periphery reduced numbers of houses were still distributed on an areal basis. The consequence of the extreme dwelling losses from 7 through 9 miles was the establishment of an inverse relationship between distance and dwelling numbers in this part of the study area. This seemed to match what had evolved in the housing distribution within 6 miles of nucleated settlements. Both new dwellings and those in the stability category comprised this latter matrix, and both were characteristically along or near paved routes.

CHAPTER V

DESCRIPTION OF RURAL DWELLING LOCATION

The description of rural dwelling locations considers how accessibility factors developed the patterns that were measured and described in the preceding chapter. It was anticipated that rural dwellers had sought out or retained rural dwelling locations that tended to optimize accessibility to nucleated settlements. In the discussion related to rural dwelling locations it was shown that accessibility could be optimized through: (1) dwelling distance to a nucleated settlement, and (2) through dwelling orientation to principal roads.

The following analysis relied almost completely upon data obtained from county highway maps, as in the previous chapter. In certain sections, the County Highway Map for Kiowa County for 1961 was used, because it provided additional documentation for certain dwelling locations. Interviews were used to acquire sufficient information relevant to the classification of nucleated settlements in the past and for developing the background on the road network that evolved in this county.

The first part of this chapter deals with rural dwelling locations and their relationships to the rural road system. It considers the development of the road network in the county and relates residual dwellings and those comprising the two settlement processes to various road surfaces and locations. The second part of the chapter considers

rural dwelling locations and distances to nucleated settlements. Changes in the nucleated settlement hierarchy from 1936 through 1973 are developed. Subsequent analysis considers changes in the road distances from rural dwelling to these centers and the attraction of rural dwellings to larger trade-service centers.

Dwelling Locations and the Rural Road System

The locations of rural dwellings in Kiowa County were related to the quality of the road network between 1936 and 1973. Such relationships illustrated the accumulation of rural inhabitants' decisions as to what constituted a suitable dwelling site with respect to roads. The evidences of their preferences were exhibited by residual and new dwellings, or by conspicuous abandonments.

In this section the county road network development since 1936 is recounted. Then, the association between newly settled, abandoned, and residual dwellings and these roads is analyzed. Relationships between the road network and the occupied rural dwellings are analyzed first, followed by an analysis of abandoned residences and the rural road networks.

Development of the Rural Road Network

Recounting the development of the road network in Kiowa County is important for three reasons. First, throughout the period involved in this study the county's roads were sequentially improved by an extensive paving program. Second, these road improvements evolved according to established route priorities at specific intervals from 1936 through 1973. Finally, rural inhabitants were well informed about the priorities

and timing for these road improvements.[1]

Roads in the study area have been constructed and maintained by either the Oklahoma Department of Highways or Kiowa County. Federal and state highways built with Federal aid for an intercounty system traverse several parts of the study area. Intracounty roads built with Federal matching funds, or annual tax revenues, also are an integral part of the county's road system. While the Federal and state highways are planned by the Oklahoma Department of Highways, the designation and planning of the intracounty road system is the responsibility of the county commissioners.

During the period considered in this research three Federal aid primary highways traversed the county. Five other principal routes were designated as state highways and eventually upgraded to Federal aid secondary highways. Another Federal aid secondary road was added to the intercounty highway network much later. Principal intracounty roads were gradually improved and later incorporated into the Federal aid secondary system as farm-to-market routes. Various rural neighborhoods within the study area were linked with the primary and secondary Federal aid systems by improved county roads or, in certain instances, Indian Service System (ISS) roads. The remaining roads, by far the most common, were those along section lines throughout the county. During much of the period these roads received minimal maintenance because of their extensive mileages.

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[1] According to several sources in Kiowa County, including several county commissioners and the county engineer, rural residents have been extremely well informed on these matters throughout the duration of the road paving program since the early 1950's.

The three Federal aid primary highways in Kiowa County are U. S. Highways Nos. 62 and 183 and State Highway No. 9. Federal Highway No. 62 crosses the county's southern portion. U. S. 183 traverses the central portion of the county from north to south and links four villages and towns (Fig.46). Oklahoma Highway No. 9 crosses the study area's northern sector in an east-west direction connecting four nucleated settlements. Between 1926 and 1932 these roads were improved with gravel surfaces. All three routes were paved between 1933 and 1940 although sections of two highways received low grade pavements.

In 1936, secondary roads, all of which became part of the Federal aid secondary road system after 1950, linked smaller service-trade centers with the primary highways providing access to many parts of the county, and formed in certain cases, connections between primary or other secondary roads (Fig. 46). The majority of these routes were gravel surfaced and distinguished by other improvements in the later 1930's. After 1950 available Federal matching funds permitted the paving of most of these roads. Five of the secondary highways were improved as Federal aid secondary projects in the 1950's and early 1960's (Table 22). Ordinarily long stretches of these highways were paved within 1 to 2 year periods and then opened to traffic. State Highway No. 6, in the county's northwest corner, was an exception with only about 4 miles. A newly designated highway, Oklahoma Route No. 49, was paved in 1973, but only 2 miles of this road was in the study area. The remaining designated Federal aid secondary roads comprised the extensive farm-to-market road system, much of which was paved during the same interval.

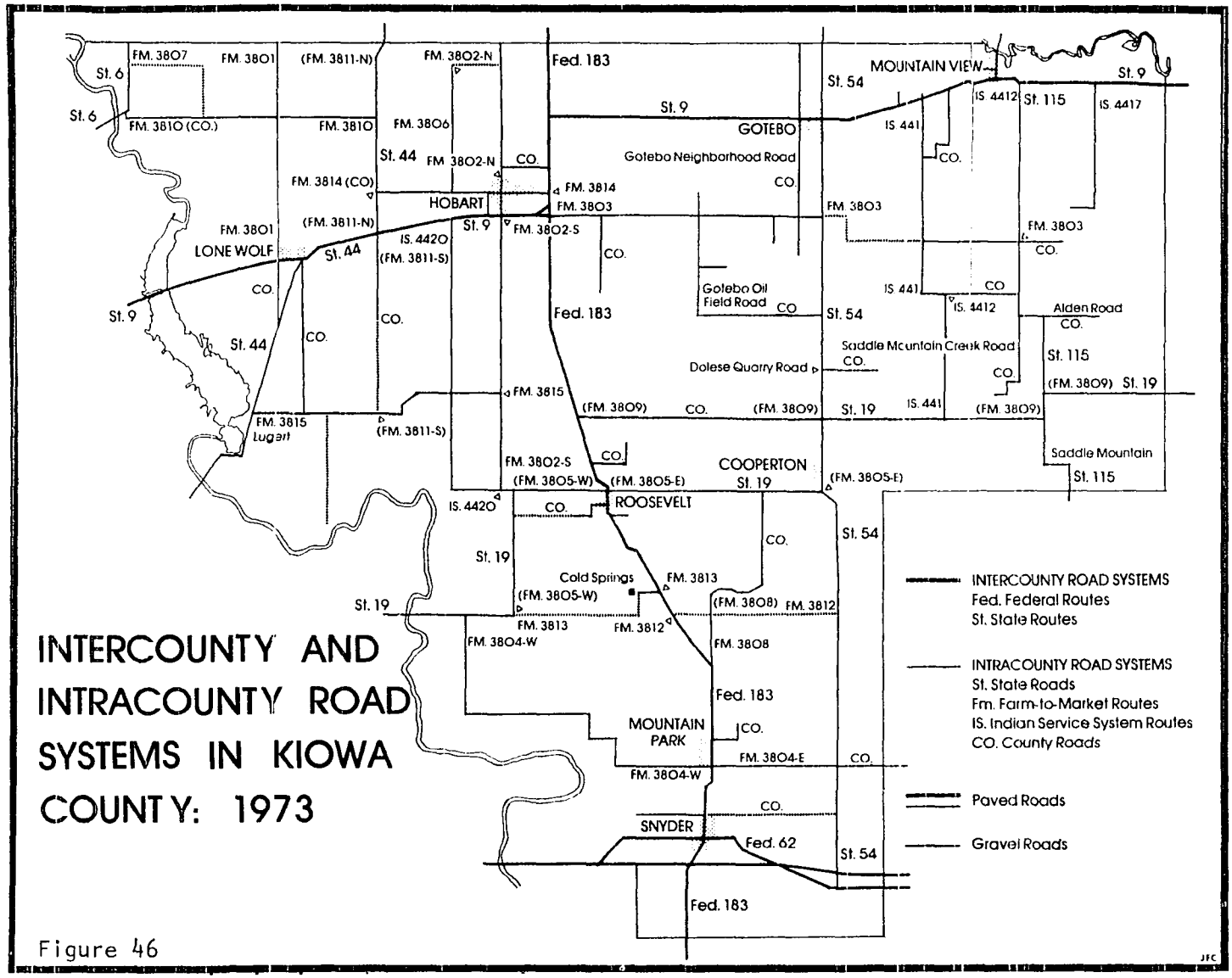
INTERCOUNTY AND INTRACOUNTY ROAD SYSTEMS IN KIOWA COUNTY: 1973
INTERCOUNTY ROAD SYSTEMS
Fed. Federal Routes
St. State Routes
INTRACOUNTY ROAD SYSTEMS
St. State Roads
Fm. Farm-to-Market Routes
IS. Indian Service System Routes
CO. County Roads
Paved Roads
Gravel Roads
FM. 3807
FM. 3801
(FM. 3811-N)
FM. 3802-N
Fed. 183
MOUNTAIN VIEW
St. 54
St. 9
St. 6
FM. 3810 (CO.)
FM. 3810
FM. 3806
GOTEBO
IS. 4412
St. 115
IS. 4417
St. 44
Gotebo Neighborhood Road
IS. 441
FM. 3814 (CO)
HOBART
FM. 3814
FM. 3803
IS. 4420
(FM. 3811-S)
LONE WOLF
Gotebo Oil Field Road
Alden Road
Saddle Mountain Creek Road
Dolese Quarry Road
FM. 3815
Lugert
(FM. 3809)
COOPERTON
Saddle Mountain
(FM. 3805-W)
(FM. 3805-E)
ROOSEVELT
Cold Springs
FM. 3813
FM. 3812
(FM. 3808)
FM. 3804-W
MOUNTAIN PARK
FM. 3804-E
SNYDER
Fed. 62
Fed. 183
CO.

Figure 46

TABLE 22

MILEAGES, CONSTRUCTION TIME, AND COMPLETION TIME FOR OKLAHOMA STATE HIGHWAYS IN KIOWA COUNTY

State Highway Number	Length (in miles)	Construction Time	Year Completed
6	3.27	1957	1957
19[a]	12.60	1960-1961	1961
(3805-E)	8.83	1964-1965	1965
(3809-E)	8.96	1970-1971	1971
44[b]	9.96	1948	1948
(3811)	10.30	1951	1951
54[c]			
(north)	18.00	1953-1954	1954
(south)	17.00	1958-1960	1960
115[b]	13.70	1947	1947
(south)[d]	4.00	1970	1970
49	2.00	1973	1973

SOURCE: State of Oklahoma, Department of Highways, Construction Records by County: Kiowa County.

[a]The original paved portion of Route No. 19 was from Roosevelt west to "Con-8", then across the county line. The second segment, FAS 3805-E, extended east from Roosevelt to its junction with State Highway No. 54 and the last extension of this highway extended from Highway No. 54 east towards Saddle Mountain, where it met State Highway No. 115.

[b]Both of these highways were originally built as state projects. Highway No. 44 extended southwest from Lone Wolf, eventually leaving the county via the bridge over the Red River fork. State Highway No. 115 extended south from Highway No. 9 and ran to the Saddle Mountain community. The original pavement stopped 3 miles north of the community.

[c]The northern and southern portions of this highway commenced along the correction line one mile south of the Cooperton community.

[d]The state highway was paved to the county line at this time increasing its length.

All of the principal intracounty roads in the study area in 1936 were designated as Federal aid secondary routes after 1950 by the county commissioners. As such, these roads constituted the farm-to-market system (Fig. 46).[2] Only one addition and two modifications were made in this system thereafter. Between 1950 and 1973 77 percent or 107.5 miles of the system were paved. Because the funds for such improvements were dispersed equally to the county's three political districts, the farm-to-market road system required a considerably longer period to develop than the state highways (Table 23). Consequently, 1 or 2 miles of pavement were applied each year to a particular road when Federal funding was utilized. Two or three miles were paved if only county monies were expended. The roads paved shortly after 1950 were Federal aid and county funded projects, whereas those improved after 1960 were more apt to be funded solely by the county. This change in the funding procedure occurred when it became apparent that specifications for road work using Federal aid exceeded the actual needs for vehicular transportation in the rural areas.[3]

Farm-to-market roads, which either originated in nucleated settlements or passed through them, were the first to be paved. Thereafter,

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[2]The roads that could be included in this system were: rural free delivery mail routes, public school bus routes, farm-to-market and mine-to-market routes, and all local roads that served as feeder and connecting roads for service to agriculture, forestry, mining, and the general uses of rural occupation and habitation.

[3]According to the County Engineer, Mr. O. P. Wilson, two Federal regulations were detrimental to the county. Many perfectly good bridges would have to be torn out and replaced with new ones and many roads made wider if Federal monies were used on the projects. These were unnecessary improvements for roads that would receive very limited use during the year.

TABLE 23

TOTAL MILEAGES, FUNDING SOURCES, CONSTRUCTION TIMES, AND REMAINING UNPAVED MILEAGES FOR FARM-TO-MARKET ROADS IN THE FEDERAL AID SECONDARY ROAD SYSTEM IN KIOWA COUNTY

Route Numbers	Length (in miles)	Paved Mileages Built With Federal Aid Secondary Funding	Paved Mileages Built With County Appropriations	Years of Completion	Unpaved Mileages Remaining
3801	5.81	5.81	0.00	1953-1957	0.00
3802-N	5.97	3.97	2.00	1965-1968	0.00
3802-S	11.58	11.58	0.00	1954-1962	0.00
3803	20.00	11.00	0.00	1963-1967	9.00
3804-E	4.98	2.98	2.00	1957-1962	0.00
3804-W	15.25	8.25	7.00	1957-1961; 1966-1972	0.00
3806	5.00	5.00	0.00	1956-1961	0.00
3807	5.00	0.00	0.00		5.00
3808	8.70	2.15	6.55	1959-1961; 1966-1967	0.00
3809	9.75	0.00	9.75	1962-1969	0.00
3810	10.15	9.00	1.15	1958-1964	0.00
3111-S	7.20	0.00	3.20	1956-1960	4.00
3812	5.90	0.00	0.00		5.90
3813	6.90	0.00	0.90	1958	6.00
3814	4.50	1.90	2.60	1953-1954	0.00
3815	10.75	8.75	2.00	1965-1971	0.00
Totals	137.44	70.39	37.15		29.90

SOURCE: State of Oklahoma, Department of Highways, Construction Records by County: Kiowa County and interviews with the Kiowa County Commissioners.

roads that provided connections between highways or extended into peripheral areas in the county were improved through paving projects. Federal Aid Secondary (FAS) Route No. 3812 was added after 1950, but it remained a gravel surfaced road. It provided an east west link south of Roosevelt between U. S. No. 183 and State Highway No. 54. Two modifications in the original farm to market network occurred as the paving program progressed. The road from State Highway No. 19 south to Centerville was dropped as the designated FAS 3804 route, while a public road two miles west took on the designation (Fig.47a). Along the former route dwelling densities were an average 1.5 per square mile in the mid 1960's, whereas those along the new route were 3.0 per square mile. Previously, FAS farm to market road No. 3810 was oriented west from State Highway No. 44 then turned north and terminated at State Highway No. 6. This route went to a school house at an earlier time. Once the paving of FAS road No. 3810 commenced it was expedient to continue the roadway due west and join it with the highway near the Red River bridge (Fig.47b). When this modification was made the school house along the former FAS road was no longer used, and dwelling densities nearby were comparatively low. The older route was designated as FAS No. 3807 and remains a gravel route.

County and Indian Service System (ISS) roads serving various locales were upgraded through paving after 1960 (Fig. 46). While these roads were important locally during the 1930's, when this research begins, their improvements lagged behind the principal transportation arteries discussed previously. By the late 1940's several of these local routes were gravel surfaced. In 1953, roads along which Indians

LOCATION MODIFICATIONS IN FEDERAL AID SECONDARY FARM TO MARKET ROADS NOS. 3804 AND 3810

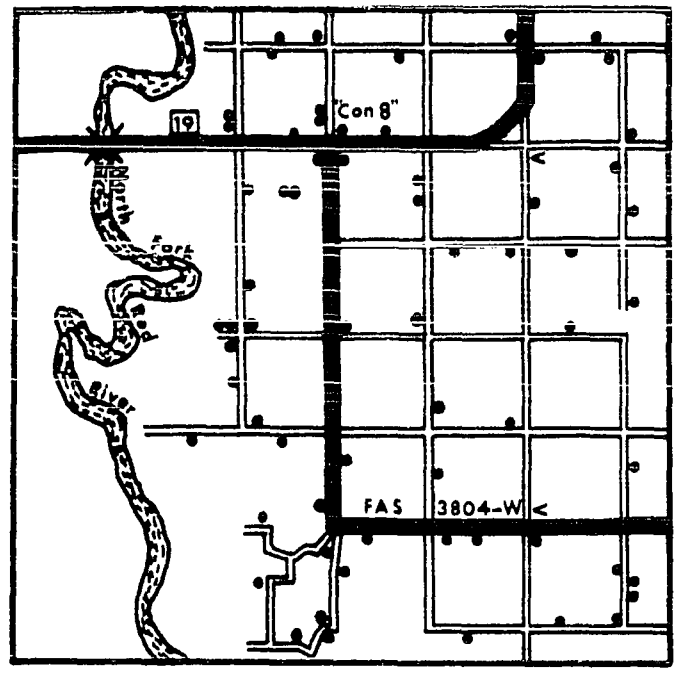

Figure 47a: The farm to market road, No. 3804-W, was moved two miles west of its former location, which is marked by the arrows on the chart above.

