BURGLARY: AN ECOLOGICAL AND AERIAL PHOTOGRAPHIC ANALYSIS

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PREFACE

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CHAPTER I

INTRODUCTION

Background

The majority of intra-urban criminological research that has accumulated since 1800 was conducted in a geographic frame of reference. Spatial relationships between crime, criminals, or delinquents and other phenomena have been analyzed by sociologists, criminologists, psychologists, and recently be geographers. One of the earliest interests of scholars in criminology involved determination of the spatial distribution of residences of delinquents. This interest endured as fundamental to many criminological works of the twentieth century. Yet these works went a step further by attempting to explain delinquency through ecological correlates. The results of this approach were significant for a nexus was discovered between the urban ecological system and delinquent behavior.

Recently several new directions of criminology have prompted additions to criminological theory. Among the most important directions are:

Smaller Geographic Units

1. The geographic unit of study employed by crime studies of the past several decades has gradually become smaller over time. Several modern criminologists have investigated crime

at the city block level and by individual offense location (9) (10) (14) (67).

Crime Specific Studies

2. A wave of recent articles emphasized the analysis of specific crimes, as opposed to delinquents and criminals. Armed robbery, burglary, and homicide have been the subjects of significant works (16) (35) (55).

Risk Related Rates

3. The development and use of risk-related based crime rates has been discussed and is now undergoing a rigorous investigation in Oklahoma (7) (48). The purpose of risk rates is to measure crime occurrences as a ratio to the number of possible targets or risk unit surrogates.

Physical Correlates

4. Perhaps the most prominent of the modern movements is the expansion of ecological correlates to include urban physical-environmental variables. Housing types, land use, street patterns and architectural design have been scrutinized for their impact on crimes and criminal behavior. The advocates of this research thrust contend that urban areas with certain physical characteristics may be high crime-risk areas (10) (32) (44).

Most contemporary criminologists acknowledge the occurrence of crime as a response to a complex interaction between social and physical conditions (27). Taken together, the innovative findings of modern crime ecologists have suggested the pooling of criminological perspectives with those from other relevant professions. Criminology might have much to gain by continuing to merge concepts with urban planning and architecture to examine the associations between specific crimes and characteristics of the urban environment. This disciplinary merging is more meaningful in regard to property crimes than to crimes against the person. The targets of property crime are fixed structures, such as residences, which are permanent components of the urban ecological system. More experimentation is needed to examine the spatial distributions of property crimes and their relationship with the urban physical and socio-economic environments. The overriding objective of property crime research should be to discover crime-area indicators that may help planners, architects, police, and possible victimes to predict the occurrence of and thus defend against crime. It has been stated that prediction, depending on the level of its reliability, may be the most valuable end-product of any social science investigation (27).

The reliability of crime-risk area prediction is a direct derivative of the quality of the crime and urban data utilized. Approximately one-half to two-thirds of all crimes go unreported, but the crimes reported form a sufficient sample for most investigations. Police department data recording and storage techniques have become computerized and more efficient. However, the quality of the urban socio-economic and urban physical data traditionally utilized is often inferior. The usual source of socio-economic data is the questionnaire and interview administered by planning agencies and the United States Bureau of Census. Urban physical data such as dwelling unit counts, housing types, and land use information are often collected through time-consuming on-site inspections conducted by local planning agencies (68). The lengthy time lag between data acquisition, the often unreliable results, plus the cost warrant the need for a new approach to urban data acquisition.

Since high quality socio-economic and property data are critical needs in any attempt to improve urban life, techniques essential for rapid retrieval of up-to-date information need more attention. Aerial photography has been recognized as a potential data source for the rapid and economical collection of information on residential conditions. For example, a considerable amount of research has been published in which urban land use types and blighted urban areas have been successfully identified with aerial photography. Few scientists however have explored the use of aerial photography for surrogate socio-economic data collection. The concept of determining interior housing conditions and resident characteristics from outward appearances is conceptually weak. Nevertheless several aerial photographic interpreters have discovered that certain socio-economic conditions are contained and characterized by certain observable external qualities (22) (30) (40).

A need exists for crime research that would contribute to the current phase of crime-research evolution. Such research should be characterized by:

1. a relatively small geographic unit of study, such as a city block;
2. the investigation of specific property crime occurrences and

their physical and socio-economic correlates;

3. an evaluation of various crime measurement methods; and
4. the exploration of alternatives to traditional urban data collection techniques.

Problem Statements and Hypotheses

This thesis was formulated in an attempt to contribute to modern ecological crime research. It has become widely accepted by criminologists that certain urban residential areas with specific socio-economic and physical characteristics may be high property-crime-risk areas. That is, urban residential areas with a high probability of property-crime occurrence may be located by and may be characterized by identifiable conditions. It is not fully known, however, which urban conditions might be predictors of property crimes at the neighborhoods or block level. This thesis analyzes in Oklahoma City the block-level relationship between ecological conditions and residential burglary. Residential burglary was selected as the property crime to undergo analysis because: (1) the targets are relatively immobile; (2) national residential burglary rates have risen at a faster rate than commercial burglary rates; and (3) residential burglary is regarded as the most feared and resented crime by the American public (13). The variables which composed the explanatory ecological conditions were utilized, in two sets: (1) an indicator of residential physical conditions developed from three variables; and (2) an indicator of socio-economic conditions developed from four variables.

Specifically, this analysis determines the relation between selected socio-economic and physical data on one hand, and residential burglary on the other. The scale of analysis was city blocks (as defined by the 1970 U.S. Census) and the temporal frame a nineteen month period. The chief goal of the analysis is to contribute to an understanding of differential residential burglary rates by city blocks and by various burglary measurement techniques. It also seeks to aid in the prediction and control of residential burglary. An attempt is made to clarify the following problems:

1. To what extent do residential burglary rates, measured by raw frequency and also as a ratio of population and dwelling units, vary among city blocks within selected, non-contiguous areas of Oklahoma City?
2. To what extent do the three measures of residential burglary vary among one another at the block level in each of the three study areas, and can the variances be explained?
3. What are the relationships between an indicator of residential physical conditions and the corresponding residential burglary rates and frequencies? The indicator is comprised of dwelling unit density, prevalence of detached (single-family) dwelling units, and a land use index.
4. What are the relationships between an indicator of residential socio-economic conditions and the corresponding residential burglary rates and frequencies? The indicator is comprised of prevalence of young people, prevalence of female household heads with children, net household migration, and an income index.

5. Which ecological indicator (socio-economic or physical), mapped by census city block, is more closely associated with the spatial distribution of residential burglary rates and frequencies?
6. To what extent can the results of this research help in understanding the differential burglary rates by city block?

Based on previous research, several hypotheses were developed. It was expected that the spatial distributions resulting from the three burglary measurement techniques would be significantly different. Moreover, the results from measuring burglary by dwelling units were expected to contradict some rooted beliefs concerning which Oklahoma City blocks were high burglary blocks. It also was hypothesized that neither the physical nor the socio-economic indicator would be significantly stronger in explaining the various burglary patterns.

A subordinate objective of this research was to determine if aerial photography might be used effectively as an assessment technique for ecological data collection. Medium scale (1:30,000) black-and-white prints and large scale (1:4,800) blue-line prints were tested for their usefulness in the identification of the three physical variables and the four socio-economic variables. Urban physical data by definition are visible data; they can be obtained by surveying an urban area and many physical variables have been satisfactorily estimated from aerial photography. A relatively unexplored research vein is the investigation of aerial photography for its feasibility in indirect socio-economic data collection. Aerial photographic data are not socio-economic, yet they may be pertinent to this research if strong correlations are discovered between residential physical conditions and residential socio-economic conditions. Therefore additional hypotheses are: (1) the three physical variables may be satisfactorily estimated from one or both of the two formats of aerial photography; (2) a strong positive relationship exists in the three study areas in Oklahoma City between the residential physical conditions and the residential socio-economic conditions at the block level.

Variables and Definitions

The selection of the ecological variables used to formulate the socio-economic and physical sets was based on data availability and previous crime ecology studies. The major consideration was to extract variables from accessible data sets that, when taken together, would provide a fair representation of the total urban environment. Furthermore, it was considered advantageous if the variables had been shown in previous research to be strongly associated with burglary. Consequently, the physical set consisted of three variables, each variable represented a different aspect of the physical urban environment. When it was determined that the three variables could be satisfactorily estimated from one or both formats of aerial photography, the optimum format was used to acquire the physical values used in the entire study. The following is a description of the physical variables extracted from the aerial photography and subsequently used to formulate the urban physical condition indicator.

1. Land use index: Each census city block in each of the three, non-contiguous study areas was assigned a value of one through

six (six was the most desirable) that indicated each block's desirability rating in terms of the land uses on and around the block. The assumption that certain land uses, such as industrial activity, have undesirable effects on living conditions of residential areas was considered to be evident in Oklahoma City. The process of arriving at the land use index is illustrated with hypothetical values in Table I. Table I shows that the assignments of an index to a block was subjective. However, the land use index data are ordinal data; the index values determine the position of a block on the desirability scale. The general hierarchy of land uses, listed from most to least desirable, is: (1) parks; (2) single-family; (3) multi-family; (4) commercial; (5) transportation/industrial.

2. Dwelling-unit density: The dwelling unit density per acre was calculated for each block. The advantage of using acres in the denominator as opposed to the block was especially obvious when working with blocks of different size. Blocks with relatively high dwelling-unit densities were considered to be less desirable than blocks with lower densities.

3. Percent detached dwelling units: Each block was assigned a percentage value indicating the ratio between detached dwelling units (which are usually single family homes) and the total dwelling units on the block. Blocks with higher percentages of detached dwelling units were considered to be more desirable than blocks with lower percentages.

TABLE I

EXAMPLES OF LAND USE ASSOCIATED WITH THE LAND USE INDEX

Index	Block Land Use	Nearby Land Use
1	Single-Family	Park
1	Single-Family	Single-Family
2	Single-Family	Multi-Family
2	Multi-Family	Park
3	Single-Family	Commercial
3	Multi-Family	Single-Family
4	Multi-Family	Commercial
5	Single-Family	Industrial
6	Multi-Family	Industrial

Unlike the physical variables, the four socio-economic variables used to formulate the socio-economic indicator were not acquired from the aerial photography. (The technique of collecting socio-economic data from aerial photography, termed "photo-sociometrics" by Witenstein (68), is in its experimental stage and was tested for its feasibility in a separate step.) These variables were acquired from the Polk Directory for Oklahoma City. Again, the four variables were selected to represent the socio-economic conditions of each city block. A description of each block-level socio-economic variable follows.

1. Percent of female household heads with children: Each city block was calculated a percentage value which indicated the number of households on the block headed by a female with children. This information was chosen to act as a surrogate for a racial variable. Evidence of its validity as a surrogate was illustrated by the 1970 Census of Population and Housing. In Oklahoma City, the Pearson's product-moment correlation coefficient between the number of blacks and the number of households headed by females (for 26 randomly selected census tracts) was 0.80. Since prior ecological crime studies revealed a strong relationships between crime rates in general and black population, blocks with relatively high percentages were considered less desirable than other blocks.
2. Net household migration: A positive or negative value, denoting a net increase or decrease in the number of households from 1970 to 1975, was given each block in each of the three study areas. A negative value indicates a declining population and is assumed to be an undesirable block.
3. Income index: The Polk Directory offers the median income of the households on each block.
4. Percent of population aged 0 to 17: Each block was assigned a value indicating the persons under seventeen years old as a percentage of the total population of the block. Since previous ecological crime studies revealed a strong

relationship between burglary rates and a young population, blocks with relatively high percentages were considered less desirable than other blocks.

It is conceded that the determination of what is "desirable" is subjective. For example, some may view a city block with many child residents as desirable. Nevertheless, the decisions were made with reference to accepted relationships between burglary and urban phenomena as specified in previous crime literature.

As will be discussed in the succeeding section of this chapter, the three physical variables were statistically manipulated to form a physical desirability indicator for each block in each study area. Likewise the four socio-economic variables were combined to form a socio-economic desirability indicator for each block in each study area. These indicators were compared in order to determine the relationship between the physical and socio-economic conditions and provide insight into the feasibility of photo-sociometrics. More importantly however the two indicators were compared with the patterns of residential burglary.

The definition of residential burglary used in this thesis is the same as that used by the Federal and Oklahoma State Bureaus of Investigation. It is defined as any unlawful or forcible entry into a structure to commit a felony or larceny, even though force may not be used to gain entry (17). The burglary data were acquired from the Oklahoma City Police Department Analysis Unit in the form of individual residential burglary occurrence locations from October 1, 1977 to April 30, 1979, a nineteen month period. The occurrences were manually plotted on maps and the following burglary measurement techniques were developed.

1. Raw frequency: The residential burglary occurrences in each census city block were simply counted and recorded.

2. Population-based, residential burglary rate: The residential burglary occurrences in each census city block were divided by the population of the block and multiplied by 100. This technique is currently employed by the Federal and State Bureaus of Investigation. However, the technique produces an ambiguous rate. For example, suppose five houses were situated on one city block and each home was occupied by five people. If each house was burglarized once during the measurement time, the burglary rate would be:

$$\frac{\text{5 burglaries}}{\text{25 people}} \times 100 = \text{20 burglaries per 100 people}$$

The result suggests that each person on the block had a twenty percent chance of being burglarized, when in fact 100 percent of the population on the block was burglarized.

3. Dwelling unit-based residential burglary rate: The residential burglary occurrences in each census city block were divided by the number of dwelling units on the block and multiplied by 100. Using the previous example, the formula for computing the dwelling unit-based rate would be:

$$\frac{\text{5 burglaries}}{\text{5 dwelling units}} \times 100 = \text{100 burglaries/dwelling units}$$

investigates the spatial distribution of the residential condition indicators and their relationships with residential burglary. The intent of this section is to outline these chapters briefly, particularly emphasizing the statistical analyses exercised in each.

Two of the problems to which this thesis was directed were: (1) to assess the extent which the three burglary-measures vary among one another at the block level in each of the three study areas; and (2) to investigate the spatial distribution of the burglary rates and frequencies in each of the three study areas. In order to accomplish the former, Pearson's product-moment correlations coefficients were calculated between the burglary-measure values for blocks within the three study areas taken together and separately. To understand the spatial distributions that resulted from each burglary measure, two techniques were employed: (1) visual areal association, in order to generally evaluate the spatial distributions and the relationships; and (2) nine chi square tests were applied to the nine spatial distributions. The chi square statistic was used to test the degree of concentration (or dispersion) of the burglary pattern resulting from the respective rate or frequency.

Much of Chapter V is devoted to the aerial photographic data accuracy evaluation. The three physical variables were estimated in sampled city blocks and statistically compared (Pearson's product-moment correlation and Spearman's rank correlation) with actual physical data obtained through field surveys. When one or both formats of aerial photographic data were discovered to be satisfactory for use in the estimation of the three physical variables, data on the three variables were collected from the optimum format of aerial photography.

An objective of this thesis which was not directly related to the analysis of residential burglary in Oklahoma City, but which has strong implications for criminologists and planners concerned "photo-sociometrics". Can aerial photography be used satisfactorily to estimate socio-economic parameters? The three physical variables were adequately estimated from aerial photography. If the correlation between the physical and socio-economic condition indicators is "strong" then it follows that aerial photography may be used effectively to delimit socio-economic conditions. Multiple correlation coefficients were calculated between the physical and socio-economic indicators to measure the relationship.

The analyses in Chapter VI involves the handling of the ecological variables in determining their relationship with burglary. This was accomplished through the application of factor analysis. The seven ecological correlates loaded onto two factors. The three physical variables consistently loaded together on one factor and the four socio-economic variables generally loaded together on the second factor with only minor exceptions. Subsequently, each city block was assigned a factor score derived from the loadings on factor one and a factor score derived from the factor loadings on factor two. These scores indicated the block's position in the physical and socio-economics desirability spectrums; the higher the factor score, the more desirable the city block.

The next procedural step involved the determination of the relationship between the residential conditions (factor scores) and the burglary rates and frequencies. First, Pearson's product moment correlation coefficients were calculated between the two factor scores and the three burglary measures. Secondly, multiple regression coefficients were calculated to determine which burglary-measure variance was most explained by the factor scores. Finally, the factor scores were mapped and chi square analysis was conducted to establish the spatial relationships between the distributions of factor scores and burglary.

Concluding Statement

The problem addressed by this thesis and a brief report of the methodology used to solve these problems have been presented. Chapter II is a review of selected crime literature published since 1942 and a review of pertinent works relating to the methodology. Many references have been made in Chapter I to three noncontiguous study areas in Oklahoma City. Chapter III is a geographical perspective of each study area describing its relationship with the city as a whole and the observable differences within it. Chapters IV through VI are the analysis chapters and Chapter VII is a summary of the results, explain the implications, outline the limitations, and make recommendations for future research.

CHAPTER II

REVIEW OF SELECTED LITERATURE

Introduction

The ecological correlates of crime and criminal areas that have been recognized by early and contemporary criminologists, have included a multitude of urban characteristics. Few early works, however, made a deliberate categorization of urban characteristics. If any groupings were made, their purpose was to separate impersonal social data (rents, crowding, etc) from personal social anomie (divorce rates, female heads of households, etc.). Accompanying the new surge of works examining the physical environment and crime, is a greater awareness of "types of correlates". David Herbert (31) maintained that the urban environment should be regarded in two main forms: (1) the built-urban or physical and (2) the socio-economic. However, this conception has been acknowledged only recently by many criminologists. Criminologists of the mid-twentieth century limited their investigations to delinquency areas and their relationships with socio-economic variables. During the past twenty years a trend has been occurring which includes not only the analysis of socio-economic and physical variables, but other approaches as well. The shift is toward the analysis of smaller geographic areas, risk-related based crime rates, and individual crimes.

This chapter is a review of selected criminological literature.

It is an attempt to present the evolution of modern criminological thought from 1942. Studies that laid much of the groundwork in criminological theory are cited first, followed by works which are more relevant to the goals of this thesis. Finally, a report on the aerial photographic studies which apply to the research are presented.

Early Works

The most prominent criminological works of the mid-twentieth century were attempting to contribute to the understanding of the urban "juvenile delinquency area". The typical study analyzed delinquency rates developed from residence data on juvenile delinquents and compared the rates with other phenomena. Originally published in 1942, Shaw and McKay's work, (58) Juvenile Delinquency and Urban Areas was an ecological examination of the breeding grounds of delinquents. The residences of thousands of boys who appeared in Cook County Juvenile Court in Chicago were mapped and aggregated to square miles, concentric zones, and "community areas". The rates of delinquency, as a ratio with total population, were calculated and compared to socio-economic data. Highest zero-order correlation rates were found between delinquency and tuberculosis, insanity, infant mortality, and population decline. The importance of the work lies in the evidence that juvenile delinquency has its roots in and is a product of the general processes of American cities. Shaw and McKay discovered that strip commercial and industrial land uses were located consistently near delinquency areas despite successive changes in the composition of the population. Although the work was concentrated on socio-economic correlates of crime, it foreshadowed modern physical correlate studies for its recognition of the association of land use and crime.

The significance of Shaw and McKay's research is indicated by the number of subsequent studies that attacked it. Robinson (56) criticized Shaw and McKay and most other ecological analyses of crime for basing conclusions on ecological correlates. He contended that individual criminal behavior can be analyzed only by examining each criminal. Robinson recognized that large geographic units of study distorted the ecological correlations. This was the first report discovered that expressed an awareness of the advantages of block-level crime studies.

Bernard Lander (34) criticized the limited nature of the correlation technique employed by Shaw. In an attempt to expand on Shaw's work, delinquency rates were agglomerated to census tracts in Baltimore and their zero-order and partial correlations with seven socio-economic variables were determined. Percent home ownership was discovered to be the strongest correlate (positive) of delinquency residences while variables indicating economic status had low correlations. In search of an underlying order between variables, Lander then used factor analysis to arrange six of the variables into two groups which he called "economic" and "anomie". Anomie was considered the basic underlying factor of juvenile delinquency. No support was discovered for the assumption that physical space or locale is a causal factor of delinquency.

Terrence Morris (41) cited other points of error in the work of Shaw and McKay, the most serious being the delinquency rates themselves. He states that court appearance data only presented a small picture of the total volume of delinquency. His study of delinquency areas in Croydon, England was an attempt to use more complete delinquency data and to test some of the hypotheses of Shaw and McKay in an urban community different than those in the United States. He also went a step further than Shaw and McKay by dividing delinquency into two groups: (1) delinquency caused by psychiatric problems of the criminal; and (2) delinquency caused by social pressures. The results were that psychiatric delinquency can occur in any urban setting and social delinquency tends to be localized in clusters of substandard housing and within the working class population.

Several studies conducted in the past twenty years have attempted to duplicate the analytical approaches of Shaw and McKay, Lander and Morris in other cities. David Bordua (11), suspicious of Lander's findings with respect to their relevance for other cities, analyzed delinquency areas in Detroit. As in Lander's work rates of home ownership by cnesus tract were the strongest correlates of high delinquency areas. Contrary to Lander's work, however, an underlying factor similar Lander's anomie factor was meaningless. Roland Chilton (11) compared Lander's Baltimore study, Bordua's Detroit study, and his own delinquency study in Indianapolis. Surprisingly strong similarities of the ecological correlates of delinquency between the three cities were discovered. Owner-occupancy rates were one of the leading three correlates of criminal residences by census tracts in each city.

Widening the Scope

During the 1960s the gradual widening of the criminological scope began. Three of the frontiers that opened were: (1) the investigation of crime areas instead of delinquency areas; (2) the analysis of the relationships between indicators of general urban conditions and delinquency areas; and (3) the search for a greater understanding of the causes of specific crimes. Studies with these goals have been referred to as crime-specific analyses.

Richard Quinney (53) and Kenneth Polk (49) discussed the advantages of social area typologies for understanding juvenile delinquency. Their research stemmed from a dissatisfaction with individual variable analyses which did not take into account the general "type" of social area in which the crime occurred. They maintained that social area typological analysis, developed by Shevky and Bell (61), allows the examination of urban area types in terms of configurations of their economic, ethnic, and famalism status scores. Quinney, in his study of Lexington, Kentucky by census tracts, revealed that an index of crime occurrence and delinquency was negatively correlated with economic status, positively associated with race, and delinquency was negatively associated with family status. It was concluded that the basic dimensions of the urban social structure are related to crime and delinquency. Quinney's work is a precursor of the socio-economic analysis in this thesis in that homogeneous socio-economic areas were compared with crime.

Other recent intraurban analyses (1960-1976) broke away from the general delinquency study and examined specific crimes. Calvin Schmid's (59) (60) massive two-part study of crime areas in Seattle by census tracts was an analysis of the relationships between each of twenty crimes and eighteen socio-economic variables. Zero-order correlations were conducted and underlying relationships between the dependent and independent variables were discovered through the use of factor analysis. Burglary appeared with five factors and was generally associated with rates of unemployment and percent male population. Beaseley and Antunes (3) divided crimes into the categories of personal, property and total crimes and related them to six independent socio-economic variables. Corsi and Harvey (14) used socio-economic variables to explain variations among each of seven crimes. In both studies, the correlates of property crimes were percent households headed by females, percent vacant housing, and the percent of the population in service occupations. It was concluded from reviewing Schmid, Beaseley and Antunes, and Corsi and Harvey that property crimes most frequently occur in low social status areas.

Physical Correlates

Criminologists have long been aware that certain physical conditions such as density and land use can have an effect on the occurrence of crime in an urban area. Shaw and McKay cited the physical environment and land use in particular for having an impact on delinquency areas. Many studies identified substandard and vacant housing as independent variables highly correlated with crime areas. Before the past decade, however, no major studies were conducted that explicitly sought relationships between the components of the physical urban environment and crime. Since 1968, advances in the understanding of the physical environment's relationship with crime have been accelerating. The physical components of a city are currently recognized as important correlates.

Little evidence was discovered in the literature that revealed the birthplace of the "physical - crime" movement. Undoubtedly however, Jane Jacobs (32) was one of the earliest proponents. In her book The Death and Life of Great American Cities, she discussed the role of public surveillance of city streets in the control of crime. She argued that: (1) dwelling unit windows should face the street to ensure constant street surveillance; (2) children should play in the street to be in constant surveillance by adults; (3) city streets should be short to assure a variety of users; and (4) city parks should be surrounded by many different city functions so that they will be used at all times of the day. In general, Jacobs maintained that lively urban areas under constant public surveillance are in themselves a deterrent to crime.

The concept of public surveillance was integrated with neighborhood planning designs in Schlomo Angel's publication (1), Discouraging Crime Through City Planning. Angel regarded the police as the primary deterrent of crime yet was aware of the importance of high intensity land uses for their ability of producing many effective witnesses. He theorized that in urban areas there is an intermediate zone between low and high land use intensity areas where crime is abundant. Based on this assertion, he designed a series of neighborhoods which he expected to promote police and public surveillance. This work did little in explaining the ecological relationship between crime and the physical city. Yet it was one of the first articles in which city planning proposals were formulated to deter crime.

A pilot study prepared by Gerald Luedtke and Associates (37) was a search for solid relationships between crime and the physical city. It was based on the premise that physical design of urban neighborhoods may be utilized as an approach to crime reduction. Land use, pedestrian traffic, lighting and entrances, and housing quality were tested for their causal relationships with various crimes in Detroit. Individual crime occurrence locations were mapped and visited by the authors. The characteristics of the immediate physical environment were then recorded and analyzed. It was discovered that: (1) most of all crimes occurred near commercial strip development areas; (2) residential burglaries were concentrated within a two-block area directly behind commercial strip development areas; (3) commercial and residential burglaries were clustered around major institutional facilities; and (4) a large majority of burglarized homes were of substandard housing quality. Luedtke's publication, although not strictly a burglary analysis, introduced the hypothesis that crimes occur along urban transition zones, a major hypothesis of this thesis.

Although the impact of public surveillance on crime had been discussed in previous works by Jacobs and Angel, Oscar Newman's work (43) (44) (45) has been regarded as the major thrust of the concept. Newman, an architect, coined the phrase "defensible space" in 1964. Defensible space is a term used to describe the residential environment in which physical characteristics function to allow the inhabitants to become key agents in ensuring their own security through surveillance. Most of Newman's experiments involved housing projects and design characteristics of housing in general. In one of Newman's (45) more recent publications, the effects of socio-economic factors on all crimes were compared with the effects of architectural factors on crimes. Using data on housing complexes in New York, he discovered that socio-economic factors were stronger predictors of crime rates than the physical characteristics of design. However, in many cases, certain architectural factors counter-influenced the social. This thesis is also a comparison of socio-economic data and physical data and their relationships with crime. Although the work here is not an offshoot of Newman's experiments, it is supplemental in that it analyzes both private homes and apartments at the city block scale.

Among other studies in which public surveillance of crime was considered, Mayhew (39) questioned the basis for their findings. Her analysis of the relationship between telephone booth vandalism and the number of overlooking windows does not fully support the contentions of Jacobs, Newman and Angel. Only a small proportion of booth vandalism was explained by physical settings. On the other hand, vandalism was strongly associated with the socio-economic characteristics of the surrounding residents. Mayhew also asserted that certain crime prevention measures proposed by proponents of surveillance concepts are impractical. For example, the redesigning of existing homes and neighborhoods to increase surveillance is usually infeasible due to cost, and crime witnesses cannot be depended upon to intervene with or report a crime. Nevertheless, Mayhew (38) realized a need for more studies which would take greater account of how physical variables combine with other relevant socio-economic factors to produce crime and crime patterns.

A review of recent criminological studies cannot ignore the works of Jeffery (33). His approach to the problem of preventing crime through physical environmental design was not directly relevant to this research. However, his concepts hold formidable positions in criminological theory. Jeffery addressed the inadequacies of traditional crime control measures such as police and the penal system. He then integrated the implications of the newly discovered physical environment and crime relationships with a crime prevention model. He concluded that a major revolution in paradigms must occur before any advances can be made in the understanding of criminal behavior.

Reevaluation of the Measurement of Crime

One of the chief objectives of this thesis is to examine at the city block level the differential spatial distributions and correlates of burglary when burglary rates are computed using various risk-related denominators. Only a handful of previous works were devoted to the study of risk-related based crime rates. The earliest study discovered in which the goal was the creation of better crime specific bases was conducted by Sarah Boggs (7) in 1965. Rates, she emphasized, should represent a risk statement for the targets of the crime. Her findings contradicted the common assertion that the core area of any city is characterized by the highest crime rates. Crimes such as homicide, assault, and residential burglary were concentrated in the offenders' home neighborhoods. A subsequent article by Phillips (48) supported Boggs' contention. Phillips conducted a study of business robbery and burglary in Minneapolis in which both traditional population-based crime rates and risk-related rates were computed. The risk-related rates were based on the number of persons employed in business establishments. He discovered the two rates to be inverted. High population based robbery and burglary rates occurred in the Central Business District while the lowest employment-based rates were found there. Also, the correlation between socio-economic status and risk-related rates was positive.

Gerald Pyle's monograph (52), The Spatial Dynamics of Crime, was a comprehensive study of crime areas in Akron, Ohio. Residential burglary rates computed per 1000 dwelling units were correlated with raw frequencies of burglary and rates computed in the traditional manner, as a ratio with population. A strong correlation (+0.90) was discovered between the dwelling-unit-based rates and the population-based rates in Akron, Ohio. As expected, the correlation between the dwelling unit-based rates and raw frequencies was much weaker (+0.40). These results offered an hypothesis for the burglary-rate analysis of this research. It was expected that the burglary frequency and rate correlations at the block level would differ by study areas, but average out to correlations similar to those found by Pyle.

Perhaps the most comprehensive crime-risk-rate study, of which this thesis is a part (see acknowledgements), is currently being conducted in Oklahoma. Funded by the Law Enforcement Assistance Administration, U.S. Department of Justice, Keith Harries is computing a variety of risk-related rates for each of the seven major crimes recognized in the Federal Bureau of Investigation's Annual Uniform

Crime Report. The seven crimes (numerators) and the land use and socioeconomic variables acting as denominators are aggregated to square miles in Oklahoma City and to transportation zones (various sizes) in Tulsa. This thesis is a logical supplement in that risk-related burglary rates were studied in Oklahoma City at a small scale.

Burglary Studies

The aim of this literature review is to present, in an approximately chronological order, the major studies that contributed to the evolution of criminological theory and to explain their effects on the formulation of this thesis. The works previously cited were not heavily relied upon when this work was created, although many of them offered valuable ideas. It follows that prior ecological crime studies in which residential burglary was investigated are the most relevant to this thesis. It should be mentioned here that several non-ecological burglary studies were reviewed. Conklin and Bittner (13) reported on burglary in the suburb, Girard (18) discussed home burglary defense techniques, and Healy (29) discussed commercial burglary defense measures. These authors placed emphasis on methods of burglarizing and defenses rather than relationships between aspects of crime and the urban environment. The following is a review of the investigations which were conducted in an attempt to understand the occurrence of residential burglary by approaching it either fully or in part, from an ecological perspective.

An ambitious study of the patterning of burglary was completed by Harry Scarr (57) for the Law Enforcement Assistance Administration.

Scarr studied residential and commercial burglary in Washington, D.C. and two adjoining counties. He used census reports, police statistics, and victimization reports to reach conclusions which were largely non-ecological. In fact, the work is best known for revealing temporal patterns of burglary. However, an ecological analysis was conducted with social variables. It was discovered that almost every social indicator was significant in distinguishing high burglary-rate areas in Washington, D.C. proper, but were meaningless in the suburbs.

Carl E. Pope (50) (51), with the help of six law enforcement agencies, conducted a massive study in the urban areas policed by those agencies in California. The analysis covered temporal aspects, offender information, economic loss, deterrent measures, and census-variable indicators of burglary. Of strongest relevance to this thesis, Pope discovered that burglary most frequently occurred in: (1) black areas, (2) low education level areas, and (3) low income areas. Once again, it was shown to be the poor who were the most common victims of burglary.