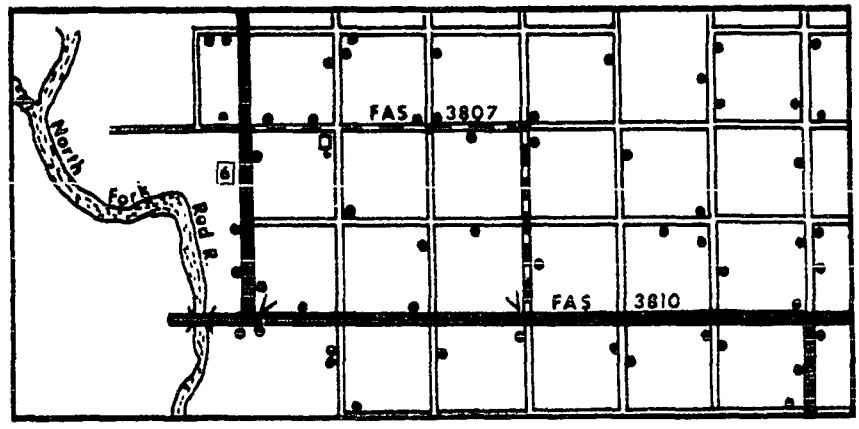

Figure 47b: The farm to market road, No. 3807, in the northwesterly part of the county remained a gravel road, but its route was changed (see arrows) with a three mile section of road that was eventually paved.

either resided or owned land were placed in the Indian Service (Road) System. Paving projects on the ISS roads were suggested by the tribal councils, then approved by the Bureau of Indian Affairs at Anadarko.[4] Once the improvements were made the Bureau ceded the roads to the county with an agreement that the roads would be maintained and kept in their improved condition.

All of the county and Indian Service System roads that were paved differed from the other improved secondary routes in their widths and engineering features. They were narrower and built for lower vehicular speeds. Most county roads were short lengths around nucleated settlements or certain rural communities (Table 24). Nevertheless, three longer, paved roads evolved in District No. 1, the northcentral and eastern part of the county. These were the Gotebo Oil Field road, the Gotebo Neighborhood road, and Alden Road, southeast of Sedan. Two roads paved for business purposes were the Monument Company road at Snyder and the Dolese Quarry road. The ISS roads that were paved were relatively longer stretches and mainly concentrated in District No. 1. However, ISS Road No. 4420 was paved for its complete length of 11 miles in 1972-1973. It is located southwest of Hobart, in District No. 2.

In several distinct rural settings in District No. 1 county roads were paved in short lengths in order to provide rural residences an all-weather road connection to the existing paved highway or farm to market systems. These "connection roads" were built sequentially after

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[4] Such road construction was normally confined to Indian reservations, but because of the relatively large Indian ownership of land in the vicinity certain road paving projects had been approved.

TABLE 24

TOTAL MILEAGES AND CONSTRUCTION TIMES FOR COUNTY AND INDIAN SERVICE SYSTEM ROADS IN KIOWA COUNTY

Names or Specific Designation	Length (in miles)	Years Completed
ISS-4420 Little Elk Creek Road	11.00	1973
Gotebo Oil Field Road	10.00	1965
ISS-441 Rainy Mountain Creek Road	8.85	1961
ISS-4412 Sedan Road	8.60	1966
Gotebo Neighborhood Road	8.00	1971
ISS-4417 Stinking Creek Road	6.50	1962
Alden Road	6.00	1967
Dolese Quarry Road	5.00	1962
Saddle Mountain Creek Road	5.00	1969
Mountain View Church Road	3.35	1971
Cooperton Cemetary Road	3.25	1968
Mountain View Neighborhood Road	3.00	1960
Snyder Monument Company Road	3.00	1962
North Roosevelt Neighborhood Road	2.30	1967
East Cooperton Neighborhood Road	2.00	1970
Lone Wolf Neighborhood Road	2.00	1960
West Roosevelt Neighborhood Road	1.50	1958
West Mountain View Church Road	0.75	1968
Roosevelt Cemetary Road	0.50	1959
Richland Store Cemetary Road	0.40	1970
Special Roads: Collectively[a]	6.50	1960-1973
Total	97.50	

SOURCE: Oklahoma Department of Highways, General Highway Map: Kiowa County, various years; interviews with the Kiowa County commissioners; interviews with other county residents; and, Approved Road Plans of the B.I.A.'s Anadarko Area Office.

[a]Special roads included those that were built in District No. 1 from paved principal roads to clusters of dwellings. Ordinarily these roads were one mile in length.

1963 in areas where dwelling densities varied between one and two per mile. Most of the special road paving was concentrated in the Gotebo Oil Field vicinity (Fig. 48).

Although gravel surfaced roads once constituted nearly all of the secondary, county, and Indian Service System networks, they have become considerably less common. In 1973 only three Federal aid secondary farm to market roads, a section of FAS farm to market road No. 3805, and a 5 mile segment of State Highway No. 19 were still gravel surfaced. Most gravel roads in the latter part of the period studied were 1 to 2 miles long and were connections between rural residences and paved roads. The writer noted during his field work in 1973 that the quality of the gravel roads varied considerably. Obviously, qualities of these roads were closely associated with the frequency of their use, the deleterious effects of the physical elements affecting them, and their maintenance schedules.

Between 1936 and 1973 an extensive paved road network evolved in Kiowa County. Although nearly all of the road paving occurred after 1950, pre-existing secondary and local routes were improved. Rural inhabitants were undoubtedly cognizant of these improved conditions and the relative effects of these improvements on their current or intended dwelling sites. In addition, many section line or feeder roads were gravel surfaced, a condition which afforded more assured all-weather links with paved routes. The analyses which follow clarify the extent to which these road improvements affected the situation for occupied rural housing.

SPECIAL ROADS TO RURAL DWELLINGS IN THE VICINITY OF THE GOTEBO OIL FIELD ROAD

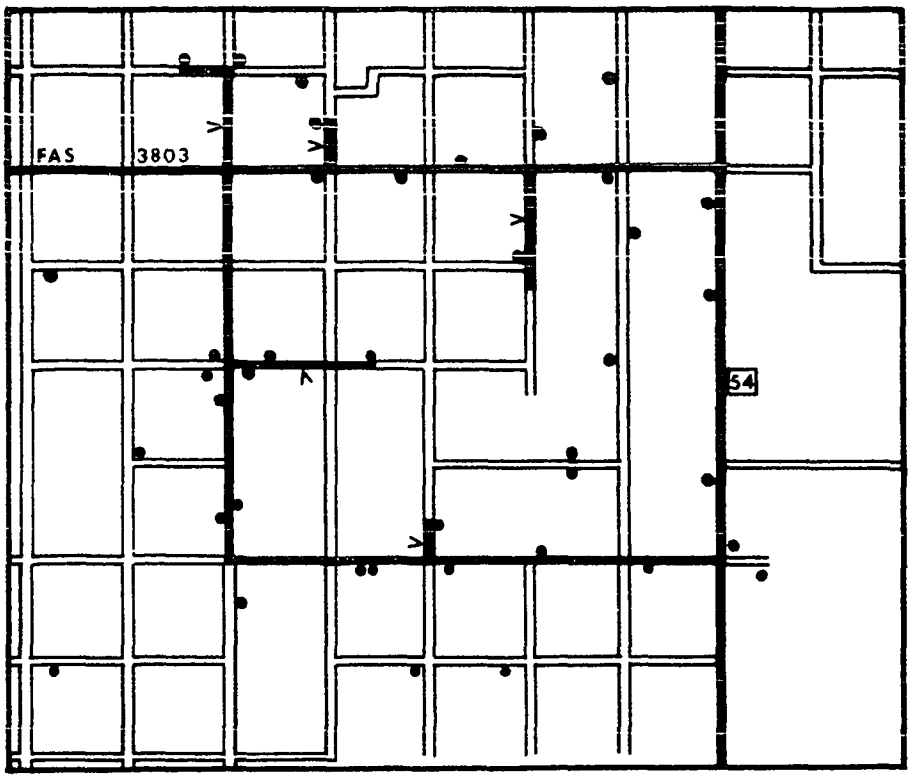

Figure 48: The special roads that were constructed in the vicinity of the Gotebo Oil Field are unique in their occurrence in the county. They were paved in the late 1960s and early 1970s. Supposedly they are to provide passable roads for rural dwellers, who could otherwise be badly inconvienced due to ruts made by trucks moving oil drilling equipment or making daily collections from oil storage tanks. Arrows mark each of these roads.

Relationships of Residual and New Dwellings To the Rural Road Network

The association between paved roads and occupied rural dwellings became stronger after 1936. Although the paved road mileages increased by 20 percent between 1936 and 1973, the proportion of those dwellings in the periodic distributions found beside such roads rose 41 percent (Table 25). This suggests that selectivity was practiced by rural peoples in retaining or siting dwellings along these routes.

Both residual and new dwellings along paved roads showed gains from 1949 to 1973. Of the dwellings comprising the settlement matrix in 1949, only 4.62 percent in the residual, and 2.58 percent of the new residences, were by paved roads (Fig. 49). Twelve years later, in 1961, these proportions were 26.25 percent and 2.34 percent, respectively.

By 1973 residual and new homes along paved routes constituted collectively 45.38 percent of those in the study area. At this time residual dwellings and new dwellings were 37.32 and 8.05 percent, respectively. The percentages of both residual and new residences along unpaved roads diminished during the same intervals.

Two subsections follow that concern the relationships between the paved road network and the housing resulting from the settlement process and the residuals. Each subsection considers whether all categories of paved roads were equally attractive for rural dwelling locations, whether the timing of road improvements effected occupied dwelling retention or new sitings, and whether occupied housing in areas adjacent to the paved routes had similar characteristics to those sited along these routes.

TABLE 25

CHARACTERISTICS OF PAVED ROAD IMPROVEMENTS
AND THE OCCUPIED RURAL DWELLINGS ALONG THESE ROUTES

Categories	Periodic Amounts and Percentages 1936	1949	1961	1973
Paved Road Mileages	97.78	124.23	206.48	439.30
Percentage of All Roads in Study Area	5.62	7.14	11.87	25.25
Rural Dwellings By Paved Roads	121	170	533	462
Percentage of All Dwellings in County	3.71	7.21	26.57	45.37

SOURCE: Author's measurements and calculations.

New Dwelling Placement and the Rural Road System

New dwelling placement was perhaps the most important indicator as to how closely rural dwellers used paved roads to maximize their accessibility to nucleated settlements. Dwelling sites along paved routes were obviously most preferred, but locations close to these routes on feeder roads were not that much of a deterrent to accessibility. Perhaps the most unique feature of these findings is that they represent contemporary preferences regarding the placement of rural housing.

New Dwelling Sites Along Paved Roads. Although new settlement in Kiowa County was concentrated along paved roads after 1936, the patterns differed between those associated with established Federal and state highways and those along secondary roads, which were paved sequentially. Each of these paved road categories were analyzed separately. The permanently paved Federal and state highways always had a significant

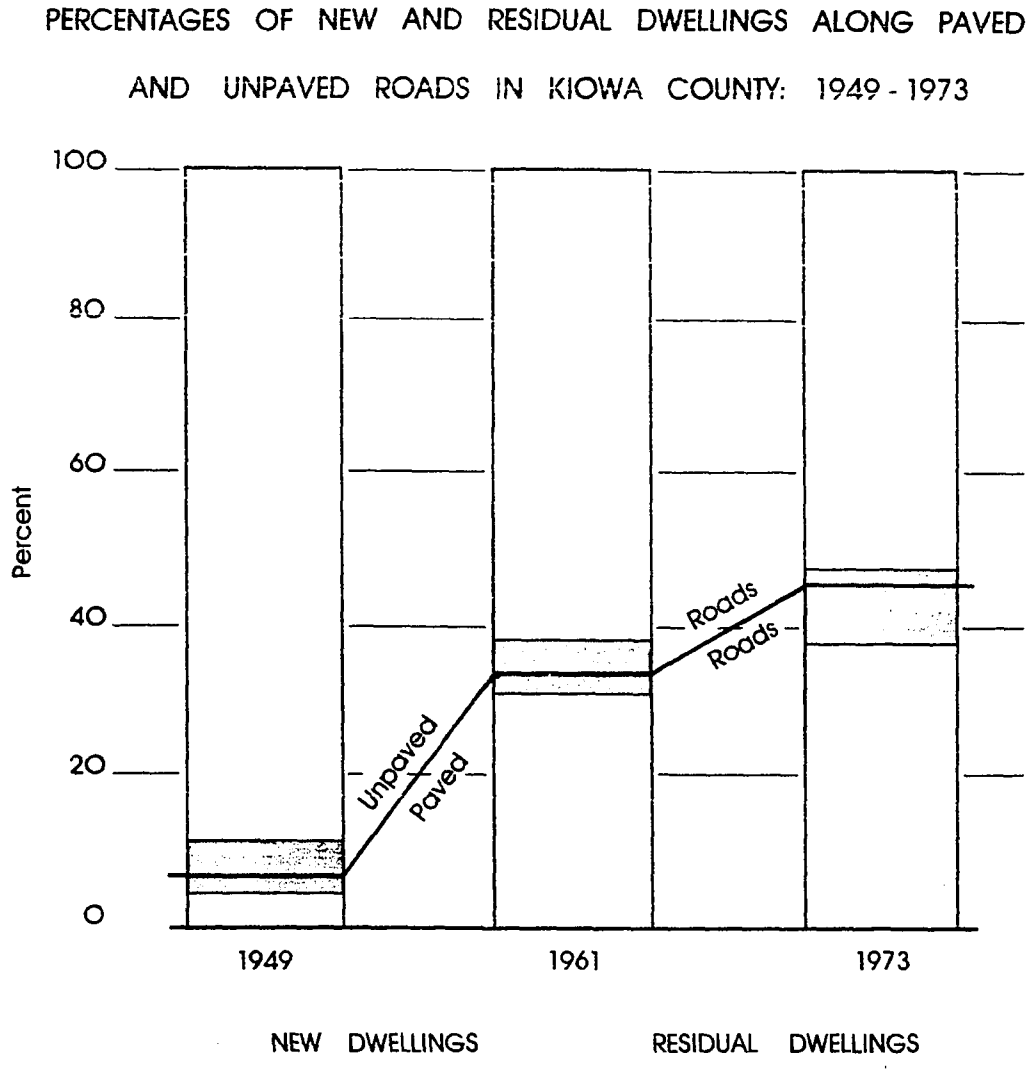
PERCENTAGES OF NEW AND RESIDUAL DWELLINGS ALONG PAVED AND UNPAVED ROADS IN KIOWA COUNTY: 1949 - 1973
100
80
60
40
20
0
Percent
Unpaved Roads
Paved Roads
1949
1961
1973
NEW DWELLINGS
RESIDUAL DWELLINGS

Figure 49

showing of new residences along their routes (Table 26). The percentage of these dwellings along the paved highways declined between 1949 and 1973 from 16 to 10 percent of the total.

TABLE 26

RESULTS OF CHI-SQUARE TESTS FOR NUMBERS OF NEW DWELLINGS FOUND BY PAVED HIGHWAYS IN KIOWA COUNTY: 1936-1973

Categories	Years That Proportions Were Tested 1949	1961	1973
Houses By Paved Highways	58	19	11
Houses By All Other Roads	301	142	95
Calculated X^2	75.13	11.59	4.52
Critical X^2 Value (.05)	3.84	3.84	3.84

SOURCE: Author's measurements and calculations.

Only two periods were used to determine whether new dwellings were attracted to paved secondary roads - 1949-1961 and 1961-1973. Prior to 1949 only two secondary roads were paved, and both were improved during 1947 and 1948, an interval judged to be too short to consider for analysis. Under these circumstances, however, it was possible to determine whether new dwellings were attracted to secondary roads in Kiowa County after paving. Significant numbers of new dwellings of those in the study area were sited along these routes after their paving during both periods (Table 27).[5] From 1949 to 1961 14 percent of the new dwellings

[5]The County Highway Maps for Kiowa County for 1961 and 1965 were extremely useful in identifying new buildings. In addition, updated yearly editions of these maps showed changes in the road surfaces and made it possible to establish paving dates in some cases.

TABLE 27

RESULTS OF CHI-SQUARE TESTS FOR NUMBERS OF NEW DWELLINGS FOUND BY SECONDARY ROADS AFTER THEIR PAVING IN KIOWA COUNTY

Categories	Periods That Proportions Were Tested For 1949-1961	1961-1973
New Dwellings Found Beside Secondary Roads After Paving	22	36
New Dwellings Found By All Other Roads	139	70
Calculated X^2 Values	15.12	26.52
Critical X^2 Values (.05)	3.84	3.84

SOURCE: Author's measurements and calculations

in the study area were beside these routes, whereas 34 percent of the new residences were at such sites by the end of the latter period.

Both highways and paved secondary roads were important in attracting new settlement. The percentages of new dwellings along paved secondary roads increased after 1949, but the number decreased slightly for the older paved highways. The different percentage trends are partially the result of a relative increase in the available frontage for housing sites along paved secondary roads.

New Dwellings In Adjacent Areas To Paved Roads. Since new dwellings were attracted to sites along paved roads, it seemed that adjacent areas would be similarly attractive for new housing sites. Adjacent areas were considered as sections (square miles) adjacent to the paved roads. In both 1949-1961 and 1961-1973 significant numbers of new dwellings for Kiowa County were in areas adjacent to paved roads

(Table 28). Twenty-four and 38 percent, respectively, of the new dwellings in the study area were along side roads for these adjacent sections during the two periods.

TABLE 28

RESULTS OF CHI-SQUARE TESTS FOR NUMBERS OF NEW DWELLINGS FOUND ALONG SIDE ROADS ON SECTIONS ADJACENT TO PAVED ROADS IN KIOWA COUNTY: 1949 - 1973

Categories	Periods For Which Dwellings Counts Were Tested	
	1949-1961	1961-1973
Houses By Side Roads On Adjacent Sections	39	40
Houses Elsewhere	122	66
Calculated X^2 Values	23.49	13.06
Critical X^2 Values (.05)	3.84	3.84

SOURCE: Author's measurements and calculations.

These results suggest that the attraction of new dwellings to sites in adjacent areas to paved roads is similar to the attraction for dwelling locations along these routes.

New Dwellings Along All Side Roads. Finally, the attraction of all new dwellings along side roads to primary and secondary roads was measured. If accessibility to the improved transportation routes became increasingly important in siting new dwellings along side roads, it appeared that this would be expressed in a reduction of the distance along side roads from the major routes to new dwellings over time. Measurements were made from all principal roads in the study area, since they were steadily paved after 1949. Nine percent of the principal

roads remained unpaved in 1973, but all unpaved roads were improved with gravel surfaces.

Average road distances between all new dwelling sites on side roads and the principal routes declined slightly and differed significantly between 1949-1961 and 1961-1973 (Table 29). The difference in average road distance for these two periods was less than one tenth of a mile, which suggests that site preferences along side roads really varied very little in response to distance. From 1949-1961, 70 percent of the new dwellings along all side roads were on the sections adjacent to the primary or secondary road traversing the area. This percentage was 81 percent from 1961-1973.

TABLE 29

MEAN ROAD DISTANCES TO NEW DWELLINGS SITUATED OFF OF PRINCIPAL ROADS FOR THE PERIODS: 1949-1961 AND 1961-1973, WITH A COMPARISON USING THE STUDENT "t" TEST

Periods	Mean Road Distances to New Dwellings Along Side Roads	Calculated "t" Test Value for a Comparison of Means
1949-1961	0.99 Miles	
1961-1973	0.92 Miles	2.77[a]

SOURCE: Author's measurements and calculations.

[a]The means differ at the 0.05 level of statistical significance.

These findings indicated that when new dwellings were sited along side roads after 1949, the distance from the dwelling sites to primary or secondary roads was extremely important. In the study area the average distance between new dwelling sites and these improved roads

was just under 1 mile.

Residual Dwelling Location and the Rural Road System

The percentages of dwellings in the residual class that were situated along paved roads in the study area steadily increased from 1936 through 1973. Of particular concern here is how the relationships between these dwellings and the county's road network evolved. Because the dwellings in this category represented remnants of earlier and widely spread settlement, it seems that two criteria were influential in evolving the "dwelling - road" relationships linked to the research hypothesis. These relationships were: (1) a large number of the remaining dwellings' relative locations represented compromises to optimum accessibility, and (2) a portion of these dwellings remained occupied during various intervals because of anticipated road paving.

Three sets of comparisons were used to discern the importance of the paved road network to the residuals. The first two comparisons concern the siting of these dwellings to different road categories, whereas the last is related to the distances of residual dwellings from the nearest principal road.

Residual Dwellings Along Paved Roads. Residual dwelling occurrences along paved highways were compared to those along four other road categories for three periods. The road categories were Federal aid secondary roads that were eventually paved, the county and Indian Service System roads that became paved, and Federal aid secondary roads that remained unpaved, and selected unpaved county roads. The latter category was thought to be representative of unpaved road segments found throughout the county.

The comparison showed residual dwelling occurrences along the two paved road categories to be similar to that on paved highways, but along the unpaved roads the rates were lower and ultimately significantly dissimilar (Table 30). The differences in percentages between the paved and unpaved road categories increased in a manner that suggested road qualities were influential in affecting residual dwelling occurrences. By 1961 the unpaved county roads which were not to be paved were the ones with the lowest residual percentages and greatest differences with the paved highways. In 1973, however, this condition not only affected the unpaved county roads, but the secondary roads that remained unpaved, also.

The analysis indicated that the occurrence of residual dwellings was considerably higher along routes that were paved or became paved after 1936. In contrast, the occurrence of dwelling residuals became progressively lower along unpaved roads or roads that were low on the paving priority list.

Residual Dwellings in Areas Adjacent to Paved Roads. If paved roads discouraged dwelling abandoning, this effect should be evident in areas proximate to the rights-of-way. Proximity was defined as sections adjacent to the respective vehicular routes. Average residual dwelling percentages along side roads on these sections were calculated and compared to similar data for the four other road categories.

Areas adjacent to paved roads once again have the highest proportions of dwellings in the residual class. The percentages in areas adjacent to highways and the paved road categories were similar at the end of the study period, but percentages in areas adjacent to unpaved roads were dissimilar to those along the paved highways (Table 31).

TABLE 30

RESULTS OF STUDENT "t" TEST FOR DETERMINING SIGNIFICANT DIFFERENCES BETWEEN MEAN PERCENTAGES OF RESIDUAL DWELLINGS ALONG PAVED HIGHWAYS AND FOUR OTHER ROAD CATEGORIES

Road Categories	Average Residual Dwelling Percentages Since 1936 Through the Ends of Respective Periods and Their Calculated "t" Values					
	1949		1961		1973	
	Percent	"t" Values	Percent	"t" Values	Percent	"t" Values
Paved Highways	71.11		57.11		35.55	
Secondary Roads, Eventually Paved	71.02	0.01	53.07	0.37	26.38	1.37
County and ISS Roads, Eventually Paved	74.32	-0.34	60.07	-0.26	36.41	-0.10
Secondary Roads, Remaining Unpaved	57.05	1.56	46.15	1.27	15.56	2.21*
Selected Unpaved County Roads	60.17	1.47	40.35	1.81*	8.56	7.49*

SOURCE: Author's measurements and calculations.

*The means differ at the 0.05 level of statistical significance.

TABLE 31

RESULTS OF STUDENT "t" TESTS FOR DETERMINING SIGNIFICANT DIFFERENCES BETWEEN MEAN PERCENTAGES OF RESIDUAL DWELLINGS ALONG SIDE ROADS ON SECTIONS TANGENT TO PAVED HIGHWAYS AND FOUR OTHER ROAD CATEGORIES

Road Categories	Average Residual Dwelling Percentages Since 1936 Through the Ends of Respective Periods and Their Calculated "t" Values					
	1949		1961		1973	
	Percent	"t" Values	Percent	"t" Values	Percent	"t" Values
Paved Highways	66.03		49.71		24.97	
Secondary Roads, Eventually Paved	67.08	-0.23	52.17	-0.59	21.69	0.72
County and ISS Roads, Eventually Paved	59.53	1.14	41.42	1.98*	23.76	0.17
Secondary Roads, Remaining Unpaved	59.35	1.36	44.61	0.78	13.79	2.47*
Selected Unpaved County Roads	57.22	0.84	41.53	1.16	14.55	3.04*

SOURCE: Author's measurements and calculations.

*The means differ at the 0.05 level of statistical significance.

The percentages along the unpaved roads were lower than those for the highways between 1936 and 1973, but they statistically were similar in 1949 and 1961. In the county and ISS road category the percentage was dissimilar from paved highways in 1961. The percentage was comparable to the other unpaved road groupings. Perhaps the delayed road paving program along these roads was influential.

From these analyses it was concluded that residual dwelling occurrences in areas proximate to paved roads was influenced by the existence of this type of road.

Residual Dwellings Along All Side Roads. Noting the attraction of residual dwelling locations to paved roads and their proximities, it was logical to deduce that a similar influence operated for rural residences sited along all side roads from these routes. If such an influence operated, rural dwellings closer to the principal route would be more likely to remain occupied, and those further away would be abandoned at an increasing rate. These changes would be depicted by a decrease in the distances from all residual dwelling sites to the principal roads with time. Measurements were made from all of the principal roads, including the 9 percent that remained gravel surfaced in 1973.[6]

The average road distance along side roads from residual dwelling sites to principal roads decreased 0.12 mile, or 10 percent, between

[6]The gravel surfaced roads were included simply because they could eventually become paved. Nearly all of the principal roads in the county were in the same category previously. Table 28 indicated that a relatively low percentage of residual dwellings occurred along such roads, and, presumably, the same applied along side roads further away.

1949-1961 and 1961-1973 (Table 32). The road distance of residual dwellings was 1.18 miles from principal roads in the early period, whereas by the end of the next period it was 1.06 miles. Tests showed the difference to be statistically dissimilar. As the average distance of these dwellings decreased along side roads during these two periods, the percentages of dwellings on sections adjacent to the principal routes increased from 51 to 80 percent.

These results showed that, after 1949, the occurrence of residual dwellings along side roads was related to the distance between the dwelling site and the closest principal route. The average distance between the dwellings and the principal road declined after 1949 and was just over 1 mile by 1973.

TABLE 32

MEAN ROAD DISTANCES TO RESIDUAL DWELLINGS SITUATED OFF OF PRINCIPAL ROADS FOR THE PERIODS: 1949-1961 AND 1961-1973, WITH A COMPARISON USING THE STUDENT "t" TEST

Periods	Mean Road Distances to Residual Dwellings Along Side Roads	Calculated "t" Test Value for a Comparison of Means
1949-1961	1.18 Miles	
1961-1973	1.06 Miles	- 2.46[a]

SOURCE: Author's measurements and calculations.

[a]The means differ at the 0.05 level of statistical significance.

Conclusions

In this section the relationship between residual and new dwellings to the rural road network was analyzed. Conclusions concerning each of

these categories follow.

Relationships between new dwellings and the rural road network were analyzed from 1936 through 1973, although much of the emphasis was after 1949, when paving improvements were accelerated. These analyses emphasize the attraction of new home sites to paved roads frontages or nearby areas. The significant findings for these rural dwellings follow, i.e., synthesized for the study period. These are:

1. There was a decided attraction of new dwellings to paved roads. Nineteen percent of the newly settled dwellings were by these routes in 1949, 30 percent by 1961, and 63 percent by 1973.

2. There was a pronounced attraction for new dwelling sites along side roads on sections adjacent to the paved routes. These adjacent sections had 70 percent of the new residences between 1949-1961 and 81 percent from 1961-1973.

3. There was a decline in the mean road distance between new dwelling sites along side roads and the nearest principal road after 1949. The principal road was likely to be a paved route. The average road distance for these dwellings was 0.92 miles in 1973.

The relationship between rural roads and the rural dwellings contained in the 1936 rural settlement through later intervals was analyzed for 1949, 1961, and 1973. The remaining dwellings at these times were representative of those in the residual class. From these analyses it was found that between 1936 and 1973:

1. There was a steady increase in the percentages of residual dwellings remaining along paved roads. Five percent were along paved roads by 1949, 26 percent by 1961, and 37 percent in 1973.

2. There was a similar retention of dwelling sites along paved Federal and state highways, the farm-to-market roads, and localized county and Indian Service System roads.

3. Dwellings were retained along side roads that were on sections adjacent to the paved roads. Over

fifty percent of the residual dwellings off of paved roads were on such sections in 1949, and this percentage exceeded 75 percent in 1973.

4. The average road distance from these dwellings to principal roads declined between 1949 and 1973 by 10 percent to 1.06 miles. Only minimal numbers of residual homes in remote areas of the county by 1973 remained distantly situated from paved roads.

Three hypotheses, which concerned dwelling placement along rural roads or related to nucleated settlements that would occur if the rural settlement matrix became clustered with time, were advanced earlier. Of concern here is the hypothesis that dwellings comprising the rural settlement would become increasingly oriented to roads with the best potential for optimizing accessibility.

Dwelling sites for both residuals and new settling were shown to have become definitely associated with paved roads during the time considered in this study. Findings support this hypothesis. The increased orientation of these dwellings to the principal routes contributed to the clustering that evolved with time in the rural settlement morphology.

The Relationship of Abandoned Dwellings To The Rural Road Network

Dwelling abandonment was moderated by the presence of paved roads. By the end of the 1936-1949 period, 7.14 percent of the county's roads were paved and 2.30 percent of the dwellings abandoned concurrently had been sited along these routes (Table 33). During the same interval nearly 10 percent of the abandonment was along unpaved secondary roads. During at least part of this interval the likelihood of these routes becoming paved was probably not foreseen by many of the rural inhabi-

TABLE 33

CHARACTERISTICS OF DWELLING ABANDONMENT IN KIOWA COUNTY: 1936-1949 AND 1949-1973

Categories	Periods	
	1936-1949	1949-1973
Paved Road Mileages	124.23	439.30
Percentages of All Roads in the Study Area	7.14	25.25
Percentages of Dwellings Abandoned Along Paved Roads During the Periods	2.30	17.06
Percentages of Dwellings Abandoned Along Unpaved Secondary Roads During the Periods	9.98	1.98
Percentages of Dwellings Abandoned Along All Other Roads During the Periods	87.72	80.96

SOURCE: Author's measurements and calculations.

tants. At the end of the 1949-1973 period, 25.25 percent of the roads in Kiowa County were paved; 17.06 percent of the abandonment for the period had occurred along roads that were or had been paved after 1949. Nearly 2 percent of the abandoned dwellings occurred along unpaved secondary roads.

Abandonment became the most dominant of the settlement processes in terms of absolute numbers effecting the study area after 1949. Eighty-seven percent of the abandoned dwellings for the 1936-1949 period were off of either primary or secondary roads (Table 33). For the 1949-1973 period, 81 percent of the abandonment was sited along side roads. Because the abandonment increased between these two periods, the respective num-

bers of abandoned dwellings along side roads increased from 1,110 to 1,305. These increases suggest that dwelling abandoning increased away from major roads, which indicates the increased importance that rural inhabitants increasingly placed upon accessibility.

The approach that follows is the same one used in the section dealing with residual dwellings. Here abandonment is compared along all paved road categories, then in areas adjacent to the paved routes, and finally along all side roads that feed into the major routes.

Dwelling Abandonment Along Paved Roads. If better road surfaces have enhanced the occurrences of residual and new settled dwellings, they have concurrently reduced the occurrences of dwelling abandonment. Dwelling abandonment along highways paved since 1936 was compared to that along four other road categories for three periods. The other road categories were the Federal aid secondary roads that were eventually paved, the county and ISS roads that were paved later, the Federal aid secondary roads that were never paved, and selected county roads that were never paved.

This comparison showed that dwelling abandonment along the two "paved" road categories was similar to that for the paved highways, however after 1949 the abandoning along the two unpaved road categories was statistically dissimilar (Table 34). Higher percentages of abandonment occurred during each succeeding period, and by the latter period dwelling losses along the paved roads were between 63 and 73 percent. Along unpaved roads during the latter period abandonment was considerably higher, with losses between 84 and 91 percent. From these analyses it was concluded that dwelling abandonment was moderated along paved roads,

TABLE 34

RESULTS OF STUDENT "t" TESTS FOR DETERMINING SIGNIFICANT DIFFERENCES BETWEEN MEAN PERCENTAGES OF DWELLING ABANDONMENT ALONG PAVED HIGHWAYS AND FOUR OTHER ROAD CATEGORIES

Road Categories	Average Dwelling Abandonment Percentages Since 1936 Through the Ends of Respective Periods and Their Calculated "t" Values					
	1949		1961		1973	
	Percent	"t" Values	Percent	"t" Values	Percent	"t" Values
Paved Highways	26.85		37.18		62.60	
Secondary Road, Eventually Paved	29.32	- 0.34	47.65	- 0.94	73.40	- 1.44
County and ISS Roads, Eventually Paved	25.76	0.06	33.20	0.72	63.59	- 0.10
Secondary Roads, Remaining Unpaved	42.95	- 1.55	53.85	- 2.62*	84.44	- 2.07*
Selected Unpaved County Roads	39.83	- 1.52	59.65	- 2.29*	91.45	- 6.69*

SOURCE: Author's measurements and calculations.

*The means differ at the 0.05 level of statistical significance.

nevertheless even along these routes the losses increased during each successive period.

Abandonment in Areas Adjacent to Paved Roads. It was logical to assume that if abandonment was moderated along paved roads, adjacent areas would be similarly affected. Adjacent areas were recognized as contiguous sections to the roads. An average abandonment percentage was computed for housing losses on the side roads of each section along paved highways and the other four road categories.

Abandonment percentages in the areas adjacent to paved roads were lower than all of the other road categories, except for the secondary roads that were eventually paved (Table 35). The percentages computed for 1949 and 1961 were relatively close for all of the road categories, and all of these were similar to those associated with the paved highways. By 1973, however, the percentages were considerably higher and those for the paved roads were nearly identical to the paved highways, but the percentages for the two unpaved road categories were higher and statistically dissimilar. It was concluded from these results that proximity to paved roads moderated the abandonment percentages slightly, but these percentages increased to moderately high levels by the latter period.