One of the most comprehensive and recognized publications on burglary is Residential Crime by Thomas A. Reppetto (55). Information regarding 2000 burglaries and robberies in Boston were analyzed to gain insight into offender characteristics and environmental correlates by police reporting areas (approximately square-miles). Burglary rates measured per 1,000 dwelling units were used. Reppetto's findings with particular applicability to this thesis were: (1) burglary rates of an area were a function of the burglary rates of the surrounding area; (2) predominantly black areas had rates about three time higher than segregated areas; (3) burglars select affluent "targets" in predominantly low income areas, often because the offenders live in the low income areas; and (4) the age of the residential population was inversely related to the crime rate. Reppetto also found that the burglary rate was high in low occupancy apartments and lower in high occupancy apartments. This supports the surveillance concept developed by Jacobs, Angel, and Newman. Witnesses and the probability of witnesses of crime may be a deterrent of crime.

Waller and Okihiro (67) analyzed the relationship between burglary rates and eleven environmental factors by census tracts in Toronto, Canada. Individual correlations were highest between burglary and percent male population (positive), percentage of households with lodgers (positive) and number of complete families per household (negative). These results coupled with the results of stepwise multiple regression prompted Waller to conclude that burglaries in Toronto occur: (1) in and near large numbers of available offenders such as young males; (2) in and near areas of low social cohesion (low percentage of families with both parents) and; (3) in relatively low income areas. Waller then broadened his methodological scope to analyze the results of 1655 interviews with victims and non-victims. One of the purposes of the analysis was to test the validity of Newman's concept of defensible space. It was found that the index of surveillance assigned to each interviewee's residence was significantly related to burglary. In other words, the victimized homes were, in fact, less surveillable than non-victimized homes. From an additional survey of about 5,000 burglarized dwelling units, land use was not considered a factor in burglary occurrences. This is contradictory to the premises of Ledtke and Angel.

Nearness to public housing was the most important variable in explaining burglary locations, followed by income, an index of occupancy (amount of time per day a home was occupied), and the surveillance index.

Many aspects of Waller and Okihiro's work support the general approach of this thesis. In a portion of their study, the ecological correlates of burglary were indices of socio-economic and physical conditions. For the most part, the geographical unit of study was the census tract, yet interesting relationships were found from the small scale analysis of individual dwelling units. Again, the main objective of this thesis is to compare indices of socio-economic and physical conditions with burglary at the city block scale. Waller also exposed the weighty influence of public housing on residential burglary: a phenomenon pertinent to a topic of study in this research.

The appendix herein is a response to a study by Carol Bevis et. al. (4). The original work was an extension of the surveillance concepts of Jacobs and Newman. Bevis assumed that the residents who perceive an area as "their territory" have a greater surveillance capacity and can better recognize potential burglars. Her premise was that more burglaries occur along through streets than along less accessible streets in Minneapolis. A simple comparison of burglary rates along through streets with burglary rates along various types of less accessible streets supported her hypothesis. Dead-end streets, cul-de-sacs, and L-type streets each had much lower mean burglary rates than nearby through streets. A stepwise multiple regression analysis by census tracts was then performed to measure the relative influence of four social variables and an index of street accessibility on six crimes. The index of street accessibility explained six percent of the variation in residential burglary. No meaningful relationship was discovered between street accessibility and the other crimes. Appendix B of this thesis is a methodologically similar study performed on the three study areas in Oklahoma City.

No other criminologists had a greater influence on the formulation of this thesis than Brantingham and Brantingham (10). Their article, "Housing, Patterns and Burglary in a Medium-Sized American City", was a search for relationships between residential burglary and one aspect of the urban physical environment--housing. Parallel with this thesis, residential burglary locations were extracted from police files and coded to city blocks. Burglary rates were calculated per 100 dwelling units. The Brantinghams categorized the city blocks by average cost of housing, average rent, percent multi-family housing, and race. It was discovered that apartments had higher burglary rates than single-family areas, but it was the design characteristics of multi-family structures that attracted burglars, not the presence of renters alone. Moreover, burglary increased with the increase in percent multi-family structures. This implies that burglary rates are a function of dwelling unit density. Racial composition also was found to be associated with burglary rates. Integrated blocks (25% - 75% white) were the most victimized blocks while segregated white or black blocks had relatively low rates.

"Residential Burglary and Urban Form" by Brantingham and

Brantingham (9) sparked the formulation of this thesis. The authors maintained that if certain crimes were related to land use, planners could consider crime in their comprehensive planning process. To test this hypothesis, the spatial patterns of residential development (neighborhoods) were compared to the spatial patterns of residential burglary through the use of set theory and point set typology. Six census variables plus mean burglary rates were used individually to construct six neighborhood topologies. These sets were structured as clusters of contiguous city blocks which had internal homogeneity or continuity from block to block. A "neighborhood" was a set of contiguous city blocks with an inter-block variation of values of less than a fixed percentage. Based on previous ecological crime studies, the Brantinghams expected high crime rates to appear along borders between neighborhoods. They hypothesis was correct. Border blocks had higher burglary rates than blocks in the interior of neighborhood sets. Brantingham then considered the individual topologies simultaneously be looking at product typologies. Using average rent, percentage small apartments, and percentage single-family dwellings, the product typology was generated. The resulting border block/high burglary-rate phenomenon was even more prominent than when individual variable topologies were used.

The two works of Brantinghma and Brantingham (9) (10) were considered important when developing this research effort for the following reasons:

1. The census city block was proven to be a satisfactory unit for investigating residential burglaries in Tallahassee, Florida.

2. Residential burglary was found to be related to land use and housing data at the city block level.
3. Unstable city blocks, such as racially integrated blocks or blocks situated in zones of neighborhood transition, were discovered to be more frequently victimized than stable blocks.
4. The utilization of ecological correlates of burglary as a set is a valid method of investigating burglary.

Ecological crime literature was reviewed to discover (1) which urban ecological variables were correlated with crime and burglary in previous studies, (2) which statistical analyses have been used to establish the relationships, and (3) to look for general deficiencies in the analyses. A listing of the urban ecological correlates of crime and delinquency areas and burglary areas is presented in Table II. The correlates are listed with the most frequently reoccurring correlate in the literature at the top of the lists. The asterisked variables in the burglary list are five of the seven variables correlated with burglary in this thesis. Each of the other two related to several of the other listed correlates. For example, net household migration used herein is a surrogate of vacant housing, and the land use index directly accounts for nearness to various land uses.

Factor analysis was used by Lander (34), Bordua (11), Chilton (11) and Schmid (59) among others to discover underlying relationships between correlates of crime. The factor analysis applied to the seven ecological variables in this research was used to group the physical variables and group the socio-economic variables and then to calculate

TABLE II

URBAN ECOLOGICAL CORRELATES OF BURGLARY (A)
AND GENERAL DELINQUENCY (B)

Burglary (A)	Delinquency and Crime Areas (B)
*low income	home ownership
racial composition	substandard housing
*age of population	low income
*female household heads	racial composition
a surveillance index	unemployment
unemployment	family status
vacant homes	population decline
substandard housing	land use
*commercial strip developments	insanity
nearness to public housing	infant deaths
street patterns	tuberculosis
*multi-family housing	

* = correlates used in this thesis.

Source: Tables I through III and V through XXXIII were compiled by the author.

the resulting factor scores for each city block. This factor score technique was not employed by any authors reviewed. Nevertheless, as will be illustrated in Chapters V and VI, this application of factor analysis was found to be a rapid and accurate technique for assigning an area a general indicator of its complex residential characteristics.

Relevant Aerial Photography Literature

It was stated in the introduction that the physical correlates of burglary were derived from aerial photographic interpretation. These three variables and the socio-economic variables were then subjected to factor analysis. The factor scores derived from factor analysis were compared with the spatial patterns of residential burglary. The remainder of this chapter is a presentation of the references consulted when (1) aerial photographic interpretation, and (2) factor analysis were applied.

The effectiveness of aerial photography in urban inventories has been recognized for decades. Its inherent value lies in its unique capacity for bringing together, quickly and completely, the total physical picture of the urban area. The traditional uses of aerial photography in urban area analyses have been in land use identification and mapping, measuring the areal extent of built-up areas, and urban change detection. Relatively few publications exist, however, in which aerial photography was investigated for its utility in housing and socio-economic data acquisition. The emphasis of the aerial photographic/housing research has been on the estimation of dwelling photographic/housing research has been on the estimation of dwelling unit counts. The earliest-discovered article of this nature was written by Green and Monier (23). The work was performed to fulfill a need identified by the U.S. Air Force for a rapid estimation technique of urban demographic and sociologic data. Their goal was to determine the validity of 1:7,000 scale, black-and-white aerial photography for use in the estimation of dwelling unit counts in portions of Birmingham, Alabama. Approximately 300 city blocks were sampled from six census tracts. The aerial photographic estimations were checked against actual dwelling unit counts obtained from field survey trips. The simple identification of residential structures was 99.8 percent accurate. However, much lower accuracy was obtained in the estimation of dwelling-unit counts. Single-family dwelling units were overestimated by twelve percent; duplexes were underestimated by twenty-one percent, and multi-dwelling-unit structures were underestimated by thirty percent. The total number of individual households were underestimated by nine-percent.

Two corresponding studies by Hadfield (25) and Lindgren (36) produced results similar to those of Green and Monier. Using black- and white, 1:20,000-scale aerial photography, the authors underestimated the total number of dwelling units by ten and four percent, respectively. Both author's estimations of apartment dwelling units were underestimated by approximately forty percent. Obviously further research is needed in which apartment dwelling units are estimated. A portion of this thesis is in response to that need.

It was previously mentioned in this chapter that aerial photography has long been recognized as an effective collection technique in urban land use inventories. Medium or small scale photography can be used accurately for delineating commercial, industrial, and residential areas. Much experimentation also has been conducted that utilizes small scale areal photography and Landsat images in the determination and mapping of land use types. Much experimentation also has been conducted in which small-scale aerial photography and Landsat (satellite) images were used in the determination of mapping land-use types. A discussion of these publications was not included in this chapter. Nevertheless several of these articles were reviewed and are listed in the bibliography Earth Satellite Corporation (15), Todd (63), Vegas (65, Wagner (66) and Witenstein (68).

One of the objectives of this thesis was to determine if a relationship exists between the urban physical conditions and the socio-economics conditions in the study areas in Oklahoma City. If a strong relationship exists, photo sociometrics may be a useful technique for socio-economic data collection in Oklahoma City. Several researchers have documented their thoughts and findings on the urban social/physical relationships. As early as 1926, Park (47) stated that what people ordinarily conceive as social may eventually be construed and defined in terms of space. Branch (8) went further to explain that the density, arrangement, spacing, situation, and character of houses are ecologically meaningful.

Norman E. Green (20) (21) (22) went beyond merely acknowledging the relationship and attempted to quantify it through the use of aerial photography. His overall goal was to explore the problem of applying photographic interpretation in urban sociology. His plan of study was (1) to develop patterns of physical and social structures, and (2) to attach a predictive value to the aerial photographic estimations of the physical data. Using census tracts in Birmingham, Alabama, Green used Guttman scaling to form a socio-economic scalogram from the variables of income, educational levels, crowding, prevalence of "social disorganization", and home ownership. His physical scalogram was successfully developed from the variables of zonal location (he divided the city into four concentric zones), dwelling unit density, prevalence of single-family homes, and land use. He used product-moment correlation between the census tract scale scores developed by the socio-economic scalogram and the census-tract scale scores developed by the physical scalogram. The correlation coefficient was 0.88. Therefore, for the city of Birmingham, a strong relationship was discovered between the social structure and the physical structure defined above at the census tract level.

Green's next step was to evaluate the accuracy of aerial photographic interpretation data on the physical variables. Green recognized the ease in accurately identifying land use and zonal location. His emphasis was on the interpretation of the two housing items. Census tracts were rank-ordered by photographically derived housing-item estimations and by actual values acquired through field surveys. Spearman's rank correlation was applied to sets of ranked blocks and coefficients greater than 0.95 were achieved. Green concluded that photographic data were sufficiently valid for reproducing the relative, comparative housing structural characteristics of urban residential neighborhoods. Since such characteristics were empirically related to the ecological patterning of the urban social system, Green maintained that photo sociometrics may be adapted as a useful research tool in urban sociology.

An interesting connection was discovered between Green's research and several criminological works relevant to this study. The physical variables employed by Green (land use, density, prevalence of single-family structures) were three of the important physical correlates of crime. Brantingham (10) focused on the relationship between multi-family structures and burglary. Dwelling unit density is a function of the prevalence of apartments and population density. Land use is a controversial correlate of burglary which needs further examination (58) (34) (32). The appearance of these variables in both Green's research and crime studies define an important point of linkage between aerial photographic interpretation and criminology. This connection is strengthened if the utility of aerial photography in estimating socio-economic variables is investigated further. Green's research also contributed the impetus to correlate indicators of the urban environment formulated from a variety of urban variables. Guttman scaling was considered for the purpose of transforming the variables into two "urban-condition indicators". It was abandoned, however, because: (1) a large degree of personal bias is involved when establishing the "desirability" of conditions; and (2) scale scores are less accurate than factor scores (from factor analysis) for positioning a block in the socio-economic or physical condition spectrum. Guttman scaling may be more applicable when working with relatively few units of observation, such as city census tracts.

Since Green's momentous research, few photo-sociometric analyses have been published. One of these works was a primitive study by McCoy and Metivier (40) in which only one physical variable was examined for its relationship with five socio-economic variables in Toronto. Simple correlations were used to measure the relationships between house density acquired from 1:6,000, black-and-white aerial photography and (1) prevalence of owner-occupied homes, (2) home values, (3) percent renter, (4) average rent, and (5) income, all recorded per census tract. Strong correlations occurred between house density and each of the five socio-economic variables, with income correlating the highest (-0.875). The study was limited, however, and the results are questionable because house density values were estimated from deliberately-selected, only single-family city blocks and the socio-economic values were census tract averages.

Henderson and Utano's study (30) in Albany and Schenectady, New York, was also limited to physical variables of house density. Density values were estimated from 1:24,000-scale, black-and-white aerial photography and recorder per block. Unlike McCoy and Metivier (40), home value, contract rent, and rooms per dwelling were recorded by city block and correlated with house density. The fourth factor, median family income, was not available by city block. This restriction necessitated an areal conversion from census tracts to blocks. The strongest correlates of house density were rooms per dwelling (0.9214) and contract rent (0.8834). Henderson realized the high degree of multi-collinearity among all four socio-economic variables and performed stepwise multiple regression to determine their relative descriptive powers with respect to house density. As a result, only two independent variables, average contract rent and average house value, explained any significant variation in house density.

It can be concluded from the aerial photographic literature that a need exists for further research into photo sociometrics. Physical variables interpretable from aerial photography should be correlated with a variety of socio-economic variables. In addition, better multi-family unit indicators will be needed in order to develop physical/social relationships for entire metropolitan areas.

CHAPTER III

STUDY AREAS

Introduction

The spatial distribution of burglaries and residential conditions was studied at the city-block level in three square-mile areas in Oklahoma City, Oklahoma. Oklahoma City was chosen for the relative ease of acquiring detailed residential burglary data from the Oklahoma City Police Department. The residential burglary data was in the form of individual burglary-location addresses recorded by the square mile. The logical study area size, then, was the square mile. The decision of which square-mile areas to investigate was made in conjunction with the research staff of the Oklahoma City Police Department Analysis Unit. The study areas were recognized by the Analysis Unit as high burglary-rate areas.

A spatial representation of the noncontiguous study areas and their situation in the Oklahoma City metropolitan area is Figure 1. The areas are numbered one, two, and three for convenience of identification, and they are referred to by their respective numbers throughout the remainder of this thesis. All three areas lie between two and four miles from the approximate center of the Central Business District. Roughly, all areas lie in the third concentric zone (just beyond the urban transition zone) developed by Park and Burgess (47).

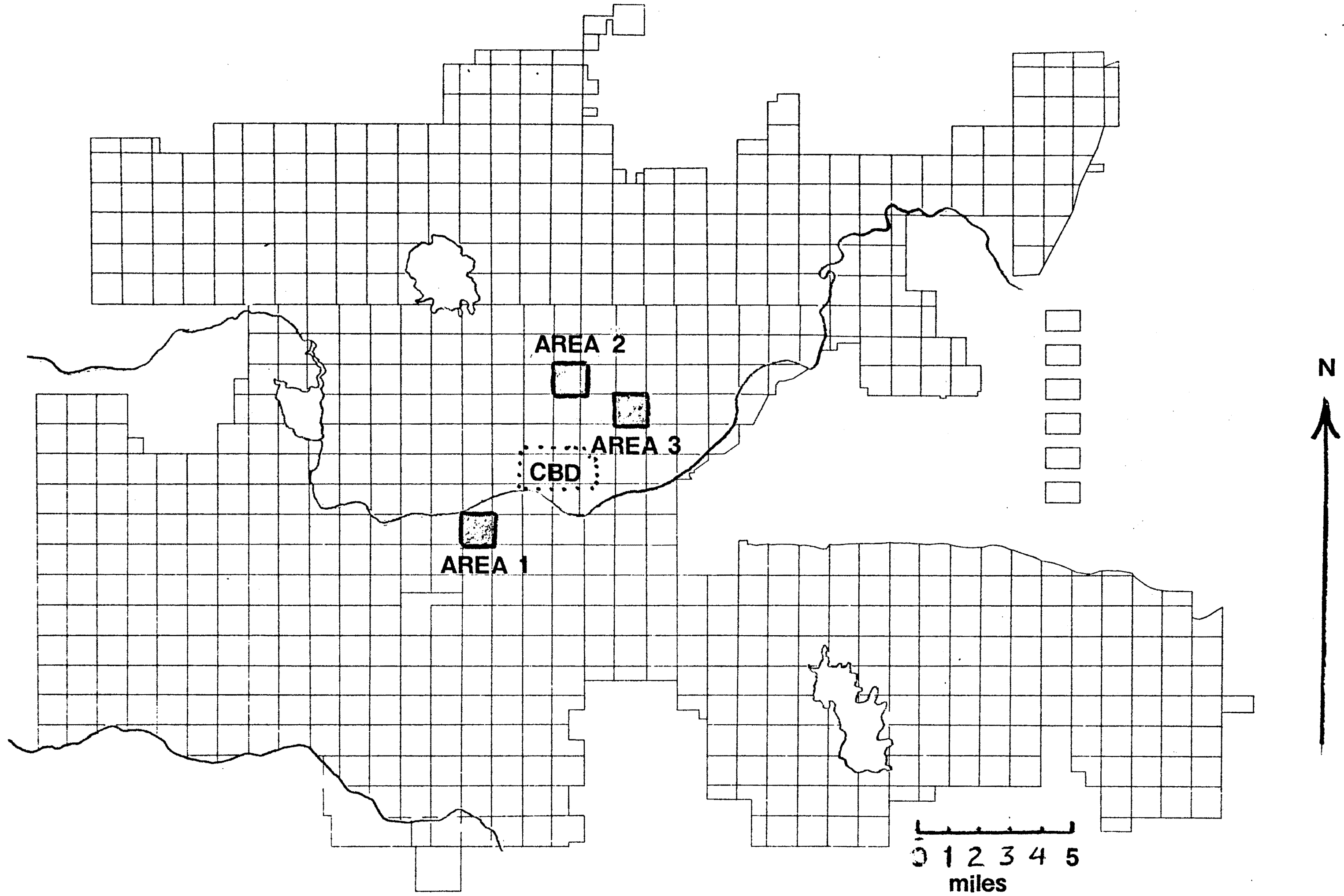


Figure 1. Oklahoma City Metropolitan Area and the Study Areas

Although the three residential sections are similar in terms of social status, income levels, and housing types, slight differences between them are apparent. Equally important to this research are the differences within each study area. It is the intention of this chapter to describe both inter- and intra- study area differences from the overall to the specific perspective.

Area One

In terms of relative location, study area One is between three and four miles southwest of the Central Business District. Interstate 240 bisects the area (north to south), offering the residents a four minute drive to the CBD. Will Rogers World Airport lies two and one-half miles to the south. The absolute location is described by the Oklahoma City Police Department as square-mile zone number 4142. It corresponds with the southern three-fourths of census tract 1056 as specified in the 1970 Block Level Statistics, U.S. Census. Study area One is bounded by Southwest Fifteenth Street on the north, Southwest Twenty-ninth Street on the south, May Avenue on the east, and Portland Avenue on the west. The detailed, large scale street pattern of area one is shown in Figure 2.

Although study area One is non-homogeneous, a drive through the area reveals a distinct environment. With the exception of the northwestern portion, the majority of the homes are of similar age and style. The few multiple-family structures within the area are located in the extreme western and southern blocks. The general low measure of upkeep and maintenance of homes and lots characterizes the area's low

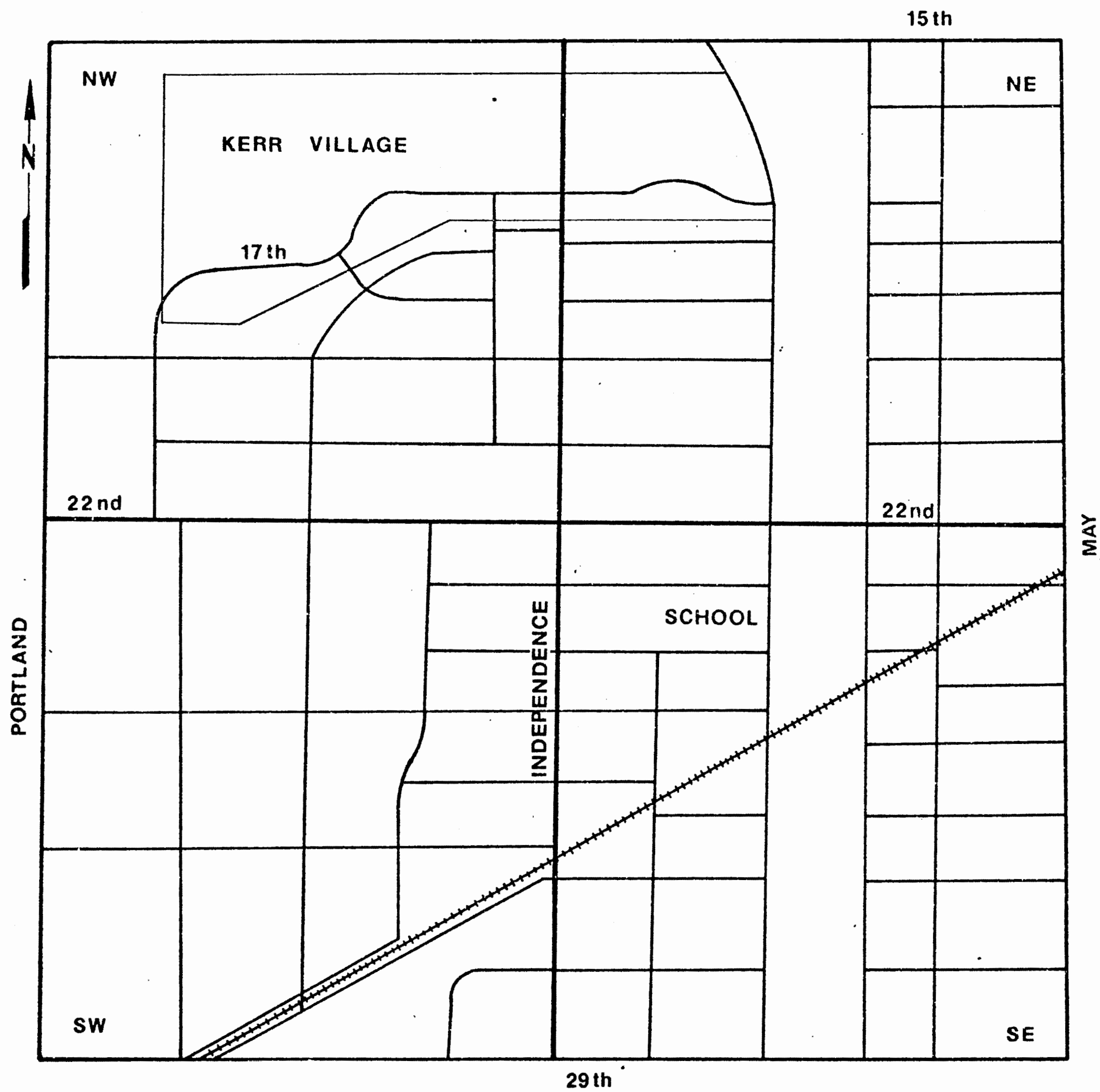


Figure 2. Study Area One

social status. The majority of the area's residents are white, with blacks residing in the northwest quadrant. Another indicator of low social status in the area is the lack of basic and professional commercial activities. Few, if any, food stores, drug stores, or offices are found in area one. The commercial establishments that are found here are automobile repair shops, gas stations, and implement dealers located along the section's boundary streets.

Examining study area One by quadrants, however, reveals the intra-area differences. The quadrants are delineated in Figure 2. Oklahoma City Housing Authority Family Development number 2-7, also known as Kerr Village, lies in the northwest quadrant. The Oklahoma City Housing Authority was established in 1965 as a public body to function in concert with the city of Oklahoma City and the Federal Urban Renewal Authority. Subsidized in part by the Department of Housing and Urban Development, the Authority's purpose is to provide safe, sanitary, and decent housing for approximately 20-25,000 low-income citizens. Kerr Village consists of 288 dwelling units and is one of six Housing Authority family developments in Oklahoma City. Figure 3 is a photograph of a representative portion of Kerr Village looking southwest on Seventeenth Street. Many of the dwelling units and some entire structures are vacant and the doors and windows have been boarded (Figure 4). The racial composition is mixed, but the largest proportion of the residents are black (Figure 5).

The northwest quadrant was originally platted as the Rockwood addition in 1910 and was replatted in 1966. Few remnants of the early 1900's exist today. Kerr Village is approximately twelve years old

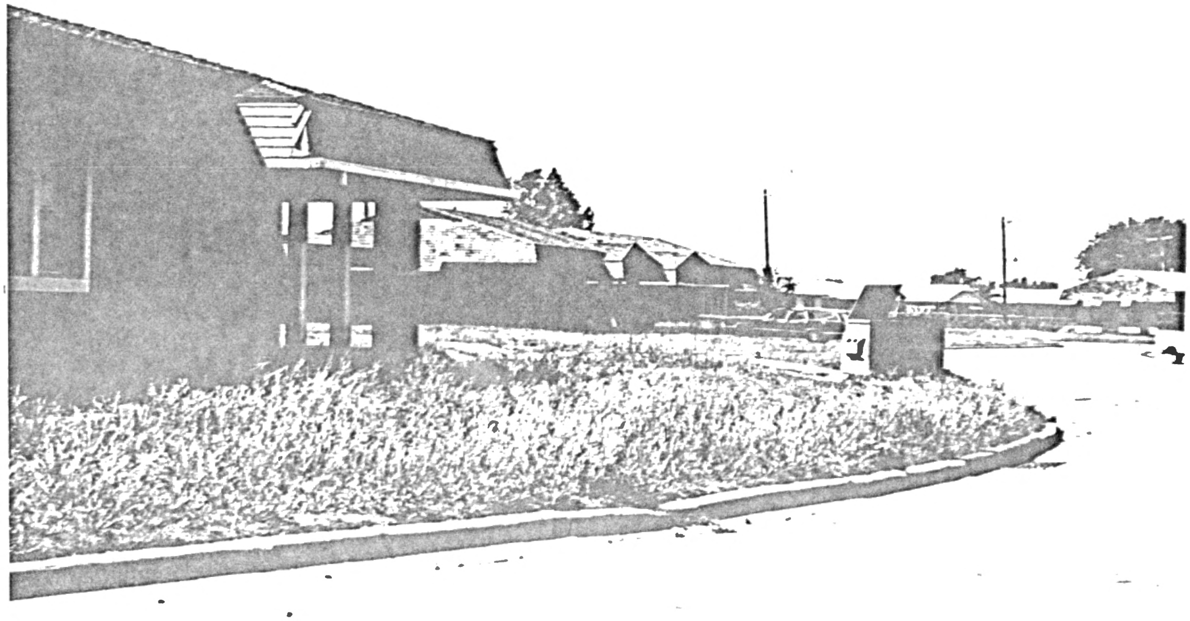


Figure 3. A Representative Street View in Kerr Village

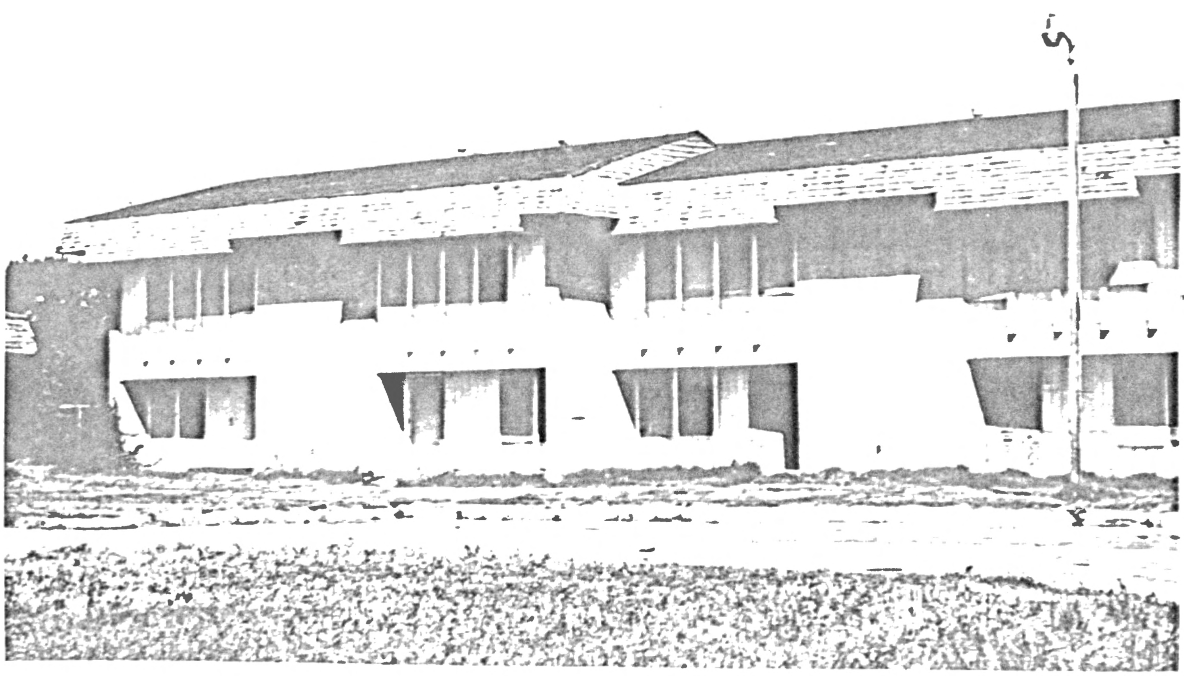


Figure 4. Vacant Units in Kerr Village

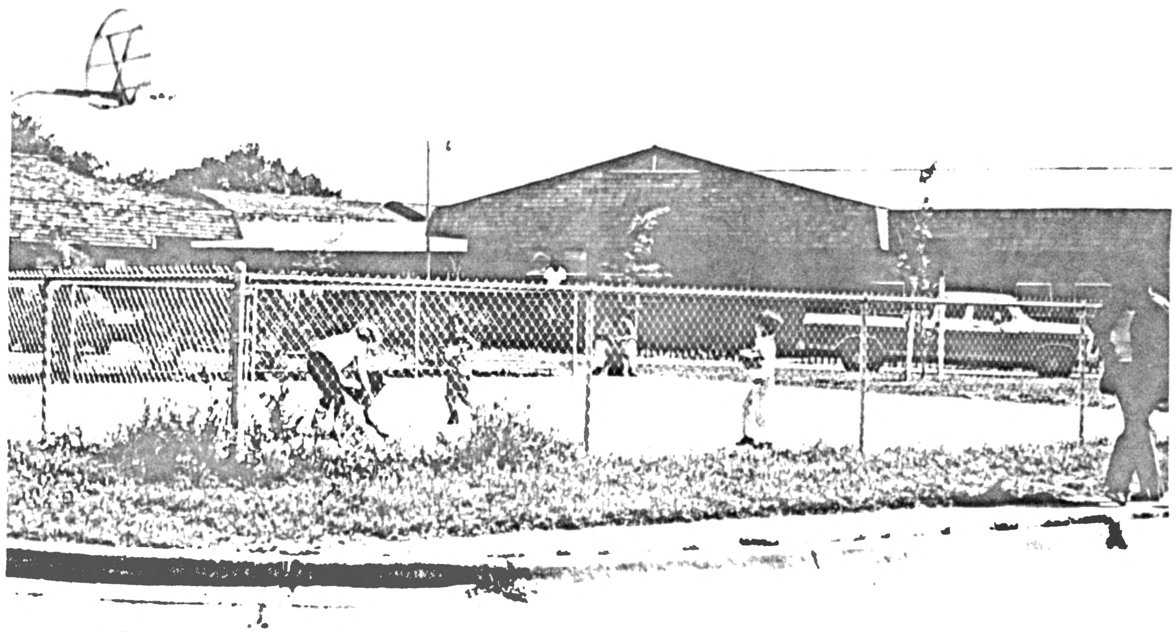


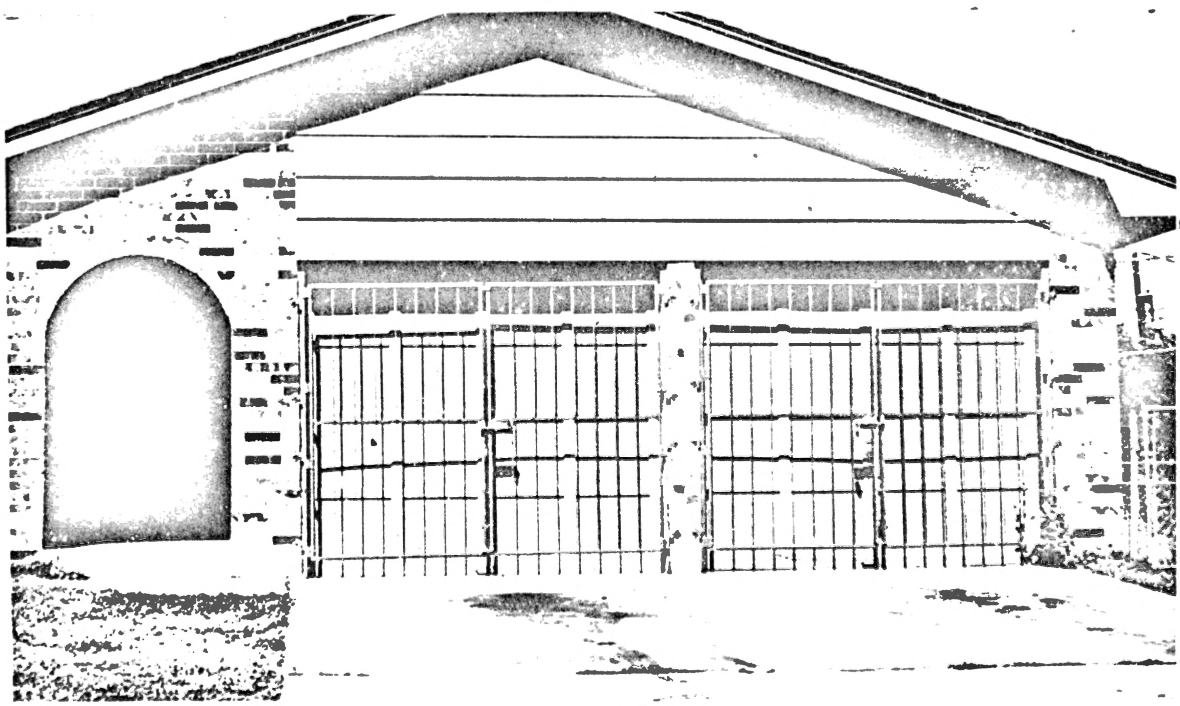
Figure 5. Playground in Kerr Village Illustrating the Racial Composition