Abandonment Along All Side Roads. Finally, the dwelling abandonment along all side roads was compared for the three periods. If abandonment was moderated along and in proximity to paved roads, it was assumed that the likelihood for abandonment was increased for dwellings at sites along side roads further from the principal routes. It appeared that, in addition, as the principal road network was improved through paving that

TABLE 35

RESULTS OF STUDENT "t" TESTS FOR DETERMINING SIGNIFICANT DIFFERENCES BETWEEN MEAN PERCENTAGES OF DWELLING ABANDONMENT ALONG SIDE ROADS ON SECTIONS ADJACENT TO PAVED HIGHWAYS AND FOUR OTHER ROAD CATEGORIES

Road Categories	Average Dwelling Abandonment Percentages Since 1936 Through the Ends of Respective Periods And Their Calculated "t" Values					
	1949		1961		1973	
	Percent	"t" Values	Percent	"t" Values	Percent	"t" Values
Paved Highways	37.17		51.82		73.85	
Secondary Roads, Eventually Paved	32.44	0.97	47.71	0.90	73.85	- 0.002
County and ISS Roads, Eventually Paved	40.47	- 0.54	58.62	- 1.43	73.87	- 0.29
Secondary Roads, Remaining Unpaved	40.64	- 0.95	55.39	- 0.47	86.20	- 2.40*
Selected Unpaved County Roads	42.78	- 0.47	58.47	- 0.82	85.45	- 2.98*

SOURCE: Author's measurements and calculations.

*The means differ at the 0.05 level of statistical significance.

dwelling sites any distance away on side roads would be less acceptable. Abandonment based upon these assumptions would be expressed through decreasing distances between former dwelling sites and the principal roads throughout the study area. Measurements between the principal roads and abandoned dwelling sites were made for three periods. The remaining 9 percent of the gravel surfaced secondary roads were included in the measurements for the latter period.[7]

The average road distance between abandoned dwelling sites on side roads and principal roads declined from 1.50 miles for the 1936-1949 period to 1.17 miles in the 1949-1961 period, but then remained essentially the same for the 1961-1973 period at 1.18 miles (Table 36). Both of the latter averages were significantly different from the earlier one. Although these measurements showed that abandonment became more oriented towards the principal routes with time, slightly more than 50 percent occurred along the side roads on sections adjacent to these routes during each of the periods.

The results showed that dwelling abandonment on all side roads was related to the road distance between the former dwelling site and the principal routes, however about one half of the abandoned residences occurred along side roads on sections adjacent to the principal routes each period. The average distances declined from 1.50 miles in the early period to 1.17 miles by 1961 and was 1.18 miles in 1973.

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[7] A similar approach was utilized in considering residual dwellings along these roads. It can be assumed that the high abandonment percentages observed along side roads adjacent to unpaved secondary roads prevailed along side roads further away.

TABLE 36

MEAN ROAD DISTANCES TO ABANDONED DWELLINGS SITUATED OFF OF PRINCIPAL ROADS FOR THE PERIODS: 1936-1949, 1949-1961, AND 1961-1973, WITH A COMPARISON USING THE STUDENT "t" TEST

Sequential Periods	Mean Road Distances to Abandoned Dwellings Along Side Roads	Calculated "t" Test Value for a Comparison of Means
1936-1949	1.50 Miles	
1949-1961	1.17 Miles	35.53*
1961-1973	1.18 Miles	54.32*

SOURCE: Author's measurements and calculations.

*The means differ at the 0.05 level of statistical significance.

Conclusions

In this section the relationship between abandoned dwellings and the rural road network was analyzed from 1936 through 1973. Of particular interest were the locations of abandoned dwellings with respect to paved roads. The most salient findings from these analyses were:

1. There was an increase in dwelling abandonment along all roads in the study area between 1936 and 1973.

2. There was a moderation in dwelling abandonment along paved routes or those that were slated for paving after 1950.

3. There was a moderating effect to the abandonment of dwellings along side roads on sections adjacent to paved roads.

4. There was a decrease in the average road distance between abandoned dwelling sites along side roads and the nearest principal roads. The average road distance was 1.50 miles for 1936-1949, 1.17 miles between 1949-1961, and then remained essentially stable at 1.18 miles for the 1961-1973 period.

In the former section both residual and new dwelling sites were shown to support the hypothesis dealing with optimizing accessibility to principal roads. Dwelling abandonment provided additional support for this hypothesis, since the orientation changed from a focus along side road locations to one much closer to the principal routes. As dwelling abandonment affected areas on either side of the principal roads the most, the results were groupings of various shapes. Such groupings in toto would contribute to a random morphology which evolved for the abandoning process during this study.

Dwelling Distances To Nucleated Settlements

The location of rural dwellings was related to their distance from nucleated settlements during the period of this study. Rural inhabitants consider this factor when siting new dwellings or through inadvertence through their continued occupance of a particular dwelling site. However, since there is a hierarchy of nucleated settlements, rural inhabitants must consider these differences as they relate to dwelling sites.

In this section the hierarchy of nucleated settlement in the study area is examined between 1936 and 1973. Then comparisons are made of the average road distance between dwellings and the closest village or town for 1936, 1949, and 1973. Finally, the relationship between dwelling locations and the hierarchial size of nucleated settlements is examined.

The Hierarchy of Nucleated Settlement in Kiowa County Since 1936

A threefold hierarchial classification was selected for identifying

and classifying differences between places in Kiowa County. Because of their applicability here, Trewartha's and Brush's functional definitions for hamlets, villages, and towns were utilized for differentiating between nucleated places (Brush, 1953; and, Trewartha, 1943). All three definitions distinguish nucleated settlements by their provision of retail and/or service functions. Each is discussed in the sections which follow.

Hamlets

The smallest nucleated settlements classified in the study area are hamlets. These form recognizable, closely-spaced groupings of residences and other structures. Such places must contain at least four active residential units and between one and nine commercial, industrial-processing, or institutional units. When minimal requirements occur, the outermost structure should be no further than 0.25 miles from the other buildings comprising the node (Trewartha, 1943, pp. 37-38).[8]

Hamlets found in the study area evolved in two ways. Most were small agglomerations providing basic retail and service activities to inhabitants in local areas. A few hamlets were residuals of degraded larger communities such as villages. All of the hamlets had at least one store, perhaps more like a general store but emphasizing groceries. Gasoline and other vehicular needs were often provided either at this store or at a separate establishment. Of those hamlets present in 1936,

[8]The requirements of industrial-processing or institutional units are more specific than those designated by Trewartha; his original requirements were termed commercial and social units. The writer believes that the new terminology is only more specific and not different from the initial intentions of Trewartha's work.

seven were near a rural school. Three hamlets had grain elevators. Larger hamlets, such as Cold Springs, Lugert, and Saddle Mountain had post offices. The hamlets that evolved through regression ordinarily had more commercial and institutional functions, since larger numbers of inhabitants had previously been served.

Villages

Nucleated settlements in the study area with some commercial-service distinctiveness are villages. Commercial establishments normally are confined to a particular area of the settlement, thereby forming a commercial section. A minimum of ten retail and service units are required, although four must represent some retail specialization, such as automobile sales, implements, hardware, appliances, or lumber. Three other essential services are also needed, such as banking, agricultural processing, agricultural storage, automobile and farm machinery repair, a post office, or public school (Brush, 1953, p. 385).

All of the villages, except Cooperton, were along the county's primary highways and railroad lines. All were incorporated places, indicating that certain improvements and public services were provided for inhabitants. While all villages had rudimentary retail and service activities and certain specialties present, all of these central places once had the elementary and/or high schools of consolidated school districts in them. Cooperton lost its school complex during the time it regressed from a village to a hamlet. Five of these villages had agricultural cooperatives, which provided processing, grain storage, and sales of various agricultural needs. Privately owned functions such as cotton gins, grain elevators, and lumber and hardware businesses were

often absorbed by the cooperatives. Neither Mountain Park nor Cooperton had agricultural cooperatives within their confines, although both had cotton gins at one time. Professionals, besides school teachers, were only in the largest villages. In 1973, Snyder had a physician, a dentist, and a veterinarian; Mountain View had a physician (Fig. 50).

Towns

Towns are agglomerated settlements with many retail and service specializations. Such places have not only a well defined central business district but also recognizable areas elsewhere within which other functions dominate. Fifty retail establishments are required for such a classification, thirty of which must be specialized in other than basic needs. Towns must also have a bank, a weekly newspaper, a high school, and the services of four professionals besides school teachers (Brush, 1953, p. 387).

Hobart, the study area's only town, typifies the higher order central place in an agricultural setting. Many of its retail establishments are directly related to agriculture. This includes businesses engaged in implement sales, seed and feed sales, lumber and hardware sales, and vehicle sales. Agricultural services also predominated here in the form of grain storage and milling, cotton ginning and compressing, tractor and machinery repair, and professional agricultural advice via either the county agent or other Federal officers (Fig. 50).

The county's administrative center had sundry retail and service establishments. Both professional and personal services were well represented. While the community had always had a hospital during the period studied, a modern hospital complex was recently constructed on the north side of town. This is the only hospital in Kiowa County.

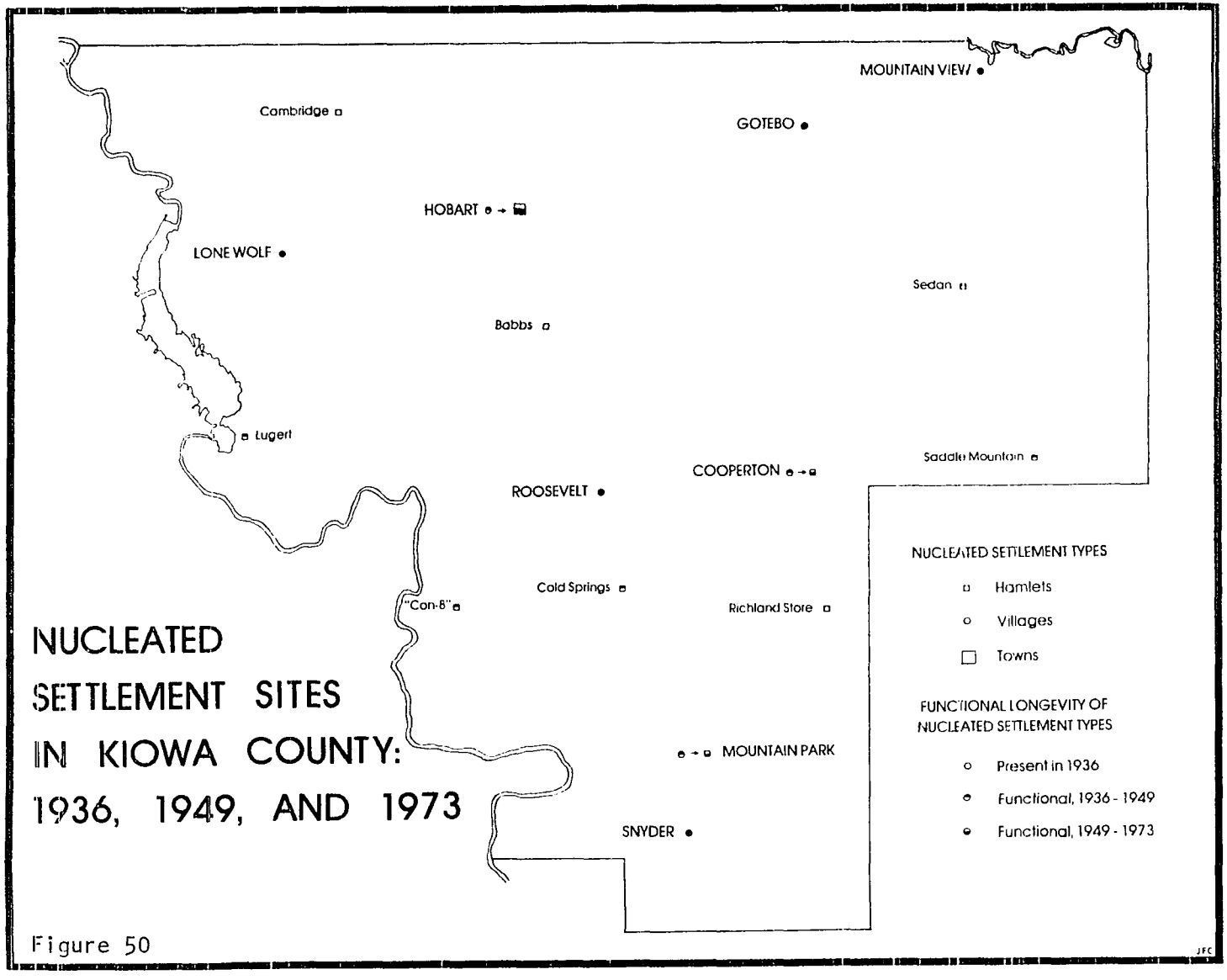
MOUNTAIN VIEW
Cambridge
GOTEBO
HOBART
LONE WOLF
Sedan
Babbs
Lugert
Saddle Mountain
COOPERTON
ROOSEVELT
Cold Springs
"Con-8"
Richland Store
MOUNTAIN PARK
SNYDER
NUCLEATED SETTLEMENT TYPES
Hamlets
Villages
Towns
FUNCTIONAL LONGEVITY OF NUCLEATED SETTLEMENT TYPES
Present in 1936
Functional, 1936 - 1949
Functional, 1949 - 1973
NUCLEATED SETTLEMENT SITES IN KIOWA COUNTY: 1936, 1949, AND 1973

Figure 50

Two light industries now operate in the community, one is a producer of tool boxes, which employs a limited number of workers, and the other is a plant operated by the Highland Supply Corporation. It employs 50 employees and manufactures paper supplies for florists.

Hierarchial Changes in the Nucleated Settlements

The nucleated settlements in Kiowa County have undergone several changes during the time period covered in this study. Because these centers provided foci for the surrounding rural settlement, changes are described for two periods, 1936-1949 and 1949-1973.

Between 1936 and 1949 thirteen nucleated settlements remained functional in Kiowa County. Only three incorporated places showed functional increases or stability during the period, while the five remaining places lost some of their functional representation (Table 37). Hobart progressed from a large village to a small town, and both Mountain View and Snyder remained medium sized villages (Fig. 50). Three medium sized villages, Gotebo, Lone Wolf, and Roosevelt, regressed to small village classifications. The two remaining incorporated places, Cooperton and Mountain Park, through the loss of functions, became large hamlets. Of the eight unincorporated places classified as hamlets in 1936, five remained in 1949. Babbs, Cambridge, and Richland Store lost their hamlet classification.

In the 24 years following 1949 the county's nucleated settlement hierarchy was modified drastically. The retail service base in all smaller places was markedly diminished or completely eroded, whereas the same functions were expanded in the three largest trade-service centers (Fig. 50). Only the eight incorporated places were classed as nucleated settlements by 1973 (Table 37). Five hamlets existing in 1949

TABLE 37

CLASSIFICATION OF NUCLEATED SETTLEMENTS IN KIOWA COUNTY: 1936-1973

Places	Periods To Which Classifications Applied		
	1936	1949	1973
Incorporated Places			
Cooperton	Small Village	Large Hamlet	Hamlet
Gotebo	Medium-sized Village	Small Village	Small Village
Hobart	Large Village	Small Town	Town
Lone Wolf	Medium-sized Village	Small Village	Small Village
Mountain Park	Small Village	Large Hamlet	Hamlet
Mountain View	Medium-sized Village	Medium-sized Village	Medium-sized Village
Roosevelt	Medium-sized Village	Small Village	Small Village
Snyder	Medium-sized Village	Medium-sized Village	Medium-sized Village
Unincorporated Places			
Babbs	Hamlet		
Cambridge	Hamlet		
Cold Springs	Hamlet	Hamlet	
"Con-8"	Hamlet	Hamlet	
Lugert	Hamlet	Hamlet	
Saddle Mountain	Hamlet	Hamlet	
Sedan	Hamlet	Hamlet	
Richland Store	Hamlet		

SOURCE: Oklahoma Department of Highways, General Highway Map: Kiowa County, 1936, and 1949 and information polled in the incorporated places in 1973 and 1976.

were no longer functional trade centers. Each still consisted of some clustered residences, but little else to suggest localized centrality for trade or service existed.

Hobart, Snyder, and Mountain View gained both retail and service establishments between 1949 and 1973. The increases in establishments in Hobart were particularly notable where the expansion was larger in service than in retail categories. Snyder and Mountain View had commercial growth comparable to that of Hobart but smaller in scale. Although the three small villages lost both retail and service establishments during this period, the agricultural cooperatives in these centers provided some of the supplies for farmers which private dealers once furnished (Fig. 50).

Dwelling Distances to Nucleated Settlements Via All-Weather Roads

Accessibility for rural inhabitants is enhanced as the distance or travel time from their dwelling site to the closest nucleated settlement is minimized. If accessibility has been important in retaining dwellings or siting new ones, then it follows that over a period of time that the distance between these dwellings and nucleated settlements would decline. The pattern analysis in the preceding chapter showed that rural dwellings have clustered around nucleated settlements to optimize accessibility. The concern here, however, is whether dwellings further away from these centers have responded to the distance factor significantly. This was formerly posed as a supportive hypothesis.

The shortest all-weather road distances were measured from all rural dwellings to the nearest village or town in the study area.[9] All weather

[9] It was assumed that basic needs could be fulfilled in the closest village or town in the county.

roads were either paved or gravel surfaced. Measurements were taken from the rural settlement matrices for 1936, 1949, and 1973. Median road distances for rural dwellings during each period were computed and compared.

The median all weather road distance between rural dwellings and the nearest village or town in the study area declined from 1936 to 1973. Median distances for 1936 and 1949 were nearly identical, being 5.99 and 5.95 miles, respectively. In 1973, however, the median distance was 5.45 miles, which represented an 8 percent reduction over that for 1949. There was a significant difference between the 1973 median distance of rural dwellings and either of those for the earlier periods (Table 38).

TABLE 38

COMPARISON OF THE 1973 MEDIAN ROAD DISTANCE OF RURAL DWELLINGS TO VILLAGES AND TOWNS TO THOSE FOR 1949 AND 1936, USING THE KRUSKAL-WALLIS ONE-WAY ANALYSIS OF VARIANCE BY RANKS

Periods	Median Distance of Dwellings From Villages and Towns	Calculated X^2 Value	Critical X^2 Value (.01)
1973 1949	5.45 Miles 5.95 Miles	9.31	6.64
1973 1936	5.45 Miles 5.95 Miles	24.10	6.64

SOURCE: Author's measurements and calculations.

These results verified the supportive hypothesis. The measurements showed, however, that the distance between rural dwellings and nucleated settlements became increasingly important to rural inhabitants after 1949, during a period when the rural road system was being improved through paving.

Dwelling Location and the Size of Nucleated Settlements

As accessibility of rural inhabitants to nucleated settlements increased in importance, it was logical to assume that the hierarchial size of these commercial centers would have some bearing upon dwelling location. Proximity to the larger commercial centers would be more attractive to new dwellings and be instrumental in the continued occupancy of longer established residences. On the other hand, proximity to smaller nucleated settlements would have less appeal, since the availability of the goods and services would be more limited. If such an influence has increased, its expression should be reflected in the contemporary housing distribution associated with the study area's nucleated settlements. These suppositions lead to the formulation of the last supportive hypothesis that was anticipated, if the rural settlement matrix became clustered over time.

Trade-service orientation for villages and towns in Kiowa County was established by use of the shortest all weather road distance between each dwelling and its nearest nucleated settlement. Two portions of the county were omitted because of their closeness to either Sentinel or Carnegie, both of which were situated in contiguous counties.[10] These outlined settings were recognized as commuting areas and delimited on the 1973 rural settlement matrix. Dwelling counts were made within each commuting area, and the square mileage contained in each was measured.

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[10] Seven percent, 70.5 square miles, of Kiowa County's area was contained in commuting areas related to these 2 nucleated settlements. The commuting area for Sentinel was along the central northern part of the county, while that for Carnegie was along the northeasterly border east of Mountain View and Saddle Mountain.

An occupancy ratio was used to assess the difference between rural dwelling distributions in each of the commuting areas in Kiowa County.[11] A rural dwelling distribution proportional to the delimited commuting area was designated with an occupancy ratio of 1.0, a ratio of > 1.0 showed a positive disproportion of rural dwellings in such a setting, while a ratio of < 1.0 depicted a negative disparity in the rural dwellings in this area.

Occupancy ratios for commuting areas associated with the county's 3 largest communities exceeded 1.0, whereas the commuting areas belonging to the 3 smaller communities had ratios below 1.0 (Table 39). It is important to recognize that the occupancy ratios for both Hobart and Snyder would have been higher, but peripheral parts of these incorporated places were annexed in the last few years. Such boundary changes lowered the housing counts for these commuting areas. Few boundary changes occurred around the other incorporated places in the county concurrently.

In the writer's opinion these findings substantiate the supportive hypothesis. Additional verification for this hypothesis was shown with both new settling and residual dwelling ratios, which were presented along with the pattern analysis.

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[11] This procedure is explained in considerably more detail in the second chapter.

TABLE 39

OCCUPANCY RATIOS FOR COMMUTING AREAS OF VILLAGES AND TOWNS IN KIOWA COUNTY

Trade Areas	Number of Rural Dwellings in the Commuting Areas	Area (in square) (miles)	Area's Homes / County's Total	Commuting Area / County's Total	Occupancy Ratio
Gotebo	97	132.93	.0952	.1327	0.7174
Hobart	156	124.87	.1532	.1246	1.2295
Lone Wolf	138	146.20	.1355	.1460	0.9280
Mountain View	178	128.61	.1748	.1284	1.3613
Roosevelt	195	249.78	.1915	.2492	0.7678
Snyder	169	149.06	.1660	.1488	1.1155
Others[a]	85	70.50			

SOURCE: Author's measurements and calculations.

[a]This includes areas tied to Sentinel in Washita County along the county's northern border and to Carnegie in Caddo County on the northeast boundary of the county.

CHAPTER V

SUMMARY AND CONCLUSIONS

Summary

The purpose of this study was to extend existing theories concerning the evolution of rural settlement patterns. Hudson's theory on rural settlement location for an agricultural setting served as the base for this theoretical extension. Rural settlement was extended to rural non-farm residences and included all residences outside of the confines of hamlets, villages, and towns, distinct recreational nodes, group quarters, or governmental holdings. In addition, the rural settlement was disaggregated into 3 components, i.e., new, abandoned, and residual dwellings.

It was theorized that a clustered rural settlement pattern would evolve as residences were positioned to optimize their inhabitants' accessibility to trade-service centers during a period with characteristics similar to Hudson's competition phase. Accessibility was expressed by a rural dwelling's location to nucleated settlements and to the principal roads leading to these centers.

Because Hudson's competition phase related to rural settlement for long established agricultural settings it was analyzed critically. This analysis led to the following findings:

1. Non-farm dwellings were excluded from considerations of rural settlement morphology, although their presence obviously affected other dwellings formulating the settlement matrix.

2. In the competition phase it appeared that the rural settlement was comprised of residual dwellings at farm sites, which were gradually eliminated as a result of small farms being consolidated into larger farms. New settling was omitted under these circumstances.

3. The basic premise of increasing land areas in farms during competition was unrealistically linked to gains from only contiguous smaller farm holdings.

4. Dwelling placement at a farm site would become more centrally positioned to the farm holding as its areal dimension increased. This premise seemed unrealistic, since farmstead locations have become more closely tied to roads to assure accessibility.

5. Hudson selected several tracts, which avoided villages and towns, for testing the settlement theory. Such a selection procedure eliminated the possibilities of measuring a rural settlement pattern with an orientation to the trade-service centers.

Both procedural and conceptual approaches, which mitigated the shortcomings of the Hudson theory, were incorporated in this study.

Rural settlement was seen as the synthesis between residual dwellings and those comprising the 2 settlement processes, i.e. new settling and abandonment. It was apparent that the trend towards rural settlement clustering was a response related to these 3 dwelling categories. Using the accessibility factor as a basic premise, anticipated morphologies were suggested for the residual, new, and abandoned dwellings, which, when synthesized, could evolve a clustered pattern in the rural settlement.

The major research hypothesis was that the rural settlement became clustered during the competition phase, as rural dwelling locations were optimized with respect to trade-service centers and the principal routes leading to these centers. Six supportive hypotheses, which pertained to the anticipated morphologies for either residual dwellings or those

related to the two settlement processes and to accessibility factors which influenced individual dwelling sites, were tested.

Rural settlement in Kiowa County, located in the southwestern part of Oklahoma, was studied. Matrices for rural settlement were constructed for three periods, 1936, 1949, and 1973, using library and field sources. Sim ple comparison of two sequential rural settlement matrices made it possible to recognize dwellings in either the residual, new, or abandoned categories. After these dwelling categories were identified, sites were charted and to form a matrix. Subsequently, matrices for the three dwelling categories were derived for 1936 to 1949 and 1949 to 1973.

The matrices were scrutinized at two levels, i.e. a macro level of analysis concerned the derivation of patterns for the rural settlement, the settlement process matrices, and residual dwelling matrices, whereas a micro level of analysis focused upon accessibility characteristics of individual dwellings. In the macro level of analysis the rural settlement and its sequential component matrices were measured and described through point pattern analysis, specifically nearest neighbor analysis and quadrat analysis.

The major research hypothesis was supported with the finding that the rural settlement in Kiowa County evolved from a nearly random to slightly clustered pattern in 1936 and 1949 to a slightly clustered pattern by 1973, as rural dwelling sites became more accessible to nucleated settlements and the major roads leading to them. However, considerably more insight about the change in the rural settlement was acquired from testing the supportive hypotheses relevant to the settlement processes or residual dwellings and the influences upon their individual sites.

The changes attributed to new settling in the rural settlement were the most revealing of the three settlement components, because they reflected decisions about dwelling sites based upon prevailing conditions in the study area. For new settling to influence clustering in the rural settlement it was hypothesized, and subsequently verified quantitatively, that new residences would have distinct concentrations around nucleated settlements as well as near the major roads leading to these central places.

Although it could not be predicted, new settling became more effective in "shaping" the rural settlement during the two periods studied because its proportional composition in this matrix increased from 15 to 26 percent. This increase occurred as absolute numbers decreased nearly 26 percent, and the absolute number of residual dwellings in the rural settlement declined at a proportionately higher rate.

The extent of the concentration of new housing around the commercial centers during the two periods demonstrates the attraction of these centers to rural dwellers. For the 1936-1949 sequence, 31 percent of the new homes in the county were within 3 miles of villages and towns, and in the 1949-1973 period 43 percent of all the new residences were situated in this setting. These percentage gains in new housing came not from the entire study area, but from the next three miles encircling these centers where new dwelling input declined from 29 to 13 percent at the same time. Consequently, comparable proportions (38 and 39 percent) of new residences for Kiowa County were situated beyond the 6 mile radii of the villages and towns in 1936 to 1949 and 1949 to 1973. Rates for new home siting from 14 miles to the county's periphery in both periods slightly exceeded expectations.

Non-farm housing showed significant increases around the nucleated settlements. Within three miles of these central places the new settling composition from non-farm housing increased from 35 percent in 1949 to 43 percent by 1973. Farm homes comprised nearly all of the remaining new settling for the remainder of the study area.

Abandonment increased in its magnitude from the first to the second period and reduced the 1936 rural settlement by 38 percent and the 1949 rural settlement by 68 percent. Its resulting nearly random, then random, settlement pattern for each period did not confirm the supportive hypothesis that dwelling site dissatisfaction was the predominant cause of dwelling abandonment. The pattern, however, was anticipated if exogenous causes affected most of the loss in occupied housing, i.e. causes other than dwelling site dissatisfaction related to either accessibility or distance to nucleated settlements. In this agricultural setting, increasing farm size was the most important non-site cause for abandonment.

Because abandonment was widely dispersed throughout the study area and lacked a distinct focus in its occurrences during these two periods, it evolved random or nearly random morphologies. Abandonments were roughly proportional to the rural settlement existing at the beginning of each sequence. Consequently, 61 percent, then 57 percent of the abandonment was within 6 miles of nucleated settlements from 1936 to 1949 and 1949 to 1973; and, concurrently, 39 and 43 percent of the abandonment occurred in the more outlying parts of the county.

Proximity to nucleated settlements served as a retardant to dwelling abandonment. Abandonment increased gradually from these central places with distance towards the outlying areas of the county in the early period,

whereas the increase was more pronounced during the latter period. Dwelling abandonment varied, however, in the outlying areas from different sized settlements. Beginning at 12-13 miles, abandonment was notably higher in areas that were closest to smaller nucleated settlements. Abandonment was moderated in the outlying areas nearest to larger central places.

Farm residences comprised 96 and 94 percent, respectively, of the abandonment in the study area in 1936-1949 and 1949-1973. This accounted for the wide dispersion of dwelling abandonment that prevailed at both times. Abandoned non-farm housing was predominately found within a few miles of the nucleated settlements where most of the former occupants were farm laborers. However, a limited part of each non-farm abandonment was comprised of dwellings formerly associated with business establishments, schools, churches, and a few agricultural processing facilities.

Residual dwellings decreased in both absolute numbers and proportional composition in the rural settlement during these two periods, however sequential matrices showed increased orientation to the nucleated settlements and the major routes leading to them. Settlement morphology became slightly clustered by the second period in the study, a change from a nearly random pattern in the earlier interval. These findings verified the supportive hypothesis for this settlement component.

The residual dwelling matrices that developed during each sequence were generally proportional to the rural settlement found at the beginning. However, recurring and noticeable deficiency from a true proportional distribution of residual homes occurred first at 5 to 6 miles from the nucleated settlements. In the second period this deficiency

was more pronounced and stretched from 4 to 8 miles. On the other hand, excesses in these residuals were within 2 miles of nucleated settlements and in settings from 10 to 13 miles and at 16 miles. Although one of these changes occurred because of the desire for rural inhabitants to remain near commercial centers, the other reflected a reluctance for rural people to vacate dwellings at distances over nine miles from the service nodes. Residual dwellings at 16 miles applied to commuting areas associated with moderate sized service centers.

As with new settling, non-farm homes in the dwelling residual matrices were responsible for much of the increase found around the nucleated settlements. These homes were occupied by sidewalk farmers and families with economic ties to the villages and towns. They represented 5 percent of the residual category by 1949 and 12 percent in 1973. Farms, comprising the largest proportion of both sequential matrices, were widely dispersed, but occupied sites reflecting a distinct accessibility adjustment.

Two factors associated with rural dwelling accessibility were examined, i.e., 1) rural dwelling location with respect to principal roads, and 2) rural dwelling location with respect to nucleated settlements.

Rural dwelling locations became increasingly oriented to roads that tended to optimize accessibility, thereby substantiating a supportive hypothesis. The roads were paved or slated for paving at a specific time. Significant numbers of new dwellings were placed along paved highways from 1936 to 1973 and along secondary roads after their paving from 1949 to 1973. Sections (square miles) adjacent to paved roads contained 70 and 81 percent, respectively, of the new dwellings situated at sites

off paved routes from 1949 to 1961 and 1961 to 1973. Residual dwellings were higher along the paved roads or routes planned for paving, as compared to the unpaved road categories throughout the period that was studied. From 1961 to 1973, there was a significant difference between the percentage of these homes along paved routes and those along unpaved roads. The sections adjacent to the paved roads and those slated for paving also influenced dwelling residuals during the study period, although the appeal of these sites never equalled those along paved roads. Between 1949 and 1961, 51 percent of the residual dwellings along side roads were on these adjacent sections, and by the end of the 1961-1973 period 80 percent of these dwellings were in such locations. Average distances of new and residual dwellings along side roads from paved roads was 0.99 and 1.18 miles, respectively, between 1949 and 1961 and 0.92 and 1.06 miles, respectively, in the latter period.

Dwelling abandonment increased along all roads in the study area between 1936 and 1973, however its occurrences were moderated in the proximity of paved roads and those routes for which paving was planned. Significant differences existed in the dwelling abandonment along paved and unpaved roads after 1949. On sections adjacent to roads abandonment was lower when the adjacent roads were paved throughout the 37 year period, but only from 1961 to 1973 was there a significant difference in the rates between areas along paved and unpaved roads. Abandonment affected areas beyond these adjacent sections considerably. At least 50 percent of the dwellings abandoned on side roads were in these settings. Moreover, dwelling abandonment was first focused further from the principal routes, then was closer after 1949. Average distance of abandoned

dwellings on side roads from principal routes was 1.50 miles in 1936 to 1949, 1.17 miles for 1949 to 1961, and 1.18 miles for 1961 to 1973.

The relationships between rural dwelling locations and nucleated settlements were examined in two ways. It was hypothesized that clustering of rural settlement over time would cause the rural dwelling distance to the nearest village or town to decline concurrently. The median all-weather road distance of occupied rural dwellings in the rural settlement declined slightly from 1936 through 1973. The median was 5.99 miles in 1936, 5.95 miles in 1949, and 5.45 miles in 1973. This change led to the acceptance of the supportive hypothesis.

The other supportive hypothesis proposed that as clustering occurred in the rural settlement, the attraction and retention of dwellings to villages and towns would be related to their size. An occupancy ratio was calculated for dwellings contained in commuting areas of all villages and towns. The commuting area for each central place was delimited by using the shortest all-weather road distances. The ratio compensated for differences in area. Ratios for the three largest central places were highest, indicating that housing in these commuting areas exceeded an equable proportion for the county in 1973. The converse was true for the three smaller villages, all of which had ratios denoting less than equable housing proportions. These results confirmed the supportive hypothesis.

Conclusions

This research, in the writer's opinion, provides two significant contributions to rural settlement geography. First, while considering both rural farm and non-farm dwellings, the major hypothesis, clustering in the rural settlement pattern as accessibility to trade-service centers becomes increasingly important, was confirmed during a period

having Hudson's competition phase characteristics. Second, a procedure was introduced and utilized for disaggregating the rural settlement into new, abandoned, and residual matrices, whose point pattern measurements yielded considerable insight into the composition and changes incurred in the rural settlement.

Although the results of this research prompt several questions, most important is whether a clustered rural settlement pattern evolves in other agricultural settings during a competition phase. Since the literature indicates the importance of accessibility to rural inhabitants and since this influence was linked to the formation of a clustered rural settlement pattern in southwestern Oklahoma, it is reasonable to presume that this influence would affect clustering in rural settlement elsewhere.