and many of the private homes situated immediately south of Kerr Village are the newest and largest homes in the study area. Many of the occupants of these homes have employed burglary reduction techniques. Barred doors and windows are the most obvious defense measures (see Figure 6). Far fewer homes in other quadrants of area One display barred windows and doors. This observation led the author to expect the blocks near Kerr Village to have higher burglary rates than blocks in other parts of the study area. It also brought to mind the ecological correlate of burglary, nearness to public housing, discovered by Waller and Okihiro (67).

The southwest quadrant of study area One exhibits a rural atmosphere in an urban residential setting. Platted in 1929, the homes and the apparent age of the population indicate that little has changed since then. The city blocks here are larger than the average Oklahoma City block; some are one-eighth of one quarter of a section or some 20 acres (see Figure 2). The homes on these blocks are small and near the street. The products are low population and dwelling unit density blocks in a low social status area. The remaining land in the center of these blocks is accounted for in two ways: (1) deep lots as seen in Figure 7; and (2) a general agricultural usage such as gardens, animal barns, and pastures (Figure 8).

The northwest and southeast quadrants of area One are the oldest quadrants (platted in 1909) and appear to be of lowest social class. The homes in both quadrants are small and of similar size and many are vacant. The undesirable commercial activities along May Avenue and the noise spewing from Interstate 240 seem to contribute to the

(a)



(b)

Figure 6. Burglary Defense Measures: Barred Doors and Windows

Figure 7. Example of Deep Lots: Southwest Quadrant, Area One

Figure 8. Example of Agricultural Land Uses: Southwest Quadrant, Area One

generally poor residential quality. However, the southwest quadrant is composed of homes that appear to be maintained better than those in the northeast quadrant. This might be partly explained by the noxious impact of the large meat packing plant located approximately 700 feet northeast of the study area (see Figure 9).

In conclusion, low home upkeep, lack of basic commercial establishments, and the many vacant homes are indications that area One is a declining neighborhood. The barred doors and windows and the abundant 'for sale' signs near Kerr Village suggest that the Northwest quadrant is an area of transition which is frequently burglarized. From this evidence and from previous crime research findings, a gradient of burglary rates sloping downward as a function of distance from Kerr Village was expected to occur. In general, study area One provided an opportunity for studying the effects of public housing and undesirable land use of residential burglary in a white, low income, declining area.

Area Two

Study area Two lies one and one-half miles directly north of the Central Business District. Although similar in age to area One, this square-mile area displays a more typical urban setting. Approximately 5000 people (double that of area one) live in a complex mixture of single-family, duplex, and multi-family units. Western Avernue borders on the west, Santa Fe Avenue on the east, Northwest Thirty-sixth on the north, and Northeast Twenty-third on the south (see Figure 10). The section is known to the police as Square Mile Zone 4545. Four complete

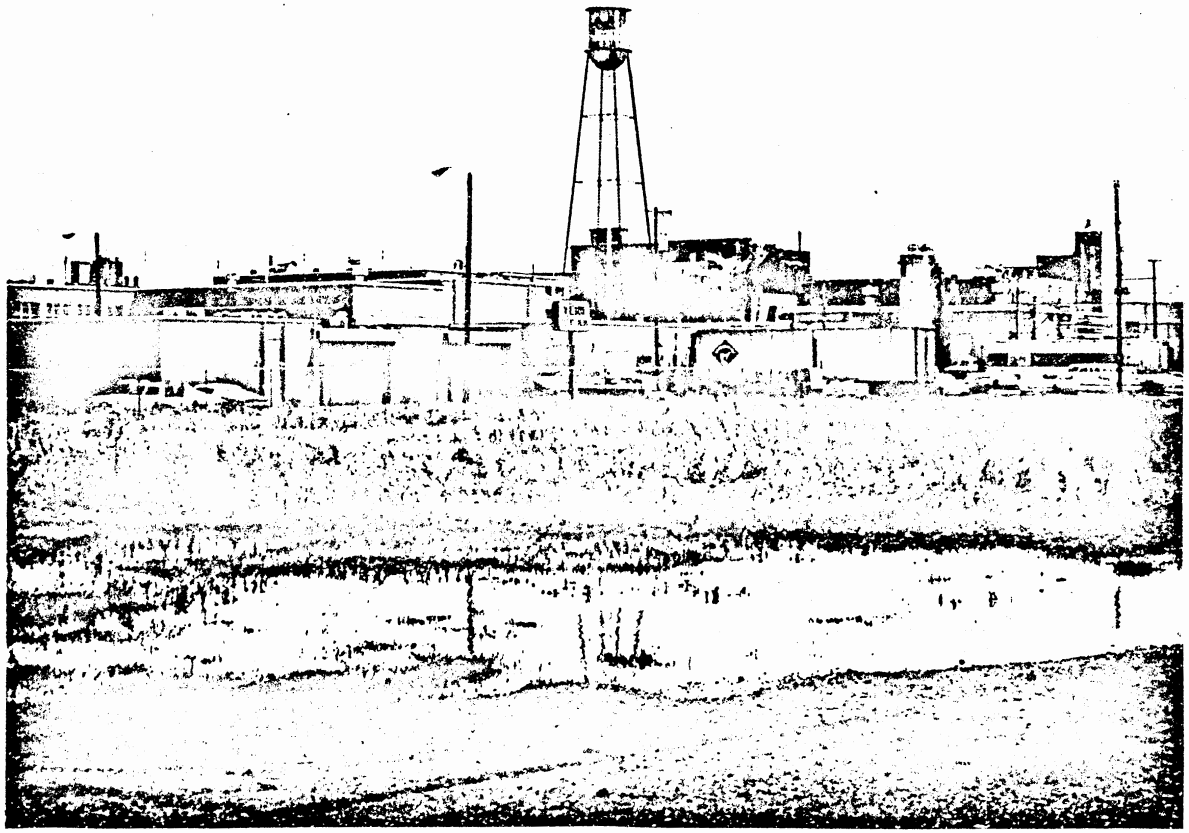


Figure 9. Meat Packing Plant Northeast of Area One

> The dwelling unit-based rate is a true risk-related based rate because it is a ratio between the number of burglaries which occurred and the number of targets. In the above example, each target (each home) that could have been burglarized was burglarized to give a rate of 100.

Aerial photographic interpretation plays a prominent role in this thesis. The three physical variables were acquired solely from aerial photography and photo sociometrics was explored. A complete description of the aerial photography utilized in this research is presented in Chapter V. To provide a greater understanding of the technique of remote sensing and specifically aerial photographic interpretation and to act as a general reference eleven terms and definitions are included in Appendix A. Many of the definitions were secured from the Glossary of Remote Sensing Terms (anonymous, n.d.) disseminated by the EROS Data Center, Sioux Falls, South Dakota.

Methodology

The chief objective of this thesis is to analyze residential burglary and its possible ecological correlates at the block level in sections of Oklahoma City, Oklahoma. The methodology or the "methods of testing the hypotheses" were systematically organized and the detailed analysis and results of the tests are presented in Chapter IV, V, and VI. Chapter IV is limited to the discussion of three burglary measurement techniques and the resulting spatial patterns of burglary. Chapter V covers the aerial photographic-data accuracy evaluation and collection and photo sociometrics. Chapter VI

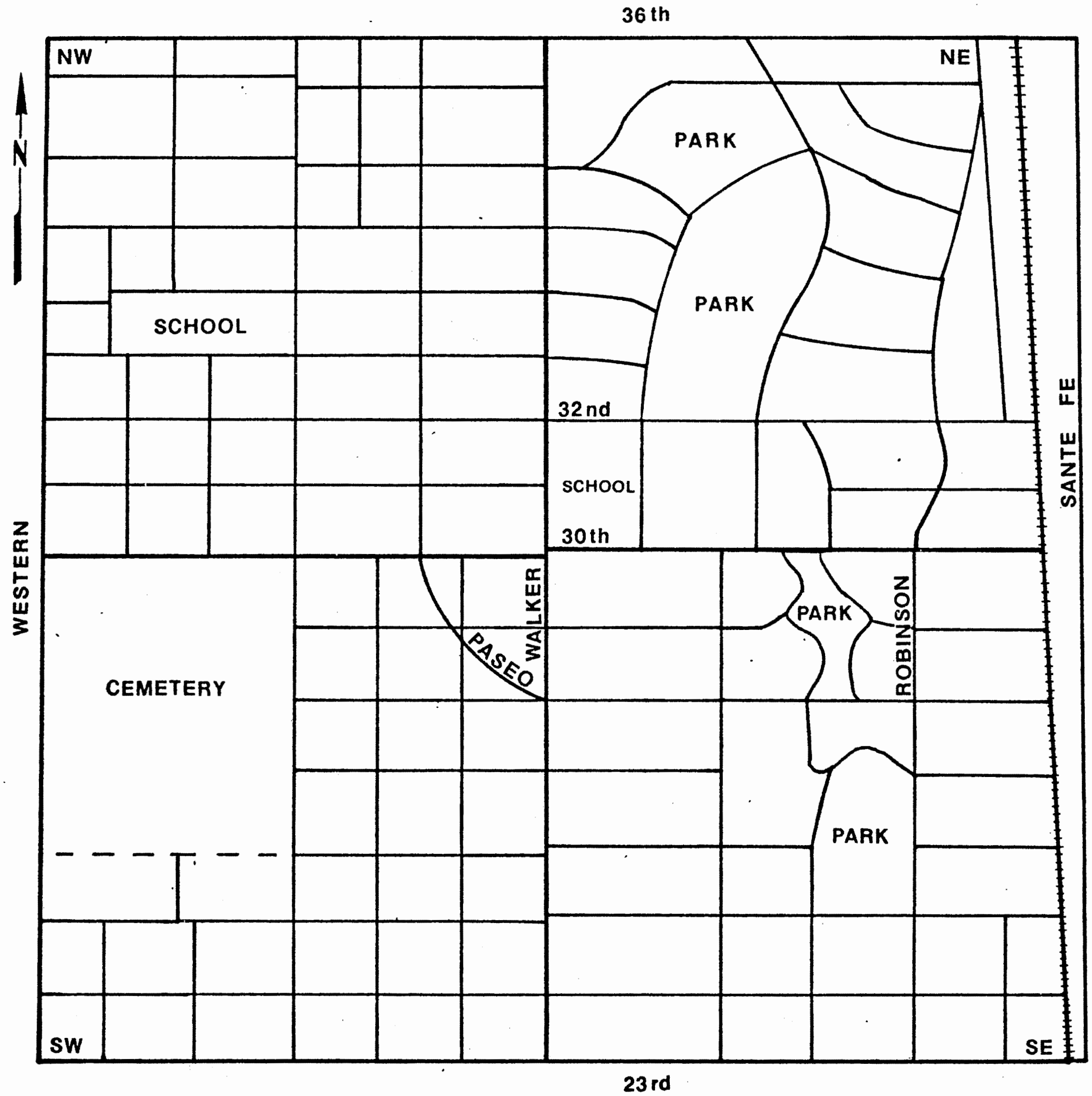


Figure 10. Study Area Two

census tracts are positioned within the area: (1) the northeast quadrant is census tract 1006; (2) the northwest quadrant is census tract 1007; (3) the southwest quadrant is census tract 1011; and (4) the southeast quadrant is census tract 1012. The area is situated along the western border of Oklahoma City's extensive "black community". Robinson Avenue approximates this border, and a few pockets of blacks are located in the area's southern half. Study area Two is the most racially integrated of the three areas analyzed.

A "land of extremes" is an appropriate description of study area Two in terms of land use. Clusters of single-family blocks are adjacent to blocks of row apartments. Commercial establishments, such as restaurants, small groceries, and taverns are near the center of the section on Paseo Avenue. A large cemetery is within the southwest quadrant while railroad tracks and industries border the area's eastern edge. Homes valued in excess of $100,000 and as low as $10,000 can be found.

Platted in 1929, the northeast quadrant is the best example of the area's steep land-use gradients. Travelling east on Thirty-second Street and beginning at Walker, the full impact of the gradient can be absorbed. First, a neighborhood grade school is on the right and medium size, single family brick homes, housing middle-class whites, are on the left. Continuing the tour, a large attractive park, used by residents from all over the city, appears on the left (Figure 11). At the corner of Harvey Parkway and Thirty-second, the largest, most expensive homes in the study area are on both sides of the street (Figure 12). East from that point, the home values and environmental

Figure 11. A City Park: Northeast Quadrant, Area Two

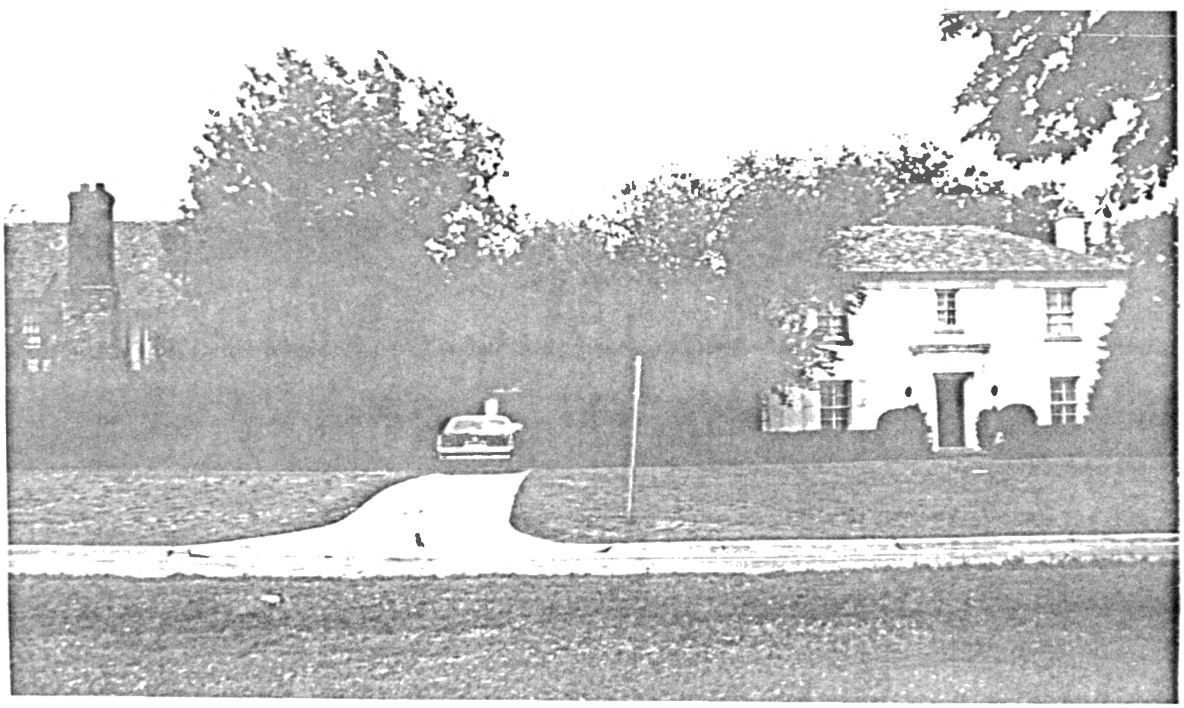


Figure 12: Homes of the Upper Class: Northeast Quadrant, Area Two

quality (indicated by the existence of trash, off-street parking, quality of vegetation, etc.) decline dramatically. Finally, the block between Robinson and the railroad tracks consists of poorly maintained multi-family structures which are occupied by low-income blacks. The entire tour was less than one-half mile.

In contrast with the northeast quadrant, the northwest quadrant is more homogeneous in housing size, type, and racial mix. The entire quadrant was platted in 1909. The residents are white lower and lower-middle class. A typical scene in terms of housing is portrayed in Figure 13. Approximately five percent of the total dwelling units are multi-family structures, and they are located in the extreme southeast corner of the quadrant.

A small percentage of land in the southwest quadrant is devoted to single-family residential uses, approximately three-eighths of the quadrant is a cemetery and the remaining blocks constitute apartments or commercial activities (see Figure 14). A healthy mix of blacks and whites reside in the quadrant. Its residents are the poorest in the study area; in 1975 the median income was $9,000. In fact, the quadrant (census tract 1011) is a part of a census defined Low Income Neighborhood in Oklahoma City. Twenty percent or more of the population were below the poverty line in 1969 (28).

Platted in 1903, the southeast quadrant is the oldest portion of all three study areas. Its general land-use pattern is similar to that of the northeast quadrant. The land uses along Twenty-eighth Street (west to east) flow from middle class, single-family homes, to upper class single-family homes near two parks, to low class multi-family

Figure 13. A Typical Street View: Northwest Quadrant, Area Two

Fiqure 14. Low Income Apartments: Southwest Quadrant, Area Two

structures near the railroad tracks. A large proportion of the blocks along the southern border of the area (twenty-third Street) are composed of multi-family and commercial land uses. These blocks are largely occupied by blacks.

Study area Two is an active, diverse, densely populated residential area. Its parks and restaurants are frequented by people from other areas of the city. Luxurious homes on large lots are situated two blocks from low income, row-type apartments. Pockets of blacks are situated in multi-family structures in the eastern and southern blocks. Steep gradients of land uses and social status are found along several transects. In summary, the area is appropriate for residential burglary analysis.

Area Three

The Bureau of the Census delineated three Low Income Neighborhoods in Oklahoma City. Two of the neighborhoods were situated south and west of the Central Business District and the population was seventy-two and seventy-three percent white. The third neighborhood, however, was east of CBD and was a mere eight-percent white. Study area Three approximates the center of the third low-income neighborhood. Specifically, this square mile, "black" area is between one and two miles northeast of the Central Business District. The State Capitol is one-half mile west. The section is bounded by Northeast Twenty-third, Northeast Tenth, Eastern, and Kelly. The study area corresponds with census tracts 1014 and portions of census tracts 1013, 1027, and 1028. Figure 15 is a large-scale map of study area Three.

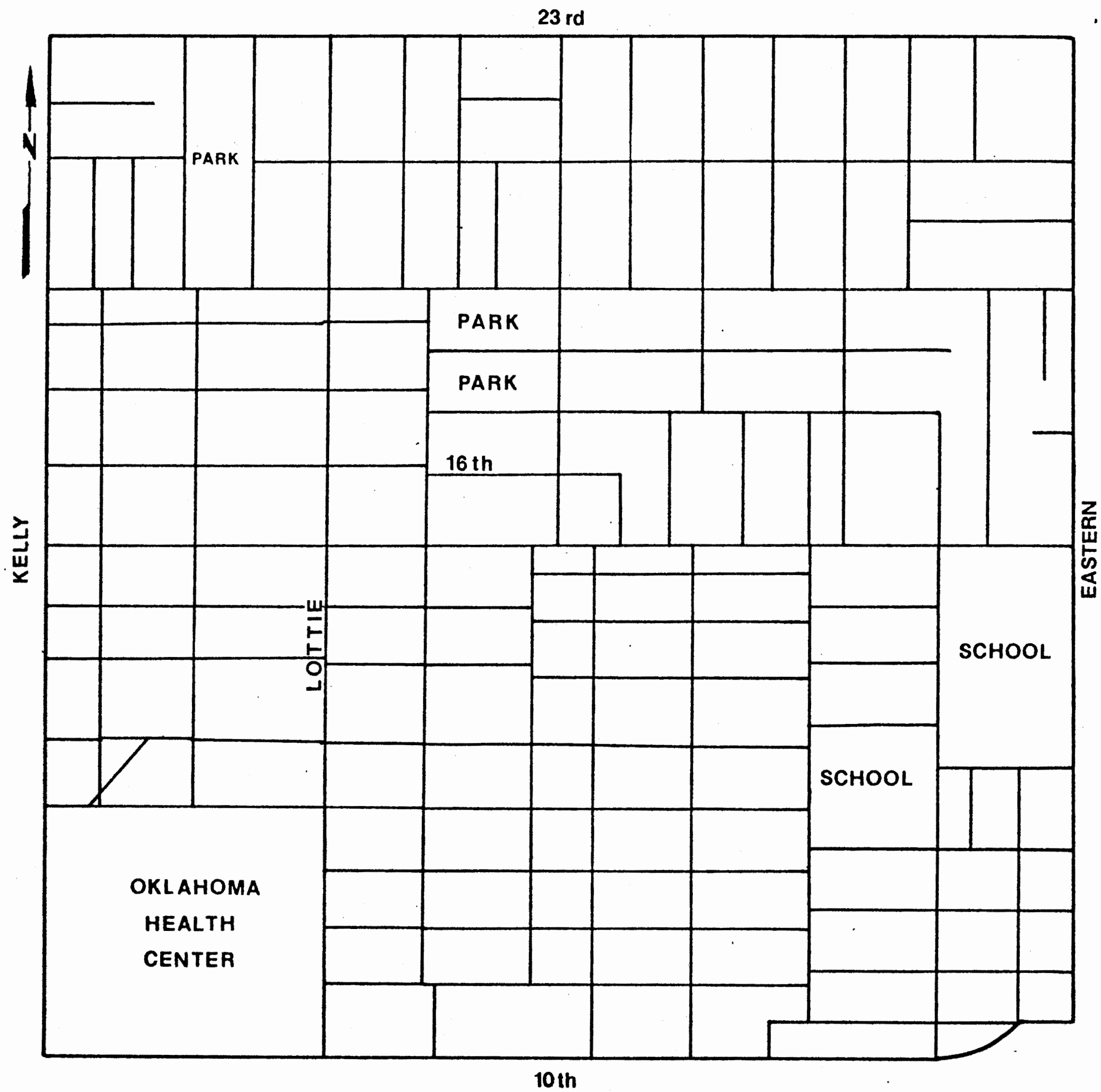


Figure 15. Study Area Three

From visual inspection of study area Three, it appears to be the most homogeneous of the three areas. The homes are small, upkeep is poor, and many are vacant. The few multi-family structures are situated in the extreme northwest corner. It is difficult, if not impossible to empirically identify any variations in income levels or social status within the area. The entire area was platted between 1904 and 1921. The racial mix seems to be constant throughout the section; many adult male blacks loiter in the area during weekday working hours, suggesting high levels of unemployment. The abundance of children playing in the streets and poorly maintained parks suggest that the average age of the population is relatively low. Figure 16 is a view of a typical street in study area Three.

In regard to possible factors causing differential burglary rates, two phenomena undermine the homogeneity of the area. The first is the spaital distribution of commercial activities. Northeast Twenty-third Street and Lottie Avenue are strip commercial avenues dividing the residential areas (see Figure 15). The homes on about twenty city blocks in the southwest corner were demolished recently to make way for the expansion of the Oklahoma University Hospital. Brantingham (10), Waller (67) and Luedtke (37) all accused commercial and institutional land uses for contributing to the incidence of residential burglary. The second urban condition that was suspected for any possible variations in burglary rates were the street patterns. Bevis (4) discovered that relatively inaccessible streets, such as dead-ends and cul-de-sacs, have lower burglary rates. She attributed this circumstance to the surveillance concept; residents of homes on

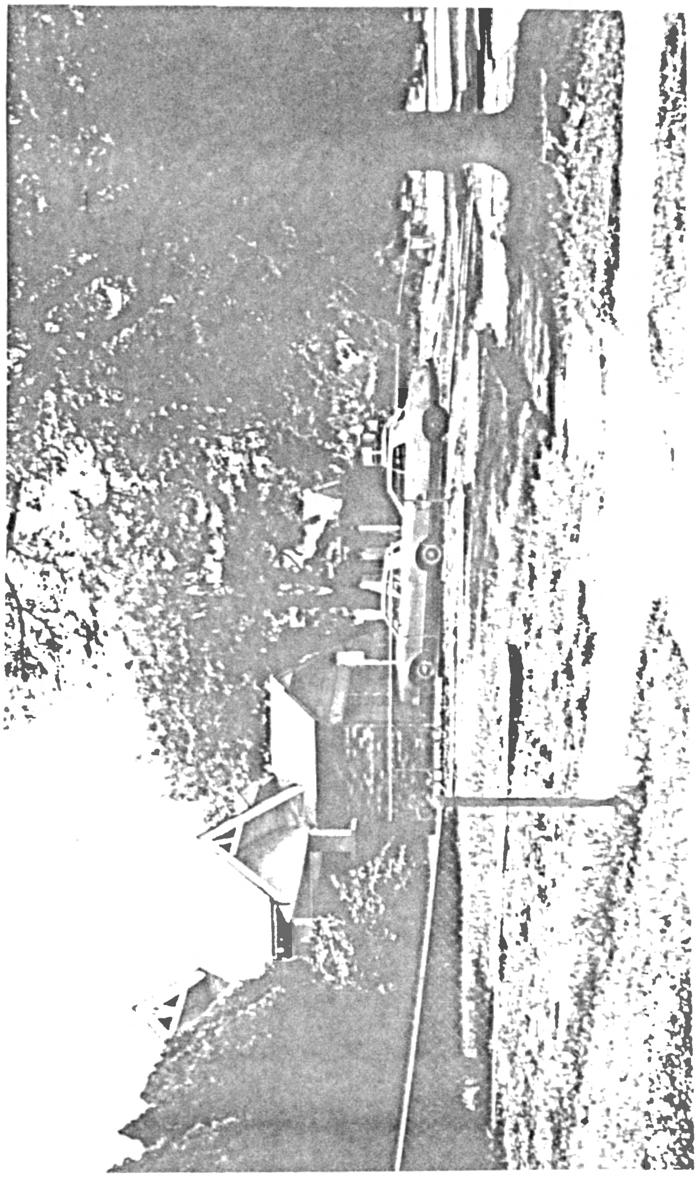


Figure 16. A Representative Street View of Area Three

dead-end streets acknowledge the street as "their territory" and are more aware of strangers. Study area Three consists of dead-end, t-type, and through streets. Appendix B of this thesis is a street pattern/burglary study relating to the street patterns of study area Three.

In general, study area Three provides an opportunity to review the incidence of burglary in a segregated black area characterized by low income, single-family homes, and a young population. A residential burglary-rate gradient was expected to slope downward from the commercial and institutional land uses. Chapter IV reveals the response to that expectation.

Concluding Remarks

The aim of this chapter was to describe the site, situation, and empirically derived observations of the three study areas analyzed in this thesis. It was a discussion of the similarities and differences between the areas, as well as the differences within each area. A detailed examination of the physical and socio-economic conditions of each area was not presented. That discussion is found in Chapters V and VI. Nevertheless, general statements can be made concerning such indicators as race, housing types, population age and social status. Table III is a summary of these general study area conditions.

TABLE III

EMPIRICALLY-ACQUIRED, STUDY-AREA CONDITIONS

Study Area:	1	2	3
social status	low	low-middle	low
race	white	integrated	black
age	old	medium	young
house types	single-fam	s.f. and m.f.	single fam.

CHAPTER IV

PATTERNS OF RESIDENTIAL BURGLARY

Introduction

Fundamental to a geographic crime analysis in which crime and urban conditions are compared is the recognition of spatial distributions. As stated in Chapters I and II, however, the work of criminological ecologists is unsatisfactory from the planner's perspective because it says very little about spatial distributions of crime at the large scale. Previous studies have been criticized for aggregating crime and urban data to census tracts and square miles which can hide important relationships. Another long-neglected problem is the use of population-based property crime rates when mapping spatial distributions. Boggs (7) stated that a valid crime rate should form a probability statement. Therefore residential burglary should be stated as the number of residences that were burglarized in relation to the number of residences that could have been burglarized. In regard to these comments, this fourth chapter is a presentation and discussion of the large-scale spatial patterning of residential burglary in Oklahoma City. Its overall goal is to identify the spatial distribution of population-based burglary rates, dwelling-unit-based burglary rates, and burglary frequencies at the census city block level in each of the three study areas. This goal was met through the analysis of the two problems stated in

Chapter I: (1) to what extent do the residential burglary rates (and frequencies) vary among one another (i.e. do the differential burglary rates and frequencies produce differential spatial distributions); and (2) to what extent do the residential burglary rates (and frequencies) vary among the city blocks: in other words, is residential burglary concentrated or evenly distributed within the study areas?