Another question that needs considering is just how much effect relatively inexpensive energy had upon the clustered rural settlement pattern. Low cost fuel for motor vehicles made it possible for farm families, in particular, to move to non-farm dwelling sites if they chose. Will higher prices for vehicle fuels cause a movement back to the farm unit? What effect would higher energy costs have upon public services or rural electrification, which, in turn could affect rural dwelling location?

There is a need for determining just what effect landownership has upon the rural settlement pattern. This consideration would focus specifically upon agricultural, rather than non-agricultural activities. Two relationships relevant to landownership and rural dwellings need to be clarified. First, does the type of landownership, such as full, partial, or tenant ownership, affect occupancy of rural

farm dwellings? And, do non-contiguous land holdings used in farming operations in any way affect the location of the farm operator's residence?

Since rural settlement was defined more realistically here than in Hudson's theory, the generalizations regarding the two settlement processes and residual dwellings can be considered as more applicable to settlement in agricultural areas. More testing is needed elsewhere to validate clustering in the rural settlement because of accessibility influences before its occurrence can be considered as characteristic for either descriptive or classificatory purposes in rural settlement geography. Providing that such validation is forthcoming there is the potential for settlement geographers to significantly influence rural planning with these basic pattern characteristics and processes.

APPENDIX I

NEAREST NEIGHBOR ANALYSIS COMPUTER PROGRAM

```
C     Nearest Neighbor Measure
      Dimension X(1000,2),ZZ(1000),FMT(20)
      Data ZZ/1000*0.0/
      Read (5,500)FMT
  500 Format(20A2)
      T1=0.0
      T2=0.0
      R=0.0
      R1=0.0
      R2=0.0
      R3=0.0
      R4=0.0
      V1=0.0
      C1=0.0
      C2=0.0
      C=0.0
C     Reading Control Card-Number of Points and Area
C     Formats are Cols 1-5 for of Point,Area Cols 6-15, Decimal Point in
C     Col 13.
      Read (5,100)KN,A
      N=(Fix(XN)
  100 Format (F5.0,F10.2)
C     Reading X and Y Coordinates- Format X=Cols 1-10-Col 8 is decimal
      Read (5,FMT)((X(I,J),J=1,2),I=1,N)
      Do 2 I=1,N
      Z=0.0
      T=1000.0
      Do 1 K=1,N
      If(I.Eq.K) Go to 1
      Z=SQRT((X(I,1)-X(K,1))**2+(X(I,2)-X(K,2))**2)
      If(Z.LT.T) T=Z
    1 Continue
      ZZ(I)=T
    2 Continue
      Write(6,300)(ZZ(I),I=1,N)
  300 Format(1X,10F10.3)
      Do 5 I=1,N
      T1=T1+ZZ(I)
    5 T2=T2+ZZ(I)**2
      Write(6,200)T1
  200 Format(1X,'Sum of Nearest Distances=',F15.5)
      Write(6,210)T2
  210 Format(1X,'Sum of Nearest Distances SQRT=',F15.5)
C     Compute Mean Distance--Mean Distance=R
      R=T1/Xn
```

```
C     Compute Variance of Mean Distance
      V1=(T2*N)-(T1**2)
      V1=V1/(XN*(XN-1.0))
      R1=R/V1
      Write(6,201)R
  201 Format(1X,'Mean Distance of Nearest Neighbor=',F10.5)
      Write(6,202)V1
  202 Format(1X,'Variance=',F10.5)
      Write(6,203)R1
  203 Format(1X,'Mean/Variance Ratio=',F10.5)
C     Compute Nearest Neighbor Statistic
      R5=0.0
      R5=A/XN
      R2= SQRT(R5)
      R3=0.5*R2
      Write(6,600)R5,R2,R3
  600 Format(1X,3F15.5)
      R4=R/R3
      Write(6,204)R4
  204 Format(1X,'Nearest Neighbor Statistic=',F7.5)
C     Calculate Standard Variate of Normal Curve
      C=SQRT(XN*R5)
      C1= 0.26136/C
      C2=(R-R3)/C1
      Write(6,206)C2
  206 Format(1X,'Standard Variate of Normal Curve=',F10.5)
      Stop
      End
```

APPENDIX II

QUADRAT ANALYSIS COMPUTER PROGRAM

```
C     Quadrat Analysis
C     IA array is the basic data array of observed frequencies
C     IC array is the cumulative array per R A Fisher
C     ILK = no. of iterations (cum/prob.) in incrementing K3 and K2
            if 0 not included in PHI3 to PHI2
C     Ex array of the array of expected frequencies
            the program ceases iteration and prints summary
C     Iexp.  If the new K differs by the old one by less than 10**(-Iexp)
C     Isum = grand total
C     Maxno. = maximum no. of cells that can be filled.
C     NN = total frequency
C     N = no. of problems
C     LL = index for number of problems
C     M = largest integer observed + one for this data set
C     0 class stored in cell 1, 1 class stores in cell 2, etc.
C     Maximum no. of classes is 100 (including the 0 class)
C     MMM = ---ET equal to 0 if MMM blank or 0
C     MMM = maximum no. of iterations allowed for estimating K
C     NSW = 1 if negative and positive binomial to be fitted irrespective
C     Of poisson results.  NSW = 0 or blank otherwise
      Implicit real*8 (A-H), real*8 (O-Z)
      Integer*2 IA(100), IC(100), X(100), PDF(100), NBDF(100), PBDF(100)
      Integer*4 SMLLN
      Real*8   K, NBCHI(100), KK(100)
      Dimension XXBAR(100), XSS(100), PP(100), POICHI(100), EX (100)
      Dimension NNN(100), MM(100), PBP(100), PBAZ(100)
      1, IST-R(3), ICOD(4), FMT(10)
      Dimension Title(10)
C     ***************************************************************************
      Data     MMM, IEXP/0,0/ ,IPROB/0/
      Data ISTAR     /'  *','    **','   NS'/
      Read (5,1)  N, MAXNO, NSW
      DO 306 L = 1,N
      POICHI (1) = 0.0
      NBCHI(L) = 0.0
      KK(L) = 0.0
      PBAZ(L) = 0.0
      PBP(L) = 0.0
  306 PP(L) = 0.0
      Do 1000 LL = 1, N
  350 Read (-, 1) No, SMLLN, MMM, IEXP, IPROB
C     No = No. of cells to be read
      If (IPROB.EQ.0)    IPROB = 5
```

```
      PROB = 0.01 * IPROB
  802 If (MMM.EQ.0)     MMM = 100
      If (IEXP.EQ.0)    IEXP = 6
      IEXP = IABS (IEXP)
      EXPO = 10.** (-IEXP)
      Read (5, 3J1) Title
      Read (5, 301) FMT
      Write (6,303) Title
      Do 310 I=1, No
  310 Read (5, FMT)  X(I), IA (I)
  302 Continue
      M = No
 1111 Continue
      Do 2 i = 1, M
      Ex(I) = 0.0Do
    2 iC(i) = 0
      ISS = 0
      ISUM = 0
      IC(M-1) = IA(M)
      M1 = M - 1
      Do 10 I = 2,M1
   10 IC(M-I) = IC(M-I+1) + IA(M-I+1)
      NN = IC(1) + IA(1)
      Write (6, 17) LL,M,NN
      Do 20 I = 2,M
      ISUM = ISUM + IA(I) *(I-1)
   20 ISS = ISS + IA(I) *(I-1)**2
      SS = (ISS - (I SUM/DFLOAT(NN))*ISUM)/(NN-1)
      XBAR = ISUM/DFLOAT(NN)
      Write (6, 3) ISUM, ISS, SS, XBAR
      XXBAR(LL) = XBAR
      XSS(LL) = SS
      NNN(LL) = NN
      MM(LL) = M
      K      = XBAR**2/(SS-XBAR)
  472 EX(1) = DEXP(-XBAR)    *NN
      XX = EX(1)
      Do 400 I = 2,M1
      Ex(I) = XBAR*EX(I-1)/(I-1)
      XX= XX+ EX(I)
  400 Continue
      EX(M) = NN-XX
      IDF=M1-1
      Call Chical (Ex, IA, JTLT, M, M1, CHI, IDF)
      Call Chisq (CHI, IDF, AZ)
      POICHI(LL) = AZ
      POF(L-)=IDF
      Write (6, 407)
      Do 120 IJ = L, M
      ILL = I-1
  120 Write (6, 11) ILL, IA(I), EX(I), IC(I)
      Write (6-401) CHI, IDF, AZ, JILT
```

```
      IF(NSW.EQ.1) Go to 1001
      if (AZ.GT.PROB) Go to 1000
 1001 If (K.GT.0.0D0) Go to 800
      Write (6, 19)
      Go to 3000
  800 If (M.GT.3) Go to 1005
      Write (6,411)
      Go to 3000
 1005 Check = K
      ISW = 0
  904 DELTA = 0.01
      Switch = -1.0
      L = 0
      ILK = 0
      Write (6,408)
C
C     This part of the program calculates until a phi is found either side
           of 0
C
      Call Phical (PHI, MI, IA, IC, K, NN, XBAR)
      Write (6,5) K, PHI, L, ILK
      A = K - JELTA
  900 Continue
      Call Phical (C, MI, IA, IC, A, NN, XBAR)
      Write (6,5) A, C, L, ILK
      If (DABS(C).GT.DABS(PHI))  SWITCH = -SWITCH
      If (PHI*C) 22, 24, 26
   22 B = K
      D = PHI
      Go to 34
   26 If (PHI.LT.0.0D0)   Go to 92
      Phi = DMIN1(PHI,C)
      If(PHI.EQ.C)   K = A
      Go to 94
   92 PHI = DMAX1(PHI,C)
      If(PHI.EQ.C)   K = A
   94 Delta = 2.*Delta
      A = K + Delta*Switch
      if(A.LE.0.0D0) A = 0.000001
      ILK = ILK + 1
      If (ILK.LE.20)   Go to 900
      If(ISW.EQ.1) Go to 32
      ISW = 1
      K = 6.0
      Go to 904
   32 Write (6,9)
      Write (6,7)  (IA(I),I = 1,M)
      Go to 3000
C
C     This part of the program then iterates on K in the - region
C
```

```
     34 Call POLATE (A, B, C, D, K)
     30 Call PHICAL (PHI, MI, IA, IC, K, NN, XBAR)
        L = L + 1
        Write (6,5) K, PHI, L, ILK
     36 If (DABS(Check-K).LE.EXPO  *K)   Go to 24
        Check = K
        If (L.GE.MMM)   Go to 24
        If(PHI*D)   82,24,86
     82 A = K
        C = Phi
        Go to 34
     86 B = K
        D = PHI
        Go to 34
C
C       Now for calculation of expected values and chi square
C
     24 Write (6,15)
        P = XBAR/K
        PP(LL) = P
        KK(LL) = K
        R = P/(1.+P)
        EX(1) = NN  /(1.+P)**K
        XX = EX(1)
        Do 80 I = 2,MI
        Ex(I) = (K+I-2)*R*EX(I-1)/(I-1)
     80 XX = XX + EX(I)
        EX(M) = NN - XX
        IDF=MI-2
        Call CHICAL (EX, IA, JILT, M, MI, CHI, IDF)
        Call CHISQ (CHI, IDF, AZ)
        NBCHI(LL) = AZ
        NBDF(LL)=IDF
        Do 402 I = 1, M
        ILL = I -1
    402 Write (6,11) ILL,IA(I),EX(I),IC(I)
    406 Write (6,13) CHI,P,K,JILT,IDF,AZ
   3000 IRDO = 5
        IWR = 6                                                    Main 83
        Call POSBI (IA,M,NN,SMLLN,XBAR,NN,SS,IRDO,IWR,X,IDF,P,AZ)
C       ***************************************************************************
        PBDF(LL)=IDF
        PBAZ(L)=AZ
        PBP(LL)=P
   1000 Continue
        Write (6,403)
        Do 700 I = 1,N
        L1=3
        L2=3
        L3=3
```

```
      If(NBCHI(I).LT.0.05)    L1=1
      If(NB-HI(I).LT.0.01)    L1=2
      If(POICHI(I).LT.0.05)   L2=1
      If(POICHI(I).LT.0.01)   L2=2
      If(PBAZ(I).LT.0.05)     L3=1
      If(PBAZ(I).LT.0.01)     L3=2
      If(NSW.EQ.1)  Go to 440
      If(L2.EQ.3)   Go to 330
      If(L2.NE.3)   Go to 440
  330 Write (6,405) I,XXBAR(I),XSS(I),MM(I),NNN(I),PDE(I),POICHI(I),ISTAR
     1(L2)
      Go to 700
  440 If (KK(I).GT.0.0D0) Go to 442
      Write (6,409) I,XXBAR(I),XSS(I),MM(I),NNN(I),PDE(I),POICHI(I),ISTAR
     1(L2),PBDF(I),PBP(I),PBAZ(I),ISTAR(L3)
      Go to 700
  442 Write (6,405) I,XXBAR(I),XSS(I),MM(I),NNN(I),PDF(I),POICHI(I),ISTAR
     1(L2),PP(I),KK(I),NBDF(I),NBCHI(I),ISTAR(L1),PBDF(I),PBP(I),PBAZ(I)
     3,ISTAR(L3)
      Go to 70J
  770 Continue
      Stop
    1 Format (2014)
    3 Format ( T10,' Sum=',I10,4X,' SS=',I10,4X,'Variance=',G14.6,4X,
     X'Mean=',G14.6//)
    5 Format(T10,' Estimate of K is ', G14.6,4X,  ' Phi Evaluation
     X is',G14.6,10X,'L=',14,10X,'ILK=',14)
    7 Format(T10,'Data Follow',2015)
    9 Format (///T10,'Help,Help,Help,Phi Doesn't Cross 0'///)
   11 Format(T10,'Class=', 14,4X, 'No. of observations=',16,4X,' Expect
     led Frequency=',G14.6,4X,'Backward cumulative frequency=',16)
   13 Format(//,T10,'Chi Square=',G14.6,4X,'Final Estimates of P=',
     XG14.6,4X,'and K=',G14.6/T10,'no. of tail classes combined for chi
     Ysquare=',14,4X,'D.F. Therefore=',14,4X,'Prob. of exceeding this V.
     Zalue=',F10.4)
   15 Format(// T20,'Summary of In- and Output Follows'//)
   17 Format(TJ0,'Problem No.=',16,4X,'Has",16,'  cells and total
          frequency =',16//)
  301 Format (10A8)
  303 Format(1H1,T10,10A8)
  401 Format (/T9,'Chi Sq.=',G14.6,4X,'D.F.=',14,4X,'Prob. of Exceeding=
          ',F6.4/T9,'No of Tail Classes Combined for Chi Sq.=',14/)
   19 Format(TJ0,'Mean Exceeds the Variance'//)
  403 Format('1 Summary Table of the Fitted Distributions'//'   General
          Statistics      Poisson         Negative Binomial
          Positive Binomial'/' Line Mean Variance No. Cells D.F. Chis
          Q.Prob.     P     K    D.F. Chisq. Prob. D.F. P. Chisq.
          Prob.'//)
  405 Format(I4,F7.3,F8.3,I4,I5,I4,F9.4,A4,F7.4,G13.6,I4,E9.4,A4,I4,F7.4
     F9.4,A4)
  407 Format (///1H0,52X,26H Calculation of the Poisson//)
  408 Format (///1H0,47X,36H Calculation of the Negative Binomial//)
```

```
409 Format(I4,F7.3,F8.3,I4,I5,I4,F9.4,A4,37X,I4,F7.4,F9.4,A4)
411 Format(//' D.F. are less than or equal to 0 for the negative
        binomial therefore no calculations will be attempted'//)
    End
```

APPENDIX III

STATISTICAL TESTS USED

1. Chi-square Test

$$\chi^2 = \frac{(O - E)^2}{E}$$

where O = the observed frequency

E = the expected frequency, derived as follows:

$$E = \frac{(\text{row total})\ (\text{column total})}{\text{overall total}}$$

2. Student "t" Test

$$t = \frac{\bar{X}_1 - \bar{X}_2}{\sqrt{\frac{(N_1 - 1)s_1^2 + (N_2 - 1)s_2^2}{N_1 + N_2 - 2}} \cdot \sqrt{\frac{1}{N_1} + \frac{1}{N_2}}}$$

3. Kruskal - Wallis One Way Analysis of Variance By Ranks

$$H' = \frac{H}{C}$$

where $$H = \frac{12}{N(N+1)} \left[\sum_{j=1}^{k} \frac{\left(\sum_{i=1}^{n} R_{ij} \right)^2}{n_j} \right] - 3(N+1)$$

$$C = 1 - \left[\frac{\sum (t^3 - t)}{N^3 - N} \right]$$

t refers to the number of tied observations in a tied group of numbers. For example, there are two sets of tied observations containing two numbers, four sets containing three numbers, etc.