Burglary Rates and Frequencies: Analyses

The crime data used in this study were all residential burglaries known to the police of Oklahoma City for the nineteen month period of October 1, 1977 to April 30, 1979. These data were extracted from police files, and are by individual street address of occurrence. The burglaries were dot-coded to individual census city blocks delineated on large base maps of the study areas. Raw frequencies were acquired by simply counting the dots in each city block. The burglary rates were calculated as burglaries per hundred people (the traditional technique) and as burglaries per hundred dwelling units per block. The population and dwelling unit data used in the denominators were obtained from the 1975 Polk Directory of Oklahoma City.

To help put the three square-mile study areas in perspective with regard to residential burglary, a statement of each study area's "burglary reputation" in context of the entire Oklahoma City Metropolitan area follows. For the month of July, 1977, the three study areas were moderately to heavily burglarized relative to other Oklahoma City square-mile areas. Quintiles of residential burglary based on various denominators were established. Each square-mile area in Oklahoma City was positioned in its appropriate quintile. The positioning of study-areas one, two, and three in the quintiles of raw frequency, population-based rates, and a surrogate of dwelling-unit based rates is displayed in Table IV. The surrogate for the dwelling unit denominator is "land area in dwelling units." Study area Two was most heavily burglarized, followed by area Three.

TABLE IV

RELATIVE POSITION OF STUDY AREAS IN "BURGLARY QUINTILES" FOR OKLAHOMA CITY

	Area 1	Area 2	Area 3
Raw Frequencies	2	1	1
Population Based Rates	2	2	2
Dwelling-unit (land area)-Based Rates	3	2	2

(1" represents the upper 20%)

Source: Harries, K.D. Personal Interview. Stillwater, Oklahoma, July 1, 1979.

In response to the overall goal of this chapter, three methods of analysis were conducted. First, Pearson's product moment correlations (r) were computed between the rates and frequencies of residential burglary for the blocks of all three study areas taken together. The statistical relationships between the values of the three burglary measurement techniques were established. The coefficients (r) were then computed by study area to measure the relationships between the rates and frequencies of each area. Secondly, visual areal association was used to evaluate the spatial distributions of residential burglary. Nine choropleth maps with five class intervals each were created: a raw frequency burglary map, a population-based burglary rate map, and a dwelling-unit based burglary rate map for each of the three study areas.

Finally, as a more exact means of measuring the differences between spatial distributions, the chi-square test, was applied to the spatial distributions represented on the nine maps. The major use of the chi square (X^2) is to compare frequency distributions. The frequency distributions need not be normally distributed. Smith (62) states that the chi-square test compares a set of observed frequencies with a set of expected frequencies and establishes the probability of the difference being the result of chance or sampling error. The three contingency tables developed for the three maps for area One had eight cells because the five class intervals needed to be collapsed to a dichotomy to avoid an excessively sparse table. The larger number of city blocks in study areas Two and Three allowed the five class intervals to be reduced to a trichotomy; therefore six of the nine contingency tables had twelve cells. Table V is the skeleton of a chi-square contingency table utilized for study area One. Table VI is the skeleton of a chi-square contingency table utilized for study areas Two and Three. The general formula of the chi-square test used

TABLE V

DUMMY CHI-SQUARE CONTINGENCY TABLE:
STUDY AREA ONE

	Upper three Class Intervals	Lower two Class Intervals	Totals
Quadrant 1			
2			
3			
4			
Totals			N = number of city blocks

TABLE VI

DUMMY CHI-SQUARE CONTINGENCY TABLE:
STUDY AREAS TWO AND THREE

	Upper two Class Intervals	Middle Class Intervals	Lower two Class Intervals	Totals
Quadrant 1				
2				
3				
4				
Totals				N = number of city blocks

here was:

$$\text{Chi Square } (X^2) = \sum_{i=1}^{\text{Classes}} \frac{(\text{Observed freq - Expected freq})^2}{\text{Expected frequencies}}$$

As previously mentioned, the chi-square test in this context established whether residential burglary, measured in one of the three ways, was significantly concentrated in study areas by quadrants. The test for each of the nine contingency tables was as follows:

H_o: frequency of observed classes = frequency of expected classes

H_a: frequency of observed classes $\neq$ frequency of expected classes

test statistic: chi square, degrees of freedom = 3

significance: $p = 0.05$

decision rule: reject H_o if $X^2 > 7.82$

The critical value of 7.82 is determined by the significance level and the degrees of freedom (number of quadrants - 1) and was found in a table of the sampling distribution of the statistic in Blalock (6). The results of the chi square analyses are forthcoming (page 87).

Results

Correlation

Pearson's product-moment correlation coefficients were computed between burglary frequencies, population-based burglary rates, and dwelling-unit-based burglary rates by study area One, Two, Three, and the three study areas combined. The four correlation matrices are Tables VII, VIII, IX, and X. Based on Pyle's (52) work, the expectations were a strong correlation between the population based and the

TABLE VII

CORRELATIONS AMONG BURGLARY RATES AND FREQUENCIES
STUDY AREA ONE

		1	2
1.	Raw Frequency	---	---
2.	Population-based rates	0.79	---
3.	Dwelling-unit-based rates	0.80	0.95

TABLE VIII

CORRELATIONS AMONG BURGLARY RATES AND FREQUENCIES:
STUDY AREA TWO

		1	2
1.	Raw frequency	---	---
2.	Population-based rates	0.66	---
3.	Dwelling-unit-based rates	0.47	0.58

TABLE IX

CORRELATIONS AMONG BURGLARY RATES AND FREQUENCIES
STUDY AREA THREE

	1	2
1. Raw frequency	---	---
2. Population-based rate	0.66	---
3. Dwelling-unit-based rates	0.73	0.85

TABLE X

CORRELATIONS AMONG BURGLARY RATES AND FREQUENCIES:
ALL STUDY AREAS

	1	2
1. Raw frequency	---	---
2. Population-based rates	0.65	---
3. Dwelling-unit-based rates	0.62	0.75

dwelling-unit-based rates. Conversely, a lower correlation was expected between burglary frequencies and the two rates.

The correlations among the burglary rates and frequencies in study area One met the expectations. The correlation between the dwelling-unit-based and population-based rates was strong (0.95) with slightly weaker correlations between frequency and the two rates (0.79 and 0.80). The correlations for study area Three were similar to those of area one in that the correlation was stronger between the "rates" and weaker between the "frequencies and rates." This trend was interpreted to be a result of strong correlations between the number of dwelling units and the population of each city block in areas One and Three. Study area Two, however, was a deviation from the trend. The strongest correlation was between the population-based rates and raw frequencies (0.66). This circumstance can be explained by the relationship between dwelling units and population. It was presumed that the number of persons per household in area two was not constant, but rather quite deviant from the mean due to the wide variety of dwelling unit sizes and types. This would cause low correlations between dwelling unit counts and population per block and ultimately between the dwelling-unit-based and population-based burglary rates.

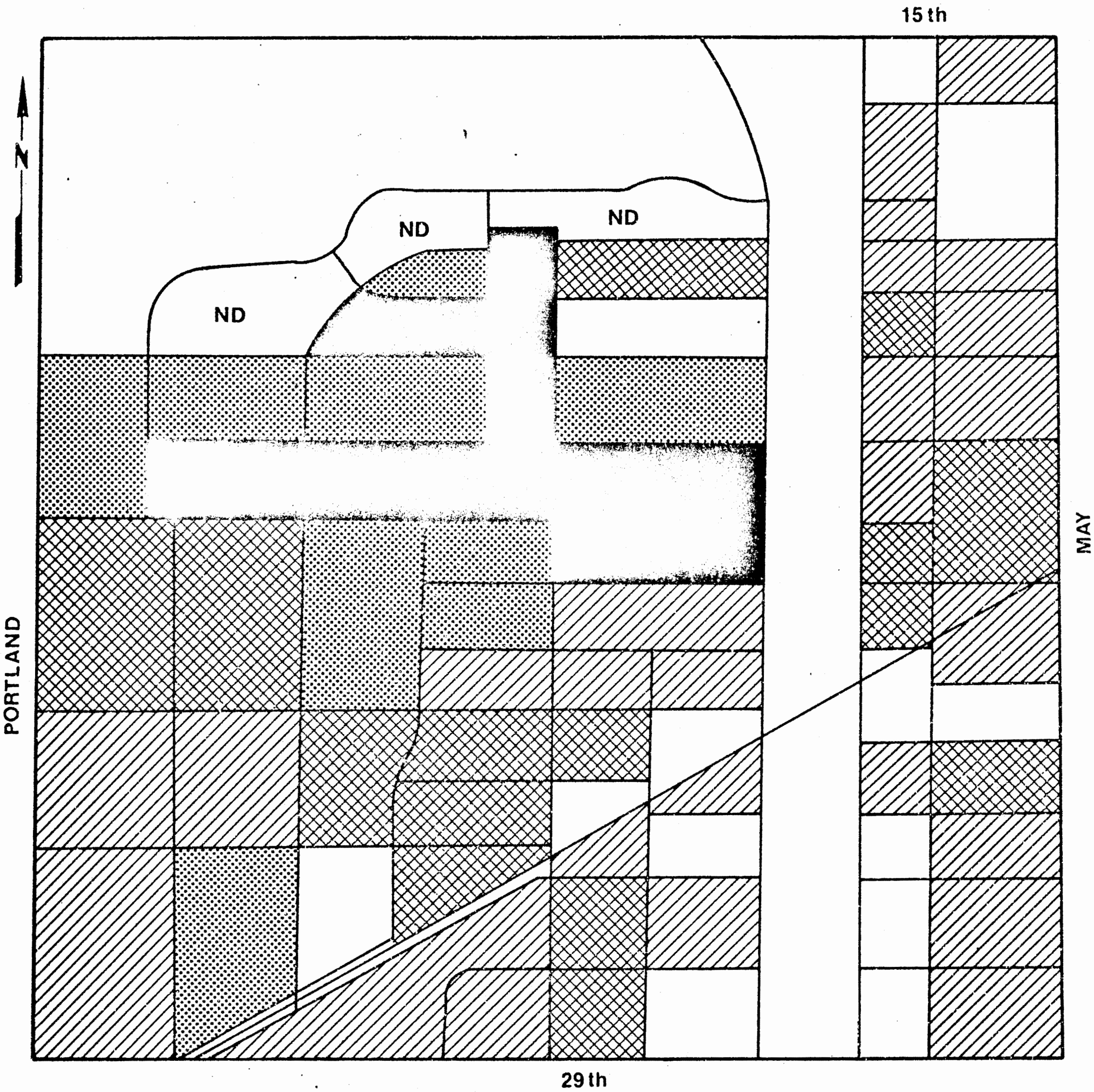
Areal Association

The technique of visual areal association proved to be a rapid and convenient means of evaluating general variations between several spatial distributions. The three choropleth maps of study area One, the raw frequency burglary map, the population-based burglary rate map, and the dwelling-unit-based burglary rate map are Figures 17, 18, and 19, respectively. The decision to select five class intervals to represent the frequency distributions for all nine maps was based on the ease of visually interpreting five shades while retaining a relatively high degree of detail. Approximately the same number of blocks fell into each of the class intervals for all nine maps.

From simply viewing one map of area One and then another and another, it was conspicuous that the expectations contrived in Chapter III were correct. The city blocks in the northwest quadrant (near Kerr Village) were more heavily burglarized than city blocks in other parts of the study area. The barred doors and windows and the many for-sale signs were prime indicators of the burglary prevalence. Several moderately to heavily burglarized city blocks in the south central portion of the study area also consistently appeared. Discrepancies between the spatial distributions of the three maps were apparent yet minor to the overall burglary pattern.

In general, the residential burglaries depicted as raw frequencies appeared to be most concentrated (Figure 17). The population-based rate map (Figure 18) seems to depict a more dispersed burglary pattern. Burglary appears less intense in the northwest quadrant and more blocks appear as high rate blocks in the remaining quadrants. Finally, the dwelling-unit-based rate map (Figure 19) suggests a spatial distribution even more dispersed than the spatial distribution of population-based rates. The conversion of frequencies to rates seemed to disperse the spatial distribution, but the general pattern remained intact.

A distinct pattern of residential burglaries was not evident in



Number of burglaries per block during nineteen month period

0 | 1-2 | 3-5 | 6-10 | >10

Figure 17. Area One: Raw Burglary Frequency Map

17

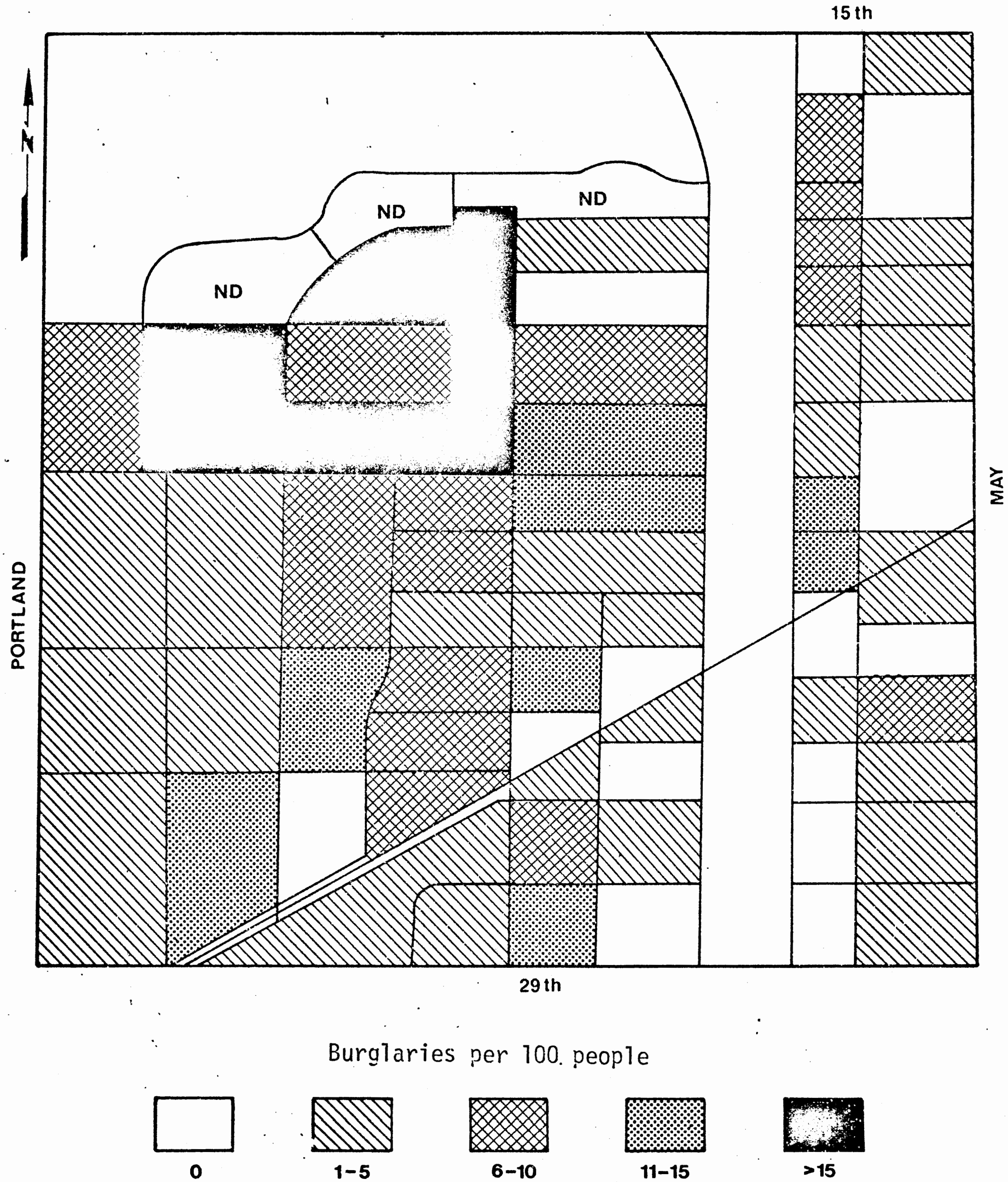


Figure 18. Area One: Population-Based Burglary Rate Map

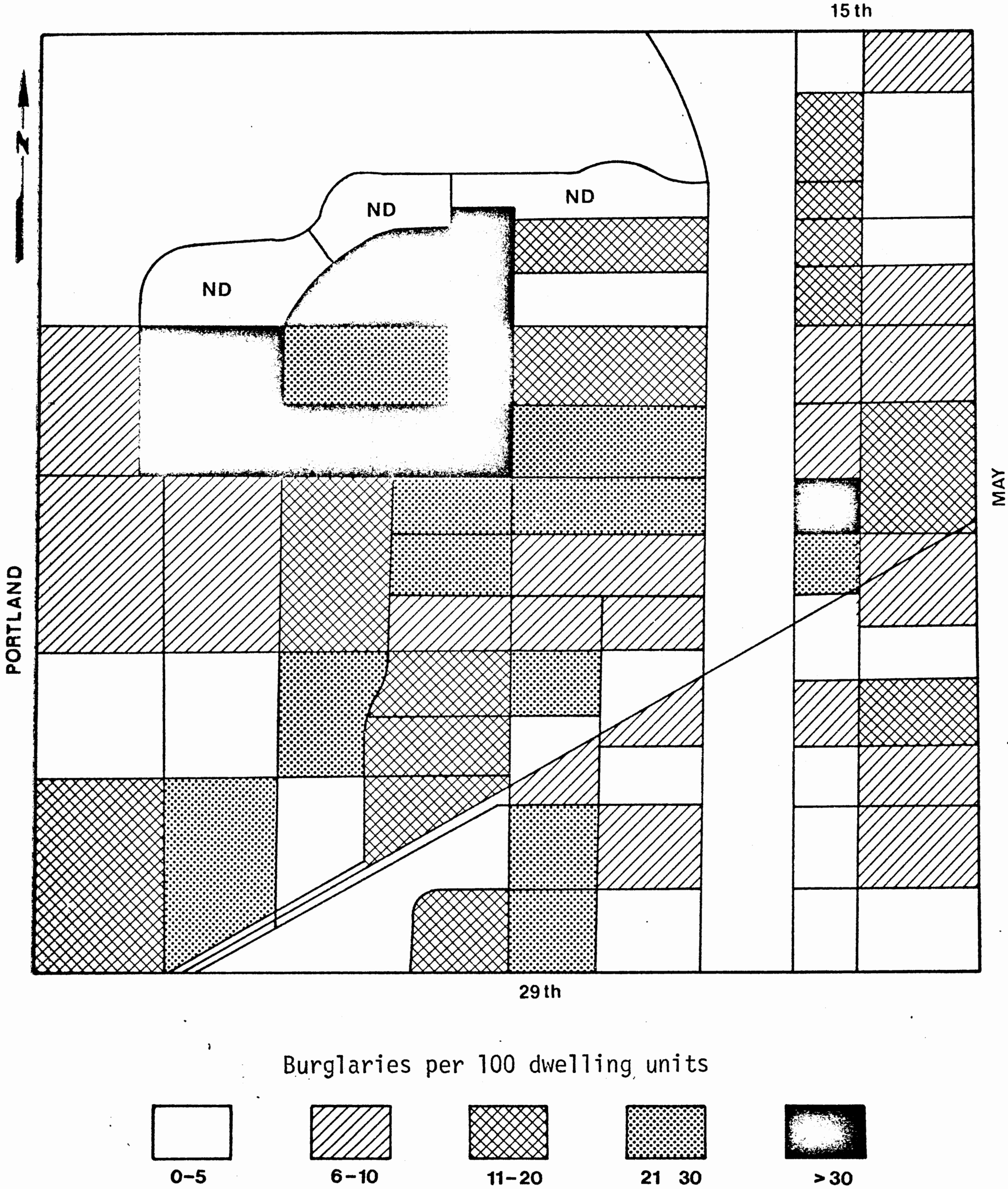


Figure 19. Area One: Dwelling Unit-Based Burglary Rate Map

the three maps of study area Two (Figures 20, 21 and 22). The raw frequency burglary map, as for study area One, represented the most concentrated pattern. The heavily burglarized blocks, in terms of occurrence only, were along the eastern edge of the study area, southeastern blocks, and blocks near the cemetery. This pattern was expected, for those were the city blocks with the largest number of apartments. Figure 20 indicates that the frequency of burglaries in study area Two were a function of the number of targets.

The spatial distribution of the population-based burglary rates was dramatically more dispersed than the raw frequency distribution (Figure 21). The blocks along the eastern border in Figure 20 appeared less burglarized and much higher burglary rates were evident in the northwest and southwest quadrants. Figure 22, the dwelling-unit-based rate map, represented a dispersed pattern as well, but it is difficult to determine which measurement technique, the population or dwelling-unit-based rates, spread out the pattern to the greater extent. Based on the three burglary maps of study area Two, the conversion of burglary frequencies to population or dwelling-unit-based rates tends to lower the level of burglary of multi-family blocks and raise the level of burglary of single-family blocks.

Similar to study areas One and Two, the three maps of study area Three were illustrative of three similar spatial distributions of residential burglary (Figures 23, 24, and 25). Burglary appeared most concentrated in the northeast quadrant and least apparent in the southeast and southwest quadrants for all three maps. Unlike the maps of study areas One and Two, however, the raw frequency map of study