APPENDIX IV

PROBABILITY SERIES FOR NEW SETTLING
MATRICES: 1936-1949, 1949-1973

1936-1949

Quadrat Size: 0.31 Square Mile

Frequency	Observed	Expected Poisson
0	2845	2813.3000
1	256	301.0080
2	20	16.1031
3	6	0.5743
4	3	0.0153
5	0	0.0003
6	0	0.0000
7	0	0.0000
8	0	0.0000
9	1	0.0000

Variance-mean Ratio: 1.442
Chi Square: 17.6945; Degrees Freedom: 1

Quadrat Size: 0.43 Square Mile

Frequency	Observed	Expected Poisson
0	1964	1928.0800
1	238	283.9470
2	18	20.9084
3	9	1.0263
4	1	0.0377
5	3	0.0011
6	0	0.0000
7	0	0.0000
8	0	0.0000
9	1	0.0000

Variance-mean Ratio: 1.564
Chi Square: 165.557; Degrees Freedom: 2

Quadrat Size: 1 Square Mile

Frequency	Observed	Expected Poisson
0	751	704.3740
1	174	229.0120
2	32	37.2291
3	7	4.0347
4	5	0.3279
5	2	0.0213
6	2	0.0011
7	1	0.0000
8	0	0.0000
9	1	0.0000

Variance-mean Ratio: 1.875
Chi Square: 59.3051; Degrees Freedom: 2

Quadrat Size: 2 Square Miles

Frequency	Observed	Expected Poisson
0	284	256.4760
1	132	163.4040
2	48	52.0536
3	13	11.0547
4	3	1.7607
5	2	0.2243
6	2	0.0238
7	0	0.0021
8	1	0.0001

Variance-mean Ratio: 1.550
Chi Square: 27.4786; Degrees Freedom: 3

Quadrat Size: 3 Square Miles

Frequency	Observed	Expected Poisson
0	144	129.5000
1	106	115.1110
2	39	51.1606
3	14	15.1587
4	8	3.3686
5	3	0.5988
6	0	0.0887
7	1	0.0126

Variance-mean Ratio: 1.401
Chi Square: 20.7835; Degrees Freedom: 3

Quadrat Size: 4 Square Miles

Frequency	Observed	Expected Poisson
0	76	64.7721
1	81	82.6403
2	44	52.7188
3	17	22.4206
4	8	7.1514
5	1	1.8248
6	0	0.3880
7	2	0.0707
8	2	0.0112
9	1	0.0018

Variance-mean Ratio: 1.670
Chi Square: 10.8033; Degrees Freedom: 4

1949-1973

Quadrat Size: 0.31 Square Mile

Frequency	Observed	Expected Poisson
0	2952	2910.4400
1	134	203.2920
2	24	7.0999
3	9	0.1653
4	1	0.0028
5	1	0.0000

Variance-mean Ratio: 1.545
Chi Square: 130.023; Degrees Freedom: 1

Quadrat Size: 0.43 Square Mile

Frequency	Observed	Expected Poisson
0	2074	2024.1300
1	117	196.0590
2	26	9.4952
3	8	0.3065
4	3	0.0074
5	1	0.0001
6	1	0.0000

Variance-mean Ratio: 1.765
Chi Square: 119.974; Degrees Freedom: 1

Quadrat Size: 1 Square Mile

Frequency	Observed	Expected Poisson
0	849	791.1490
1	93	170.1650
2	21	18.3002
3	8	1.3120
4	5	0.0705
5	1	0.0030
6	3	0.0001
7	0	0.0000
8	0	0.0000
9	1	0.0000

Variance-mean Ratio: 2.360
Chi Square: 238.817; Degrees Freedom: 2

Quadrat Size: 2 Square Miles

Frequency	Observed	Expected Poisson
0	365	317.1600
1	82	134.7110
2	18	28.6088
3	9	4.0504
4	3	0.4301
5	3	0.0365
6	2	0.0025
7	2	0.0001
8	1	0.0000

Variance-mean Ratio: 2.454
Chi Square: 84.7940; Degrees Freedom: 2

Quadrat Size: 3 Square Miles

Frequency	Observed	Expected Poisson
0	198	165.6990
1	77	106.9700
2	28	34.5284
3	4	7.4301
4	1	1.1991
5	2	0.1548
6	2	0.0166
7	1	0.0015
8	1	0.0001
9	2	0.0000

Variance-mean Ratio: 2.489
Chi Square: 59.9075; Degrees Freedom: 3

Quadrat Size: 4 Square Miles

Frequency	Observed	Expected Poisson
0	137	97.5493
1	52	84.5147
2	24	36.6109
3	8	10.5730
4	1	2.2900
5	3	0.3968
6	2	0.0572
7	4	0.0070
8	0	0.0007
9	0	0.0000
10	0	0.0000
11	0	0.0000
12	0	0.0000
13	0	0.0000
14	0	0.0000
15	0	0.0000
16	0	0.0000
17	0	0.0000
18	1	0.0000

Variance-mean Ratio: 3.641
Chi Square: 58.1523; Degrees Freedom: 3

APPENDIX V

PROBABILITY SERIES FOR ABANDONMENT
MATRICES: 1936-1949, 1949-1973

1936-1949

Quadrat Size: 0.31 Square Mile

Frequency	Observed	Expected Poisson
0	2234	2134.8700
1	651	817.5390
2	196	156.5360
3	44	19.9816
4	6	2.0693

Variance-mean Ratio: 1.224
Chi Square: 84.8139; Degrees Freedom: 3

Quadrat Size: 0.43 Square Mile

Frequency	Observed	Expected Poisson
0	1353	1313.1900
1	632	697.7430
2	200	185.3670
3	42	32.8306
4	6	4.3610
5	1	0.5078

Variance-mean Ratio: 1.095
Chi Square: 12.0502; Degrees Freedom: 3

Quadrat Size: 1 Square Mile

Frequency	Observed	Expected Poisson
0	271	289.4780
1	367	351.5300
2	239	213.4420
3	68	86.3983
4	21	26.2296
5	7	6.3704

Frequency	Observed	Expected Poisson
6	1	1.2893
7	0	0.2236
8	0	0.0339
9	0	0.0045
10	1	0.0006

Variance-mean Ratio: 0.967
Chi Square: 10.0727; Degrees Freedom: 5

Quadrat Size: 2 Square Miles

Frequency	Observed	Expected Poisson
0	58	47.3883
1	114	110.2140
2	110	128.1670
3	101	99.3624
4	51	57.7736
5	30	26.8737
6	17	10.4170
7	0	3.4610
8	3	1.0062
9	0	0.2600
10	0	0.0604
11	1	0.0157

Variance-mean Ratio: 1.181
Chi Square: 19.1479; Degrees Freedom: 7

Quadrat Size: 3 Square Miles

Frequency	Observed	Expected Poisson
0		10.6264
1		36.0489
2		61.1462
3		69.1443
4		58.6413
5		39.7870
6		22.4956
7		10.9020
8		4.6230
9		1.7425
10		0.5911
11		0.1823
12		0.0515

Frequency	Observed	Expected Poisson
13		0.0134
14		0.0041

Variance-mean Ratio: 1.449
Chi Square: 32.2447; Degrees Freedom: 8

Quadrat Size: 4 Square Miles

Frequency	Observed	Expected Poisson
0	2	1.9060
1	11	9.1521
2	26	21.9730
3	27	35.1695
4	48	42.2185
5	44	40.5444
6	26	32.4471
7	23	22.2575
8	8	13.3593
9	8	7.1275
10	4	3.4224
11	2	1.4939
12	0	0.5977
13	1	0.2208
14	0	0.0757
15	2	0.0343

Variance-mean Ratio: 1.226
Chi Square: 10.5018; Degrees Freedom: 10

1949-1973

Quadrat Size: 0.31 Square Mile

Frequency	Observed	Expected Poisson
0	1967	1920.4800
1	856	931.9270
2	246	226.1120
3	43	36.5740
4	5	4.4369
5	1	0.4306
6	2	0.0373

Variance-mean Ratio: 1.102
Chi Square: 12.1440; Degrees Freedom: 3

Quadrat Size: 0.43 Square Mile

Frequency	Observed	Expected Poisson
0	1162	1135.5500
1	727	766.3660
2	261	258.6060
3	68	58.1766
4	9	9.8156
5	2	1.3249
6	1	0.1647

Variance-mean Ratio: 1.061
Chi Square: 5.91859; Degrees Freedom: 4

Quadrat Size: 1 Square Mile

Frequency	Observed	Expected Poisson
0	212	210.4200
1	305	322.6440
2	261	247.3600
3	143	126.4280
4	39	48.4642
5	9	14.8624
6	4	3.7981
7	2	1.0234

Variance-mean Ratio: 0.960
Chi Square: 9.00407; Degrees Freedom: 6

Quadrat Size: 2 Square Miles

Frequency	Observed	Expected Poisson
0	35	24.1467
1	76	72.4402
2	101	108.6600
3	105	108.6600
4	72	81.4952
5	45	48.8971
6	25	24.4486
7	13	10.4780
8	9	3.9292
9	4	1.8444

Variance-mean Ratio: 1.221
Chi Square: 16.8160; Degrees Freedom: 8

Quadrat Size: 3 Square Miles

Frequency	Observed	Expected Poisson
0	9	3.6811
1	26	16.3902
2	37	36.4889
3	45	54.1560
4	53	60.2829
5	41	53.6823
6	46	39.8370
7	25	25.3394
8	16	14.1030
9	10	6.9771
10	4	3.1065
11	3	1.2574
12	0	0.4665
13	1	0.2313

Variance-mean Ratio: 1.307
Chi Square: 23.6685; Degrees Freedom: 10

Quadrat Size: 4 Square Miles

Frequency	Observed	Expected Poisson
0	2	0.4459
1	4	2.7890
2	13	8.7217
3	15	18.1829
4	29	28.4303
5	39	35.5624
6	36	37.0697
7	25	33.1208
8	25	25.8935
9	7	17.9940
10	16	11.2540
11	8	6.3987
12	7	3.3349
13	5	1.6044
14	1	1.1974

Variance-mean Ratio: 1.287
Chi Square: 24.1734; Degrees Freedom: 12

APPENDIX VI

PROBABILITY SERIES FOR STABILITY
MATRICES: 1936-1949, 1949-1973

1936-1949

Quadrat Size: 0.31 Square Mile

Frequency	Observed	Expected Poisson
0	1743	1679.0500
1	970	1046.2600
2	334	325.9740
3	70	67.7073
4	6	10.5475
5	2	1.3144
6	1	0.1365
7	1	0.0121
8	0	0.0009
9	1	0.0000
10	0	0.0000
11	0	0.0000
12	1	0.0000
13	0	0.0000
14	1	0.0000
15	0	0.0000
16	0	0.0000
17	0	0.0000
18	0	0.0000
19	0	0.0000
20	0	0.0000
21	1	0.0000

Variance-mean Ratio: 1.442
Chi Square: 39.4046; Degrees Freedom: 4

Quadrat Size: 0.43 Square Mile

Frequency	Observed	Expected Poisson
0	982	945.4460
1	780	812.9820
2	339	349.5380
3	110	100.1890

Frequency	Observed	Expected Poisson
4	12	21.5378
5	5	3.7040
6	2	0.5308
7	2	0.0652
8	0	0.0070
9	0	0.0006
10	0	0.0000
11	0	0.0000
12	0	0.0000
13	1	0.0000
14	0	0.0000
15	0	0.0000
16	0	0.0000
17	0	0.0000
18	0	0.0000
19	0	0.0000
20	0	0.0000
21	1	0.0000

Variance-mean Ratio: 1.339
Chi Square: 18.6498; Degrees Freedom: 4

Quadrat Size: 1 Square Mile

Frequency	Observed	Expected Poisson
0	104	137.3370
1	265	269.1800
2	319	263.7970
3	206	172.3470
4	64	84.4502
5	9	33.1045
6	2	10.8141
7	0	3.0279
8	2	0.7418
9	1	0.1615
10	0	0.0316
11	0	0.0056
12	1	0.0009
13	0	0.0000
14	1	0.0000
15	0	0.0000
16	0	0.0000
17	0	0.0000
18	0	0.0000
19	0	0.0000
20	0	0.0000
21	0	0.0000

Frequency	Observed	Expected Poisson
22	0	0.0000
23	0	0.0000
24	0	0.0000
25	0	0.0000
26	0	0.0000

Variance-mean Ratio: 1.150
Chi Square: 57.0059; Degrees Freedom: 6

Quadrat Size: 2 Square Miles

Frequency	Observed	Expected Poisson
0	22	11.5184
1	47	43.0811
2	78	80.5660
3	99	100.4450
4	84	93.9208
5	73	70.2566
6	36	43.7957
7	26	23.4007
8	8	10.9404
9	7	4.5466
10	1	1.7005
11	1	0.5782
12	0	0.1802
13	0	0.0518
14	0	0.0138
15	0	0.0034
16	0	0.0008
17	0	0.0001
18	0	0.0000
19	0	0.0000
20	1	0.0000
21	1	0.0000
22	0	0.0000
23	0	0.0000
24	0	0.0000
25	0	0.0000
26	1	0.0000

Variance-mean Ratio: 1.668
Chi Square: 17.3567; Degrees Freedom: 9

Quadrat Size: 3 Square Miles

Frequency	Observed	Expected Poisson
0	8	1.2083
1	8	6.7264
2	26	18.7212
3	29	34.7369
4	40	48.3404
5	54	53.8169
6	46	49.9282
7	38	39.7033
8	31	27.6258
9	16	17.0865
10	9	9.5111
11	5	4.8130
12	2	2.2326
13	0	0.9559
14	0	0.3801
15	0	0.1410
16	0	0.0490
17	1	0.0160
18	1	0.0049
19	0	0.0014
20	1	0.0004
21	0	0.0001
22	0	0.0000
23	0	0.0000
24	1	0.0000

Variance-mean Ratio: 1.569
Chi Square: 48.4289; Degrees Freedom: 12

Quadrat Size: 4 Square Miles

Frequency	Observed	Expected Poisson
0	3	0.1038
1	1	0.8010
2	5	3.0886
3	9	7.9390
4	12	15.3049
5	26	23.6039
6	29	30.3358
7	27	33.4179
8	29	32.2116
9	31	27.5989
10	23	21.2821
11	16	14.9191
12	11	9.5870
13	3	5.6867

Frequency	Observed	Expected Poisson
14	1	3.1322
15	1	1.6102
16	2	0.7760
17	1	0.3520
18	0	0.1508
19	0	0.0612
20	1	0.0235
21	0	0.0086
22	0	0.0030
23	0	0.0010
24	1	0.0004

Variance-mean Ratio: 1.351
Chi Square: 96.3282; Degrees Freedom: 13

1949-1973

Quadrat Size: 0.31 Square Mile

Frequency	Observed	Expected Poisson
0	2596	2481.1900
1	416	569.2200
2	80	65.2934
3	14	4.9930
4	4	0.2863
5	4	0.0131
6	2	0.0005
7	1	0.0000
8	2	0.0000
9	0	0.0000
10	0	0.0000
11	0	0.0000
12	1	0.0000
13	0	0.0000
14	0	0.0000
15	1	0.0000

Variance-mean Ratio: 2.067
Chi Square: 156.047; Degrees Freedom: 2

Quadrat Size: 0.43 Square Mile

Frequency	Observed	Expected Poisson
0	1728	1619.7500
1	374	517.8840
2	101	82.7917

Frequency	Observed	Expected Poisson
3	11	8.8236
4	8	0.7053
5	4	0.0451
6	1	0.0024
7	0	0.0001
8	0	0.0000
9	0	0.0000
10	1	0.0000
11	0	0.0000
12	0	0.0000
13	0	0.0000
14	0	0.0000
15	1	0.0000
16	0	0.0000
17	0	0.0000
18	0	0.0000
19	0	0.0000
20	0	0.0000
21	1	0.0000

Variance-mean Ratio: 2.355
Chi Square: 82.9140; Degrees Freedom: 2

Quadrat Size: 1 Square Mile

Frequency	Observed	Expected Poisson
0	515	475.5580
1	322	341.4260
2	98	122.5630
3	26	29.3314
4	7	5.2646
5	2	0.7559
6	0	0.0904
7	1	0.0092
8	0	0.0008
9	1	0.0000
10	0	0.0000
11	0	0.0000
12	0	0.0000
13	1	0.0000
14	1	0.0000
15	0	0.0000
16	0	0.0000
17	0	0.0000
18	0	0.0000
19	0	0.0000
20	0	0.0000

Frequency	Observed	Expected Poisson
21	0	0.0000
22	0	0.0000
23	1	0.0000

Variance-mean Ratio: 2.333
Chi Square: 19.8188; Degrees Freedom: 3

Quadrat Size: 2 Square Miles

Frequency	Observed	Expected Poisson
0	174	121.0880
1	150	168.0260
2	77	116.5790
3	43	53.9226
4	24	18.7061
5	7	5.1914
6	2	1.2006
7	3	0.2380
8	0	0.0412
9	0	0.0063
10	1	0.0008
11	0	0.0001
12	1	0.0000
13	0	0.0000
14	1	0.0000
15	1	0.0000
16	0	0.0000
17	0	0.0000
18	0	0.0000
19	0	0.0000
20	0	0.0000
21	0	0.0000
22	0	0.0000
23	0	0.0000
24	0	0.0000
25	1	0.0000

Variance-mean Ratio: 2.946
Chi Square: 91.5558; Degrees Freedom: 5

Quadrat Size: 3 Square Miles

Frequency	Observed	Expected Poisson
0	75	41.5651
1	79	84.3140
2	67	85.5147

Frequency	Observed	Expected Poisson
3	50	57.8217
4	16	29.3225
5	11	11.8960
6	8	4.0218
7	3	1.1654
8	1	0.2955
9	2	0.0666
10	1	0.0135
11	0	0.0024
12	0	0.0004
13	0	0.0000
14	0	0.0000
15	0	0.0000
16	0	0.0000
17	1	0.0000
18	1	0.0000
19	1	0.0000

Variance-mean Ratio: 2.758
Chi Square: 88.6600; Degrees Freedom: 6

Quadrat Size: 4 Square Miles

Frequency	Observed	Expected Poisson
0	24	15.6861
1	53	42.2577
2	50	56.9204
3	47	51.1138
4	26	34.4247
5	10	18.5478
6	7	8.3278
7	7	3.2049
8	1	1.0792
9	3	0.3230
10	2	0.0870
11	0	0.0213
12	0	0.0047
13	1	0.0009
14	0	0.0001
15	0	0.0000
16	0	0.0000
17	0	0.0000
18	1	0.0000
19	0	0.0000
20	0	0.0000
21	0	0.0000
22	2	0.0000

Variance-mean Ratio: 2.013
Chi Square: 46.7304; Degrees Freedom: 7

APPENDIX VII

PROBABILITY SERIES FOR RURAL SETTLEMENT
MATRICES: 1936, 1949, and 1973

1936

Quadrat Size: 0.31 Square Miles

Frequency	Observed	Expected Poisson
0	1311	1161.0300
1	946	1160.6600
2	605	580.1460
3	228	193.3210
4	45	48.3148
5	10	9.6599
6	3	1.6094
7	2	0.2298
8	0	0.0287
9	2	0.0031
10	1	0.0003
11	1	0.0000
12	0	0.0000
13	1	0.0000

Variance-mean Ratio: 1.266
Chi Square: 101.900; Degrees Freedom: 5

Quadrat Size: 0.43 Square Miles

Frequency	Observed	Expected Poisson
0	621	545.6460
1	658	769.1310
2	579	542.0750
3	255	254.6990
4	80	89.7547
5	23	25.3033
6	10	5.9445
7	2	1.1970
8	3	0.2109
9	0	0.0330
10	0	0.0046
11	2	0.0005
12	0	0.0000
13	1	0.0000

Variance-mean Ratio: 1.190
Chi Square: 62.7126; Degrees Freedom: 6

Quadrat Size: 1 Square Mile

Frequency	Observed	Expected Poisson
0	32	40.4837
1	91	128.8000
2	196	204.8920
3	280	217.2900
4	222	172.8290
5	103	109.9730
6	32	58.3137
7	8	26.5039
8	4	10.5404
9	1	3.7260
10	1	1.1854
11	0	0.3428
12	2	0.0909
13	1	0.0222
14	0	0.0050
15	1	0.0010
16	0	0.0002
17	0	0.0000
18	0	0.0000
19	0	0.0000
20	0	0.0000
21	0	0.0000
22	0	0.0000
23	0	0.0000
24	0	0.0000
25	1	0.0000

Variance-mean Ratio: 0.949
Chi Square: 88.1261; Degrees Freedom: 9

Quadrat Size: 2 Square Miles

Frequency	Observed	Expected Poisson
0	4	1.0554
1	10	6.4680
2	19	19.8183
3	45	40.4829
4	63	62.0208
5	75	76.0140
6	78	77.6369
7	55	67.9666
8	54	52.0633
9	35	35.4499
10	19	21.7240
11	9	12.1025
12	6	6.1804
13	6	2.9134
14	1	1.2752

Frequency	Observed	Expected Poisson
15	1	0.5209
16	0	0.1995
17	0	0.0719
18	1	0.0244
19	1	0.0078
20	0	0.0024
21	0	0.0007
22	1	0.0001
23	0	0.0000
24	0	0.0000
25	0	0.0000
26	0	0.0000
27	0	0.0000
28	0	0.0000
29	1	0.0000

Variance-mean Radio: 1.449
Chi Square: 24.8933; Degrees Freedom: 13

Quadrat Size: 3 Square Miles

Frequency	Observed	Expected Poisson
0	4	0.0361
1	4	0.3280
2	3	1.4887
3	4	4.5037
4	12	10.2190
5	18	18.5495
6	18	28.0590
7	38	36.3803
8	42	41.2732
9	36	41.6215
10	43	37.7755
11	31	31.1680
12	19	23.5733
13	10	16.4577
14	14	10.6692
15	8	6.4555
16	4	3.6618
17	1	1.9550
18	2	0.9857
19	1	0.4708
20	2	0.2136
21	0	0.0923
22	1	0.0380
23	0	0.0150
24	0	0.0056
25	0	0.0020
26	0	0.0007
27	0	0.0002

Frequency	Observed	Expected Poisson
28	0	0.0000
29	0	0.0000
30	0	0.0000
31	1	0.0000

Variance-mean Ratio: 1.527
Chi Square: 502.395; Degrees Freedom: 15

Quadrat Size: 4 Square Miles

Frequency	Observed	Expected Poisson
0	1	0.0007
1	0	0.0090
2	1	0.0574
3	1	0.2427
4	1	0.7701
5	2	1.9542
6	3	4.1327
7	13	7.4910
8	8	11.8811
9	13	16.7502
10	19	21.2532
11	24	24.5152
12	29	25.9213
13	30	25.2998
14	22	22.9294
15	21	19.3957
16	18	15.3812
17	9	11.4801
18	2	8.0923
19	4	5.4041
20	2	3.4284
21	1	2.0715
22	1	1.1947
23	1	0.6590
24	1	0.3484
25	0	0.1768
26	2	0.0863
27	0	0.0405
28	0	0.0183
29	0	0.0080
30	0	0.0034
31	0	0.0013
32	0	0.0005
33	0	0.0002
34	0	0.0000
35	1	0.0000

Frequency	Observed	Expected Poisson
36	0	0.0000
37	1	0.0000

Variance-mean Ratio: 1.495
Chi Square: 1448.09; Degrees Freedom: 18

1949

Quadrat Size: 0.31 Square Mile

Frequency	Observed	Expected Poisson
0	1522	1508.6800
1	1097	1101.5100
2	395	402.1180
3	105	97.8645
4	6	17.8632
5	2	2.6084
6	1	0.3174
7	0	0.0331
8	0	0.0030
9	1	0.0002
10	0	0.0000
11	0	0.0000
12	0	0.0000
13	0	0.0000
14	1	0.0000
15	0	0.0000
16	0	0.0000
17	0	0.0000
18	0	0.0000
19	0	0.0000
20	0	0.0000
21	1	0.0000

Variance-mean Ratio: 1.248
Chi Square: 11.7760; Degrees Freedom: 4

Quadrat Size: 0.43 Square Mile

Frequency	Observed	Expected Poisson
0	864	803.2930
1	777	821.6320
2	391	420.1940
3	145	143.2620
4	36	36.6332
5	12	7.4939

Frequency	Observed	Expected Poisson
6	3	1.2775
7	2	0.1866
8	0	0.0238
9	1	0.0027
10	0	0.0002
11	0	0.0000
12	1	0.0000
13	1	0.0000
14	0	0.0000
15	0	0.0000
16	0	0.0000
17	0	0.0000
18	0	0.0000
19	0	0.0000
20	0	0.0000
21	1	0.0000

Variance-mean Ratio: 1.412
Chi Square: 49.5974; Degrees Freedom: 5

Quadrat Size: 1 Square Mile

Frequency	Observed	Expected Poisson
0	81	95.4245
1	227	291.7760
2	279	257.7150
3	239	199.6520
4	82	116.0030
5	41	53.9206
6	9	20.8862
7	6	6.9345
8	2	2.0145
9	2	0.5202
10	1	0.1209
11	2	0.0255
12	1	0.0049
13	0	0.0008
14	0	0.0001
15	1	0.0000
16	0	0.0000
17	1	0.0000
18	0	0.0000
19	0	0.0000
20	0	0.0000
21	0	0.0000
22	0	0.0000
23	0	0.0000

Frequency	Observed	Expected Poisson
24	0	0.0000
25	1	0.0000

Variance-mean Ratio: 1.368
Chi Square: 57.4841; Degrees Freedom: 7

Quadrat Size: 2 Square Miles

Frequency	Observed	Expected Poisson
0	11	5.2770
1	36	23.8017
2	61	53.6779
3	84	80.7032
4	76	91.0013
5	78	82.0908
6	41	61.7106
7	40	39.7629
8	23	22.4184
9	11	11.2352
10	5	5.0675
11	8	2.0778
12	1	0.7810
13	1	0.2709
14	1	0.0873
15	0	0.0262
16	0	0.0074
17	0	0.0019
18	0	0.0004
19	0	0.0001
20	0	0.0000
21	1	0.0000
22	0	0.0000
23	0	0.0000
24	0	0.0000
25	0	0.0000
26	0	0.0000
27	2	0.0000

Variance-mean Ratio: 1.903
Chi Square: 59.9196; Degrees Freedom: 11

Quadrat Size: 3 Square Miles

Frequency	Observed	Expected Poisson
0	1	0.4306
1	7	2.8417

Frequency	Observed	Expected Poisson
2	17	9.3751
3	28	20.6193
4	28	34.0120
5	43	44.8830
6	48	49.3571
7	41	46.5233
8	35	38.3707
9	18	28.1304
10	22	18.5607
11	13	11.1332
12	1	6.1215
13	1	3.1069
14	4	1.4642
15	2	0.6441
16	2	0.2656
17	1	0.1030
18	1	0.0377
19	0	0.0131
20	0	0.0043
21	0	0.0013
22	0	0.0004
23	1	0.0001
24	0	0.0000
25	1	0.0000
26	0	0.0000
27	1	0.0000

Variance-mean Ratio: 1.855
Chi Square: 86,8961; Degrees Freedom: 13

Quadrat Size: 4 Square Miles

Frequency	Observed	Expected Poisson
0	1	0.0235
1	1	0.2168
2	4	0.9967
3	5	3.0546
4	6	7.0210
5	13	12.9102
6	25	19.7826
7	21	25.9830
8	31	29.8608
9	31	30.5044
10	23	28.0456
11	17	23.4410
12	20	17.9596
13	13	12.7015
14	7	8.3412

Frequency	Observed	Expected Poisson
15	4	5.1126
16	0	2.9378
17	4	1.5888
18	1	0.8115
19	2	0.3926
20	0	0.1805
21	0	0.0790
22	0	0.0330
23	0	0.0132
24	0	0.0050
25	0	0.0018
26	0	0.0006
27	1	0.0002
28	0	0.0000
29	1	0.0000
30	0	0.0000
31	0	0.0000
32	1	0.0000

Variance-mean Ratio: 1.788
Chi Square: 72.6849; Degrees Freedom: 15

1973

Quadrat Size: 0.31 Square Mile

Frequency	Observed	Expected Poisson
0	2439	2288.7300
1	515	709.8650
2	119	110.0850
3	23	11.3812
4	11	0.8824
5	6	0.0547
6	4	0.0028
7	0	0.0001
8	1	0.0000
9	0	0.0000
10	0	0.0000
11	1	0.0000
12	1	0.0000
13	0	0.0000
14	0	0.0000
15	0	0.0000
16	0	0.0000
17	1	0.0000

Variance-mean Ratio: 2.052
Chi Square: 167.394; Degrees Freedom: 2

Quadrat Size: 0.43 Square Mile

Frequency	Observed	Expected Poisson
0	1618	1462.9800
1	427	616.6830
2	134	129.9740
3	22	18.2624
4	12	1.9245
5	8	0.1622
6	2	0.0113
7	2	0.0006
8	2	0.0000
9	0	0.0000
10	1	0.0000
11	0	0.0000
12	0	0.0000
13	0	0.0000
14	0	0.0000
15	0	0.0000
16	0	0.0000
17	0	0.0000
18	1	0.0000
19	0	0.0000
20	0	0.0000
21	1	0.0000

Variance-mean Ratio: 2.468
Chi Square: 420.449; Degrees Freedom: 3

Quadrat Size: 1 Square Mile

Frequency	Observed	Expected Poisson
0	439	371.0430
1	325	358.0910
2	130	172.7960
3	52	55.5879
4	12	13.4119
5	4	2.5887
6	4	0.4163
7	2	0.0574
8	0	0.0069
9	0	0.0007
10	1	0.0000
11	0	0.0000
12	1	0.0000
13	1	0.0000
14	0	0.0000
15	2	0.0000

Frequency	Observed	Expected Poisson
16	0	0.0000
17	0	0.0000
18	0	0.0000
19	0	0.0000
20	0	0.0000
21	0	0.0000
22	0	0.0000
23	0	0.0000
24	0	0.0000
25	0	0.0000
26	0	0.0000
27	0	0.0000
28	1	0.0000

Variance-mean Ratio: 2.745
Chi Square: 80.9335; Degrees Freedom: 4

Quadrat Size: 2 Square Miles

Frequency	Observed	Expected Poisson
0	142	76.7728
1	141	141.5150
2	82	130.4270
3	53	80.1389
4	32	36.9300
5	13	13.6146
6	8	4.1826
7	2	1.1014
8	4	0.2537
9	1	0.0519
10	1	0.0095
11	1	0.0016
12	0	0.0002
13	0	0.0000
14	0	0.0000
15	0	0.0000
16	0	0.0000
17	2	0.0000
18	1	0.0000
19	0	0.0000
20	0	0.0000
21	0	0.0000
22	0	0.0000
23	0	0.0000
24	0	0.0000
25	0	0.0000
26	0	0.0000

Frequency	Observed	Expected Poisson
27	0	0.0000
28	0	0.0000
29	0	0.0000
30	1	0.0000
31	1	0.0000

Variance-mean Ratio: 4.306
Chi Square: 198.341; Degrees Freedom: 6

Quadrat Size: 3 Square Miles

Frequency	Observed	Expected Poisson
0	60	22.0729
1	67	58.7446
2	64	78.1712
3	50	69.3481
4	36	46.1406
5	12	24.5597
6	2	10.8938
7	6	4.1418
8	6	1.3778
9	1	0.4074
10	3	0.1084
11	3	0.0262
12	0	0.0058
13	0	0.0011
14	0	0.0002
15	1	0.0000
16	1	0.0000
17	0	0.0000
18	0	0.0000
19	1	0.0000
20	0	0.0000
21	0	0.0000
22	1	0.0000
23	2	0.0000

Variance-mean Ratio: 3.922
Chi Square: 242.280; Degrees Freedom: 7

Quadrat Size: 4 Square Miles

Frequency	Observed	Expected Poisson
0	16	6.3445
1	40	22.8350
2	45	41.0931

Frequency	Observed	Expected Poisson
3	41	49.2999
4	38	44.3593
5	13	31.9311
6	10	19.1541
7	8	9.8483
8	8	4.4306
9	4	1.7718
10	2	0.6377
11	1	0.2086
12	2	0.0625
13	1	0.0173
14	0	0.0044
15	0	0.0010
16	0	0.0002
17	0	0.0000
18	0	0.0000
19	1	0.0000
20	0	0.0000
21	0	0.0000
22	0	0.0000
23	0	0.0000
24	0	0.0000
25	0	0.0000
26	1	0.0000
27	0	0.0000
28	0	0.0000
29	0	0.0000
30	0	0.0000
31	0	0.0000
32	0	0.0000
33	0	0.0000
34	0	0.0000
35	0	0.0000
36	1	0.0000

Variance-mean Ratio: 3.867
Chi Square: 88.3035; Degrees Freedom: 8

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Mrs. Ruth Freeman, Librarian, Carnegie Library, Hobart, Oklahoma, May 1976.

Mr. Harold Graves, Farm-to-Market Road Engineer, Oklahoma Department of Highway, Oklahoma City, November 1972, July 1973 and July 1976.

Mr. Charles Gray, Mountain Park, Oklahoma, May 1976.

Mr. Dewey Harris, Public Service Company, Hobart, Oklahoma, June 1976.

Mrs. Gertrude McBride, 729 Oklahoma Street, Mountain View, Oklahoma, May 1976.

Mr. and Mrs. J. W. McConnell, 600 North Broadway, Hobart, Oklahoma, May 1976.

Mr. Virgil Morris, Gotebo, Oklahoma, June 1974.

Mr. Clifford Nelms, Rural Transportation Planning Engineer, Oklahoma Department of Highways, Oklahoma City, Oklahoma, November 1972 and July 1973.

Mr. Nicholas Petkoff, County Commissioner-District 2, Kiowa County Court House, Hobart, Oklahoma, May 1976.

Mr. Frank Pirez, Supervisory Highway Engineer, Roads Department, Bureau of Indian Affairs, Anadarko, Oklahoma, June 1976.

Mr. D. H. Ragland, County Commissioner-District 1, Mountain View, Oklahoma, May 1976.

Mr. Leon Richardson, County Commissioner-District 3, Snyder, Oklahoma, May 1976.

Mr. Joe Reynolds, Grand Avenue, Weatherford, Oklahoma, January 1974.

Mr. and Mrs. Life Smith, Main Street, Roosevelt, Oklahoma, June 1976.

Mrs. Minnie Mae Smith, Elm Street, Weatherford, Oklahoma, June 1976.

Mr. and Mrs. Pete Williams, Cooperton, Oklahoma, June 1976.

Mr. Ray Williams, Main Street, Hobart, Oklahoma, June 1976.

Mr. Steve Willis, Eighth Street, Snyder, Oklahoma, June 1976.

Mr. O. P. Wilson, County Engineer, Kiowa County Court House, Hobart, Oklahoma, December 1972, January 1973, July 1973 and August 1973.

Mr. and Mrs. Fred Watkins, Washington Street, Hobart, Oklahoma, June 1976.