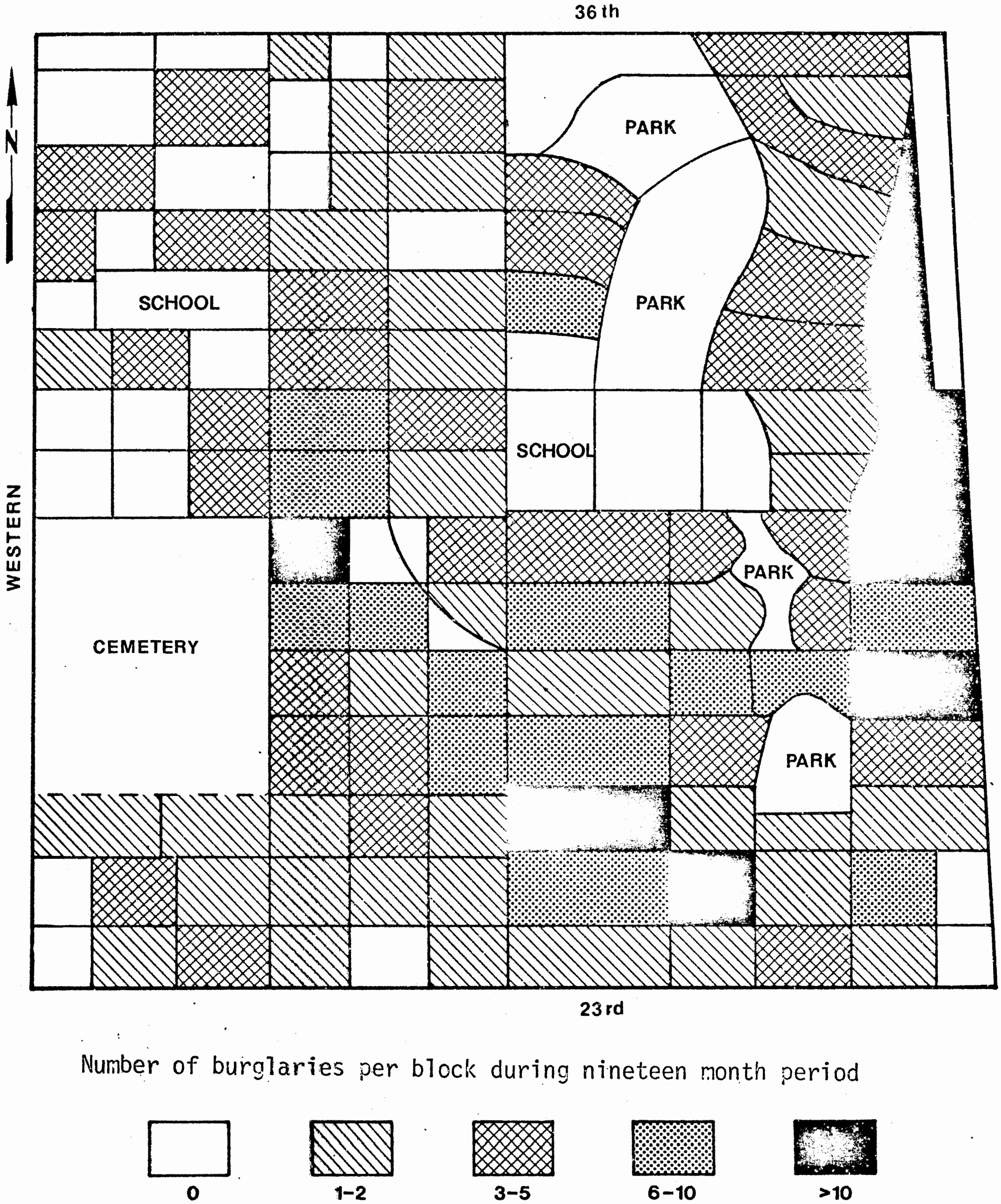


Figure 20. Area Two: Raw Burglary Frequency Map

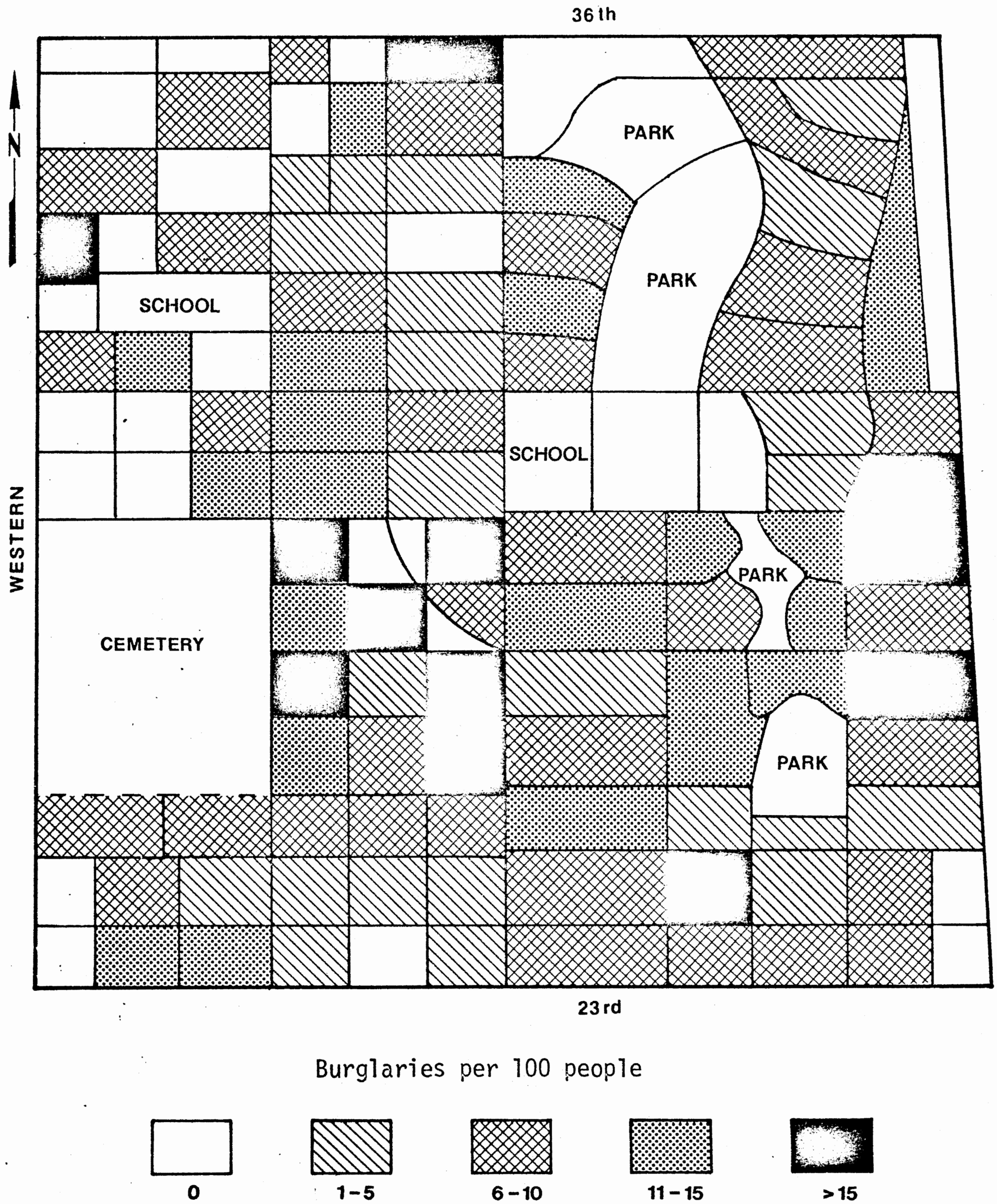


Figure 21. Area Two: Population-Based Burglary Rate Map

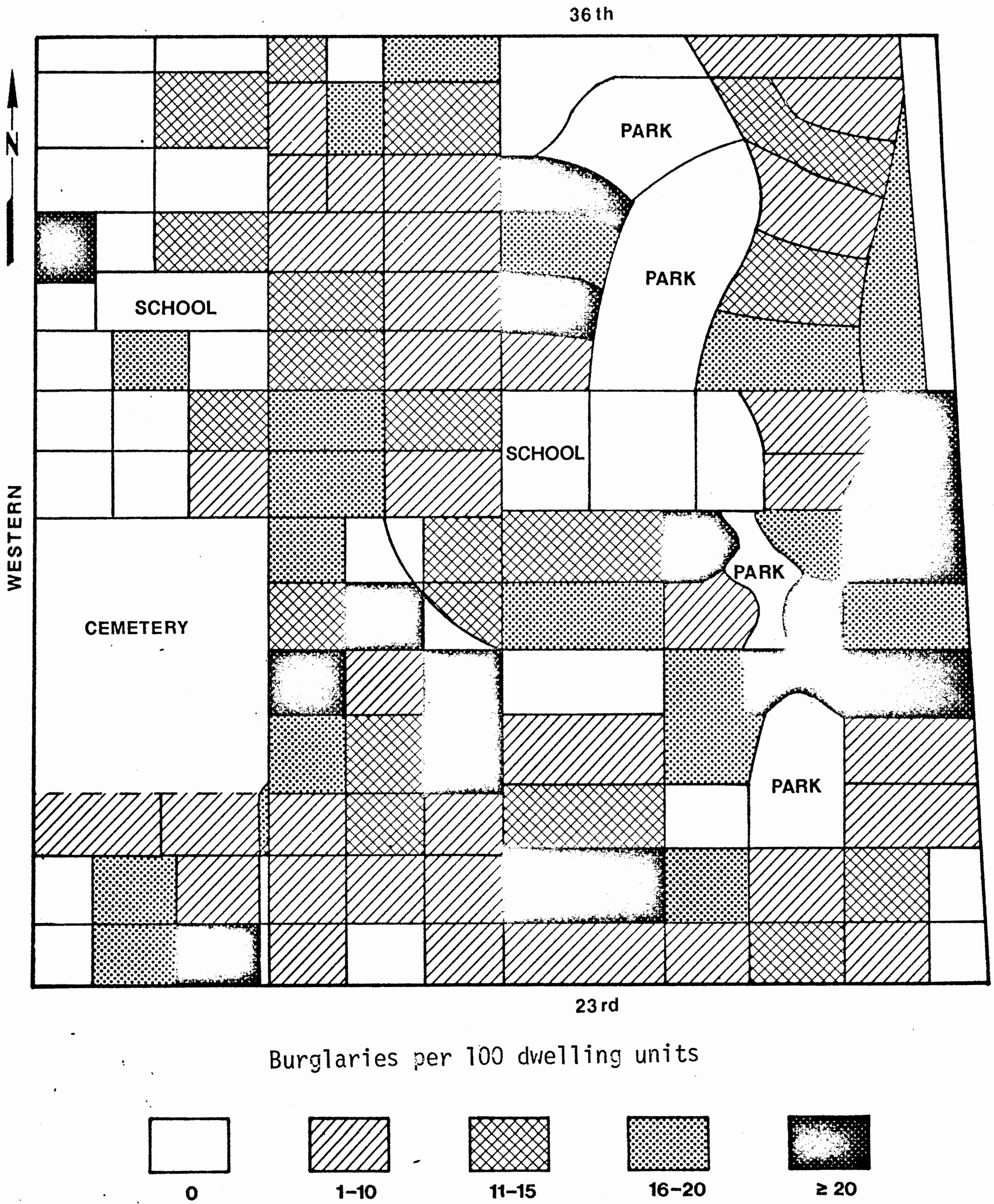


Figure 22. Area Two: Dwelling-Unit-Based Burglary Rate Map

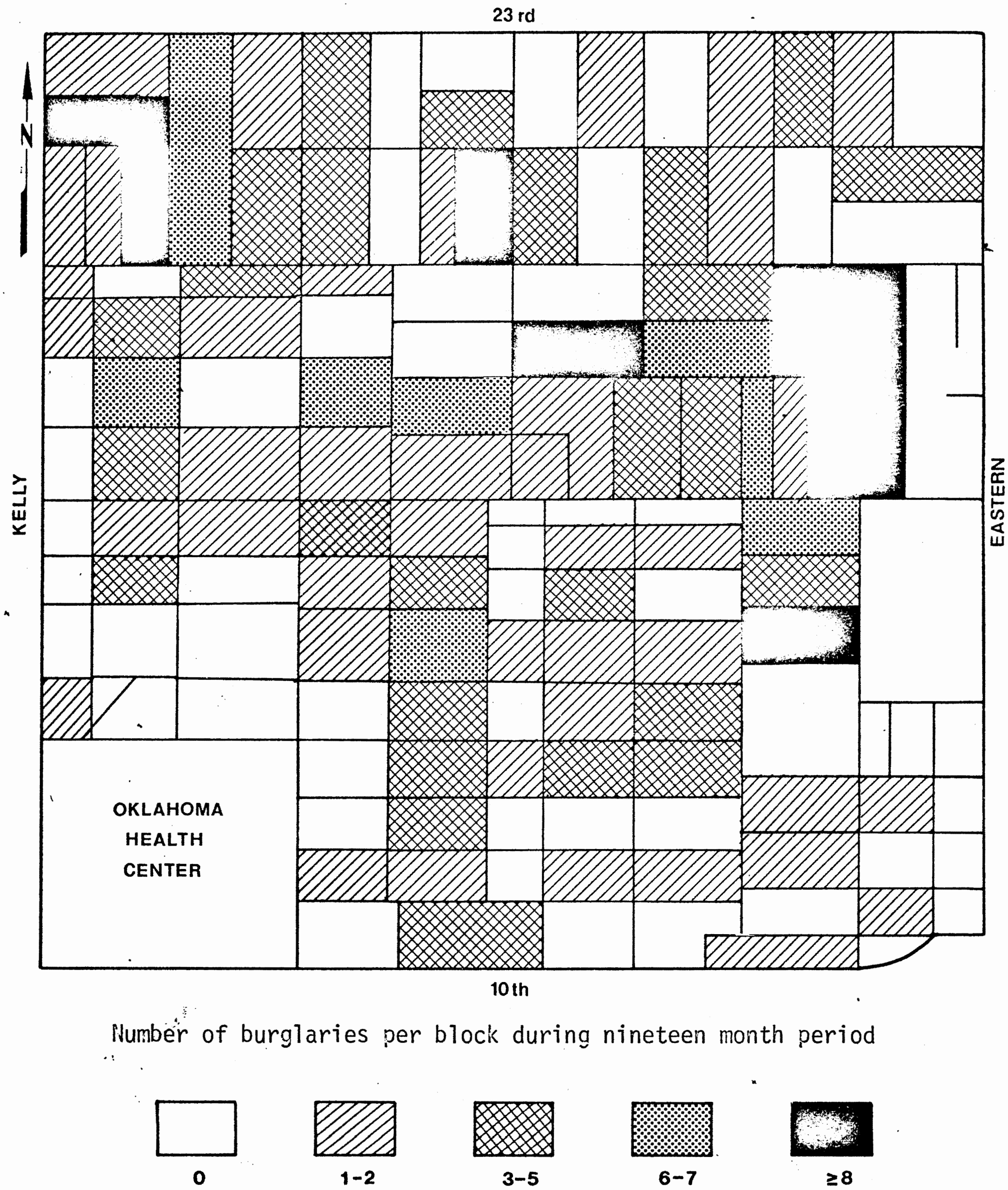


Figure 23. Area Three: Raw Burglary Frequency Map

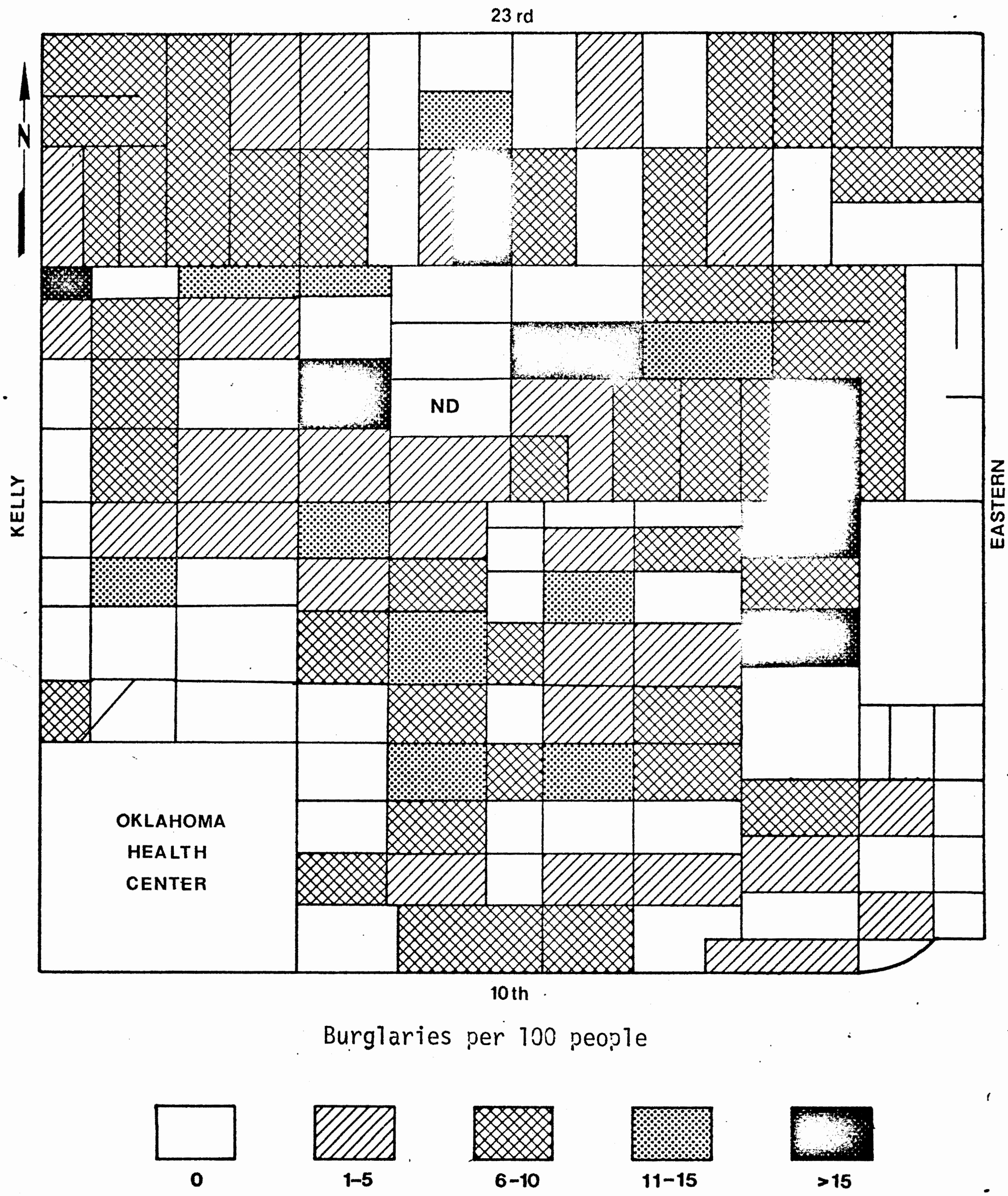


Figure 24. Area Three: Population-Based Burglary Rate Map

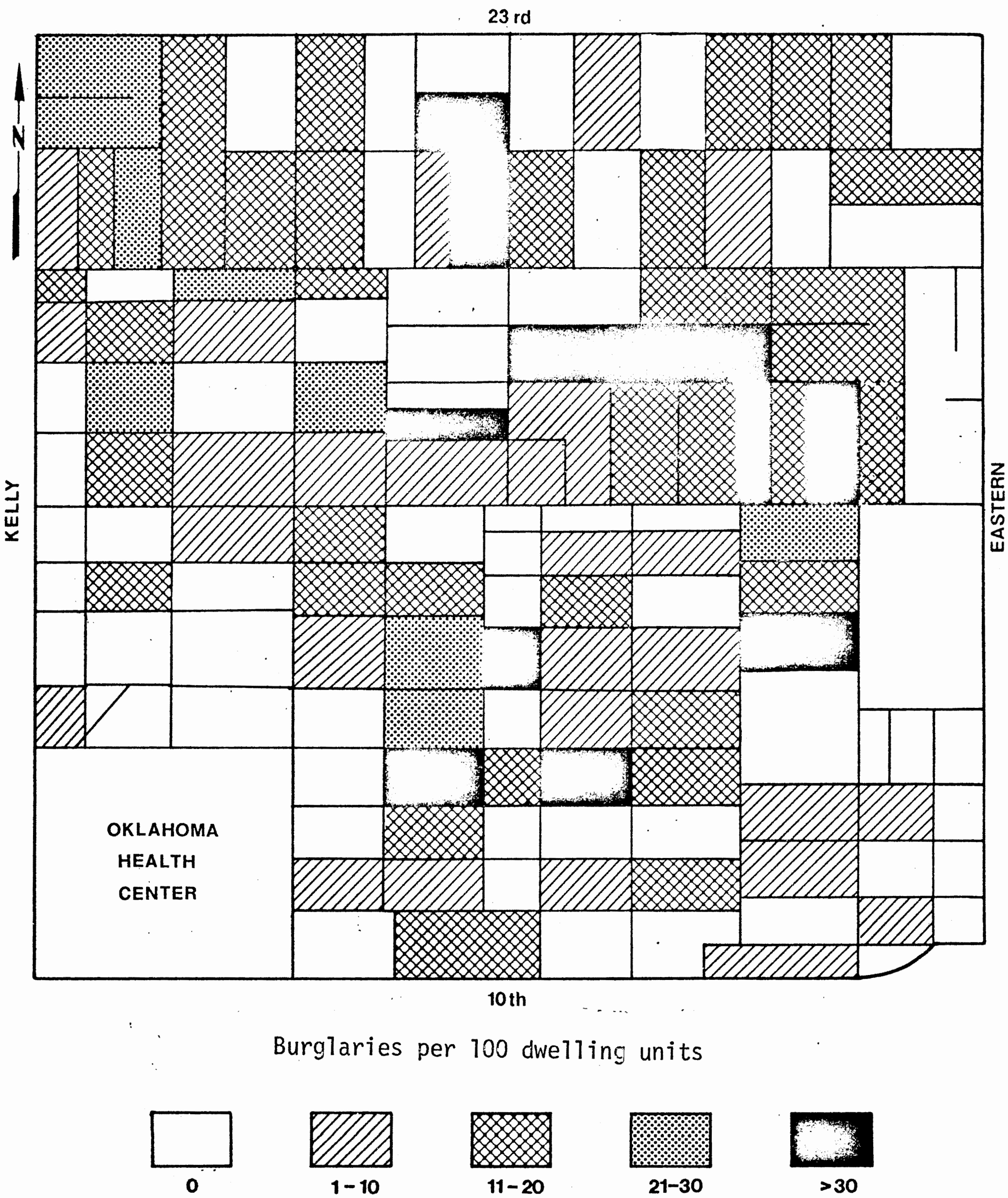


Figure 25. Area Three: Dwelling-Unit-Based Burglary Rate Map

area Three (Figure 23) did not represent the most concentrated distribution. In fact, it was difficult to determine which of the three spatial distributions was the most concentrated or dispersed. An attempt at explaining this phenomenon is presented in Chapters V and VI. Nevertheless, from empirical observation of the urban features in study area Three, few multi-family structures were discovered. The racial mix and social status of the population were constant throughout the area. The variations in burglary (if any) were expected to be related to the commercial and institutional land uses in the area. That is, the city blocks along Lottie Avenue, the extreme northern and the extreme southwestern city blocks were expected to have the highest burglary rates and frequencies. These expectations were not met. Therefore, it was theorized at this early stage in the analysis that patterns of residential burglary and their ecological correlates are more ambiguous in relatively homogeneous urban areas.

Chi-Square Analysis

The chi-square test was used to establish whether the spatial distribution of residential burglary, measured as a frequency, a population-based rate, and as a dwelling-unit-based rate, was significantly different from expected. The null hypothesis stated that there was no difference of burglary distributions between study area quadrants. Nine chi-square tests were manually conducted: one for each burglary measurement technique for each of the three study areas. If the chi-square was greater than 7.82 for any of the nine tests, the null hypothesis was rejected and residential burglary was significantly concentrated in a study area quadrant.

The results of the nine chi-square tests are given in Table XI. All chi square values except one were greater than the decision rule value of 7.82. In other words, the spatial distribution of dwelling-unit based rates in study area Two was the only distribution which was evenly distributed among the four quadrants.

TABLE XI

CHI-SQUARE RESULTS

Study Area	Raw Frequency	Pop.-Based Rates	D.U.-Based Rates
1	X^2= 14.58	13.98	10.06
2	15.20	11.35	7.28
3	9.98	8.34	11.93

significance: p = 0.05, df = 3

critical value = 7.82

The chi square values supported the observations made from the visual areal association technique. The raw frequency distributions in study areas One and Two were, in fact, more concentrated than population-based rates, and the population-based rates were more concentrated than the dwelling-unit-based rates. Study area Two, which was termed "the area of extremes" in Chapter III for its diversity of urban conditions, also had the largest range of chi-square values. The transition from burglary frequencies to dwelling-unit-based rates was most extreme in area Two. The obscure relationships between the three spatial distributions for area Three were elucidated by the chi square tests. The transformation of raw frequencies to the population-based rates in area Three slightly dispersed the spatial distribution. The transformation to dwelling-unit-based rates, however, unexpectedly reversed the trend and the result was the most concentrated distribution of burglary for area Three.

Summary

The spatial distribution of residential burglary presented in the forms of frequencies, population-based rates, and dwelling-unit-based rates were established and have been presented. Two problems were addressed specifically: (1) to what extent do residential burglary rates and frequencies vary among one another, and (2) to what extent do the residential burglary rates and frequencies vary among the city blocks in each study area? The correlations reveal that the rates and frequencies are different from one another. In relatively homogeneous urban areas (homogeneous of family structure and dwelling unit types) population-based rates and dwelling-unit-based rates described a similar quantity of burglary. Visual areal association and chi-square techniques served to measure the extent that the burglary rates and frequencies varied among city blocks. It was discovered that residential burglary, measured in at least two of the three ways, was concentrated in a quadrant of every study area. Residential burglary appeared more dispersed when the dwelling-unit rate was applied to frequencies or population-based rates in two of the three areas. It was theorized that this "trend of dispersion" did not hold true to study area Three because area Three was characterized by: (1) a relatively dispersed burglary pattern initially, and (2) a relatively homogeneous population and housing-type urban structure.

CHAPTER V

AERIAL PHOTOGRAPHIC ANALYSIS OF ECOLOGICAL RESIDENTIAL CONDITIONS

Introduction

The argument for aerial photographic urban data collection is founded in the poor data collection techniques currently used by many city planning agencies and criminologists. As stated in the introduction, evaluations of urban areas have been obtained conventionally through ground surveys, tax and utility receipts, questionnaires, and the United States Census. The Census is published decenially, (soon to be quinqennially) and techniques administered locally are costly and often dilatory. Consequently, urban data suffers from unreliability which not only impacts the quality or urban ecological crime studies, but also causes a loss of public confidence in local planning agencies. There is a need for a technique capable of providing housing and socio-economic data quickly and inexpensively. Research suggests remote sensors may be capable of providing many of the necessary data.

The feasibility of the application of aerial photographic interpretation to urban physical and socio-economics data was investigated as a part of this thesis. The primary concern was to evaluate the accuracy of aerial photographic estimates of the following three, block-level physical variables: dwelling-unit density, percent detached dwelling units, and the land-use index in the three study areas in Oklahoma City in order to test certain hypotheses relating to burglary patterns. As an adjunct to this research, photo sociometrics was explored through the determination of the relationships between interpretable urban physical data and "invisible" socio-economics data. The proposition was that if certain physical variables can be estimated satisfactorily from aerial photography, and if a strong relationship is discovered between the physical variables and certain socio-economic conditions. The following hypotheses were tested: (1) dwelling-unit density, percent detached dwelling-units, and the land-use index (each aggregated to the city block) may be satisfactorily estimated from aerial photography; and (2) a strong positive relationship exists in the three study areas in Oklahoma City between the physical variables and the socio-economic variables at the city-block level. The succeeding sections of this chapter are devoted to the testing of these hypotheses. The discussions cover the aerial photographic formats, the evaluation of photographic data accuracy, the collection process, and photo sociometrics.

The Aerial Photography

Most photo interpreters who use aerial photographs for housing and land use evaluation prefer to use aerial photographs at scales of 1:2,400 to 1:30,000. Only in rare instances, when general patterns of urban land uses are desired, small scale aerial photography or satellite imagery is employed. Although black-and-white photographs are suitable for many urban applications, natural color or color-infrared films are preferred because of the additional information they provide regarding vegetation composition. Reeves (54) maintained that urban vegetation data has shown potential for determining the age and quality of residential structures. Other studies have determined that poverty areas may be identified using color infrared photographs. Indicators such as poor street quality, presence of litter, and poor lawn quality are identifiable on color-infrared photographs.

The only recent aerial photographs available for the three study areas in Oklahoma City were procured by the Oklahoma City Planning Office with black-and-white, panchromatic film from medium-altitude aircraft. The vertical photographs were acquired in December, 1976--during the season when most vegetative cover types were undeveloped phenologically. The areas were free of snow. In the case of black-and white film, the December date of acquisition proved to be advantageous to the interpretation process because an unobstructed view of residential structures was provided. Although building heights could have been directly measured to determine number of stories, building shadows were measured as the surrogate. The scale of the original film is approximately 1:30,000 and stereo contact prints (9 x 9 inches) were available. Enlargements of these photographs to 1:4,800 in the from of 42 x 42 inch blue-line prints were also available. Before undertaking any aerial photographic analyses, it was assumed that both formats of photography were suitable for assessing urban residential data and both were employed by the author. The location of each study area within the aerial photographic prints is illustrated in Figure 26.

The resolution of black-and-white, panchromatic contact prints (free of camera and processing imperfections) is a function of scale. The scale of the contact prints used here is near the maximum limit of the scale suitable for housing inventories. Higher resolution, larger scale (1:2,400 to 1:12,000) contact prints might facilitate more accurate dwelling unit inventories. However, such photography was not obtainable. The resolution of the contact prints was further enhanced through stereoscopic analysis. Poorer resolution is inherent to blue-line prints because they are characteristically "second-generation" images. Their advantage lies in their larger scale and rapid and inexpensive reproducibility feature. It was hypothesized that blue-line prints of larger scale (1:4,800) would be of the same or greater utility than 1:30,000-scale contact prints.

Examples of the resolution of the 1:4,800 blue-line prints and a variety of urban features identifiable from the prints are presented in Figure 27 and 28. An example of the 1:30,000 contact prints was unavailable. Figure 27 is an aerial photograph of the east-central portion of study area Two. Large and small single-family homes, multi-family structures, and other land-use types are interpretable. Small lot sizes, the conglomeration of structures and land-use types, and the large (leafless) trees are evidence that the scene depicted is an older, bustling urban area. The north-central portion of study area One is depicted in Figure 28. Approximately half of the Oklahoma City Housing Authority family complex, Kerr Village, is in view. An interesting transition is apparent between the newer, middle-sized

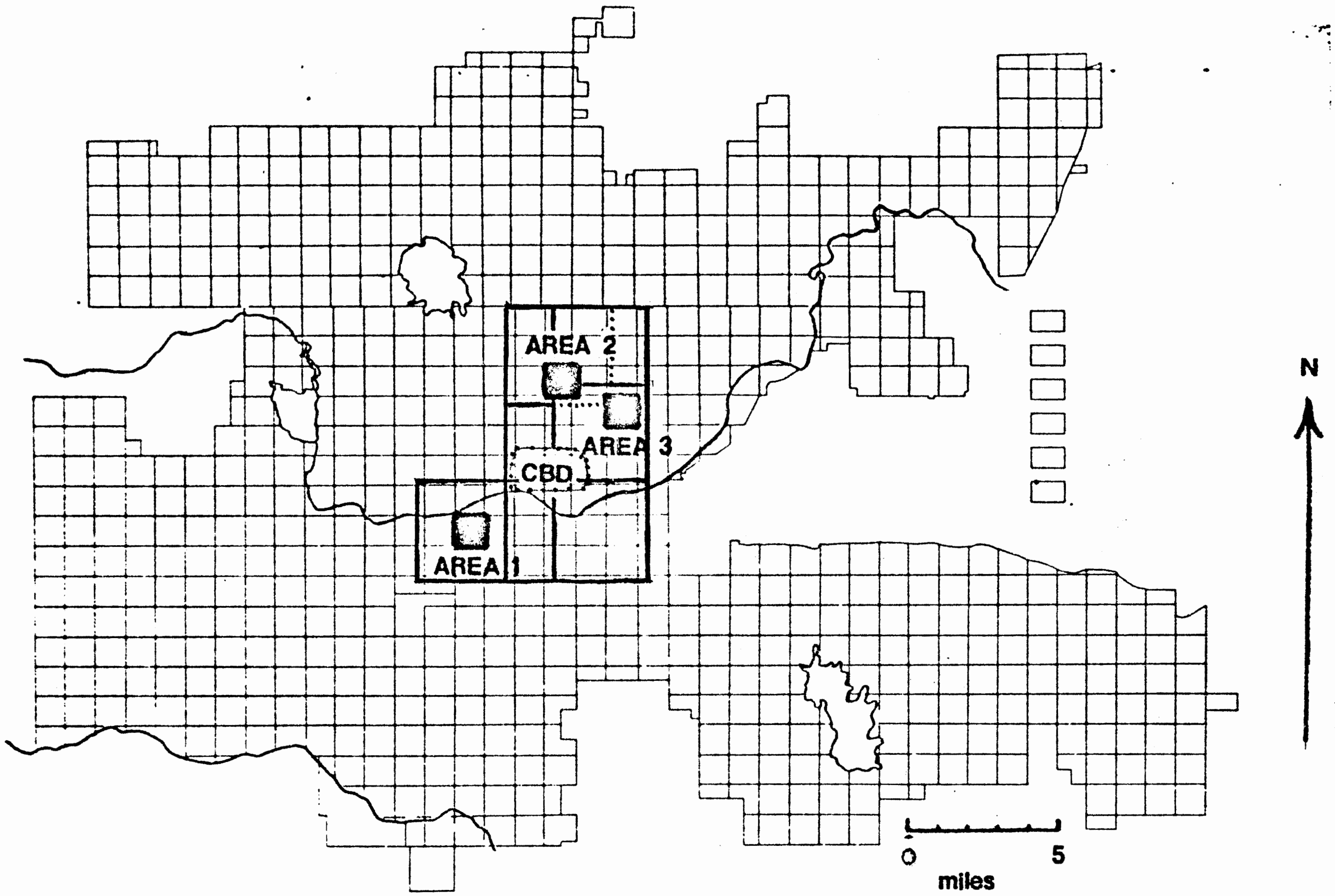


Figure 26. Aerial Photographic Coverage

Figure 27. A Blue-Line Print Sample: East Central Portion of Study Area Two. (A) Large, single-family homes; (B) smaller single-family homes; (C) multi-family structures; (D) two story duplexes

Figure 28. A Blue-Line Print Sample: North Central Portion of Study Area One. (A) Kerr Village; (B) relatively new middle-size, single-family homes; (C) older smaller single-family homes; (D) automobiles

single-family homes and the older, smaller single-family homes south of Kerr Village. The newer homes were constructed since 1966 and some of the older homes, surrounded by mature vegetation, may have existed since 1910. An example of the resolution capabilities is offered by the automobiles on the four-lane, divided highway.

Evaluation of Aerial Photographic Data Accuracy

The specific problem was to investigate the reliability and validity of aerial photographic interpretation as a collection method for the three physical variables in each of the three study areas. It was explained in Chapter II that urban land-use types have been easily identified and accurately mapped through aerial photographic interpretation. Many prior works have been successful in showing that the land uses herein are identifiable through black-and-white aerial photographic interpretation. The land use types in the study areas were no exception. A preliminary inventory of actual land-use data obtained from land-use maps and field surveys supported the findings of previous literature. Therefore, the attention was focused on: (1) the dwelling unit density per acre recorded per city block; and (2) the percentage of all dwelling units classified as single units, detached.

The objective of the sampling procedure was to insure the inclusion of the full range of the residential structural types in the study areas. Toward this end, the criterion was to select city blocks which were representative of a variety of residential land-use categories. The identification of the land-use classifications was made by referring to land-use maps produced by the Planning Department, City of Oklahoma City, and from two visits to the study areas. Since study area Two was a mosaic of all possible residential land uses, each sampled city block was randomly selected from area Two. Approximately forty percent (forty blocks) of the city blocks in area Two were randomly chosen. Forty was chosen to insure an adequate number of observations for statistical analyses. That the sample did in fact included the desired variety of structural characteristics was confirmed by the later analyses of the ground observations. For example, it was found that the prevalence of single-family homes varied from 0% to 100% in the blocks sampled.

The next procedure involved the aerial photographic interpretation of the two housing (physical) variables using the 1:4,800 blue-line prints and the 1:30,000 contact prints. Both variables were estimated from simply interpreting residential structure counts and dwelling unit counts for each sampled block. The dilemma was to estimate the number of dwelling units within multiple family structures. This was especially difficult when the multiple-family structure was originally constructed as a single-family home and later subdivided into apartments. "Aerial photo-interpretation keys" were used for identifying these structural types. These keys or recognition guides were physical features of the photographic image. Described as follows, they aided in determing whether a structure was residential and in estimating dwelling unit counts: (1) form, structure, and size of roof; (2) height of the building (suggested by the size of shadow); (3) location of building with respect to streets and other structures; (4) presence of parking lots, garages, and driveways; (5) sidewalks and entrances; and (6) the size, shape, and dividing lines of yards or lots. In many instances, only one or two of these keys were required for correct identification of a structure. The identification of duplexes was aided by the prevalence of twin sidewalks, entrances, and driveways. Plural entrance ways, offstreet parking areas, and comparative size and height were often reliable indicators of a multiple-family structure.

The interpretation of twenty of the forty sample blocks was conducted monoscopically using the blue-line prints. Stereoscopic analysis was performed on the remaining twenty blocks using the 9 x 9 inch contact prints. The housing data were interpreted by the author and recorded. Two interpreters might have increased estimation accuracy, but that situation was not feasible due to the limited access to the contact prints. Block acreage estimations were acquired through the use of a Numonics electronic digitizer. The density values and the percentages of detached dwelling units were calculated.

The ground data collection processes were field surveys of the same forty city blocks in study area Two. For most blocks, the correct number and classification of dwelling units were acquired from simply slowly driving around the block observing, and recording. In some cases of multiple-family structures it was necessary to count the mailboxes. The acreages used to compute the "actual" density values were digitally measured from 1:4,800 scale base maps. A weakness of this part of the analysis was the temporal gap between the 1976 aerial photography and the ground data collection. No attempt was made to account for this problem, but since the study areas were "mature," few housing changes occurred during the three year interval.

The aerial photographic data accuracy technique was the correlation of the aerial photographic and ground observations for each format of photography. The observations were converted to ordinal (ranked) data and Spearman's rank correlation coefficients were calculated. Smith (62) noted that rank correlations are useful when figures on the actual magnitudes seem of doubtful accuracy in themselves but probably good enough to rank observations. The analyses are presented in Tables XII and XIII. For the 1:4,800 scale blue-line prints, the correlations between aerial photographic and field collected density and percent detached variables were 0.79 and 0.82, respectively. For the 1:30,000 scale contact prints, the correlations between aerial photographic and field-collected density and percent detached variables were 0.42 and 0.74, respectively. The correlation coefficients indicate that larger scale blue-line prints were more successful for use in the interpretation of the housing variables.

The results supported the hypothesis that the two "housing" physical variables may be satisfactorily estimated from aerial photography. The larger scale, blue-line prints were more useful in obtaining accurate estimates than the contact prints. Therefore, the blue-line prints were selected for use in the acquisition of the physical variable parameters of each block in the three study areas. This more extensive interpretation process was again aided by the photo keys and the electronic digitizer. However, a closer look at Tables XII and XIII revealed that the photo-estimates of density were consistently

TABLE XII

EVALUATION OF PHOTOGRAPHIC DATA ACCURACY:
1:4800 BLUE-LINE PRINTS

Study Area Two		DU Density		Rank Order		% Detached DU		Rank Order	
Census Tr.	Block No.	Photo	Ground	Photo	Ground	Photo	Ground	Photo	Ground
1011	114	12.38	15.73	1	1	0	1	19	19
1012	209	11.32	11.03	2	4	12	17	18	14
1007	316	10.49	9.96	3	7	100	47	5.5	10
1006	109	10.43	11.14	4	3	17	09	16	17
1011	115	10.41	12.74	5	2	24	11	15	16
1012	212	8.95	10.20	6	5	86	35	12	14
1012	217	8.69	8.57	7	15	68	76	13	8
1007	301	8.63	8.83	8	10	100	100	5.5	2
1007	107	8.61	8.45	9	16	100	90	5.5	6
1006	205	8.55	10.14	10	6	100	42	5.5	12
1011	117	8.52	9.05	11	8	100	80	5.5	8
1011	116	8.50	8.64	12	13	100	88	5.5	7
1006	112	8.47	8.65	13	12	100	100	5.5	2
1006	308	8.43	8.49	14	14	100	100	5.5	2
1011	107	8.25	8.94	15.5	9	55	74	14	9
1006	106	8.25	8.35	15.5	17	100	100	5.5	2
1011	209	8.23	8.77	17	11	08	06	17	18
1011	102	7.96	8.23	18	18	100	38	5.5	12
1006	201	7.43	7.45	19	19	100	100	5.5	2
1012	217*	---	---	---	---	---	---	20	20

Spearman's Rank Correlation
Coefficient = 0.79

Spearman's Rank Correlation
Coefficient = 0.82

*No dwelling units

TABLE XIII

EVALUATION OF PHOTOGRAPHIC DATA ACCURACY:
1:30,000 CONTACT PRINTS

Study Area Two		DU Density		Rank Order		% Detached DU		Rank Order	
Census Tr.	Block No.	Photo	Ground	Photo	Ground	Photo	Ground	Photo	Ground
1011	201	10.91	10.74	1	3	23	18	17	15
1011	204	10.67	10.28	2	6	00	00	20	20
1011	206	10.43	8.57	3	19	55	75	14	10
1012	204	9.97	10.73	4	4	21	14	18	16
1006	108	9.87	10.94	5	2	24	09	16	17
1006	206	9.40	10.33	6	5	30	08	15	18
1011	101	9.31	13.06	7	1	08	02	19	19
1007	304	8.90	9.15	8	10	88	90	12	5
1007	314	8.75	8.87	9	15	100	85	4.5	4
1007	108	8.72	8.59	10	18	100	95	4.5	3
1007	105	8.65	8.68	11	16	100	100	4.5	1.5
1007	201	8.63	8.94	12	14	100	79	4.5	8.5
1012	213	8.61	9.17	13	11	80	59	13	12
1007	110	8.56	8.66	14	17	91	83	11	7
1011	106	8.42	9.98	15	7	100	41	4.5	14
1007	306	8.37	9.04	16	13	92	79	10	8.5
1012	102	8.29	9.65	17	8	100	50	4.5	13
1012	211	8.24	9.06	18	12	100	70	4.5	11
1006	102	8.22	9.25	19	9	100	100	4.5	1.5
1006	107	8.20	8.21	20	20	100	100	4.5	1.5

Spearman's Rank Correlation Coefficient = 0.42

Spearman's Rank Correlation Coefficient = 0.74

lower than ground data and the photo estimates of percent detached dwelling units were higher. These errors resulted from misinterpreting small apartments as single-family structures. Therefore, the interpretation was conducted with the knowledge that there is a tendency to underestimate dwelling unit counts in multi-family structures.

Photo Sociometrics

Background

The supposition has been advanced (1) that if certain physical variables can be estimated satisfactorily from aerial photography, and (2) if a strong relationship is discovered among the physical variables and certain socio-economic variables, then aerial photography may be used to estimate socio-economic conditions. Blue-line prints at a scale of 1:4,800 were found to be suitable aerial photographic formats for the interpretation of the three physical variables of this thesis. The next task was to determine the relationships between the physical and socio-economic variables. The rationale for this recognizes that physical and socio-economic aspects of a city are related.

Before continuing, the findings of several photo-sociometric researchers discussed in Chapter III should be reemphasized. Norman Green (22) discovered a strong positive relationship between a set of four physical variables and a set of five socio-economic variables in Birmingham, Alabama. The variables were aggregated to the census tract level and a random sample of census tracts were selected from all parts of Birmingham. McCoy and Metivier (40) limited their analysis to examine relationships between dwelling unit density and five socio-economic variables in Lexington, Kentucky. Again, the variables were aggregated to census tracts selected from all over the city and strong relationships were discovered. Randomly sampled block-level data were similarly investigated by Henderson and Utano (30) in Albany and Schenectady, New York. Dwelling-unit density was found to be highly associated with five block-level socio-economic variables.

Each of the three photo-sociometric studies above were successful in revealing strong relationships among physical and socio-economic urban conditions. The three were similar in that their samples of census tracts or blocks were representative of a wide variety of subareas within entire metropolitan areas. Their findings were general statements concerning urban morphology and urban social structures.

The photo sociometric analysis of this thesis, however, was restricted to 246 city blocks in three one square-mile areas. This restriction was illuminated by the relative homogeneity between and within the study areas. It was conceded before the analysis that a significant proportion of differences in ecological variable parameters may be a function of chance--because of the small variance. Therefore, an interesting objective was to compare the findings of this "restricted-sample" study with the results of previous research.

Analysis and Results

Norman Green (22) employed Guttman scaling (Cornell technique) in grouping his physical variables and socio-economic variables. The scaling technique assigned each census tract two scale scores, one indicating the block's physical desirability and the other indicating the block's socio-economic desirability. The scale scores were then correlated to reveal the relationship between the physical and the socio-economic urban conditions. The use of this technique, however, requires that the user subjectively decides what constitutes a desirable or undesirable city block. Nevertheless, Green discovered that scale analysis provided a convenient and precise method for defining ecological interrelationships.

The end products of factor analysis, on the other hand, are similar to those of Guttman scaling as manipulated by Green. If physical variables load on one factor and the socio-economic variables load on another factor, then two factor scores may be assigned to each block. The scores are interval data, indicating each city block's position in the physical and the socio-economic spectra. The scores may then be regressed with urban variables to establish the physical/socio-economic relationships.

Both statistical techniques, Guttman scaling and factor analysis, were considered for inclusion in the analysis of photo sociometrics. Both techniques were tested for their feasibility of application to the seven block-level ecological variables. Because of the awkward and time consuming computational procedures associated with Guttman scaling, it was not used. However, a presentation of the initial testing of Guttman scaling for its feasibility in this research is found in Appendix C.

The first part of the analysis consisted of applying factor analysis to the seven ecological variables for all three study areas to determine if, in fact, the three physical variables loaded on one factor and the four socio-economic factors loaded on another. Two factors were specified, and the rotated factor pattern is given in Table XIV. The results were partially successful. The three physical variables did load on factor one. Percent female heads and age of population were loaded on factor two. The income index was split between the two factors, and household migration was not strongly loaded on either factor. Since income was associated with the physical variables, Factor 1 was termed the "Property Factor." Factor 2

TABLE XIV

ROTATED FACTOR PATTERN: ALL THREE STUDY AREAS

		'Property' Factor 1	'Population' Factor 2
	DU Density	-0.491	-0.142
Physical	% Detached DU	0.775	0.233
	Land-Use Index	0.739	0.053
	% Female Heads	0.023	0.861
Socio-	Household Migration	-0.169	-0.230
Economic	Income	0.451	-0.435
	Age of Population	0.304	0.803

*Principle axis initial factoring followed by equamax rotation was more an indicator of population than socio-economic conditions and was termed the "Population Factor."

As mentioned previously, the presumption was that socio-economic conditions may be estimated from physical conditions. Therefore, the Population Factor, represented by the appropriate factor scores, was the dependent variable in a multiple regression analysis. How much variation in Population Factor was explained by each and all of the physical variables? In extreme contrast to the findings of Green, McCoy and Metivier, and Henderson and Utano, low relationships were discovered. Only six percent of the variation in the population factor was explained by the three physical variables (see Table XV). This association, plus the signs of the factor loadings (Table XIV) indicated that many children and many female heads were associated with single-family homes, desirable land use, and low density. This was surprising since female heads of households and many children have been recognized as reliable indicators of the poor. In fact, twelve percent of the variation in the age variable was explained by the three physical variables. Correlation coefficients greater than -0.80 were discovered between density and income in the prior studies. This analysis revealed that no relationship existed between the two variables for all three study areas.

The multiple-regresstion technique was then applied to the physical variables and the population factors of each study area. The strongest relationships were in area One. The newer homes near Kerr Village are occupied by many children and the occupants are of moderate socio-economic status. Again, this illustrates that stronger

TABLE XV

R-SQUARES AMONG PHYSICAL AND SOCIO-ECONOMIC ECOLOGICAL VARIABLES

ALL THREE STUDY AREAS	DENSITY	% DETACHED	LAND USE	ALL
Population Factor	0.02	0.05	0.00	0.06
Female Heads	0.00	0.04	0.01	0.04
Household Migration	0.01	0.01	0.02	0.02
Income	0.00	0.01	0.02	0.02
Age	0.04	0.11	0.05	0.12
STUDY AREA 1				
Population Factor	0.18	0.14	0.17	0.21
Female Heads	0.03	0.06	0.05	0.07
Household Migration	0.06	0.06	0.00	0.10
Income	0.01	0.04	0.03	0.13
Age	0.30	0.30	0.49	0.58
STUDY AREA 2				
Population Factor	0.06	0.00	0.01	0.09
Female Heads	0.02	0.02	0.00	0.04
Household Migration	0.04	0.00	0.06	0.09
Income	0.00	0.07	0.07	0.11
Age	0.11	0.07	0.08	0.14
STUDY AREA 3				
Population Factor	0.00	0.00	0.00	0.01
Female Heads	0.01	0.01	0.01	0.02
Household Migration	0.00	0.01	0.00	0.01
Income	0.00	0.00	0.00	0.00
Age	0.00	0.00	0.00	0.00

relationships occur in diverse urban areas. Nine percent of the variation in the Population Factor was explained by the three physical variables in area Two. As in area One, high income and young people were associated with desirable physical conditions. Study area Three continued to display its homogeneity. The saptial distributions of the burglary rates and frequencies were not significantly different. Likewise, no relationships between socio-economic conditions and physical conditions were discovered.

Summary

The results of this aerial photograhic study (1) lent strong support to the potential of large scale blue-line prints in assessing three physical urban characteristics of similar residential subareas in Oklahoma City; and (2) revealed little or no evidence supporting the feasibility of photo sociometrics in similar residential subareas in Oklahoma City. It was concluded that the outward appearance of the relatively homogeneous study areas was not a reliable indication of the socio-economic variables as a set or individually. The physical variables accounted for a significant amount of the variance in the age variable in study area One and Two. Weak relationships were discovered between the other urban conditions.

The low correlations were in themselves significant because they contradict prior research findings. In light of this statement, the differences between this analysis and past analyses should be referred to. Again, this study was performed with ecological parameters from three similar study areas. Each study area consisted of low to low-middle class households with the exception of approximately four city blocks in study area Two. Racial balance differed between study areas, yet this condition apparently did not influence relationships between the seven ecological variables. It was acknowledged that stronger correlations between the physical and socio-economic variables would probably have resulted if a more diversified sample had been used. Nevertheless the findings here showed that the relationships which exist at the metropolitan scale were absent in three selected subareas.

CHAPTER VI

ECOLOGICAL ANALYSIS OF RESIDENTIAL BURGLARY

Introduction

Review of the criminological literature revealed that there is more than one theory of burglary causation and therefore several approaches to burglary analysis. Waller and Okihiro (67) identified one theory as opportunity, with the key factors being those relating to the availability of goods to be stolen, dwellings to be entered, and the affluence of neighborhoods. Cloward and Ohlin (12) also discussed the theory and opportunity, with the key factors relating to the locations of the residences of burglars and potential burglars. Yet another concept advocated by Robinson (56) and discussed by Jeffrey (33) was that anomie is the primary cause of crime. Finally, Mahew (38) related burglary to the socio-physical characteristics of the offense location. She stated that this theory deals with the residential factors which affect the extent to which an offender, who wants to burglarize a dwelling, can do it.

The conceptual approach to the residential burglary analysis of this study is a version of Mayhew's "crime as opportunity" concept. Specifically, it is a look at where the burglary offense occurs in the context of the surrounding environment. The selection of this approach does not mean that it is considered a more significant or efficient means of understanding burglary. However, the concept may be the most important to possible victims and urban planners and others. If it is discovered which urban physical and socio-economic factors usually prevail in or near residential burglary offense locations, then burglary-risk areas may be delineated. It then may be possible to administer proper defense measures and ultimately reduce burglary.

The key questions addressed in this chapter directly involved burglary/environment relationships in Oklahoma City. In particular ecological conditions were correlated with burglary in an attempt to clarify the following problems.

1. What are the relationships between a general indicator of residential physical conditions by census city block and the corresponding residential burglary rates and frequencies?
2. What are the relationships between a general indicator of residential socio-economic conditions by census city block and the corresponding residential burglary rates and frequencies?
3. Which ecological indicator (physical or socio-economic), mapped by census city block, is more closely associated with the spatial distribution of residential burglary rates and frequencies?

Several criminologists have conceptualized that burglars strike affluent targets within low income areas. Since each study area is generally a low social-status area, it was hypothesized that the high burglary city blocks would also be the city blocks ranked high on the physical and socio-economic desirability scale. Land use was identified by criminologists as a causative agent of burglary, together with a young population and multi-family structures. These finds were kept in sight as the analysis of this research unfolded.

Methodology

The statistical analyses used to investigate the relationships between residential burglary and residential conditions were applied in the following manner: (1) the data of all three study areas combined were analyzed to discover general relationships; and (2) the data of each study area were analyzed separately to discover the relationships unique to each study area. Therefore the analysis procedure was replicated four times.

The first phase of the procedure was the development and interpretation of the two residential condition indicators. Factor analysis was applied to the data in an attempt to group the physical variables separately from the socio-economic variables as described in Chapter V. The meaning of each indicator or "factor" depended upon the strengths of the loadings of each variable on the factor. Each city block was then assigned two factor scores derived from the strong positive or negative loadings of the variables on the two factors. For example, if the physical variables loaded strongly on factor one, a relatively high factor-one score was expected to represent a city block characterized by low density (negative loading), single family homes (positive loading), and favorable land uses (positive loading). If the four socio-economic variables loaded strongly on factor two, then it was hypothesized that a high factor-two score would represent a block characterized by high income (positive loading), few female heads of households (negative loading), a stable or an in-migration of households (zero or positive loading), and few people under seventeen years old (negative loading).

The next step was the development of the Pearson's product-moment correlation matrix, in which each factor or residential condition indicator was correlated with the burglary rates and frequencies. Multiple correlation analysis was conducted subsequently to determine the amount of variance in burglary (rates and frequencies) explained by each residential condition indicator (factor).

Analyses and Results

All Three Study Areas

Factor analysis was applied to the parameters of the seven ecological variables of all three study areas taken as one data set. Two factors were specified along with principle axis initial factoring and an equamax (orthagonal) rotation. (A promax rotation was performed but results were not improved). The rotated factors are presented in Table XIV in Chapter V. As previously discussed, factor one was a fair representation of a physical (visible) residential condition indicator. Income also loaded on factor one, but this was not considered unusual since a person's wealth is often reflected by physical environmental attributes. Factor two, on the other hand, was composed of the variables prevalence of youth, percent female heads, and also income. However, from observing the signs of the factor loadings, factor two was an indicator of undesirable socio-economic conditions. It represented many female heads of households, many young people, and low income. Household migration was not strongly loaded on factor two, but it loaded negatively indicating out-migration. Therefore, a high factor-one score signified a desirable city block in terms of the three physical variables. A high factor-two score signified an undesirable city block in terms of the four socio-economic variables.

In an attempt to discover the relative residential quality of each study area in terms of their factor scores, schematic plots were developed. Tukey (64) maintained that schematic plots reduce the busyness of data so that areas may be compared. Figure 29 is an illustration of the factor-one score distributions in each study area. Some interesting similarities were found between an area's factor scores and its empirically obtained characteristics. As discussed in Chapter III, study area Two was observed as a diverse urban area in terms of physical variables while areas One and Three were more homogeneous. This is depicted by the schematic plots. The mean of the factor-one scores was highest in area One and lowest in area Two. However, the highest factor-one scores were in study area Two--undoubtedly in the northeast quadrant. Figure 30 is a schematic plot of factor-two scores by study areas. Again, a high factor-two score indicated a low socio-economic desirability. As expected, study area Three which appeared to be evenly populated with many children, low income households, and blacks (a surrogate of percent female heads) had the highest factor-two scores. Study area Two was

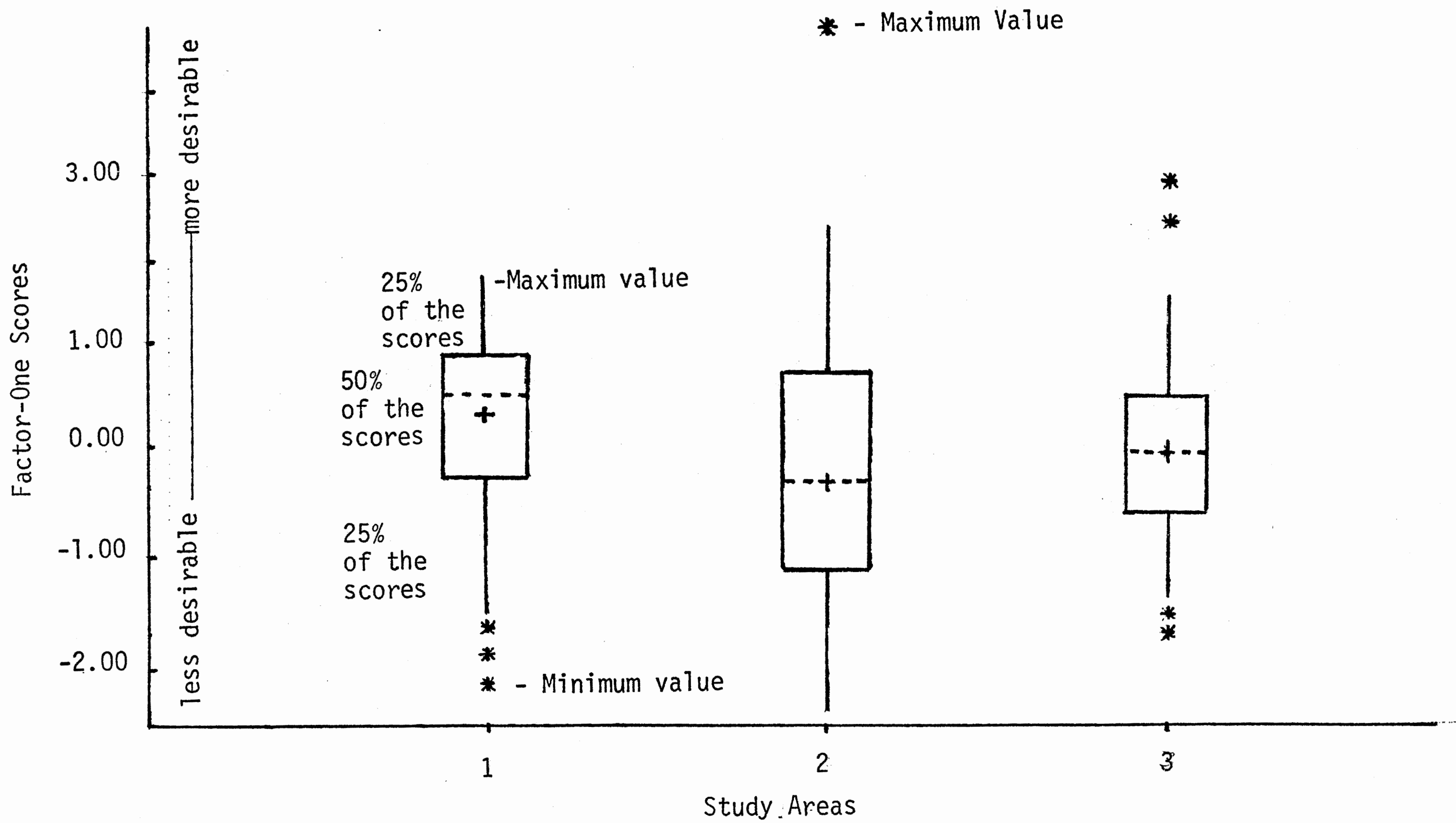


Figure 29. Schematic Plot: Factor-One Scores by Study Area

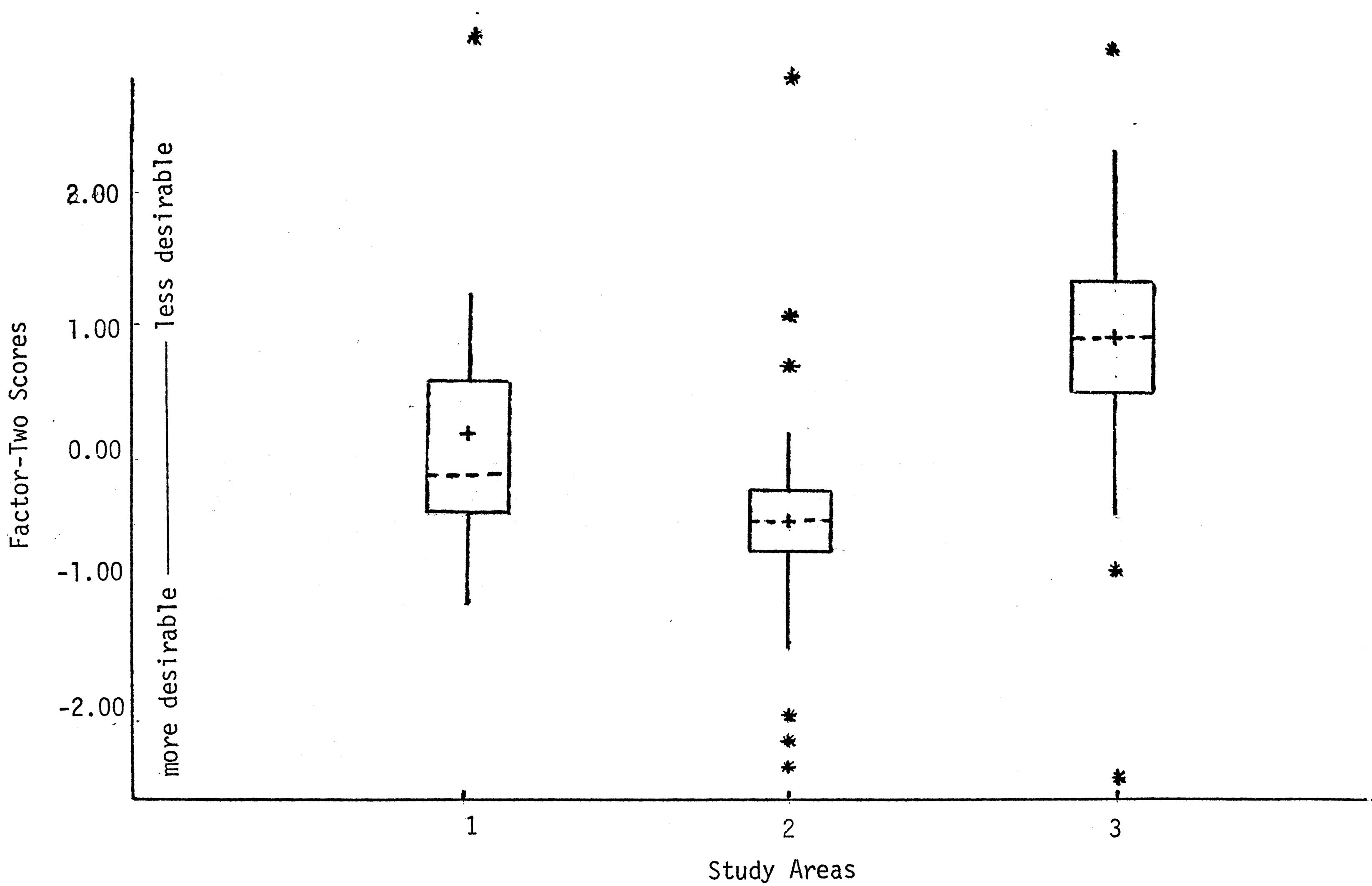


Figure 30. Schematic Plot: Factor-Two Scores by Study Area

the most desirable "socio-economic area," having the lowest factor two scores.

The correlations among the burglary rates and frequencies and the factor scores were weak (see Table XVI). Hence, the residential-condition indicators were not significantly related to the occurrence of residential burglary in all three study areas taken together. The multiple regression (R-square) analysis was conducted to answer the question: how much of the variance in residential burglary can be explained by the two residential condition indicators, together and separately? The results of the R-square analysis is presented in Table XVII. The residential condition indicators taken together explained 1.7 percent of the total variance in burglary frequency and 1.3 percent of the variance in both the population-based burglary rates and the dwelling-unit-based burglary rates. The R-square values are so close to zero that any conclusions concerning which residential condition indicator explains the most variance in burglary were considered ridiculous. The analyses by study area were conducted to discover any deviations from the above results.

Area One

Factor analysis was performed on the ecological variable parameters of study area One. Again, two factors and an orthogonal rotation were specified. The factors which resulted were representative of different residential conditions than the factors of the previous analysis (see Table XVIII). The three physical variables loaded strongly on factor one as expected. However, the age and

TABLE XVI

CORRELATIONS (r) AMONG BURGLARY AND RESIDENTIAL CONDITION INDICATORS: ALL THREE STUDY AREAS

Burglary	Factor 1	Factor 2
Raw Frequency	-0.129	0.000
Population-Based Rates	-0.111	0.025
Dwelling-Unit-Based Rates	0.025	0.112

TABLE XVII

R-SQUARE ANALYSIS: ALL THREE STUDY AREAS

Burglary	Factor 1	Factor 2	Factors 1 & 2
Raw Frequency	0.017	0.000	0.017
Population-Based Rates	0.012	0.001	0.013
Dwelling-Unit-Based Rates	0.001	0.013	0.013

income variables loaded on the same factor as the physical variables. Therefore, city blocks with high factor-one scores were characterized by desirable physical conditions as well as many young people (<17) and many female heads of households. This circumstance was consistent with the observations of study area One gathered empirically. The newer, larger homes near Kerr Village were obviously occupied by many children. The porches of the older homes in the southern sections of area One exhibited many senior citizens. Household migration (positive) and income (negative) loaded strongly on factor two. City blocks with high factor-two scores consisted of low income households which declined in number from 1970 to 1975.

TABLE XVIII

ROTATED FACTOR PATTERN: AREA ONE*

	Factor 1	Factor 2
Land Use	0.764	0.336
% Detached DU	0.799	-0.208
DU Density	-0.763	0.181
Household Migration	-0.244	0.856
% Pop. Age 17	0.900	-0.018
% Female Heads	0.547	-0.169
Income	-0.024	-0.871

*Principle axis initial factoring followed by equamax rotation.

Pearson's product-moment correlation coefficients (r) and R-square coefficients were calculated to measure the relationships between each residential condition indicator and residential burglary in area One. The results are offered in Tables XIX and XX. Surprisingly strong, positive correlations were found to exist between factor one and residential burglary. To a significant degree, residential burglary in study area One occurs in city blocks with many young people, many female heads of household, and relatively desirable physical conditions. Factor two was more weakly related to residential burglary, although the correlations were consistently negative. This was interpreted to mean that the relatively affluent, stable city blocks were burglarized more than the poorer, declining city blocks. The dwelling-unit-based rates were most related to the factor scores, with twenty-one percent of the variation explained by factor one alone.

The factor scores were then mapped and their spatial distributions were compared with the spatial distributions of residential burglary as established in Chapter IV. Ecological data were unavailable for part of area One, but this had little effect on the analysis. Figure 31 is a choropleth map of factor-one scores in area One. Five class intervals were selected for the ease of comparison with the burglary maps in Chapter IV. Smith (62) states that in areal classification with factor scores, classes may be estalished arbitrarily. Hence, the classes were established by the data's natural breaks. Comparing Figure 30 with the burglary maps of area One, the similarity was obvious. The city blocks near Kerr Village had the highest factor-one scores and the highest burglary rates. Figure 32 is a choropleth

TABLE XIX

CORRELATIONS (r) AMONG BURGLARY AND RESIDENTIAL CONDITION INDICATORS: AREA ONE

Burglary	Factor 1	Factor 2
Raw Frequency	0.342	-0.008
Population-Based Rates	0.289	-0.140
Dwelling-Unit-Based Rates	0.459	-0.212

TABLE XX

R-SQUARE ANALYSIS: AREA ONE

Burglary	Factor 1	Factor 2	Factors 1 & 2
Raw Frequency	0.117	0.000	0.117
Population-Based Rates	0.080	0.020	0.100
Dwelling-Unit-Based Rates	0.211	0.045	0.256

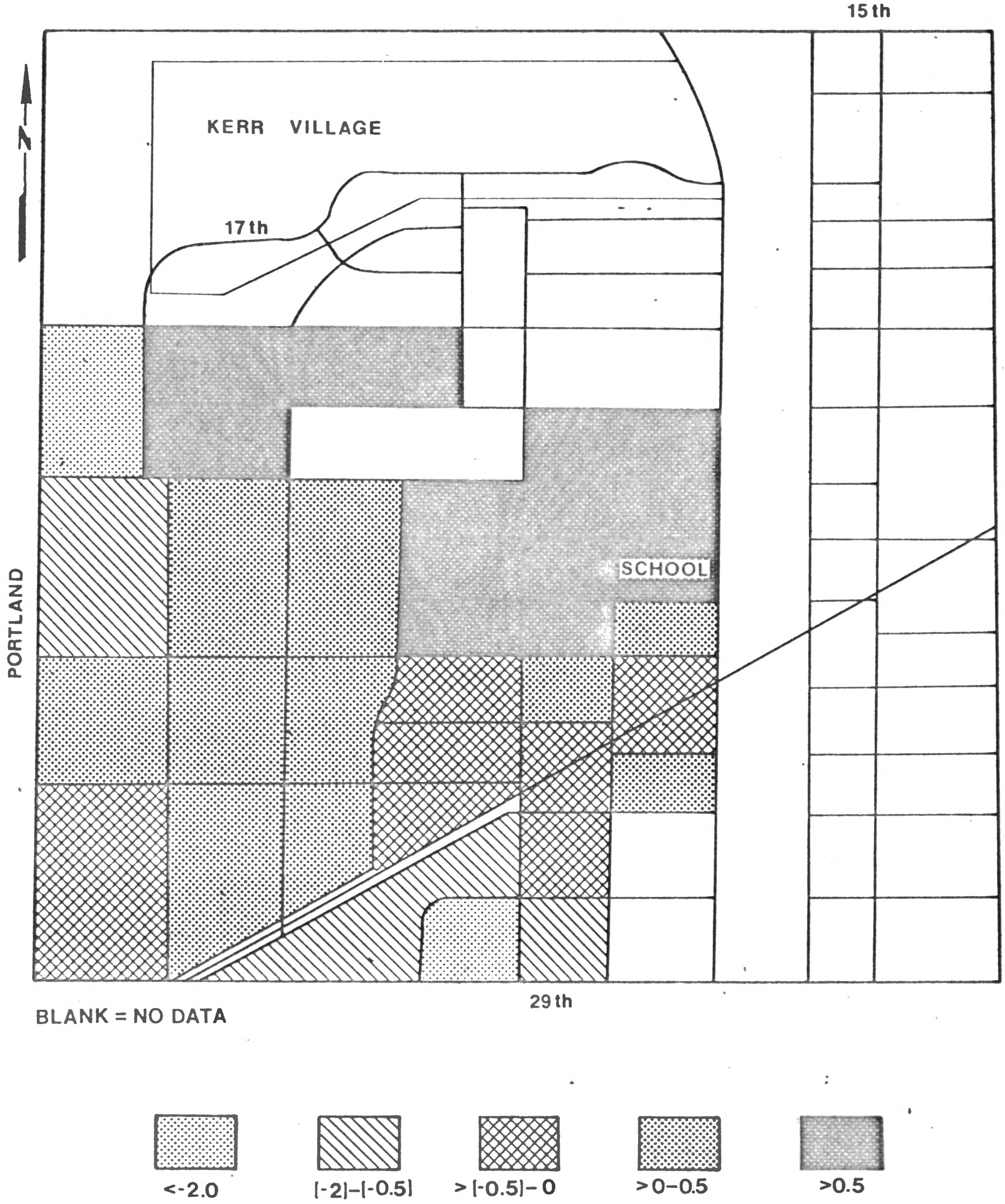


Figure 31. Area One: Factor-One Scores. Property Variables Plus Female Heads of Household and Youth

Figure 32. Area One: Factor-Two Scores. Household In-Migration and Low Income

map of factor-two scores. Again, the high factor-two scores indicated poor, declining city blocks. Any relationships between the mapped factor-two scores and the burglary maps were visually unobservable.

Area Two

Factor analysis was performed on the ecological variable parameters of study area Two to establish two residential condition indicators. Two factors resulted, similar to the two developed in the factor analysis of all three study areas (see Table XXI). The three physical variables and income loaded together on factor one. The youth variable and percent female heads composed factor two; household migration did not load on either factor. The factor loadings were expected to result in this manner. Study area Two appeared to be a stable area suggested by few if any vacant homes. Thus, household migration would not be grouped with either factor. Income was grouped with the physical variables because, in area Two, the wealthier families lived in more visually pleasing city blocks.

The correlations (r) and multiple correlations (r^2) revealed that weak relationships existed between burglary and the residential condition indicators in study area Two. However, it was clear that factor one generally was slightly more closely associated with burglary than factor two (Tables XXII and XXIII). The negative correlation coefficients (r) suggested that burglary rates and frequencies were higher in the less visually pleasing, poorer city blocks and the city blocks with relatively few female household heads and youth.

Only nine percent of the variance in the population-based burglary rates was explained by both residential indicators, six percent in the burglary frequencies, and less than two percent in the dwelling-unit rates. The spatial distributions of factor one and two scores are illustrated in Figures 33 and 34, respectively.

TABLE XXI

ROTATED FACTOR PATTERN: AREA TWO*

	Factor 1	Factor 2
Land Use	0.827	-0.020
% Detached DU	0.810	0.128
DU Density	-0.642	-0.280
Household Migration	-0.279	-0.057
% Pop. Age 17	0.322	0.808
% Female Heads	-0.082	0.913
Income	0.463	-0.004

* Principle axis initial factoring followed by equamax rotation.

Area Three

They physical variable homogeneity of study area Three was expressed by the factor analysis loadings. Only two of the three

The correlations (R) and multiple correlations (R^2) revealed that weak relationships existed between burglary and the residential condition indicators in study area two. Stronger relationships existed in area one. However, it was clear that factor one generally was more closely associated with burglary than factor two.

TABLE XXII

CORRELATIONS (R) AMONG BURGLARY AND RESIDENTIAL CONDITION INDICATORS: AREA TWO

Burglary	Factor 1	Factor 2
Raw Frequency	-0.223	-0.114
Population-Based Rates	-0.254	-0.165
Dwelling-Unit-Based Rates	0.032	-0.118

TABLE XXIII

R-SQUARE ANALYSIS: AREA TWO

Burglary	Factor 1	Factor 2	Factor 1 & Factor 2
Raw Frequency	0.050	0.013	0.063
Population-Based Rates	0.065	0.027	0.092
Dwelling-Unit-Based Rates	0.001	0.014	0.015

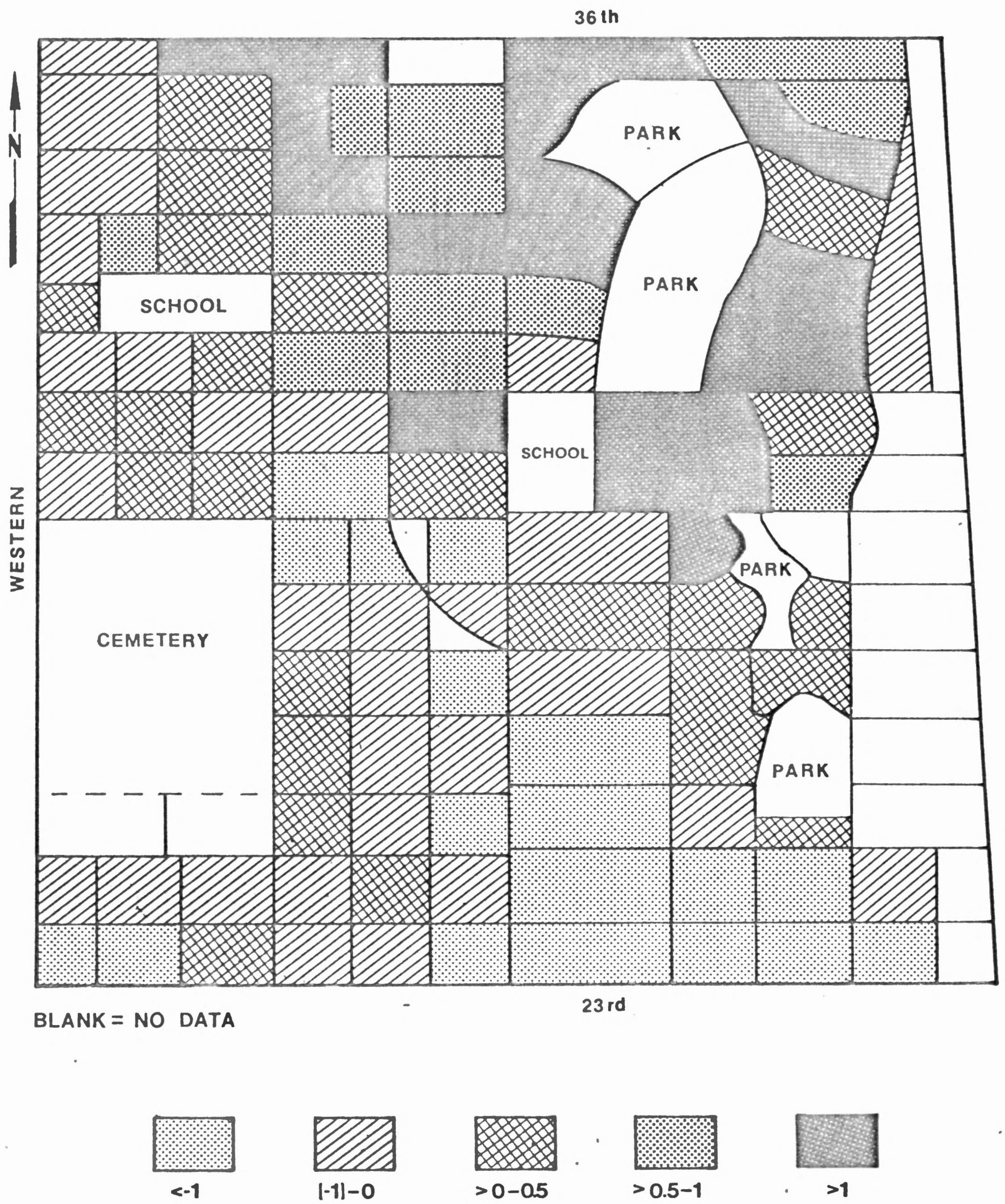


Figure 33. Area Two: Factor-One Scores. Property Variables Plus Income

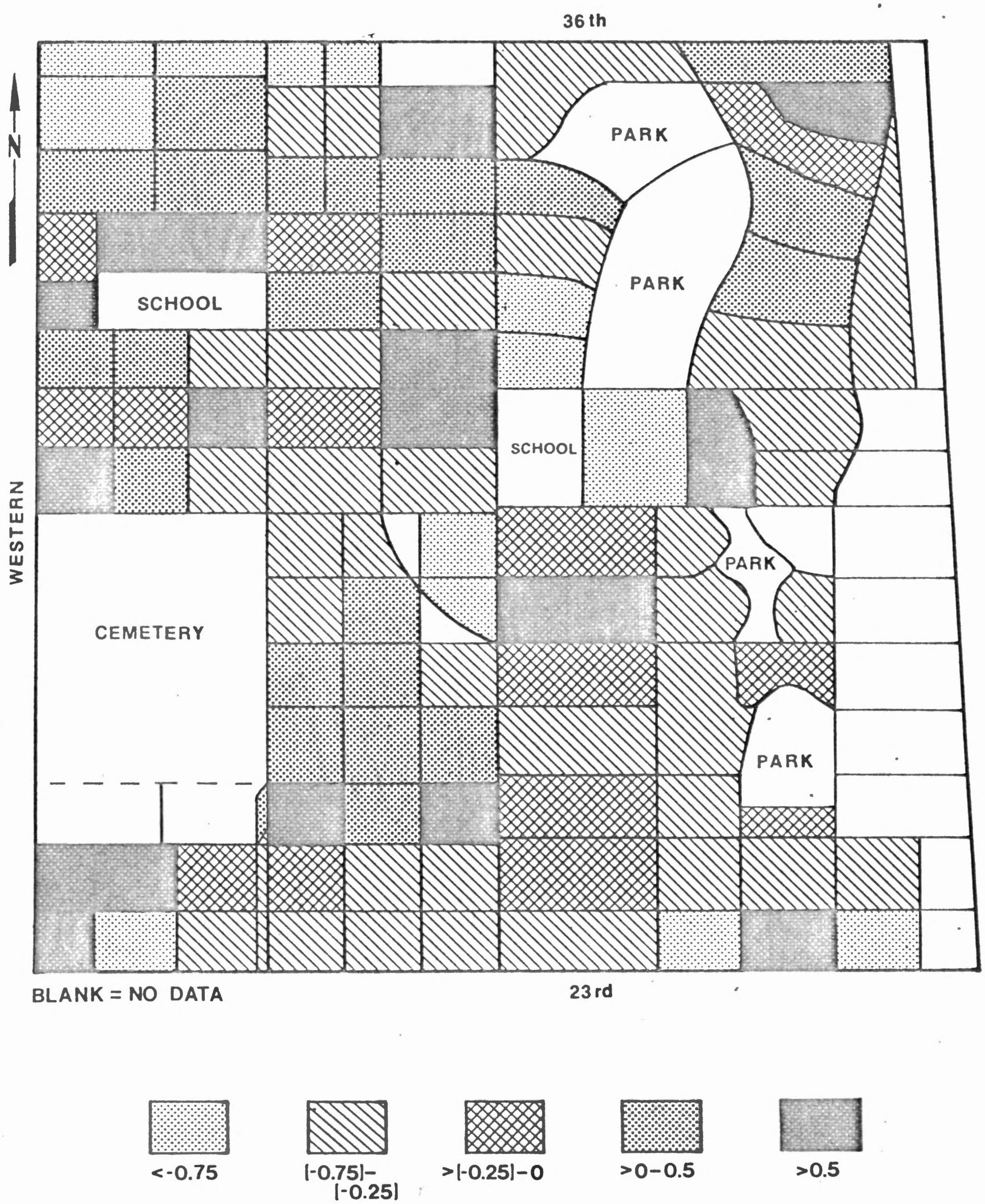


Figure 34. Area Two: Factor-Two Scores. Many Female Heads and Youth

physical variables loaded strongly on the second factor. This implied that the area was more easily characterized by the socio-economic variables. As can be seen in Table XXIV, the land-use index and percent detached dwelling units composed factor two. Only the age and percent female heads variables loaded strongly on factor one. Therefore, a high factor-one score represented a city block with many youth and female heads of household. A high factor-two score was indicative of a city block with desirable land-use types and a majority of single-family homes.

TABLE XXIV

ROTATED FACTOR PATTERN:
STUDY AREA THREE*

	Factor 1	Factor 2
Land Use	0.092	0.788
% Detached DU	-0.121	0.719
DU Density	0.212	0.293
Household Migration	0.304	0.202
% Pop. Age < 17	0.743	-0.155
% Female Heads	0.852	-0.016
Income	-0.185	-0.070

*Principle axis initial factoring followed by equamax rotation.

Unlike areas one and two, one factor of area Three was not significantly more associated with residential burglary than the other (Tables XXV and XXVI). Low correlation coefficients were calculated and all were positive. The factors explained almost nine percent of the variance in the dwelling-unit-based burglary rates, eight percent of the raw frequencies, and two percent of the population-based rates. All that could be concluded was that factors one and two explained minimal amounts of variance in residential burglary.

TABLE XXV

CORRELATIONS (r's) AMONG BURGLARY AND RESIDENTIAL CONDITION INDICATORS: AREA THREE

Burglary	Factor 1	Factor 2
Raw Frequency	0.165	0.225
Population-Based Rates	0.091	0.107
Dwelling-Unit-Based Rates	0.263	0.140

TABLE XXVI

R-SQUARE ANALYSIS: AREA THREE

Burglary	Factor 1	Factor 2	Factors 1 & 2
Raw Frequency	0.027	0.051	0.078
Population-Based Rates	0.008	0.012	0.020
Dwelling-Unit-Based Rates	0.069	0.020	0.089

The factor score maps of study area Three are Figures 35 and 36. The visible homogeneity was clarified somewhat by the spatial distribution of the factor-two (physical) scores. Most desirable city blocks were situated in the eastern half of the study area. The spatial distribution of the factor-one scores appeared random.

Summary

Residential burglary was analyzed with the assumption that burglary can be controlled through an awareness of the residential conditions in which it most often occurs. Seven ecological residential variables were aggregated to the block level in study areas in Oklahoma City and grouped by factor analysis to form two residential condition indicators. One of the indicators in all study areas consistently represented property data and the other consistently represented population and/or economic data. These indicators were compared with residential burglary rates and frequencies and the

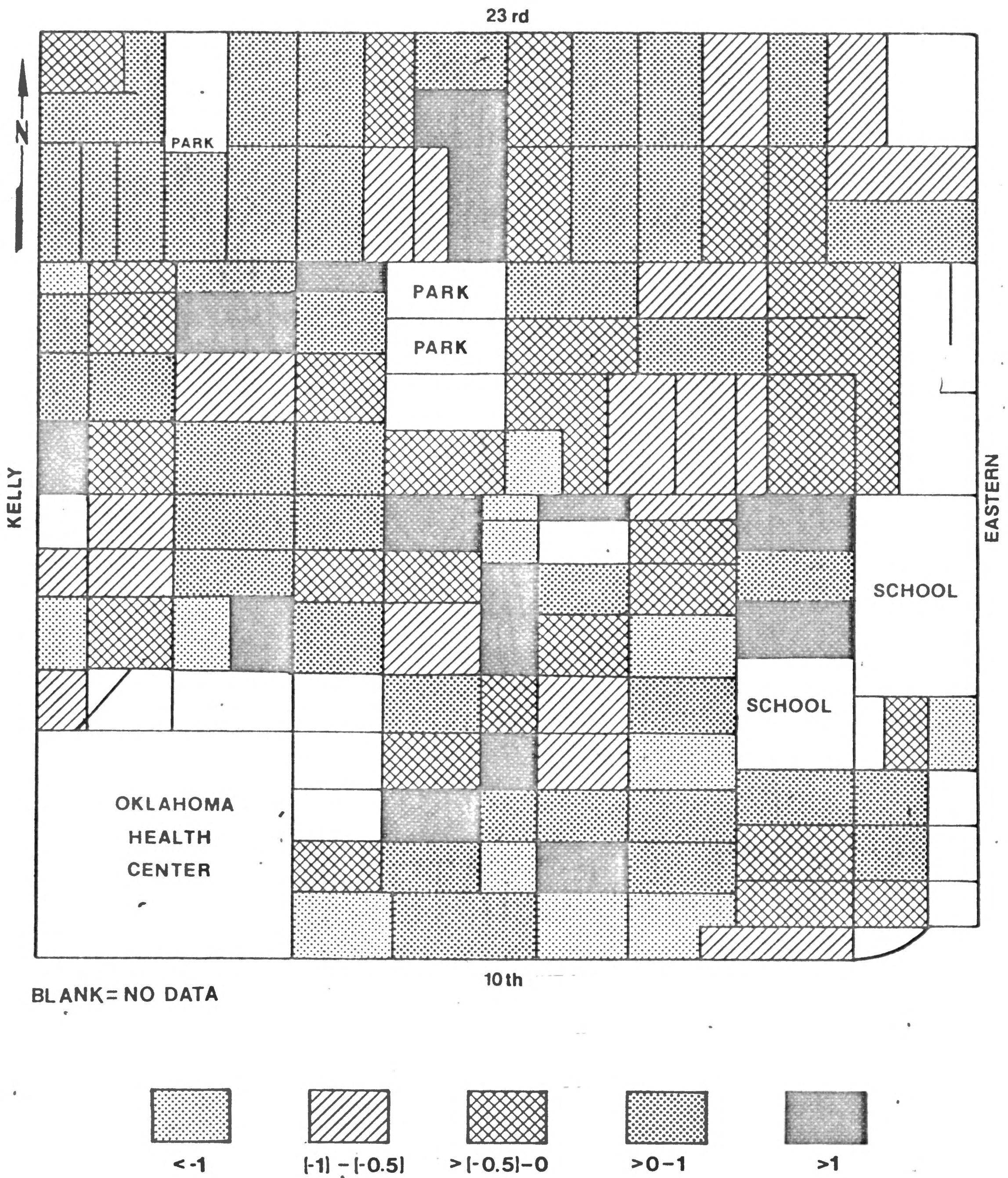


Figure 35. Area Three: Factor-One Scores.
In-Household Migration, Many
Female Heads and Youth

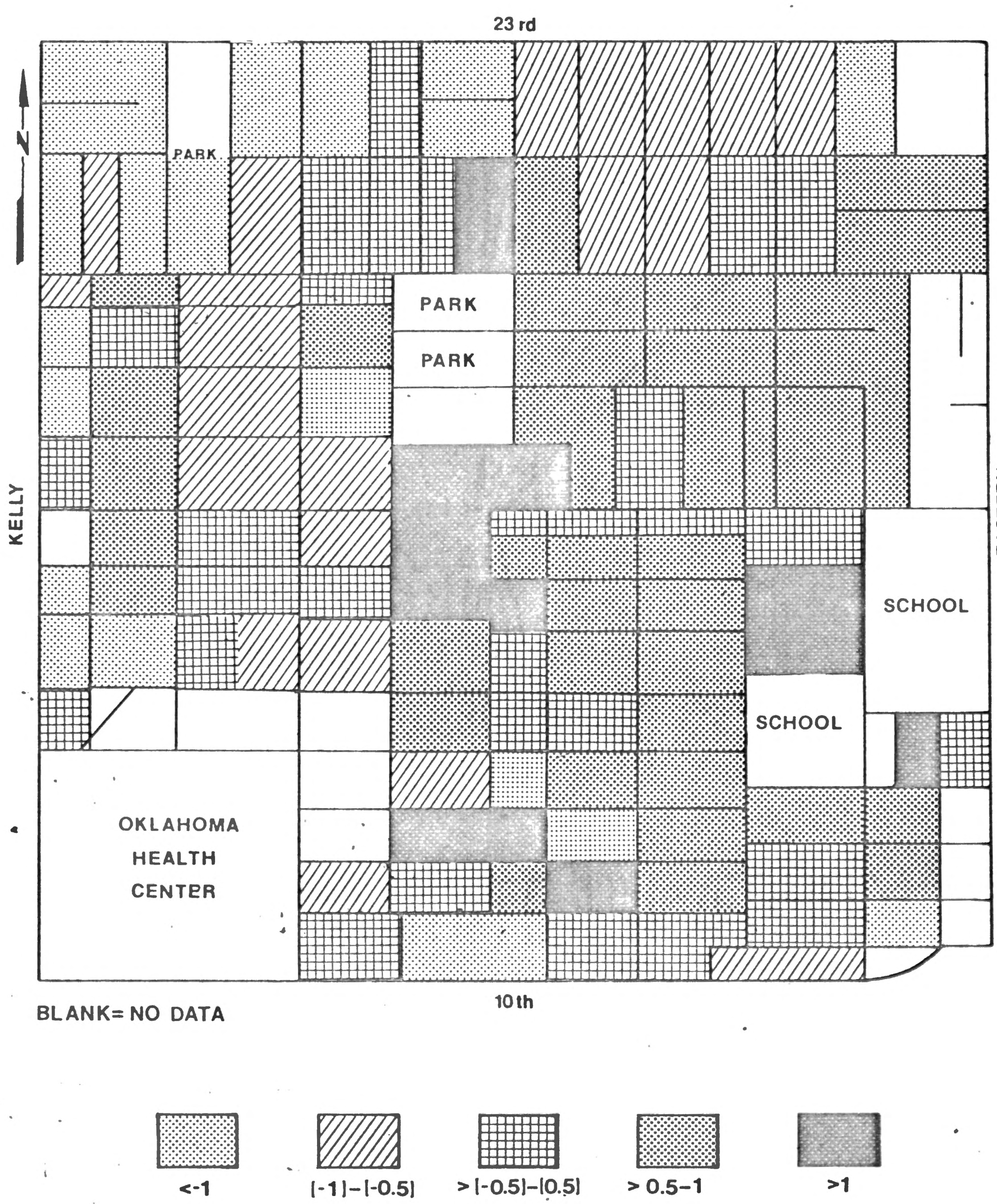


Figure 36. Area Three: Factor-Two Scores. Property Variables

problem statements presented in the introduction were answered.

1. What are the relationships between a general indicator of residential physical conditions by census city block and the corresponding residential burglary rates and frequencies? The physical condition indicator, composed of a land-use index, percent detached dwellings, and usually dwelling-unit density and income, on the whole was associated poorly with residential burglary. In study areas Two and Three, where many of the dwellings were small and crowded, the physical condition indicator explained little or no variance in residential burglary. However, in area One, burglary was a function of residential physical desirability. As land uses increased in desirability and as single-family homes became increasingly prevalent, burglaries increased. The explanation of this was that Kerr Village is the dominant factor in residential burglary in study area One. Burglary rates and frequencies were high in the northwest quadrant of area One because of the nearness to Kerr Village.

2. What are the relationships between a general indicator of residential socio-economic conditions by census city block and the corresponding residential burglary rates and frequencies? The socio-economic indicator, which was more aptly termed a population indicator, was not strongly associated with residential burglary. The most variance in burglary (dwelling-unit rates) explained by the "population" indicator was only seven percent, in study area Three.

3. <u>Which ecological indicator, mapped by census city block, is more closely associated with the spatial distribution of residential burglary rates and frequencies?</u> Visual areal association was performed and low burglary/residential condition relationships were confirmed. The regression analyses results indicated that the physical desirability indicator was generally more associated with burglary than the socio-economic indicator. However, the correlation coefficients were so low that relationships were clearly weak or non-existent.

Although the above results do not describe strong causative relationships, they are significant. Ecological variables, which were considered factors in residential burglary in a variety of previous burglary studies, were not strong factors in burglary in this study.

This study is different from most previous works in that the ecological variables were: (1) grouped to form residential condition indicators; (2) the indicators were correlated with residential burglary at the block level; and (3) the study areas were relatively homogeneous in terms of the ecological correlates. The primary cause of low correlations was considered to be the sample. If larger, more diverse study areas had been studied, base variables would probably have exhibited more variability and more useful patterns of association would have been revealed.

CHAPTER VII

SUMMARY AND CONCLUSIONS

Introduction

The formulation of this thesis was prompted by the accelerating changes in crime theory and research. Contemporary ecological crime studies have experimented with: (1) small geographic units of study; (2) crime-specific analyses; (3) risk-related crime rates; and (4) physical-environmental correlates of crime. Each of these new research thrusts was developed by the research reported here. In addition, the aerial photographic analyses herein tested an applied research technique. That is, they were conducted in an attempt to fulfill the practical need for quality urban ecological data.

This study analyzed the relationships, in three noncontiguous study areas in Oklahoma City, Oklahoma, between urban ecological data and residential burglary. The scale of analysis was city blocks and burglary was expressed as a risk-related rate, as a population-based rate and as a raw frequency. Furthermore, the ecological variables were composed of three physical-environmental urban characteristics and four socio-economic residential characteristics. Eight specific problems addressed by this study were outlined in Chapter I. The problems may be summarized as follows: (1) to what extent do the three measures of residential burglary vary among one another and by city blocks; (2) can the urban ecological data be estimated satisfactorily from conventional aerial photography; and (3) what are the relationships between the ecological conditions and residential burglary? A chapter was devoted to each of these summarized problems. Chapter IV discussed the three measures of residential burglary. Chapter V was restricted to the aerial photographic analyses. Chapter VI was a presentation of the analyses and results of the urban ecological data comparison with residential burglary.

Summary of Findings

Results reported in Chapter IV revealed that the perceived severity of residential burglary is a function of the burglary measurement technique employed. The spatial distribution of burglary appears to be altered by changing the measurement technique. However, in the three study areas in Oklahoma City, an inverse relationship was not discovered between population-based burglary rates and the risk-related, dwelling-unit-based rates. In fact, they were strongly correlated. It was discovered that both the population and the dwelling unit based rates tended to 'smooth' the spatial distribution from the original raw frequency distribution. The amount of dispersion was a function of the population and dwelling unit types of the area. Residential burglary, measured in at least two of the three techniques, was found to be concentrated in one quadrant in study areas One and Two. Residential burglary was dispersed in study area Three.

Chapter V was devoted to: (1) testing the feasibility of aerial photographic interpretation as an urban physical data collection technique; and (2) continuing research in photo-sociometrics, the technique of estimating socio-economic urban conditions from surrogate visible data. The formats of aerial photography tested were 1:30,000 scale, black-and white contact prints and 1:4,800 scale blue-line prints. Both formats were considered useful for urban physical data collection. The blue-line prints, however, were used at higher level of accuracy. Prior research efforts in this area were limited. Many of the works were restricted to a sample of only single-family structures and many aggregated to the census tract level. The results of this analysis were considered significant because strong results were obtained when a variety of housing types were interpreted at the city block level.

The photo-sociometric analysis was not successful, contrary to expectations based on previous analyses in the literature. Low correlations (r's) and R-square values were discovered between physical and socio-economic components of the three study areas. The primary difference between this study and previous photo-sociometric studies is the sample. The three study areas in Oklahoma City were relatively homogeneous in terms of the ecological variables analyzed. It was concluded that, when homogeneous subareas are studied out of the metropolitan area context, the physical environment is not a reliable indicator of the socio-economic structure.

The final substantive chapter investigated the relationships between residential burglary and ecological data in the three study areas. In general, the results were disappointing. Weak relationships were discovered between the burglary rates and frequencies on one hand,

and the ecological data on the other. Grouping of the urban ecological variables into a physical condition indicator and a population condition indicator was accomplished with factor analysis. Furthermore, in study areas One and Two, the physical condition indicator was more related to residential burglary than the population indicator. In area Three, the population indicator explained more of the burglary variance. However, the correlations were so weak that these results may have been a function of chance or sampling error. Again, the sample was blamed for these results. If a greater diversity of ecological data would have existed, more defined patterns and relationships might have been discovered. The burglary distributions were considered diverse; burglary was found to be concentrated in one quadrant in two out of three study areas. The main causative factors of residential burglary in the three study areas eluded satisfactory statistical detection.

Implications and Suggestions for Further Research

It is hoped that the results of this thesis offer the criminologist and urban planner further insight into several urban problems. First, the importance of defining and using a risk-related crime rate should be acknowledged. The population-based rates currently employed do not offer a true estimate of the intensity of property crimes. The findings of this thesis indicate that the burglary rate (or frequency) used to measure burglary does influence its spatial distribution at the city block level. Secondly, aerial photography was found to be a rapid and convenient technique for urban physical data inventories. The interpretation of economical, large scale blue-line prints was more accurate for urban inventories than medium scale, black-and-white contact prints. Specifically, dwelling unit counts were photographically estimated with accuracy within single-family, duplex, and multi-family land uses. Finally, criminologists and urban planners should be cautious when selecting samples for block-level urban analyses. The city block is still recognized as an optimum geographical unit in urban studies. However, the sample of city blocks must be truly random and must be large enough to avoid problems associated with environmental homogeneity.

Future urban crime analyses should employ the city block as the geographical unit of study. Larger, more diverse samples should be chosen. Perhaps study areas of four square miles in size, situated in several portions of the city, should be used. Further research is needed which would compare burglary with more ecological variables. Also, residential condition indicators should be composed of more residential variables. In general, this thesis laid the foundation for a much larger work which would simply expand on and improve its analytical approach.

Concluding Statement

The concept that residential burglary risk areas are characterized by certain urban characteristics was the underlying hypothesis of this research. Although the urban characteristics used in this thesis were not strongly correlated with burglary, the basic assumptions are still felt to be valid. Future research should avoid the pitfalls discovered and described herein. If the fundamental analytical approach of this thesis is duplicated and the above recommendations heeded, criminologists will have a more comprehensive understanding of where burglary occurs and why. This predictive capability will allow the application of effective burglary control measures and the possible reduction of residential burglary.

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APPENDICES

APPENDIX A

REMOTE SENSING DEFINITIONS

1. remote sensing: the act of obtaining information about certain objects or conditions through the use of aerial cameras or other sensing devices that are situated at a distance from them.
2. photographic interpretation: the act of examining photographic images for the purpose of identifying objects and judging their significance.
3. contact print: a photographic image produced by the exposure of a sensitized emulsion in direct contact with a negative or positive transparency.
4. blue-line print: in the context of this research, a photograph image produced by the transfer of an ammonia emulsion from a second generation, mylar image onto blue paper.
5. scale: the ratio existing between a distance on the map or photograph and the corresponding distance on the ground.
6. steroscopic coverage: aerial photography taken with sufficient overlap to permit complete stereoscopic observation.
7. stereoscope: an optical instrument which permits the operator to view two properly prepared photographs and perceive the three-dimensional effect.

8. resolution: the ability of a remote sensing system to render a sharply defined image.

9. vertical photograph: an aerial photograph taken with the axis of the camera being maintained as closely as possible to a truly vertical position with the resultant photograph lying approximately in a horizontal plane.

10. infrared film: photographic film sensitized to record near infrared wavelengths beyond the red end of the light spectrum; healthy vegetation appears bright red.

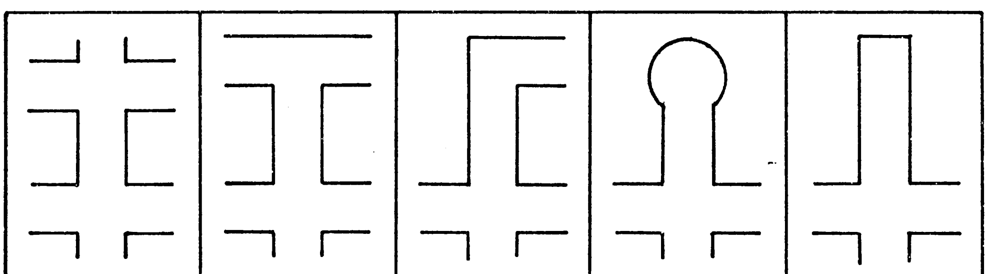
11. photo interpretation key: reference materials dsigned to facilitate rapid and accurate identification and the determination of the significance of objects or conditions from an analysis of their photo images.

APPENDIX B

STREET ACCESSIBILITY AND RESIDENTIAL BURGLARY: A RE-EVALUATION

One of the most interesting of relatively recent spatial analyses of criminogenic processes was developed by Bevis and Nutter. This work, dealing with street layout and residential burglary patterns, appeared as a paper of the Governor's Commission on Crime in St. Paul (4). The hypothesis under investigation was that relatively accessible street layouts are associated with relatively high rates of residential burglary. This hypothesis is an off-shoot of the surveillance concept developed by Jacobs (32) and Newman (44). According to the concept, accessible streets are travelled more by nonresidents than are other streets. Thus, dwelling units along more accessible streets will be more familiar to nonresident burglars. It follows, from the hypothesis, that less accessible units will be burglarized less. In addition, less travelled streets are under relatively sensitive resident surveillance, increasing the number of potential offense witnesses. The chance of an offender being recognized as an offender, and perhaps apprehended, is enhanced.

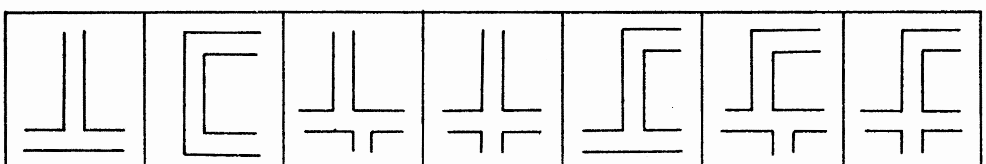
Based on the concept of Jacobs and Newman, the conceptual approach of Bevis and Nutter's study was sound. The hypothesis that accessible street layouts are associated with high burglary rates was tested in two phases. The first phase was a comparison of the residential burglary rates (burglaries per 1,000 dwelling units) of individual street segments representing various layout types. Five layout types were identified; they are presented in hierarchical order from most to least accessible in Figure 37. Relative accessibility was measured by the number of directions from which a vehicle could enter a street segment. A sample of eleven to sixteen street segments was randomly selected for each of the five street segment types in Minneapolis. The residential burglary rate of each sampled segment was compared to the residential burglary rate of "control" street segment. The control was the nearest through street. Bevis and Nutter's findings supported their hypothesis: Dead end, cul de sac, and L-type streets had lower burglary rates than their respective control through streets.



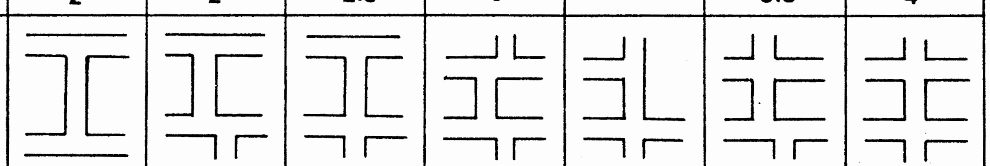
	Through	T-type	L-type	Cul-de-sac	Dead-end
No. of access directions	6	5	4	3	3
Most Accessible ——— Least Accessible					

Figure 37. Bevis and Nutter's Street Layout Types

A problem emerged, however, in connection with this first phase of analysis. The problem concerns the various street layouts themselves. Each of the five street layout examples (Figure 37) had a four-way intersetion at one end. The accessibility of each street was determined by the variation of one intersection only. By altering both intersections, more street layout types can be made. Figure 38 is an illustration of the complete hierarchy of street layout types. They are ranked by the number of access directions to and from the street segment by a vehicle. To fully test the hypothesis that residential burglary is a function of street layouts, all types of layouts should be considered.



Type	T-Type, dead end	L-L Type	dead end offset	dead end	L-T type	L-type, offset	L-type
No. of access directions	2	2	2.5	3		3.5	4



Type	T-T type	T-type, offset	T-type	offset, offset	T-type	offset	through
No. of access directions	4	4.5	5	5	5	5.5	6

Figure 38. Complete Hierarchy of Street Layout Types

The second phase of the Bevis-Nutter study investigated the relationship between residential burglary and street layouts at a larger scale. Using multiple regression analysis, five independent variables were regressed with six residential crimes at the census tract scale. The independent variables were measures of (1) street layout; (2) poor juveniles; (3) nearby poor juveniles; (4) blacks, and (5) nearby blacks. The measure of street layout used was the graphy theory concept of beta, a network connectivity measure, calculated by the formula:

$$\text{Beta } (\beta) = \frac{\text{No. of Edges}}{\text{No. of Vertices}} \text{ or } \frac{\text{No. of Streets}}{\text{No. of Intersections}}$$

The higher a beta value, the more permeable or connected is the network. Bevis and Nutter hypothesized that a relatively impermeable residential area (low beta) limits the travel of potential burglars. Thus, census tracts with low beta values were expected to have lower residential burglary rates.

Unfortunately, the beta connectivity measure was an improper technique for measuring street layouts in the context of this analysis (Figure 39). Network A is a representation of a typical grid-iron street pattern. Eac street segment is a through street. The beta value for the network is 1.33. The operating hypothesis implies that the addition of a less accessible street to network A should lower the beta. A T-type street has been added to network A to produce network B. Its beta is 1.36. The addition of another T-type street (network C) raises the beta to 1.39. This contradicts Bevis and Nutter's fundamental hypothesis. Network D is composed of seven through streets and its beta is 1.17. Four dead end streets are within network E. No matter how many through streets are in network E, the four dead ends should lower the mean burglary rate of the entire network. However, its beta value is slightly higher than that for network D. Finally, network F consists of four interior through streets and four L-type streets and has the same beta as network A. Clearly, the use of beta is an inappropriate technique for measuring residential street pattern accessibility. Bevis and Nutter discovered that beta accounted for six percent of the variance in residential burglary rates at the census tract scale.

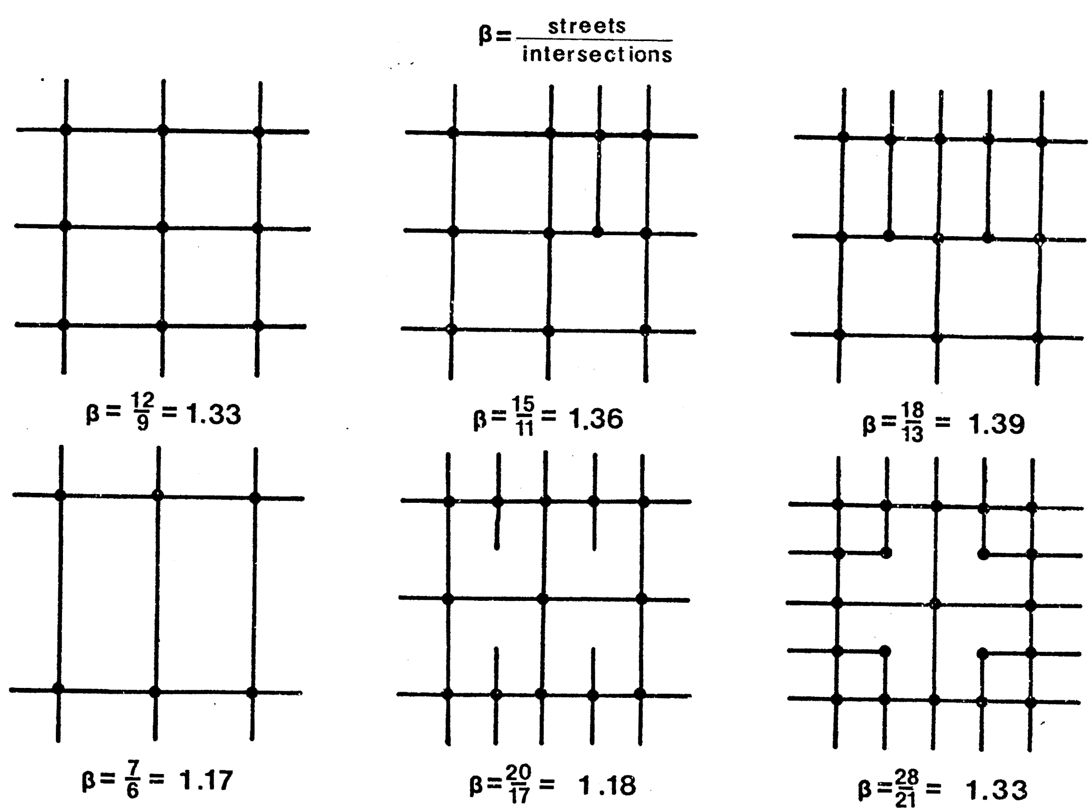


Figure 39. Examples of Street Networks and Betas

Another shortcoming of the Bevis-Nutter study indicated that beta was used mechanically incorrectly as well as theoretically incorrectly. Four sample networks were illustrated with their respective beta values. However, the calculations of beta were incorrect for three of the four networks. The sample networks, Bevis and Nutter's incorrect betas, and the correct betas are displayed in Figure 40. Ironically, the only correct beta value calculated by Bevis and Nutter related to a network that is impossible as a residential street pattern.

The relationship between street accessibility and residential burglary was determined for three square-mile study areas in Oklahoma City. The analysis was an attempt to refine and retest the Bevis-Nutter approach. The basic problem was to establish a reliable technique for measuring street layout accessibility. The technique should: (1) consider all types of street segments; and (2) produce consistent results when used for a variety of street layout patterns. The number of vehicle access directions of each street proved to be an efficient indicator of a street or of a street network's accessibility.

The analytical procedure was simple and direct. First, each square-mile study area was divided into equal-sized subareas. Each street in a subarea was then assigned a value (alpha) indicating its number of vehicle access directions. The mean of the alphas in each network was calculated and correlated with the mean residential burglary rate (per 100 dwelling units) of the network. To compensate for extremely high burglary rate blocks, burglary was also specified, in an alternate measure, as the percent of blocks in the network with a burglary rate greater than ten. Correlation coefficients (r's) were

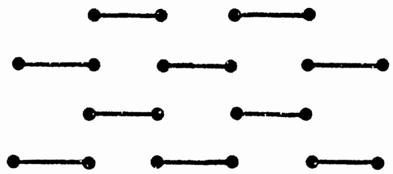
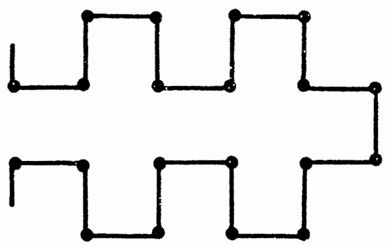
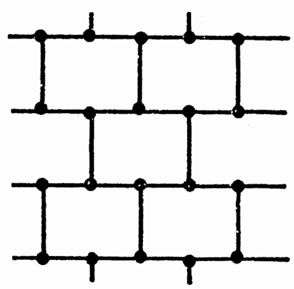
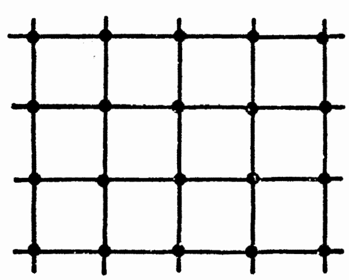
	$\frac{e}{v} = \beta$	Bevis and Nutter's β	Correct β
	$\frac{10}{20}$	0.50	0.50
	$\frac{19}{20}$	1.00	0.95
	$\frac{24}{20}$	1.50	1.20
	$\frac{31}{20}$	2.00	1.55

Figure 40. Sample Networks, Bevis and Nutter's Betas, Correct Betas

calculated between alpha and the two burglary measures for each study area and also for all three study areas combined.

The results of the analysis refuted the findings of Bevis and Nutter. The correlation between alpha and the burglary measures for all study areas was inverse (see Table XXVII). Less accessible streets in the three study areas in Oklahoma City were burglarized more frequently than more accessible streets. This was especially prevalent in study area Three where the correlation coefficient between alpha and the burglary rate was -0.586. The scatter diagram of the relationship is presented in Figure 41. For all three study areas, the correlation between alpha and the percent high burglary block measure was -0.354 (Figure 42).

TABLE XXVII

CORRELATION COEFFICIENTS (r's) AMONG STREET ACCESSIBILITY AND RESIDENTIAL BURGLARY

	Alpha/Burglary Rate	Alpha/Burglary %
Study Area One	-0.486	-0.231
Study Area Two	-0.202	-0.317
Study Area Three	-0.586	-0.406
All Three Study Areas	-0.318	-0.354

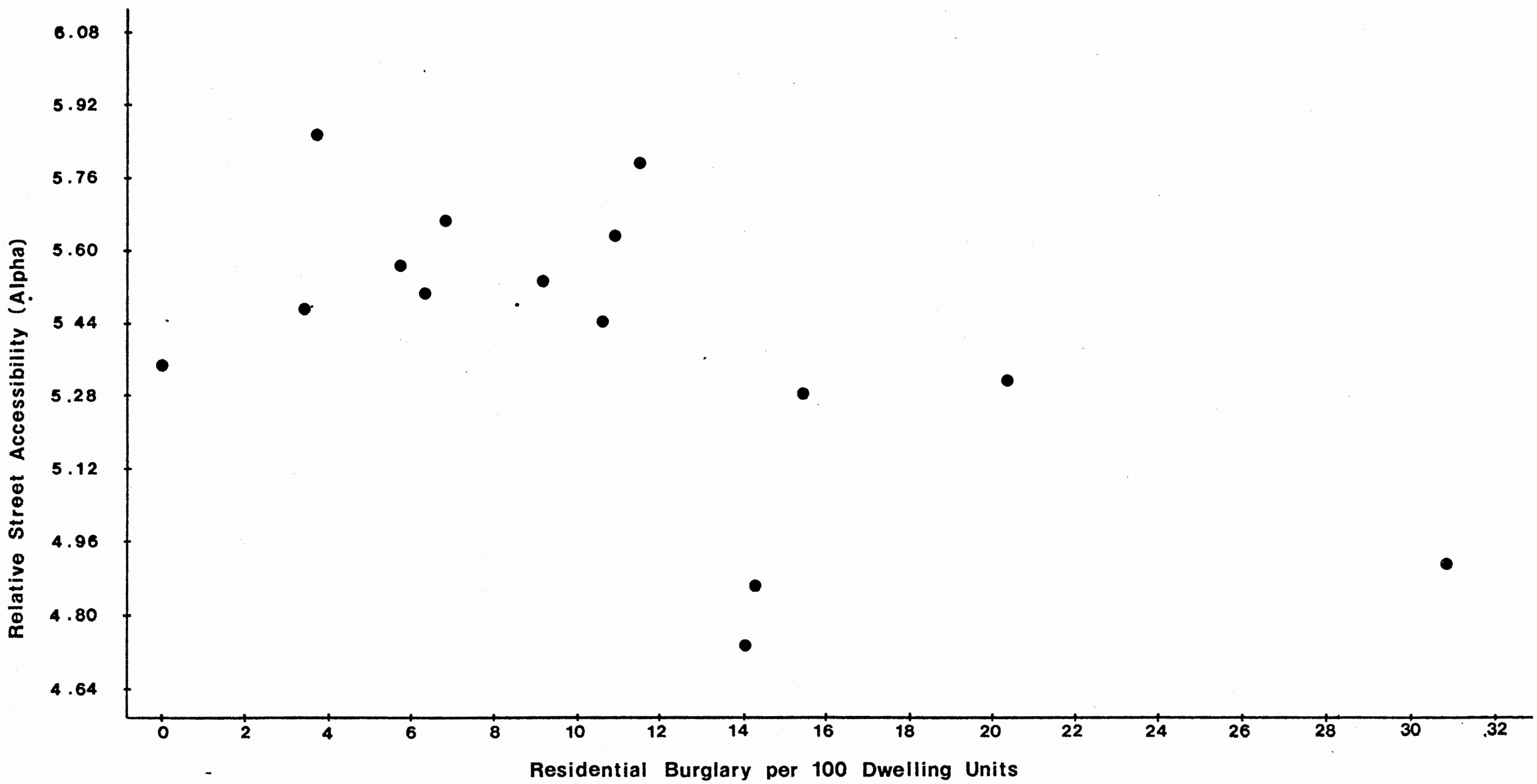


Figure 41. The Alpha/Burglary Rate Relationship: Area Three

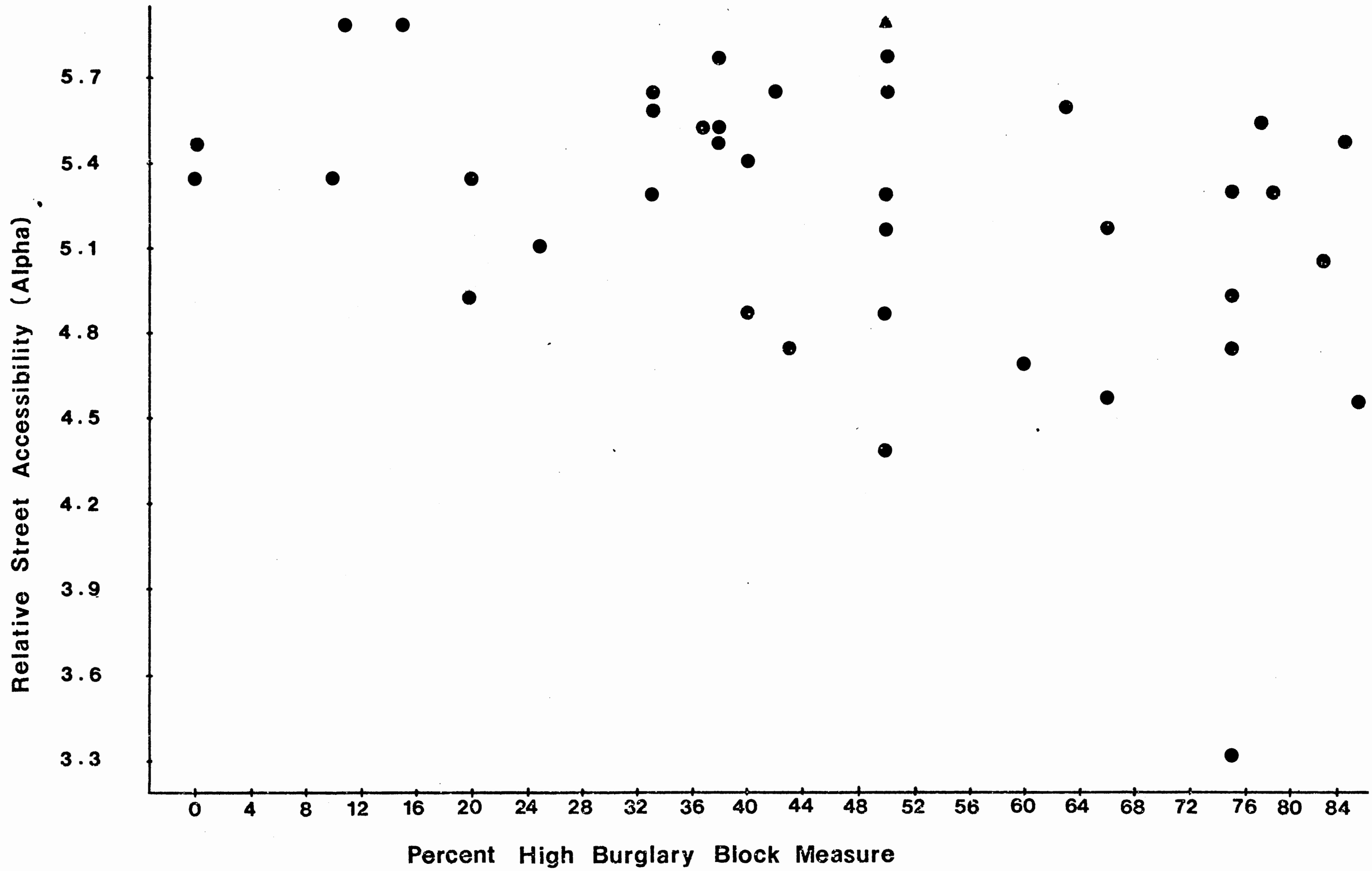


Figure 42. The Alpha/Percent High Burglary Block Relationship: All Three Study Areas

The hypothesis that highly accessible streets are associated with residential burglary was discredited, at least with respect to three square-mile study areas in Oklahoma City. Larger more diverse samples within Oklahoma City and other communities should be investigated before general conclusions will be valid. Nevertheless, significant negative correlations were discovered between street accessibility and residential burglary. A prior analysis in which contrary results emerged was found to be analytically inadequate. Clearly, the results presented here should lead to a reevaluation of the impact of street accessibility (and its implied surveillance component) on residential burglary. Mayhew, et. al. (39) have recently suggested that "the chances of witnesses behaving in ways which will have serious consequences for (the offender) are often small." This observation, coupled with the research reported here, may have broad ramifications in the context of residential burglary and neighborhood movement patterns.

APPENDIX C

GUTTMAN SCALING

One of the objectives of the present thesis was to evaluate the usefulness of aerial photographic interpretation for socio-economic data collection. This relatively new procedure was explored in response to a need for high quality ecological data to be used by criminologists and urban planners. The first procedural step of satisfactorily identifying physical conditions was accomplished. The next specific task was to determine the relationship between physical conditions (obtainable from aerial photography) and socio-economic conditions in the three study areas in Oklahoma City. A technique was sought which would (1) merge the three physical variable to form a single indicator of physical conditions, and (2) merge the four socio-economic variables to form a socio-economic condition indicator. The indicators would then be compared to determine the physical/socio-economic relationships . To accomplish this, factor analysis and Guttman scaling were initially applied to the data. Factor analysis was chosen to complete the analysis because it easily lent itself to computer analysis. Early in the study, however, Guttman scaling was manually applied to a sample of the ecological data to evaluate its feasibility. The results of this application are presented in this appendix.

Norman Green (22) stated that scale analysis has been found to provide a convenient and precise method for defining ecological interrelationships between physical and socio-economic variables. His scale analysis in Birmingham, Alabama, revealed that these interrelationships were strong at the census tract scale. The approach of this analysis differs from Green's in that city blocks were utilized as the geographical unit of study. However, the hypotheses of this Guttman analysis are identical to Green's: (1) The physical variables (of each study area) constitute a scalable content area. (2) The socio-economic variables constitute a scalable content area. (3) The resulting scale scores of the two scales are strongly (positively) correlated. The correlation would define certain linkages between the socio-economic and physical structure of the study areas at the block level.

Two scalograms were developed for a sample of approximately forty percent of the blocks from each study area. Starting with area one, the three physical variables were tested for their ability to formulate a unidimensional scale. The response categories were defined as representing desirable, neutral, and undesirable physical conditions relative to area One. Two of the variables were trichotomous (land use and percent detached dwellings) and one was dichotomous (dwelling unit density). Each randomly sampled block was observed for category classification on each of the three variables. The scale analysis of the seventy-two responses followed procedural steps of Guttman scaling as identified by Gordon (19). As shown in Table XVIII, the resulting pattern was not truly scalable, having a coefficient of reproducibility of 0.69 (0.90

TABLE XXVIII

SCALE OF PHYSICAL DESIRABILITY FOR AREA ONE

Variable 1 = Land-Use Index
Variable 2 = Percent Detached Dwellings
Variable 3 = Dwelling Unit Density

(Coefficient of Reproducibility = 0.69)

Scale Score	Block No.	Response Category and Variable Number: Desirable			Neutral			Undesirable	
		1	2	3	1	2	3	1	2
9	217	X	X	X					
8	305	X	X				X		
8	509			X		X			
8	306		X	X	X				
8	501		X	X	X				
7	503		X	X					X
7	120		X	X				X	
7	313		X		X		X		
7	207		X		X		X		
7	407		X		X		X		
7	401		X		X		X		
7	405		X		X		X		
7	507	X				X	X		
6	309		X				X	X	
6	302				X	X	X		
6	502				X	X	X		
6	212				X	X	X		
6	603				X		X		X
6	511			X	X	X			
5	417			X				X	X
5	416					X	X	X	
5	418			X				X	X
4	322						X	X	X
4	415						X	X	X
Errors		1	1	3	5	2	6	1	2

$\sum = 21$

is the accepted minimum coefficient needed to deem a pattern truly scalable.) The pattern does represent a quasi-scale since the coefficient is greater than 0.60. Gordon stated that a quasi-scale is applicable to most studies, but should be used with reservation. There is no perfect relationship between the scale scores and the responses in a quasi-scale; instead it is only likely that the scale scores accurately represent each block's conditions.

For the same sample of blocks from area One, Guttman scaling was applied to four socio-economic variables. The response categories were trichotomous for three variables and dichotomous for one. The categories were defined as representing desirable, neutral, and undesirable socio-economic conditions respective to area One. The response pattern (Table XXIX) represented a quasi-scale with a coefficient of reproducibility of 0.74. The physical/socio-economic condition relationship in study area One was then determined by product moment correlation between the scale scores on the two scale continua. The correlation coefficient (r) was found to be -0.03, representing an insignificant negative relationship. The physical condition of area One is not an indicator of the socio-economic condition based on the variables herein, at least based on the physical variables selected. (Note: The four socio-economic variables are not those used in the factor analysis; hence the different results.)

The same scaling procedure was applied to the sampled blocks of study areas Two and Three. The four scalograms are presented in Tables XXX through XXXIII. Each of the scales had a coefficient of reproducibility greater than 0.70. The results of the correlation

TABLE XXIX

SCALE OF SOCIO-ECONOMIC DESIRABILITY FOR AREA ONE

Variable 1 = Ave. Rent
Variable 2 = No. of Persons per Room
Variable 3 = Ave. Home Value
Variable 4 = No. of Rooms

(Coefficient of Reproducibility = 0.74)

Scale Score	Block No.	Response Category and Variable Number: Desirable				Neutral				Undesirable		
		1	2	3	4	1	2	3	4	1	2	3
11	511	X	X	X	X							
10	309	X	X		X			X				
10	407	X		X	X		X					
10	417	X	X		X			X				
10	507	X		X	X		X					
9	415	X	X					X	X			
9	401		X	X	X					X		
9	418		X	X	X					X		
9	405		X	X	X					X		
9	501			X	X	X	X					
9	212			X	X	X	X					
9	217			X	X	X	X					
8	502			X	X		X			X		
8	322		X		X	X						X
8	503		X		X	X						X
7	120			X		X			X		X	
7	509				X		X	X		X		
6	207				X			X		X	X	
6	603				X		X	X				
6	313							X	X	X	X	
6	305					X	X		X			X
5	416						X		X	X		X
5	306						X		X	X		X
4	302								X	X	X	X
Errors		0	2	1	0	1	5	3	2	7	2	2

$\sum = 25$

TABLE XXX

SCALE OF PHYSICAL DESIRABILITY FOR AREA TWO

Variable 1 = % Detached Dwellings
Variable 2 = Dwelling-Unit Density
Variable 3 = Land-Use Index

(Coefficient of Reproducibility = 0.94)

Scale Score	Block No.	Response Category and Variable								
		Desirable			Neutral			Undesirable		
		1	2	3	1	2	3	1	2	3
9	7107	X	X	X						
9	11116	X	X	X						
8	6102		X	X	X					
8	7201		X	X	X					
8	7203		X	X	X					
8	7207		X	X	X					
8	7304		X	X	X					
8	7315		X	X	X					
8	11108		X	X	X					
7	7204		X		X		X			
7	7303		X		X		X			
7	6207			X	X	X				
7	7206			X	X	X				
7	7202			X	X	X				
7	11117			X	X	X				
7	11118			X	X	X				
7	12211			X	X	X				
7	12212			X	X	X				
6	11107				X	X	X			
6	11109				X	X	X			
6	11213				X	X	X			
6	11217	X				X				X
6	12217				X	X	X			
5	11106				X	X				X
5	12208			X				X	X	
4	6108						X	X	X	
4	11115						X	X	X	
4	12210						X	X	X	
4	12101					X		X		X
3	7205							X	X	X
	Errors	1	0	1	0	1	2	0	0	2

$\sum = 7$

TABLE XXXI

SCALE OF SOCIO-ECONOMIC DESIRABILITY FOR AREA TWO

Variable 1 = Home Value
Variable 2 = Persons per Room
Variable 3 = Average Rent
Variable 4 = No. of Rooms

(Coefficient of Reproducibility = 0.77)

Scale Score	Block No.	Response Category and Variable: Desirable				Neutral				Undesirable		
		1	2	3	4	1	2	3	4	1	2	3
12	7107	X	X	X	X							
11	6207	X		X	X		X					
11	7201	X		X	X		X					
10	6102	X		X	X						X	
10	12211	X	X		X							X
10	7202	X			X		X	X				
9	6108	X	X					X	X			
9	7207	X			X		X					X
9	7203			X	X	X			X		X	
9	7204			X	X	X					X	
9	7206				X	X	X	X				
8	12212	X	X						X			X
8	12210			X		X	X		X			
8	11107		X			X		X	X			
8	12208			X		X	X		X			
7	7315					X	X	X	X			
7	7205					X	X	X	X			
7	11106					X	X	X	X			
7	12101					X	X	X	X			
7	11109		X				X		X			X
6	11108					X	X		X			X
6	11115					X	X		X			X
6	11117					X	X		X			X
6	12217					X		X	X	X		
5	11116					X	X		X			X
5	11118							X	X	X	X	
5	7304				X					X	X	X
5	11217							X	X	X	X	
4	7303								X	X	X	X
4	11213								X	X	X	X
	Errors	1	3	1	1	0	4	3	2	1	3	9

$\sum = 28$

TABLE XXXII

SCALE OF PHYSICAL DESIRABILITY FOR AREA THREE

Variable 1 = Dwelling-Unit Density
Variable 2 = % Detached Dwellings
Variable 3 = Land-Use Index

(Coefficient of Reproducibility = 0.81)

Scale Score	Block No.	Response Categories and Variables: Desirable			Neutral			Undesirable	
		1	2	3	1	2	3	1	2
9	13313	X	X	X					
9	13402	X	X	X					
9	13409	X	X	X					
9	13412	X	X	X					
9	13405	X	X	X					
9	13506	X	X	X					
9	14110	X	X	X					
8	27106	X		X		X			
8	28507		X	X	X				
8	28703		X	X	X				
8	28412		X	X	X				
8	13503		X	X	X				
8	28606		X	X	X				
8	28602		X	X	X				
8	28706		X	X	X				
7	13415	X	X				X		
7	14302		X	X				X	
7	14204			X	X	X			
7	28715			X		X			
7	14409	X		X	X				X
6	14104	X				X	X		
6	13509	X				X	X		
6	14402			X		X		X	
6	14410			X		X		X	
6	27203			X		X		X	
6	28510			X		X		X	
6	28711			X		X		X	
6	27108			X	X				X
5	28312				X	X	X		
5	14107			X				X	X
5	14211			X				X	X
5	14314			X				X	X
5	14104				X	X	X		
4	27307					X	X	X	
4	27110				X		X		X

TABLE XXXII. (Continued)

Scale Score	Block No.	Response Categories and Variables							
		Desirable			Neutral			Undesirable	
		1	2	3	1	2	3	1	2
3	14108						X	X	X
3	14208						X	X	X
3	11306						X	X	X
3	14311						X	X	X
3	28402						X	X	X
	Errors	4	0	3	2	3	3	6	2

$\sum = 23$

TABLE XXXIII

SCALE OF SOCIO-ECONOMIC DESIRABILITY FOR AREA THREE

Variable 1 = Home Value
Variable 2 = Average Rent
Variable 3 = Persons per Room
Variable 4 = No. of Rooms

(Coefficient of Reproducibility = 0.73)

Scale Score	Block No.	Response Categories and Variables										
		Desirable				Neutral				Undesirable		
		1	2	3	4	1	2	3	4	1	2	3
12	14311	X	X	X	X							
11	13412	X	X		X			X				
11	37108	X	X		X			X				
11	27106	X		X	X		X					
10	14314	X	X	X					X			
10	14409	X	X	X					X			
10	13509	X	X	X					X			
10	13409	X		X	X						X	
10	14104	X	X		X							X
10	28606		X	X	X					X		
9	14105		X		X	X						X
9	13402			X	X	X					X	
9	13415				X	X	X	X				
9	14105		X	X		X			X			
8	13506		X	X					X	X		
8	14404		X			X		X	X			
8	28510	X		X					X		X	
8	14410			X		X	X		X			
8	27110	X		X					X		X	
8	28715			X		X	X		X			
8	27203				X	X		X			X	
7	14402			X		X			X		X	
7	28412					X	X	X	X			
7	13313					X	X	X	X			
7	14204		X			X			X			X
7	14208	X					X		X			X
7	28711					X	X	X	X			
6	28312					X		X	X		X	
6	28703					X		X	X		X	
6	14107					X	X		X			X
6	14211					X	X		X			X
6	27307					X	X		X			X
6	13405				X		X			X		X
6	28602						X	X	X	X		

TABLE XXXIII (Continued)

Scale Score	Block No.	Response Categories and Variables: Desirable				Neutral				Undesirable		
		1	2	3	4	1	2	3	4	1	2	3
5	14302						X		X	X		X
5	28507						X		X	X		X
5	14306						X		X	X		X
4	14110								X	X	X	X
4	13503								X	X	X	X
4	28402								X	X	X	X
4	28706								X	X	X	X
	Errors	3	1	5	2	0	2	4	6	2	8	11

technique indicated weak relationships between the ecological strata. For study areas Two and Three, the correlation coefficients (r) were 0.22 and 0.04, respectively. It is quite clear that the physical desirability scales, comprising the type of data obtainable through aerial photographic interpretation, do not have predictive power for determining general socio-economic conditions. In summary, these findings, relating to city block data, contradict the results of Green's census tract analysis, probably owing to the selection of different variables on different geographic bases.

VITA

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